Development of a Smart Building Directory System for Asia Pacific College

RamNav

A Design Project Proposal Submitted to the School of Engineering
in Partial Fulfilment of the Requirements for the Degree

Bachelor of Science in Computer Engineering

Asia Pacific College

by

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September 2021

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As oral examination panel members, we certify that the project prototype and this paper has been examined and hereby recommend to be accepted as fulfillment of the design project requirement for the Degree **Bachelor of Science in Computer Engineering.**

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This design project proposal is hereby approved and accepted by the School of Engineering as partial fulfillment of the requirement for the degree of **Bachelor of Science in Computer Engineering.**

Sergio R. Peruda, Jr.

Program Director, School of Engineering

DEDICATION

The team dedicate this project to beloved school that helped them grow. Their families that keep them motivated to never give up every single day.

Their client and project adviser that has been with them throughout the project. Highly appreciated the contribution he gave to make sure the project was built successfully.

Asia Pacific College's School of Engineering (SOE) for their extended help to provide the needs for the project.

And lastly to Almighty God that showered guidance and wisdom to keep going.

ACKNOWLEDGEMENT

The team leader would like to express gratitude to the team for continuously providing encouragement, advice, and patience to make this project possible. The completion of this project could not be accomplished without the consistency of the team who led one another.

Deepest gratitude to the families for the motivation, support, and belief in the proponent's strengths and manage to provide a pearl of wisdom to execute the project at its best.

To the panelists, Engr. Leonardo Samaniego Jr., Engr. Einstein Yong, Engr. Luigi Carlo De Jesus, and Engr. Sergio Peruda Jr., for giving vision to the team from CPEMETS, up to the time of CPEDES2. They were the people who gave a lot of insightful comments, suggestions, and wisdom about the documentation. They were the people behind this successful project.

To Engr. Stanley Glenn Brucal, the adviser, provided assistance, guidance, and willingness to impart knowledge and leadership. With his vision, he enlightens the team to make this project smooth and successful. The team are extremely thankful for having such a sincere mentor and adviser.

ABSTRACT

Nowadays, almost everything is geared toward technological advancement, whether it be an individual, a small group, or even an entire company. One of this advancement is gearing towards achieving a smart building; a smart building is one that makes use of technology to enable efficient and economical resource utilization while producing a safe and comfortable environment for its occupants. While everything is striving to be a smart building, a specific feature of almost every building is still left out and it is building directories. Traditional building directories are commonly seen on signages, in Asia Pacific College (APC) we still use a traditional building directory where people walk pass by it barely noticing. RamNav developed an advance, responsive, and complete directory which enables people to locate a specific room in the building through speech recognition and give the information they need. The directory system caters speech recognition feature used for performing query and output the room details for queries such as: floor level, nearby room names, map-like image, and a predefined QR code that the user can scan using their phones to show a copy of query result in their mobile devices. RamNav has been exceptional in acquiring and processing the speech of the user even on different environment situations and met all the team desired output.

Keywords: speech recognition, building directory, advancement, QR code

EXECUTIVE SUMMARY

RamNav is a design project developed to serve as an innovation to the current building directory system used in Asia Pacific College. The idea was to apply Machine Learning concepts to further improve and make advancements to the already-existing digital building directory systems found on big buildings like malls and offices. In addition to that, it aims to lessen human contact which is relevant from the conception of the idea up to this day.

During the prototype development, the team formally designed the principal and secondary functions of the system—along with the selection of the different means that they will use for the system. After successfully creating a working prototype, the team followed the Agile methodology for the Software Development Life Cycle. It is a continuous iteration of providing deliverables that will further improve the system and meet the needs of the user. Numerous system testing process—by the team and the target users—were conducted to objectively evaluate the functions and asses if the objectives were met. During the system evaluation, the team concluded that the system was able to pass all the benchmarks required for the different system functions and objectives. For the accuracy, the system got an overall rating of 98.12%. For reliability, the system attained a score of 97.05% recognition rate. The user-friendliness rating of the system was rated 4.66 out of 5 by the target users. Lastly, for the accessibility objective, the system got a score of 4.70 out of 5.

Despite attaining all the target scores. The researchers were able to point out multiple areas wherein the system can further be improved to achieve the best results and experience for its intended users. The team recommends the future researchers to improve the UI appearance of the application by redesigning the assets, integrate application settings to the maintenance website, addition of the schedule of public events, and use of Natural Language Processing for better user query interpretation of the system.

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Chapter 1

THE PROBLEM AND ITS BACKGROUND

1.1 Introduction

Through the advancement of technology, companies and individuals are gearing towards upgrading into a smart building and home. When achieving a smart building, one should consider improving a current system into more efficient and smarter way. Modernizing a building directory is a step to attaining a smart building.

Traditional building directories are commonly seen on signages. In Asia Pacific College (APC), a traditional building directory is still practiced where people walk pass by it barely noticing. When a person is at an unfamiliar place, the first thing that they usually do is to ask the staff for directions. A smart building directory using speech recognition will aid this recurring practice and will lessen the work of the staff and security personnel.

1.2 Problem Statement

The team conducted a survey regarding the current APC building directory because it has become a habit of people or guests to ask other personnel when going in of the school premises as seen in Figure 1.1. According to the survey results in Figure 1.2, 58% of the respondents found it difficult to look for a certain room during their first visit in APC. In addition, referring to Figure 1.3, 90% of them believes that there can still be an improvement of the formerly accustomed. On the other hand, Figure 1.4 shows that 70% respondents totally appreciate to have multiple directories in different building floors of APC. So, in this case, the researchers aim to develop an advanced, responsive, and complete directory which enables people to locate a specific room or office in the building through speech recognition and give the information they need. This also provides convenience to the staff and guests because it is placed at each floor so that it is immediately visible to everyone and can be efficiently used.

1.3 Design Objectives and Constraints

1.3.1 General Objective

To create a smart building directory system with a good speech recognition feature. It is PC-based interactive APC building directory that is easily accessible.

1.3.2 Specific Objectives

- To create an accurate Building Directory System.
- To develop a reliable system for the APC Building Directory.
- To design a user-friendly graphical user interface (GUI) for the system.
- To make the APC Building Directory System more accessible.

1.3.3 Constraints

- The application must integrate a speech recognition feature for user queries.
- Utilize QR codes for letting the user transfer the search result to their device.

1.3.4 Metrics Description and Scale Measurement

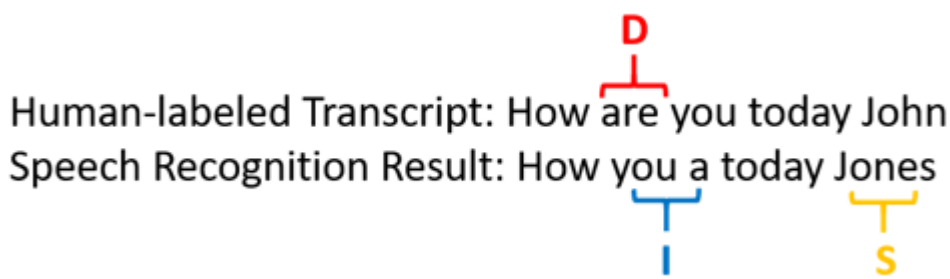
Objectives	Definitions	Metrics	Scale	Description
Accuracy	Ability of the system to correctly recognize the words said by the user	Subtract Word Error Rate (WER) percentage of the model to 100%.	Above 95%	Excellent
			90% - 95%	Good
			85% - 89%	Neutral
			80% - 84%	Insufficient
			Below 80%	Unacceptable
Reliability	Ability of the system to recognize the keywords in the word bank	Ratio of the keywords recognized over the total keywords in the word bank	Above 95%	Excellent
			91% - 95%	Good
			86% - 90%	Satisfactory
			81% - 85%	Insufficient
			Below 81%	Poor
User-Friendliness	The ability of the user to easily navigate and understand the GUI	Measured through Likert survey by averaging of all the user ratings.	5	Very Satisfied
			4-4.99	Satisfied
			3-3.99	Neutral
			2-2.99	Unsatisfied
			1-1.99	Very Unsatisfied
Accessibility	Pertains to the system's openness and accessibility to the intended users	Measured through Likert survey by averaging of all the user ratings.	5	Very Satisfied
			4-4.99	Satisfied
			3-3.99	Neutral
			2-2.99	Unsatisfied
			1-1.99	Very Unsatisfied

For the metrics description and scale measurement, there are 4 different objectives identified for the project. The accuracy, reliability, user-friendliness, and accessibility of the system. There are mathematical models used to measure the accuracy and the

reliability, while the user-friendliness and the accessibility of the system will be measured based on the survey results to be given once the building directory system is already implemented.

Accuracy

There are 4 important variables in the equation. Insertion (I) is the number of words that are incorrectly added in the speech recognition result. Deletion (D) is the number of words that are undetected in the speech recognition result. Substitution (S) is the number of words that were substituted between the original query to the speech-recognition result. Lastly, N is the total number of words in the original query provided by the user. Once the WER is calculated, it is to be subtracted from 100%, which will be the final number of the model's accuracy.



Example 1.1 Deletion, Insertion, and Substitution

$$WER = \frac{I + D + S}{N} * 100\%$$

Equation 1.1 Word Error Rate Formula

Reliability

The reliability of the system is defined as the ability of the system to successfully recognize the keywords that are contained within the word bank that the group created for the system.

The group have decided to create this computational model since there are no fixed way to measure the reliability of a speech recognition system due to the differences in the number of words in the word bank.

$$Reliability = \frac{Number\ of\ successfully\ recognized\ keywords}{Total\ number\ of\ keywords\ in\ the\ word\ bank} * 100\%$$

Equation 1.2 Reliability Formula

User-Friendliness

Since the group aims for this system to be used mostly by the APC visitors, one of the objectives is to create a system interface design that is fluid, simple, and appealing to the users. To measure that, the group will conduct a survey once the project is already launched. Then, each of the ratings from the users will be averaged to get the user-friendliness scale of the system.

$$\frac{\sum x}{n};\ x = user\ rating, n = \ sample\ size$$

Equation 1.3 Averaging User-Friendliness Rating

Accessibility

Just like the user-friendliness, the accessibility of this system will also be measured based on the users' feedback when the system is already up and running. The key points that the group considers for the accessibility of the system is the positioning and location of the directory system when placed in the building, and whether the directory system can easily be noticed by the people as they enter the building premises. Then, each of the ratings from the users will be averaged to get the accessibility scale of the system.

$$\frac{\sum x}{n};\ x = user\ rating, n = \ sample\ size$$

Equation 1.4 Averaging Accessibility Rating

1.4 Scope and Delimitations

1.4.1 Scope

- The directory system should cover the following facilities and rooms inside the APC building (Basement 2 to 11th floor)
    - Rooms
    - Admin offices
    - Rest rooms
    - Laboratories
    - Auditorium
    - Library
    - Cafeteria
- The speech recognition feature will only be used for performing a query. While the touchscreen will be used to navigate through the other functionalities of the system.
- The system will be installed in a touch-screen device with a microphone input.
- The system should provide the following details for queries:
    - Floor level
    - Names of nearby rooms
    - Map-like image of the room location coming from the nearest elevator/stair exit.
    - Predefined QR code that the user can scan using their phones to show a copy of the query result in their own device.
- There would be a feedback or report system in cases of malfunction or failure.
- The system should be able to identify the rooms by their names, room number, or services like:
    - Room 813
    - Auditorium
    - Registrar's Office
    - Payments

- Document Requests

- The application will use a speech-to-text API.
- Provide a simple facility that will let the admin to easily edit building/room information without having to change the program code.
- Below is the group's initial idea for the word bank of the system. It will still be improved upon once the group got the official copy of the building floor plan.

Name	Keyword 1	Keyword 2	Keyword 3
Laboratories			
Chem Lab	Chemistry	Experiment	Laboratory
Physics Lab	Physics	Experiment	Laboratory
Computer Lab	Computer	PC	Laboratory
Project Lab	Project	Laboratory	Thesis
Art Room	Art	Painting	Drawing
Photography/Videography Room	Photo	Video	MMA
Recording Room	Music	Record	Sound
Student Dormitories	Dorm	Student	Dormitory
Game Room	Game	Play	Video Game
Admin Offices			
Admissions Office	Inquire	Application	Transfer/Enroll
Student Activities Office	SAO	Extra-curricular	Activities
Registrar	Records	Documents	Request
Finance Office	Payment	Balance	Tuition
ITRO	Computer	IT	ID
ESLO	Engineering	Logistics	Equipment
Building Maintenance Office	Equipment	Locker	Building
Logistics Office	Inventory	Equipment	Operations
Disciplinary Office	DO	Discipline	
Clinical Office	Sick	Dentist	Medicine
Guidance Office	Counselor	Counsel	Counseling
7th Flr			
Audio Visual Room	AV	Audio	Visual
Study Area	Study	Open	Coffee
Presentation Rooms	Presentation	Defense	Proposal
Faculty Room	Faculty	Teacher	Professor
Open Library	Library	Books	Read
Others			
Open Gym	Gym	Exercise	Instructor
Table Tennis Area	Table Tennis	Ping Pong	Sports
Shower Rooms	Shower	Bath	Wash
Comfort Rooms	CR	Wash	Rest Room
Auditorium	Event	Performance	Theatre
Basketball Court	Basketball	Gym	Sports
Cafeteria	Food	Eat	Drink
Microsoft Hub	Entertainment	Meeting	Event
Multi-Purpose Hall	MPH	Event	Hall

1.4.2 Delimitations

- The application will require internet connection.
- The speech recognition feature will only be used for room querying. Otherwise, the touch screen monitor or computer mouse will be used for navigating through the application.
- Any changes with the building facilities and layout would require a system maintenance for updates.
- The application cannot provide the status or event of the queried room, whether if it is currently being used or available for providing service.
- The speech recognition feature only supports English language.
- The keywords that will be used in the system are only limited to the word bank created by the group.

1.5 Significance of the Study

- **To APC Visitors**

  This study will greatly be beneficial for the visitors and guests of APC. It will help them easily locate the room/event that they are looking for without asking for any directions. In addition, it will help them get to the place much faster and with ease.

- **To APC Community**

  This study will provide the APC Community, to locate and get to know more the specific room locations in APC. It will also aid security personnel in reducing their workload so that they will no longer need to assist/answer guests' questions regarding room locations, events, and so on.

- **To the Community**

  This research will assist the community in gearing toward more technologically advanced buildings and facilities, allowing individuals to work more efficiently.

- **To Future Researchers**

This study will serve as a guide for future researchers as they gather data, as well as a foundation for a larger study based on this current research. It will also serve as a beneficial reference for any future researcher who wishes to conduct a study that is related to this one.

1.6 Conceptual Framework

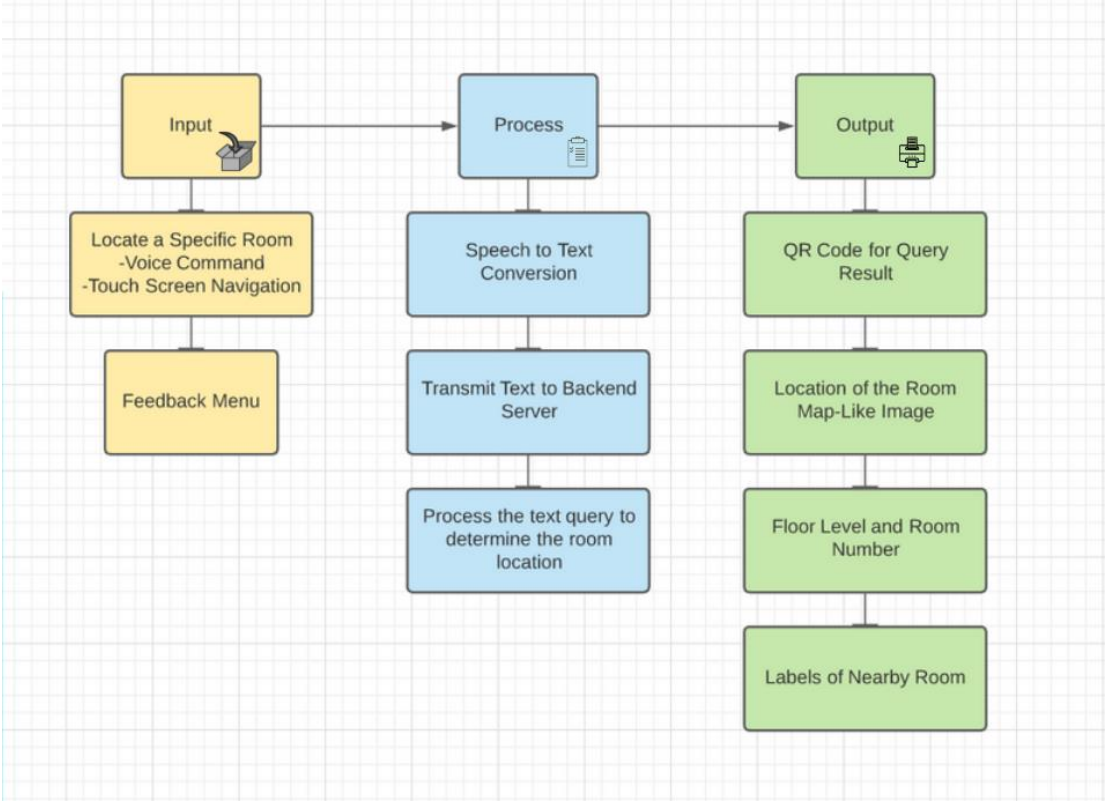


Figure 1.5. Conceptual framework of the study

In input stage of the system, the user has two options. The first is to locate a specific room, which will need a voice command from the user. The second option is for the user to give feedback about the system's performance.

The system will have three major stages to process the information received from the user. First, the user's speech will be converted into text, and then the system will recognize the specific keyword that the user asked. After the first procedure is completed,

the keyword will be sent to the backend server, where it will be matched with the keywords in the Word Bank. Finally, once the algorithm has determined the correct keyword, the room information is given back to the frontend and is ready to be displayed.

Finally, the room information will be displayed in the monitor. The room information are as follows: Room location image, floor level and room number, labels of nearby room. Likewise, it will also show a QR code about the queried room where the user can scan. An image is going to be transferred to the smartphone, which the user can carry around while looking for the room.

1.7 Definition of Terms

Terms	Definition
Smart	Referring to a system integrated with advanced technology, in this case, the use of speech recognition.
Smart Directory	A guide to a building's layout in which displayed on a device that can be used via speech recognition.
Query	The user's question about a specific office or room.
Touch Screen System	An input device where a user can interact with by touch and will be registered immediately by the system to process the event.
Speech Recognition	The process of identifying the user's query and converting it to text.
Security Personnel	The people who guard the school premises.
Visitors	The people who are in a place temporarily to make a visit for a certain matter.

Chapter 2

REVIEW OF RELATED LITERATURE AND STUDIES

2.1 APIs and Frameworks

2.1.1 Microsoft Speech API Service Documentation

A software documentation about the Speech SDK of Microsoft Services for easier development of speech-enabled software. It is available for various platforms like Windows, Linux, Mac, Android, etc.

Keyword Recognition

This refers to the speech technology that can recognize a short phrase or word from a given audio. One of the main uses of this in speech recognition applications is for the activation of a virtual assistant like “Hey, Cortana”.

Once the keyword is recognized, a specific action will be carried out. This prevents any unwanted audio to cross from the local device to the cloud server. It is a multi-staged system to balance the latency, accuracy, and computational complexity as seen in the figure below.

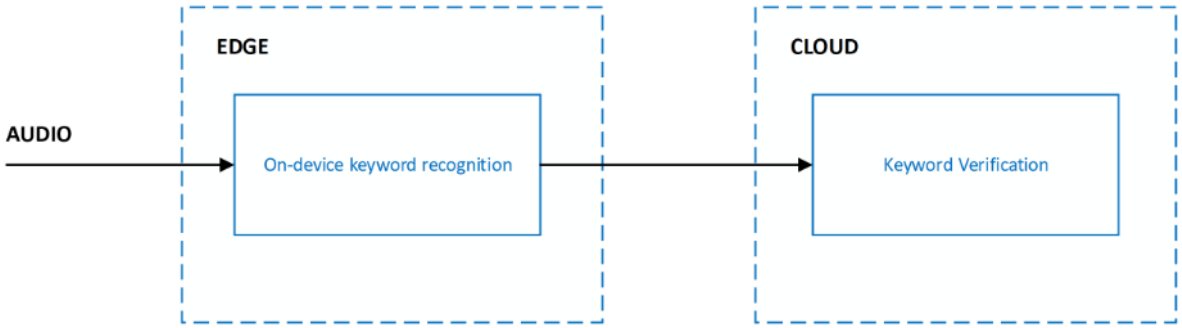


Figure 2.1 Microsoft Speech Service Keyword Recognition

Speech-to-Text

This service allows the real-time transcription of audio inputs into a text format. It can also assess the real-time pronunciation and provide feedback to the speaker on the fluency and accuracy of the given audio with the help of additional reference text input.

Voice Assistant

Voice assistant of Microsoft Speech Services can help in developing a natural conversational interface to your system. There are 2 different solutions that you can choose from. First, the Azure Bot Service with Direct Line Speed Channel. This is best for open-ended conversations with robust skills integrations. Next would be the custom commands. It is best for systems with voice commands or basic task-oriented conversations.

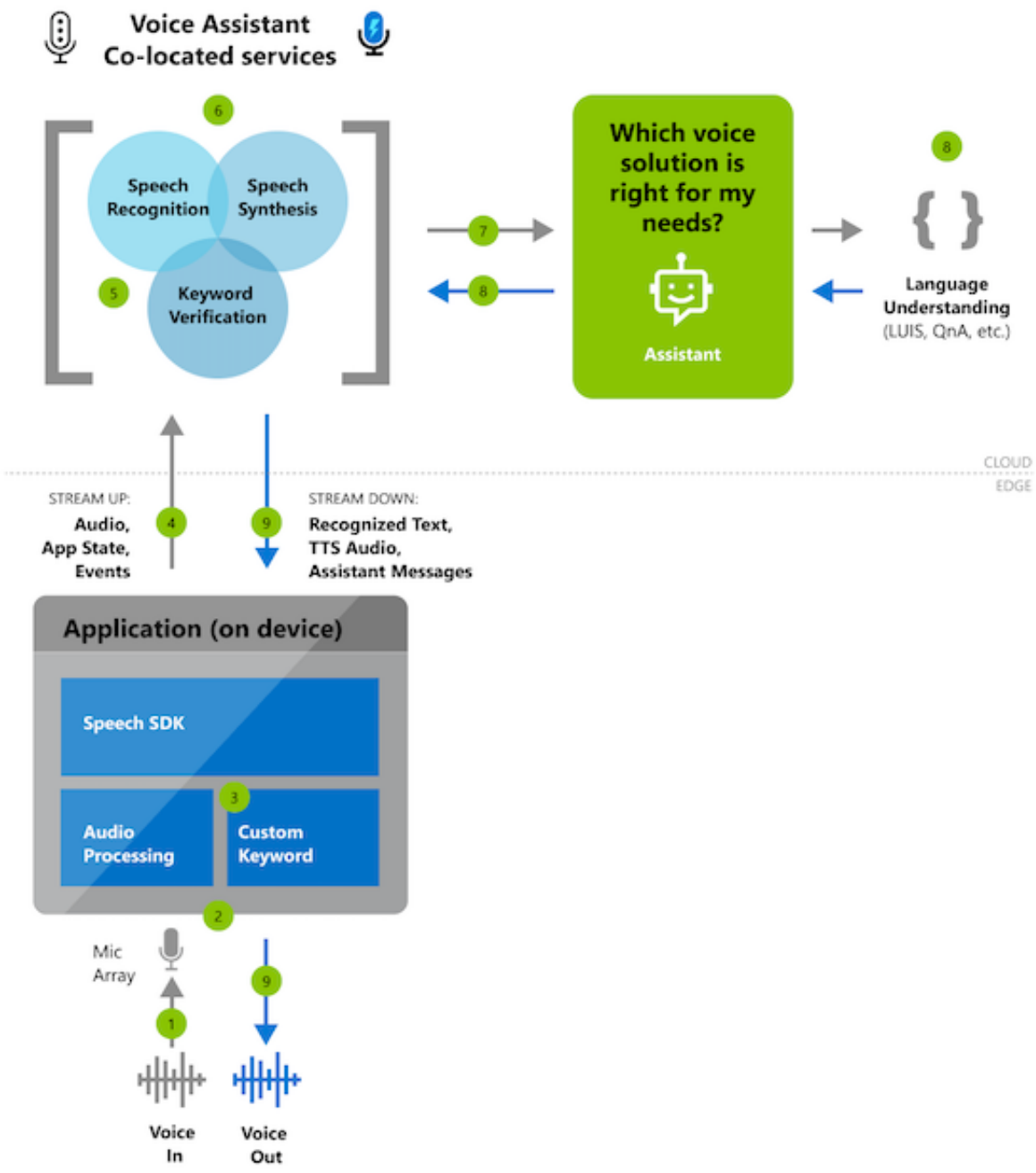


Figure 2.2 Reference Architecture for building a voice assistant using the Speech SDK

2.1.2 Deep Learning with Applications Using Python: Chatbots and Face, Object, and Speech Recognition with Tensorflow and Keras.

This book explores the application of deep learning like speech recognition, chatbots, computer vision, etc. This also talks about the use of frameworks like TensorFlow and Keras. It also covers recurrent neural networks, convolutional neural networks, and several APIs that can be used for such projects.

TensorFlow

This section covers all the essential information about TensorFlow. From the basics like variables, constants, placeholders, creating tensors, functions. Up to the complex tasks like the optimizers and metrics.

Keras

This section talks about how to work with Keras and teaches the major steps to deep learning models. On the more complex side, this part also discusses how to work using both Keras and TensorFlow.

Convolutional Neural Network in Keras and TensorFlow

This part discusses the importance of why and how you can work with CNNs using TensorFlow and Keras. The most common are image classifiers, defining the model architecture, sequence prediction, and so on.

Also, it has a chapter that is solely about Speech-to-Text conversion from the basics along with the many different APIs that you can use for integration and their differences from each other.

2.1.3 The PyTorch-Kaldi Speech Recognition Toolkit

The toolkit is intended to make integrating user-defined acoustic models as straightforward as feasible. This toolkit uses PyTorch to create acoustic models, while the Kaldi toolkit handles feature extraction, label/alignment computation, and

decoding, making it ideal for developing state-of-the-art DNN-HMM speech recognizers.

Acoustic modeling with DNN Each minibatch is processed by a neural network written in PyTorch, which accepts the features as input and produces a set of posterior probabilities for the context-dependent phone states as output. The code is set up in such a way that customized models may be simply added.

```
class my_NN(nn.Module):
    def __init__(self, options):
        super(my_NN, self).__init__()
        # Definition of Model Parameters
        # Parameter Initialization

    def forward(self, minibatch):
        # Definition of Model Computations
        return [output_prob]
```

Figure 2.3 Adding a user model into PyTorch-Kaldi

2.2 Neural Networks

2.2.1 Development of Filipino Speech to Text System Using Convolutional Network

This study is about closed captioning where its researchers developed a system that uses Filipino language for the Speech to Text. The researchers had many speakers to serve as a sample to the system to have a better recognition. The results of the system in this study shows that the system process is dependent on the hardware used. The higher specifications of the computer, the faster the speed of the displaying the output from Speech to Text. A higher accuracy rate was present when the speaker is female than from a male since their female participants pronounced the words similarly. Even though a filter was present, an audio input with background noise produced the lowest accuracy score among other testing methods conducted by the authors.

Filter Signal

This is the process used by the authors where they filtered the lower frequencies of the input audio by extracting the audio converting it to a wavfile to use for their training of the system. This is responsible for refining the audio signal to lessen the noise which uses Low Pass Filter.

2.2.2 Speech Recognition Using Convolutional Neural Networks on Small Training Sets

The paper was written because, in the past, speech recognition could only be accurate if it was said correctly. The researchers will propose a method based on a convolutional neural network in this study. According to the article, the methods of speech recognition used at the time were based on the time-spectral parametric portrait. The experiments were carried out by the researchers, who are mostly interested in neural networks. There are data that demonstrate brilliance in word recognition when the researchers set the frequency to 18 and 25 for the time intervals.

For the experiments that the researchers conducted, the researchers concluded in the owner speaker recognition without noise that the errors decrease when there are many speakers and it can greatly affect the quality of the recognition, whereas in the speaker recognition with noise, for each sample, unique noise were selected from a cockpit of a Boeing aircraft with an average volume of 80 dB. From all the results that's been conducted, the researchers concluded that the convolutional neural network of deep learning, best works if there's without noise. Convolutional neural network architecture works and produces decent results in determining whether there is noise in numerous circumstances.

This paper will help the team know what is more effective to use when it comes to speech recognition. It will help the group decide whether to use a

convolutional neural network architecture since the paper has conducted some experiments.

Speech signal parametric portrait in automatic speech recognition.

It is based on time-spectral quantization with an input of a word record.

Other speakers' recognition with noise

The usage of extra noise choices applied to the same source samples aids in the neural network training process. The more noise option are used, the better the output

Other speakers' recognition without noise

The percentage of mistakes reduces gradually as the number of speakers in the training set increases. It allows to get rid of speaker dependence.

Number of speakers	Percentage of errors
1 speaker	5.9%
2 speakers	2.4%
3 speakers	1.7%
4 speakers	1.2%
5 speakers	1.0%
6 speakers	0.8%
7 speakers	0.6%

Figure 2.4 Results on other speakers' recognition without noise

Own speaker recognition with noise

It demonstrates what error levels should be sought when identifying samples with noise from other speakers to avoid the influence of speaker dependency.

Own speaker recognition without noise

The column describes displays the number of samples in the training set for each word. The rows represent the degree of noise in identified samples.

Noise level	Number of samples in training set								
	1	2	5	7	9	15	21	25	29
w/o noise	29.5	13.4	3.8	1.8	1.8	0.9	0.5	0.4	1.1
SNR = 6	27.5	14.5	4.1	2.6	2.0	1.6	0.6	0.9	1.1
SNR = 4	25.6	13.8	5.1	3.2	2.5	1.7	0.8	1.1	1.1
SNR = 2	27.3	15.5	5.2	3.7	2.5	1.8	0.9	1.0	1.7
SNR = 1	32.2	16.1	5.8	4.3	3.2	1.9	1.5	1.1	2.2
SNR = 0.5	35.6	18.8	7.0	5.1	4.8	2.8	1.7	2.1	2.2

Figure 2.5 Results on own speaker recognition without noise

2.3 Methods/Techniques

2.3.1 A Review on Speech Recognition Technique

This study provides an outline of significant technological perspectives as well as an assessment of speech recognition's fundamental progress. This document aids in the selection of a technique, as well as its relative merits and drawbacks. In this paper, the group will be focusing on speech recognition techniques to analyze, extract and recognize information about the speaker identity.

Speech Analysis

Speech data includes a variety of information that reveals a speaker's identity. This comprises information relevant to the speaker, such as the vocal tract, the source of excitation, and the behavior aspect. The signal also contains information about the behavior attribute, which can be used for specialized recognition.

Feature Extraction

Speech Feature extraction is concerned with lowering the dimensionality of the input vector while keeping the signal's power.

Modeling Technique

The goal of the modeling technique is to create speaker models from a set of features. Speaker recognition and speaker identification are two modeling

techniques. Based on the individual information embedded in the audio signal, the speaker identification technology automatically determines who is speaking. While speaker identification focuses on extracting the intended message while ignoring the speaker's specific traits.

Matching Techniques

There are two techniques for match detection:

1. Whole-word matching. This method uses a lot less computing power than sub-word matching, but it requires the user to pre-record every word that will be recognized — which can be hundreds of thousands of words. It also requires a lot of storage, with each word requiring roughly 512 bytes.
2. Sub-word matching. This technique requires more computation than whole-word matching, but it requires significantly less storage, usually around 20 bytes per word.

2.3.2 Evaluation Methodology for Speech-to-Text Services Similarity and Speed Characteristics Focused on Small Size Computers

In this study, three most used Speech to Text (STT) services were tested and compared which are Google Web Speech API by Google, Watson by IBM and Azure Speech Services by Microsoft. The researchers conducted methods to know the efficiency and accuracy of each service in this study.

STT System Types

1. Offline

When using an offline STT system, the information is stored locally so the system must be trained before implementation. In addition, to improve the system performance and accuracy, its dictionary should be updated and fed with new words. The audio is processed into the micro-controlled system, that is programmed to capture, analyze, and process the audio signals.

2. Online

A web service is used in online STT systems. The audio is captured locally then processed on a remote server. Every audio processed trains the system. People around the world also contributes to feed its dictionary. An advantage of an online STT system is it has a wider scope of dictionary and are more trained. In result, it can return a more accurate text to get better results.

Using this study, the team can decide on what STT system to integrate in the project based on the results of this study. Using an STT system will help the team during the implementation of the project.

STT systems	Average conversion time (mS)
Google	6101,579
Microsoft	9205,645
IBM	11744,616
Grand Total	9017,279822

Figure 2.6 General average conversion time per STT system

Figure 2.6 shows the result of the conversion time of each system. Google's STT system is way faster than Microsoft's and IBM's STT system, as seen in the table.

STT Systems	Similarity percentage Average
Google	97,116%
Microsoft	90,825%
IBM	90,337%
Grand Total	92,759%

Figure 2.7 General average of precision per STT system

Figure 2.7 shows the accuracy of recognizing the speech and converting it to text. All the STT system have an accuracy above 90% but Google is ahead of the other systems. Google presents a more accurate system than that of the IBM's and Microsoft's.

2.3.3 Audio-visual speech recognition using deep learning

This research is about audio-visual speech recognition, and it discusses options for accurate speech detection, especially when the audio is distorted by noise. This research also introduces a variety of deep learning methods that will dramatically improve audio-visual speech recognition.

Deep Neural Network

A deep neural network (DNN) is an artificial neural network (ANN). Neurons, synapses, weights, biases, and functions are all components of neural networks, which come in a variety of shapes and sizes.

Deep Autoencoder

The deep autoencoder is a type of DNN that is often used for feature extraction and dimensionality compression. Artificial neural network models with numerous layers of hidden units between inputs and outputs are referred to as DNNs. The network is trained to model the identity mappings between inputs and outputs, and the autoencoder is a variant of a multilayered artificial neural network

with a bottleneck-shaped structure (the number of nodes for the central hidden layer becomes smaller than that for the input (encoder) and output (decoder) layers). PCA is a basic and widely used approach for dimensionality compression mechanisms.

Convolutional neural network

A CNN is a type of DNN (Deep Neural Network) that is widely used to solve picture classification challenges. Local receptive fields, shared weights, and spatial subsampling are three architectural approaches that CNNs use to ensure spatial invariance. As a result, CNNs outperform traditional fully linked feed-forward networks in the following three ways.

1. The convolutional layers' local receptive fields extract local visual characteristics by linking each unit to small local portions of an input image. Visual elements such as oriented-edges, endpoints, and corners can be extracted using local receptive fields. In most cases, pixels that are near together are highly connected, while pixels that are far apart are weakly correlated. As a result, the stack of convolutional layers is structurally favorable for recognizing images by extracting and combining obtained elements effectively.

2. By forcing the sharing of same weight configurations across the input space, CNNs have a little benefit over spatial invariance in terms of shift, scale, or local distortion of inputs. On different sections of the image, units in a plane are obliged to do the same operation. Many characteristics are recovered at each site because CNNs have multiple local receptive fields. Fully connected networks, in theory, can also accomplish comparable invariances. To cover all conceivable variants, however, learning such weight setups necessitates a huge number of training samples.

3. Subsampling layers are used to minimize the resolution of the feature map and the susceptibility of the output to input shifts and distortions by performing local averaging and subsampling.

2.4 Related Works

2.4.1 Venue Display Report: Small Directories Do Big Job at Mall of America

The Mall of America located in Minneapolis practiced the use of printed directories, where it was on big standalone structures with printed displays, overcrowded with maps and list of locations. According to their Information Technology (IT) Director, Janette Smrcka, they found out that the overloaded information on the printed maps were a frustrating experience for their guests. To improve, the mall's IT team thought of having digital touchscreen directories throughout the 5.6 milllion square foot mall with the goal of helping their guests find what they are looking for efficiently.

Hardware

The display of the digital touchscreen directory is a size of an iMac desktop screen that is tilted vertically. The mall opted to go with a size of a desktop screen rather than the larger interactive mall directory display since according to Smrcka, they want the experience to be more personal and private for their guests.

Advantages

With the use of the digital directory, the IT team can make use of the usage analytics to improve the directory list further and know the most searched to show on the main screen. Analyzing the data also helped them see that there was a confusion on one of the locations of their directory since as stated by Smrcka, people were instructed to take a left turn but ended up at a different store. To solve this

problem and help improve its features, they moved the directory around the nearby corner. A study from AOpen and Express Image shows that the average search time of guests using the physical directory were 3 minutes, while the average interaction time is 38.98 seconds when using the digital directory, significantly faster than the former. An extra feature that the mall offers in their digital directory is a user has an option to input their phone number for them to receive a map view with a step-by-step navigation which also allows the user to live-text the mall's digital concierge.

2.4.2 Digital Building Directory: How to Implement for Your Properties

Traditional building directories are being replaced by digital building directories, which aspire to be better and modern. If you manage a business or own a store, it's a terrific investment because it can route consumers and prospects to where they want to go. Building directories are improving with time, and there are certain things to consider if you're going to have an excellent signage system for your building or office. Knowing where it is essential, so choose a place with a lot of foot activity to easily find it and figure out where they need to go. When the correct visuals and graphics are used to make the information more conversational, digital building directories are significant. It can also be utilized as a lobby display for broadcasting other types of data like news, weather forecasts, or other events. Another essential part of developing an excellent digital signage solution for your business or company is readability. It would be preferable if the letters were visible and readable. It would be preferable if the letters were in a visual and legible font. As a result, building the directory's material should be concise and clear to access with less hassle.

Easily Updated

They use administration software to allow you to update display information whenever you wish. This keeps the material current and relevant.

Save Time

New information is updated in digital directories in a couple of moments. This makes them helpful when you need to update information regarding changes in the layout of the building in real-time.

This paper will help the team make use of this idea and information to maximize the improvement of the project in relation to smart digital building directory. It will also help the team know the essence of how to make it easily accessible to the users.

2.4.3 How Wayfinding Creates a Better College Experience

According to this article, wayfinding is not just about navigating, it also involves different aspects such as architecture, graphic design, signage, and psychology. Several schools already implemented the use of digital signage wayfinding placed strategically around the campus to orient their new students. ScreenCloud is a software platform that offers to make digital signages to schools, businesses, and other companies. The hardware of the digital signage can be on a tablet, computer, television, and more depending on the budget and needs of the customer. Convenience of the user is the top priority with the development of ScreenCloud.

User Interface

The contents seen on the ScreenCloud building directory app are orientation week timetables, campus map, animated arrows, room names, and room changes.

The app allows the administrator to list all the rooms or offices in a building, group by floors, add logos, and update everything real-time for their guests to be always pointed in the right direction, as seen in Figure 2.8. In addition, the app allows the user to scan a QR code to open the map of the location they are looking for in their phone to be able to navigate the campus without the need to go back and forth to the directory in case the user forgets the direction.

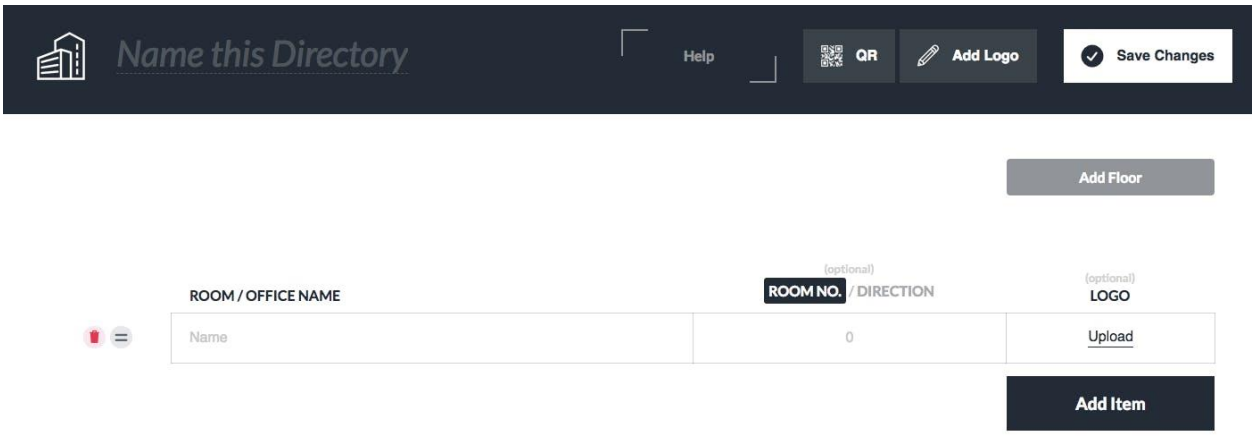


Figure 2.8 Admin Side

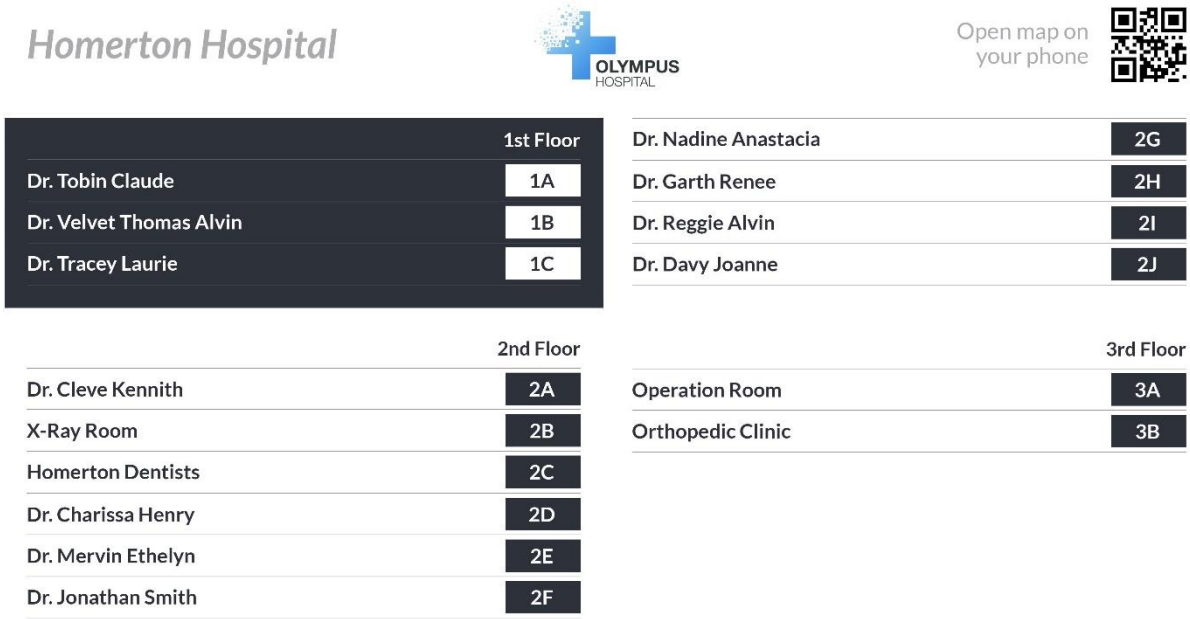


Figure 2.9 User Side

2.5 Relevance to the Present Study

The studies mentioned in this chapter have been mostly about the relevant and important concepts that group will need in order to implement the smart building directory system properly. It was divided in to three (3) different categories: APIs & Frameworks, Neural Networks, and Methods/Techniques. Those works can be wisely used to avoid unnecessarily working some things from scratch when there are already existing repositories or frameworks that the group can use to lessen the tasks if the project would be implemented.

There are also several techniques and approach that the group can consider using for the said project. It is a critical decision since it can also affect the result of the project such as the efficiency, reliability, and accuracy of the system. With those existing research, the group can also consider several frameworks and APIs that they can use to achieve the best result for the study.

The works mentioned above can also be used for deciding the platform of the said system since there are many APIs that can be used across all the platforms such as Windows, Mac, Linux, Android, Swift, and so on. This can also provide an opportunity for the group to improve the currently existing related systems or programs by innovating them with the use of different methodologies or techniques.

Chapter 3

CONCEPTUAL DESIGN

3.1 Functional Analysis

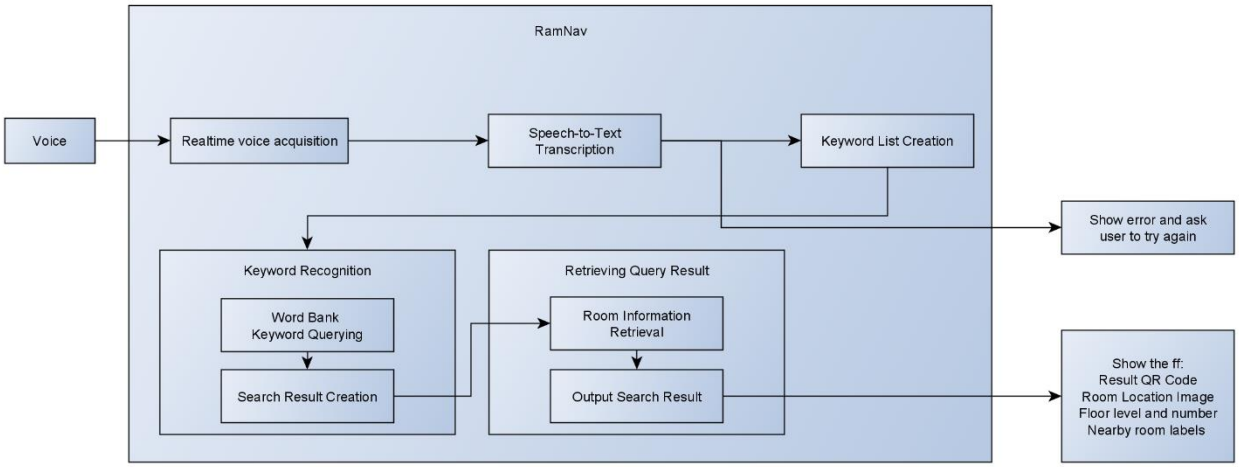


Figure 3.1 Functions and Analysis

The figure above illustrates all the functions that the RamNav system will perform on the user side. The process starts by acquiring the voice input coming from the user themselves, which will pass through via a microphone. The voice input would be processed by the Microsoft Speech SDK on a real time request. Once the speech input has been transcribed, the system will check for errors and handle if there are any.

After the transcription process, the transcribed input would be broken into separate words. Each of those words would be used for querying in the Word Bank of the system. During the querying process, the filler words, those which are not in the Word Bank, would be disregarded. This process would only retain the words that are in the Word Bank, which also act as the *keywords*.

Once the keywords have been finalized. It would create a list of possible results, which is where the user would choose from. This function gives the system more flexibility if there are different room keywords recognized in the query. If there are multiple results,

the user will have the option to choose in the list. Also, if the result that they were looking for was not in the list, they can retry the room query.

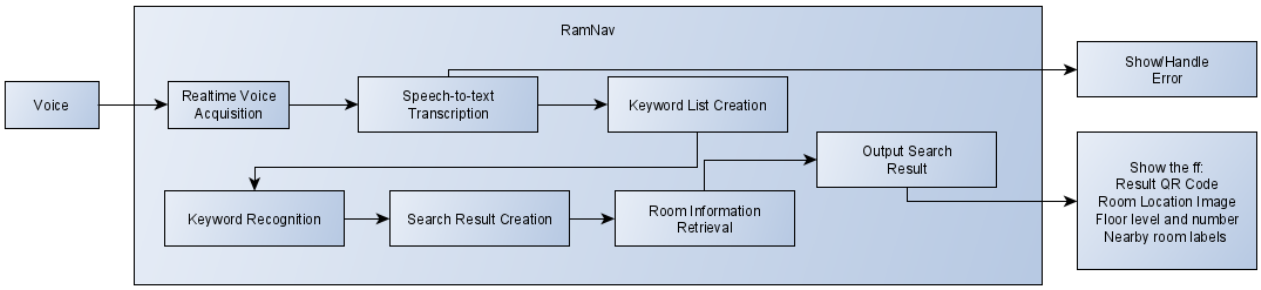


Figure 3.2 Glass Box

Figure 3.2 illustrates the same functions mentioned in the previous figure, but in a more compressed and straightforward way. The image above still effectively explains the flow of how the system will work on the user's end. This is a more encapsulated version of the figure above as it summarizes the processes from the 2 different environments which is the Microsoft Speech SDK and the System Database.

3.1.1 Principal Functions

- Realtime voice acquisition
- Speech-to-text transcription
- Keyword Recognition
- Retrieving Query Result

3.1.2 Secondary Function

- Keyword List Creation
- Word Bank Keyword Querying
- Search Result Creation
- Room Information Retrieval
- Output Result

Table 3.1 Function and Specification

Function	Type	Specification	Classification
Realtime Voice Acquisition	Principal	This function will be done with the use of an external microphone to capture the voice query by the user.	Performance
Speech-to-text Transcription	Principal	The voice query from the user will be transcribed into a text format using an online SDK.	Procedural
Keyword Recognition	Principal	The system would delete all the filler words in the user's query and only the keywords would remain. The keywords would be used for querying in the system's Word Bank	Procedural
Retrieving Query Result	Principal	The system would create a list of possible results from the user's query. Once they've confirmed, it will show the result of their query.	Procedural
Keyword List Creation	Secondary	Once the voice query is already in a text format, this function would separate the words of the text individually to serve as the initial list of keywords.	Performance
Word Bank Keyword Querying	Secondary	This is the part where the system will check if the keywords exist in the system's Word Bank. If not, they will be discarded.	Procedural
Search Result Creation	Secondary	Keywords that have a match on the system's word bank would be considered as the final keyword for the search query. There are possibilities of one (1) or more keywords that are recognized in the user's query so the user will select and confirm which room/result they are looking for.	Performance
Room Information Retrieval	Secondary	This function is to retrieve all the necessary details of the room that will be shown in the search result. It will be stored in a variable for easy access.	Procedural
Output Result	Secondary	The system will display the room information on the user's end, and there would be an option to go back to the main screen or do another room query.	Performance

Table 3.1 shows all the functions of RamNav. It also indicates the type, specification, and classification of each function. The function type defines whether the function is a principal or a secondary function. A principal function is a main function in a system that may be superior or a parent of sub-functions. Meanwhile, secondary functions are those that are called sub-functions. They are mostly dependent with each other to complete a bigger process/function, which is the essence of main or principal function.

Moreover, the table above also classifies the function whether they are procedural or performance. Procedural means that the function is working and dependent with its co-function/s to achieve a certain outcome. On the other hand, performance is the opposite. Which means that the function performs independently and straightforward.

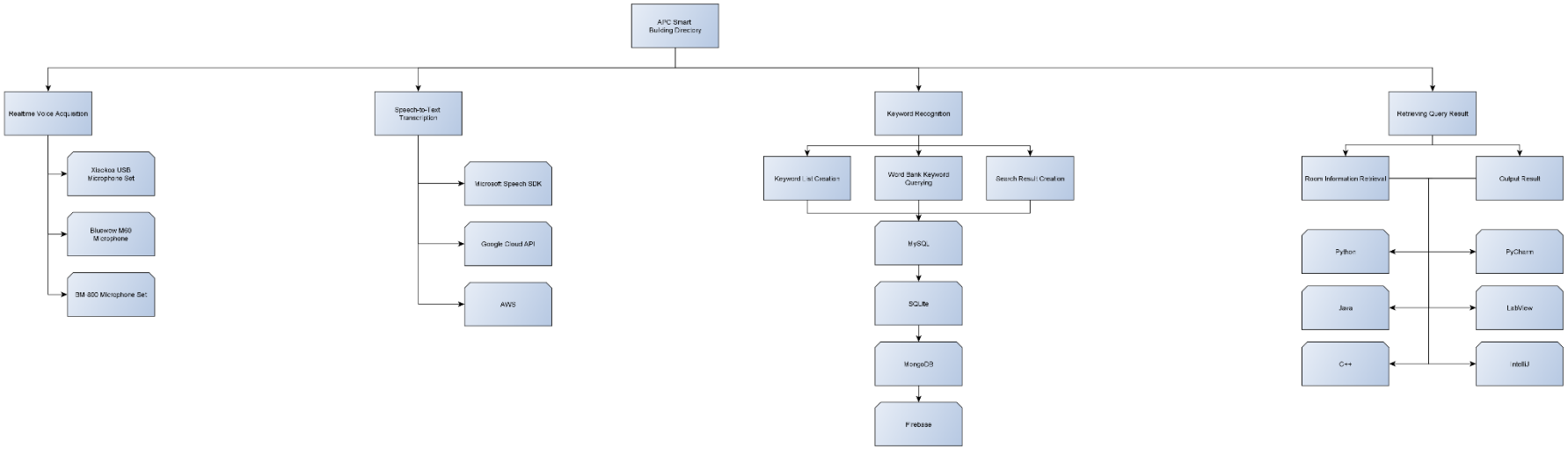
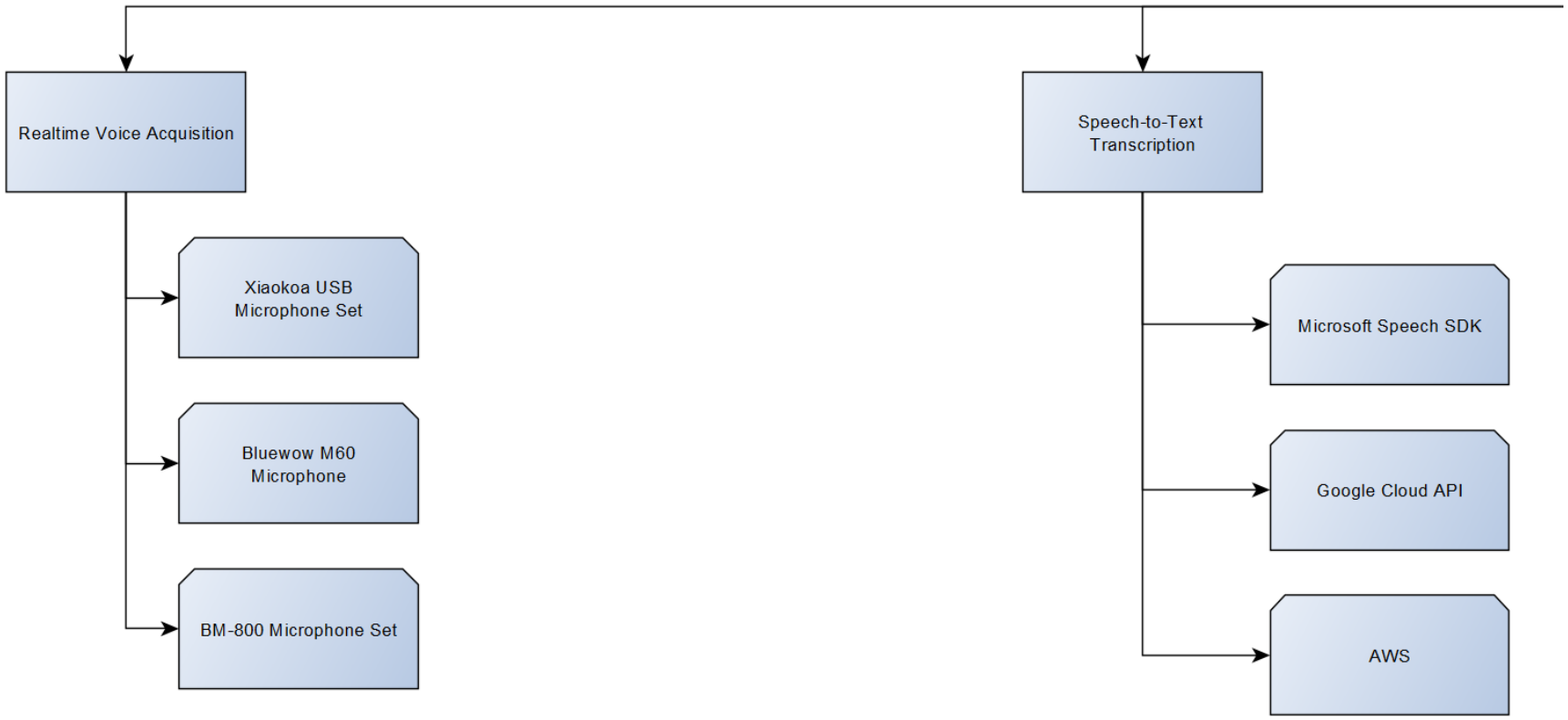


Figure 3.3 Function-means Tree


Realtime Voice Acquisition
Xiaokoa USB Microphone Set
Bluewow M60 Microphone
BM-800 Microphone Set
Speech-to-Text Transcription
Microsoft Speech SDK
Google Cloud API
AWS

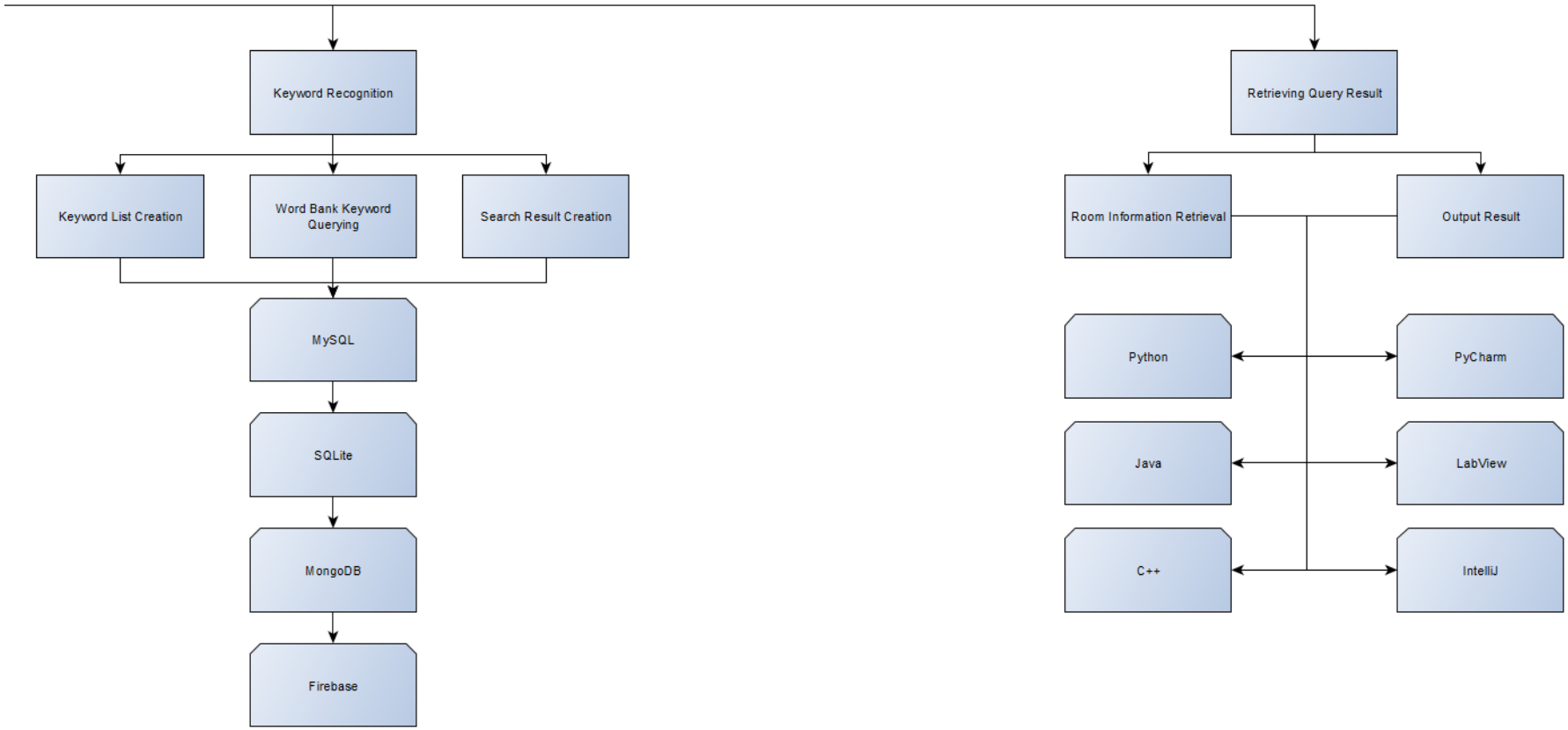

Keyword Recognition
Keyword List Creation
Word Bank Keyword Querying
Search Result Creation
MySQL
SQLite
MongoDB
Firebase
Retrieving Query Result
Room Information Retrieval
Output Result
Python
PyCharm
Java
LabView
C++
IntelliJ

Figure 3.3 above shows the complete functions and the means that will be used by the system in a tree-type figure. The order of those principal functions from left to right pertains as to how the team envision the program will flow on the user's side. They are categorized and separated into each different principal functions. Then, under the principal functions are each of the sub-functions, which are also in a sequential order. Lastly, under the sub-functions are the selected means by the group.

First, the Realtime Voice Acquisition function will be performed. After that, the Speech-to-Text Transcription will take place. Then, the keyword recognition function would have several sub-functions. First is the Keyword List Creation, Word Bank Querying, and last is the Search Results Creation. The last principal function would be the Query Result Retrieval which has 2 sub-functions: Room Information Retrieval and Output Result.

Each of those means will be further discussed on the next chapter of the design project documentation. The real-time voice acquisition would be using an external microphone connected to the PC to get and filter the voice query input by the user. Then, the Microsoft Speech SDK would handle the speech-to-text functionality of the system. Once it successfully transcribed the speech, the Speech SDK would then check and handle the error/s, if there are any. For this function, the priority mean is the Microsoft Speech SDK, but the 2 other means are Google Cloud API and the Amazon Web Services.

During the keyword recognition process, this is where most of the team' own knowledge would be utilized since the process would require manual development of the algorithm for removing the filler words and how the system will check the keywords on the system's Word Bank. The first 2 priority means are SQL-type databases which focuses more on the relationships of the data to be handled. While the other 2 is more on the friendliness and speed of the database. Lastly, the query result pertains to the whole process of how the output result would be shown to the user. There are 3 possible means for the programming language to be used and 3 possible programming environments that the team have chosen.

3.2 Design Alternatives

Table 3.2. Design Space

Functions	Engineering Standard	Standard Description	Means		
Voice Acquisition	ISO/IEC/IEEE 26512:2018	Presents the management processes that are applicable to the acquisition of information for users.	Bluewow M60 Microphone	XIAOKOA Condenser Microphone	BM-800 Microphone
Speech-to-Text Transcription	Evaluation Criteria for Selection of API Products	This research discusses the selection process and the different criteria to consider when selecting an API product.	Microsoft Speech SDK	Google Cloud API	AWS
Keyword Recognition	ISO/IEC 13249-3:2016	Consists of different parts under database languages, SQL multimedia, and its application packages.	MySQL	Firebase	SQLite
Retrieving Query Result	ISO/IEC JTC 1/SC 22	Also called portability subcommittee is the standardization for programming languages, their environments and system software interfaces.	Python	Java	C++

Table 3.2 shows the functions with its corresponding engineering standard, standard description, and means. In voice acquisition, systems and software engineering — requirements for acquirers and suppliers of information for users (ISO/IEC/IEEE 26512:2018) provides the requirement and management processes in acquiring or supplying information for users. In speech-to-text transcription, the team found a research alternative that discusses the criteria and selection process of an API product to be able to evaluate a certain product well (Chikkala, 2017). Some of the criteria to consider are the API's flexibility, usability, performance, and price. In keyword recognition, (ISO/IEC 13249-3:2016) consists of various parts that defines the application types and its associated routines to be used when selecting database languages. Lastly, in retrieving query result, (ISO/IEC JTC 1/SC 22) is for the standards of programming languages and system software interfaces. These are the proper methods to consider when selecting the means for each function.

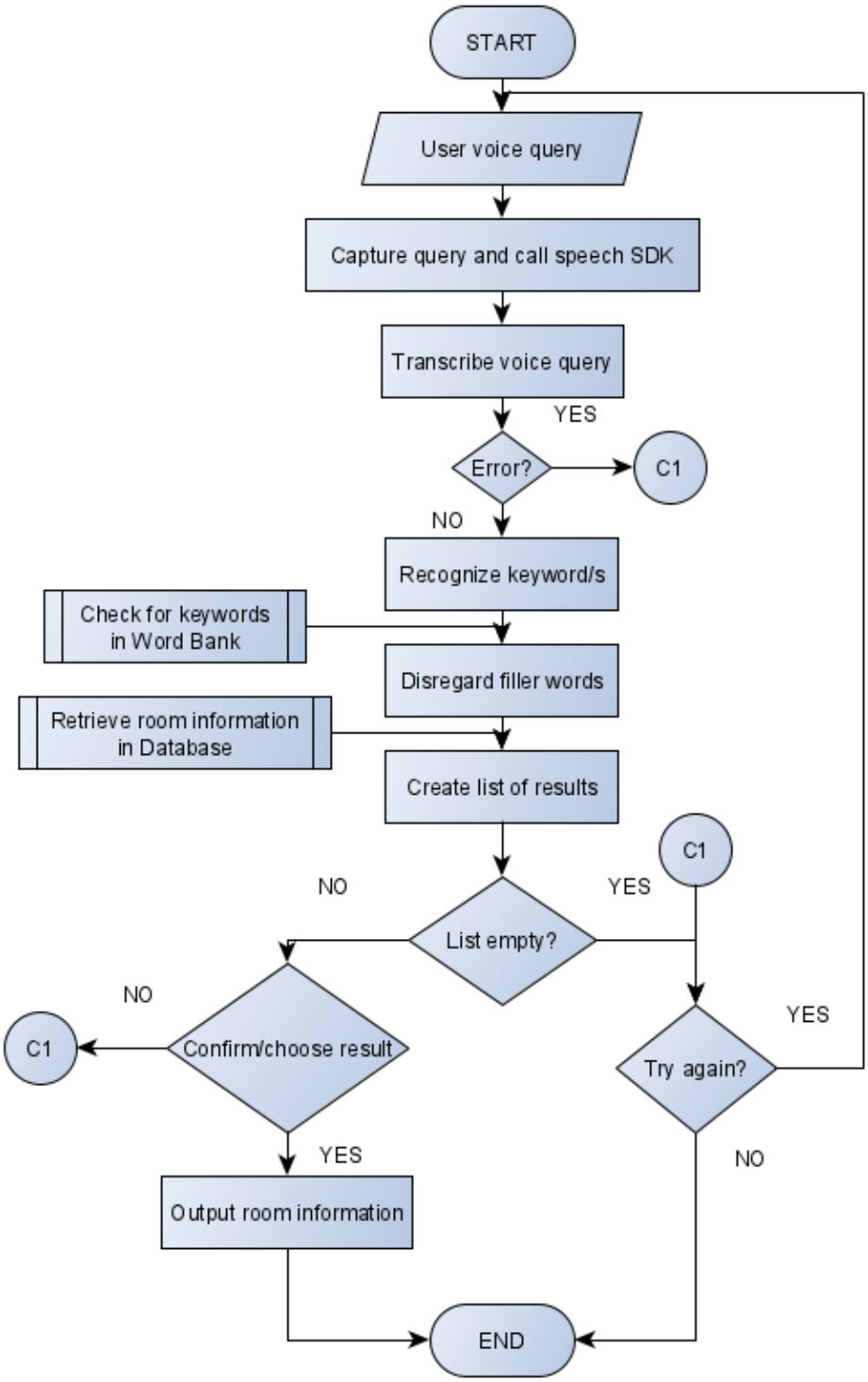


Figure 3.4. System Flowchart

The figure 3.4 illustrates how the team understand and conceptualize the program flow on the user side. It would start by acquiring the voice query of the user. Then, the system will capture that voice input and send it to the speech SDK for transcription processing. After that, it will check for errors, and if there are any, it would ask the user to try again. If none, it would proceed to the keyword recognition process. Once it determines the final list of keywords, it will create a list of possible results for the user's query. If the list is empty, it means there are no keywords recognized from the query, which then will prompt the user if they want to try again. On the other hand, if the search result list is not empty, it would ask the user to confirm which result they want to select. Once they've confirmed, it would then proceed to display the result for their query. Another possible situation is that the search result list is not empty, but the user cannot find the specific room that they're looking for. With that, there will also be an option to try again in such cases.

3.3 Selection Process

In selection process, the design objectives and constraints were considered for each function. The rank for each mean is based on the priority weight per design objectives. While the prioritization for each mean is based on what the team researched on in relation to the design objectives indicated. The percentage of the priority score attainment differs since the team based it from the online resources researched and estimated how close and suitable the means are for each function. Moreover, Accessibility objective was not considered in the selection process since this objective was defined by the team as the final prototype's availability during the implementation stage. Therefore, the accessibility objective does not touch any of the means selected by the team for this project. Priority weight is based on the subjective judgment of the team considering the metrics description for each objective mentioned to assess its prioritization depending on the function.

Table 3.3. Selection Process for Voice Acquisition

Voice Acquisition							
Priority Score Attainment		1st = 100%		2nd = 90%		3rd = 80%	
Design Constraints (C) and Objectives (O)	**Priority Weight**	**Bluewow M60 Microphone**		**XIAOKOA Condenser Microphone**		**BM-800 Microphone**	
		Priority	Score	**Priority**	Score	**Priority**	Score
O: Accuracy	50	3	40	1	50	2	45
O: Reliability	50	1	50	2	45	3	40
Total Score	**100**	**90**		**95**		**85**	

Table 3.3 shows the selection process for the microphone that will be used for the voice acquisition. As seen on the table, the possible means for this function is Bluewow M60, XIAOKOA Condenser Microphone, and BM-800 Microphone. Condenser microphones are often considered better than ordinary microphones since it captures the users voice fully, clearly, crisper, and more detailed due to its high sensitivity (Teach Me Audio, 2021). Which led to Bluewow M60 having the lowest score in accuracy compared to the other two means since it was just an ordinary microphone. For the reliability, the team considered the cost of each means which is why the BM-800 microphone had the lowest since its price was significantly higher than the other two despite its similar specifications with the XIOAKOA. The XIAKOA Condenser Microphone has the highest total score since its specifications compared to the other two are better and more cost-efficient.

Table 3.4. Selection Process for Speech-to-Text Transcription

Transcribe from Speech-to-Text							
Priority Score Attainment		1st = 95%		2nd = 90%		3rd = 85%	
Design Constraints (C) and Objectives (O)	**Priority Weight**	**Microsoft Speech SDK**		**Google Cloud API**		**AWS**	
		Priority	Score	**Priority**	Score	**Priority**	Score
O: Accuracy	60	1	56.94	2	56.64	3	56.28
O: Reliability	40	1	38	2	36	3	34
Total Score	**100**	**94.94**		**92.64**		**90.28**	

Table 3.4 shows the selection process for speech software development kit (SDK). For the accuracy, the scores were multiplied by the percentage of correctly recognized words, based on the study from Binbin Xu and his co-authors, to its corresponding priority weight. While the scoring for the reliability is based on the percentage of priority score attainment multiplied to its corresponding priority weight which is 40. The speech SDK from Microsoft had an accuracy of 94.9%, Google Cloud's had 94.4%, and Amazon's Transcribe had 93.8% accuracy (Xu, Tao, Feng, & Raqui, 2021). Microsoft Speech SDK has the highest score since the transcription accuracy and speed were higher compared to Google's and Amazon's Speech SDK.

Table 3.5. Selection Process for Keyword Recognition

Keyword Recognition									
Priority Score Attainment		1st = 100%		2nd = 75%		3rd = 50%		4th = 25%	
Design Constraints (C) and Objectives (O)	**Priority Weight**	**MySQL**		**SQLite**		**MongoDB**		**Firebase**	
		Priority	Score	**Priority**	Score	**Priority**	Score	**Priority**	Score
O: Reliability	60	1	60	2	45	4	15	3	30
O: User-Friendliness	40	3	20	4	10	1	40	2	30
Total Score	**100**	**80**		**55**		**55**		**60**	

Table 3.5 shows the selection process for the database that will be used for keyword recognition. The possible means for this function are MySQL, SQLite, MongoDB, and Firebase. The team think that MySQL would be more suitable to use with how the system will handle the data. Since MongoDB and Firebase has a different structure and are not SQL, it had the lowest score in terms of reliability. But for the user-friendliness, MySQL and SQLite had a lower score compared to MongoDB and Firebase since based on the proponent's research, scaling in SQL has a longer development time compared to the NoSQL-based database (Ohyver, Moniaga, Sungkawa, Subagyo, & Chandra, 2019). MySQL has the highest score since its structure is table-based and it is more preferred in handling complex data compared to the other means. MySQL, an open-source database management system that

also supports more programming languages which makes it as a priority option for the function.

Table 3.6. Selection Process for Retrieving Query Result

Retrieving Query Result							
Priority Score Attainment		1st = 100%		2nd = 50%		3rd = 25%	
Design Constraints (C) and Objectives (O)	**Priority Weight**	**Python**		**Java**		**C++**	
		Priority	Score	**Priority**	Score	**Priority**	Score
O: Reliability	50	1	50	2	25	3	12.5
O: User-Friendliness	50	1	50	2	25	3	12.5
Total Score	**100**	**100**		**50**		**25**	

Table 3.6 shows the selection process for the programming language that will be used for the system development of retrieving query result. The possible means for this are Python, Java, and C++. In terms of reliability and user-friendliness, Python is the preferred programming language by machine learning developers, said by 53% of the 2000 plus data scientists and machine learning developers' respondents to the survey in an article (Voskoglou, 2017). Java is prioritized by developers who are working on fraud detection and cyber security, while C++ is preferred in robot locomotion when AI libraries are available. Python has a significantly higher score compared to Java and C++ since when machine learning is involved, using Python programming language is more user-friendly and straightforward. It has a larger set of libraries compared to the two means mentioned which makes it a more suitable option for the function.

3.4 Function Means Matrix

Table 3.7. Function Means Matrix

Function	Means		
Voice Acquisition	XIAOKOA Condenser Microphone	Bluewow M60 Microphone	BM-800 Microphone
Speech-to-text Transcription	Microsoft Speech SDK	Google Cloud API	AWS
Keyword Recognition	MySQL	Firebase	SQLite
Retrieving Query Result	Python	Java	C++
Legend:	1st Option	2nd Option	3rd Option

Table 3.7 illustrates the design space of the project based on the selected means for each of the principal functions. For the voice acquisition, the Xiaokoa emerged as the best microphone fit for the project considering the objectives mentioned in the selection process. The speech-to-text transcription function has Microsoft Speech SDK as the priority mean mainly due to its accuracy being highest among the 3 possible choices. For the keyword recognition function, the possible means are 3 different databases available. MySQL emerged as the main priority due to its compatibility in terms with how the data will be structured and processed by the system. The team also considered the user-friendliness of the databases which gave Firebase a slight edge over the SQLite despite that relational database would be more fitting than non-relational in the context of the project. Lastly, for the query result, most of the work would be programmed by the team themselves, which is why there are 3 possible languages that can be used for the function. Python became the priority language mainly because of the simplicity and friendliness of the language when it comes to both simple GUI programming and machine learning programming.

3.5 Final Design Concept

3.5.1 Software Application Design

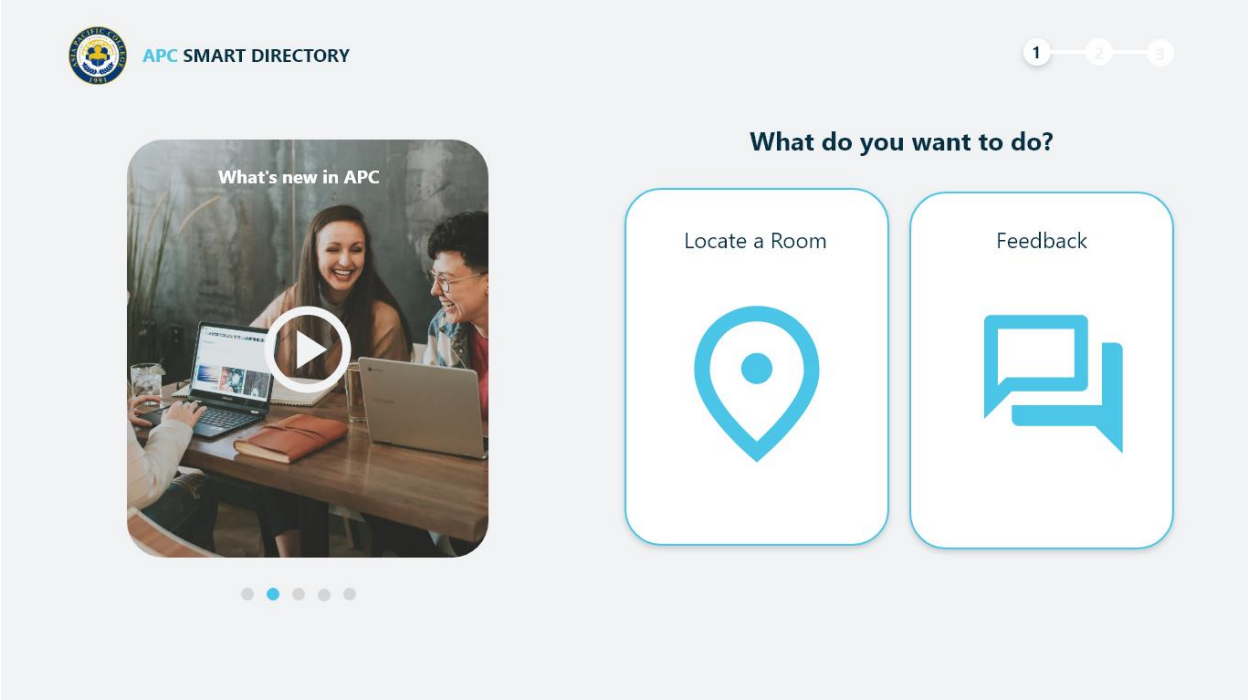


Figure 3.5 Main Menu Design Concept

Figure 3.5 shows the main menu screen of the building directory. The main menu contains two options: Find a Room as well as Feedback option. Since there are a lot of rooms remaining on the display screen, we'll decided to put a news/update on what's going on APC currently.

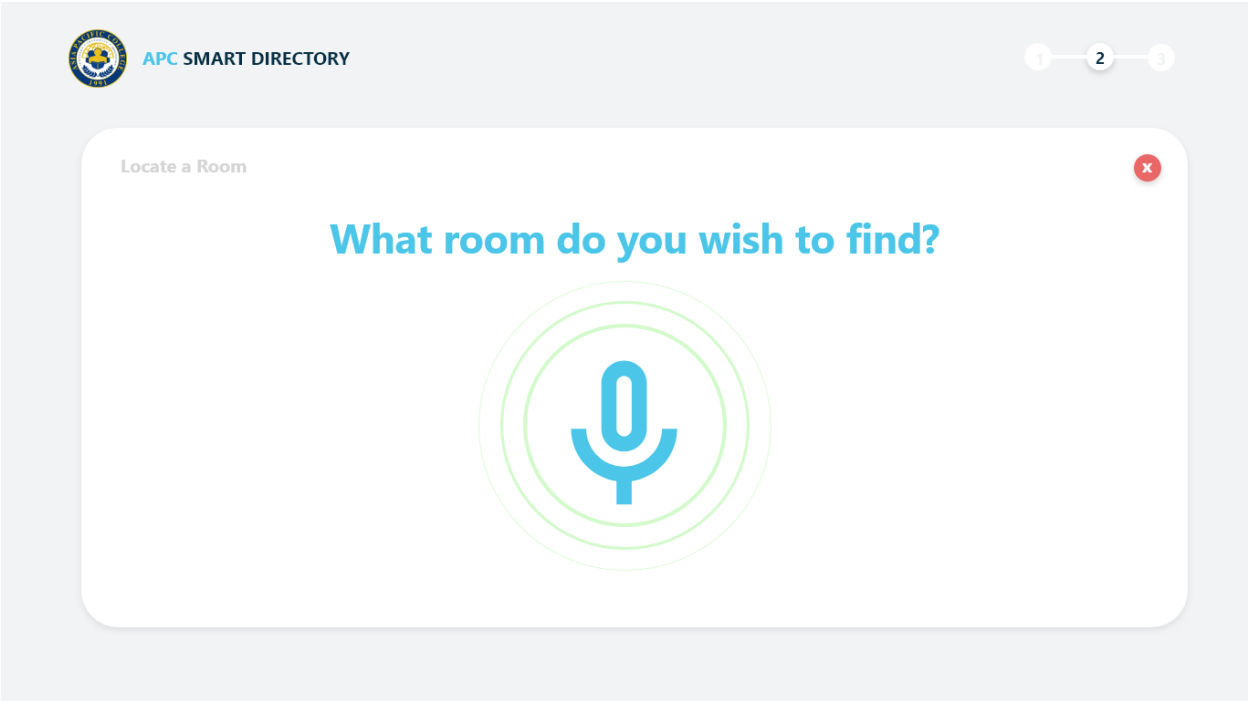


Figure 3.6 User Query Page Design Concept

Figure 3.6 shows the menu which the user will going to ask the system on what room the user wanted to locate. A green pulse will show as an indication for the user to begin asking his or her query. The back-end system will process the question after the user query.

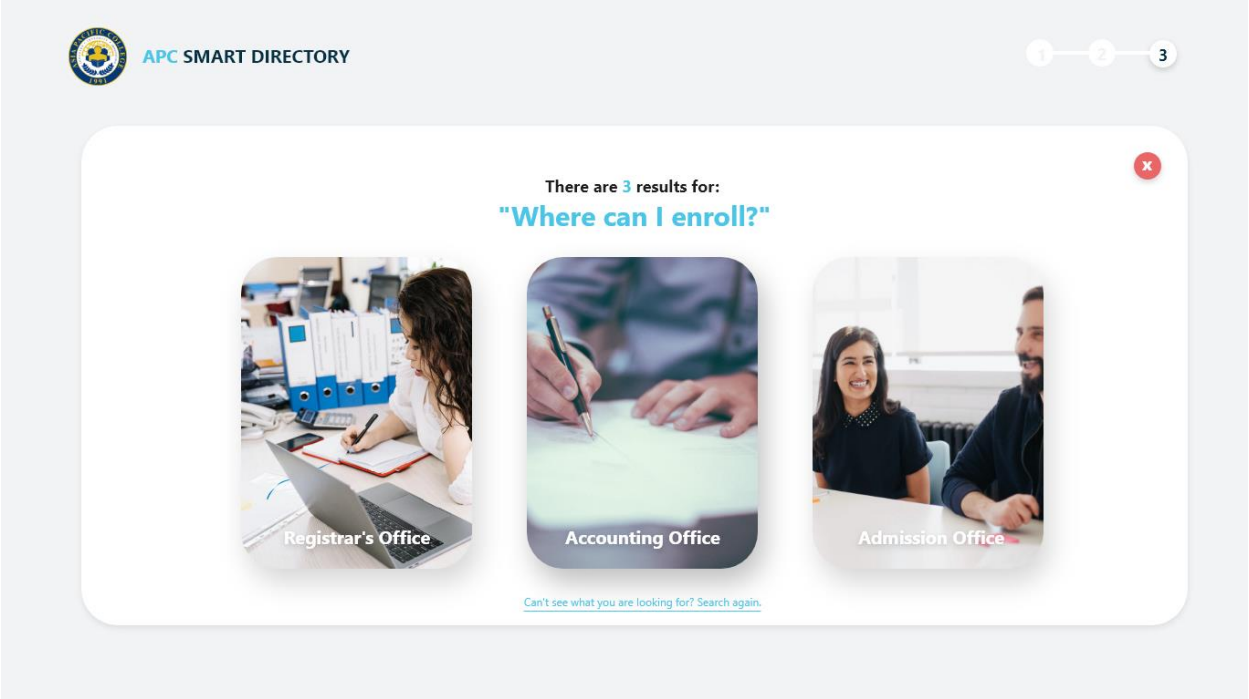


Figure 3.7 Possible Results Page Design Concept

Figure 3.7 shows the possible result based on user query. The system will assist the user in appropriately selecting the output that the user desired on this screen. This menu will display only if the system suggests multiple options to the user's query.

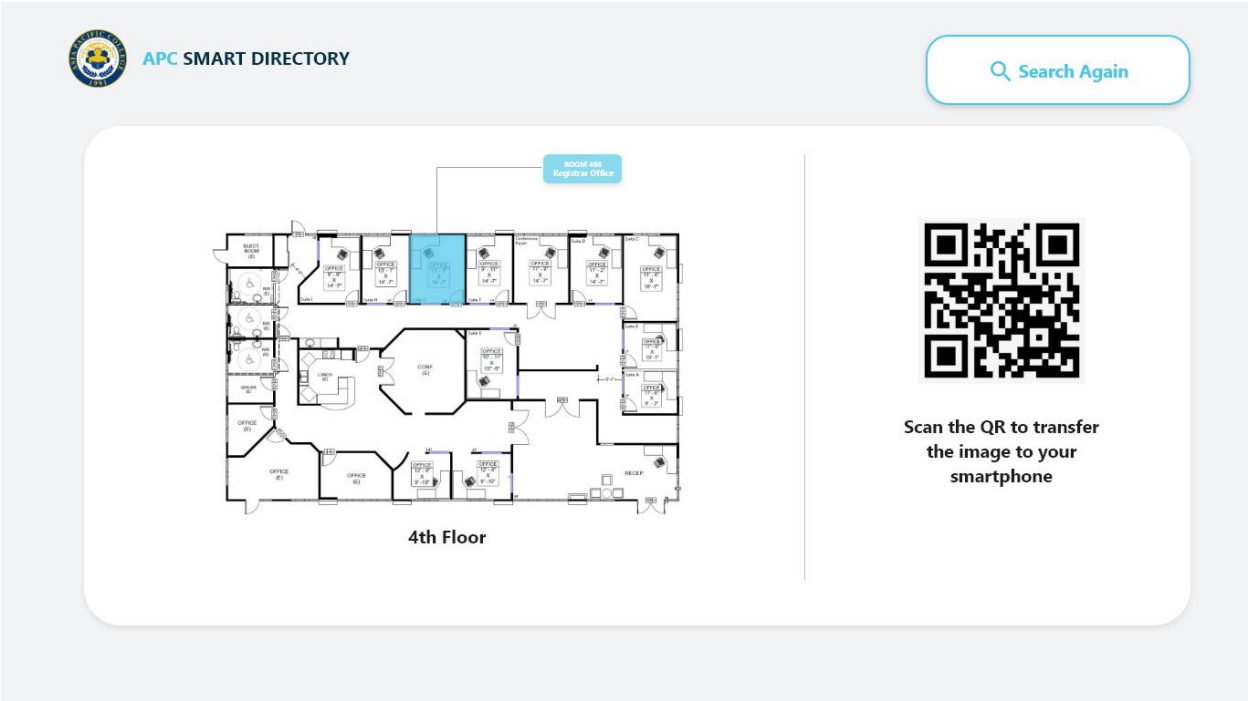


Figure 3.8 Output Page Design Concept

Figure 3.8 shows the display result based on the user query. This screen is divided into two sections: the QR code and the map location of the user's query. We can see the map location on the left side, which will display the floor level of the desired room. It will then highlight the room that the user requested, as well as the room labels on that floor. There will be a QR code on the right side that can be scanned to transfer the image to the user's smartphone. Lastly, if the user wants to search another room, there will be a search again button.

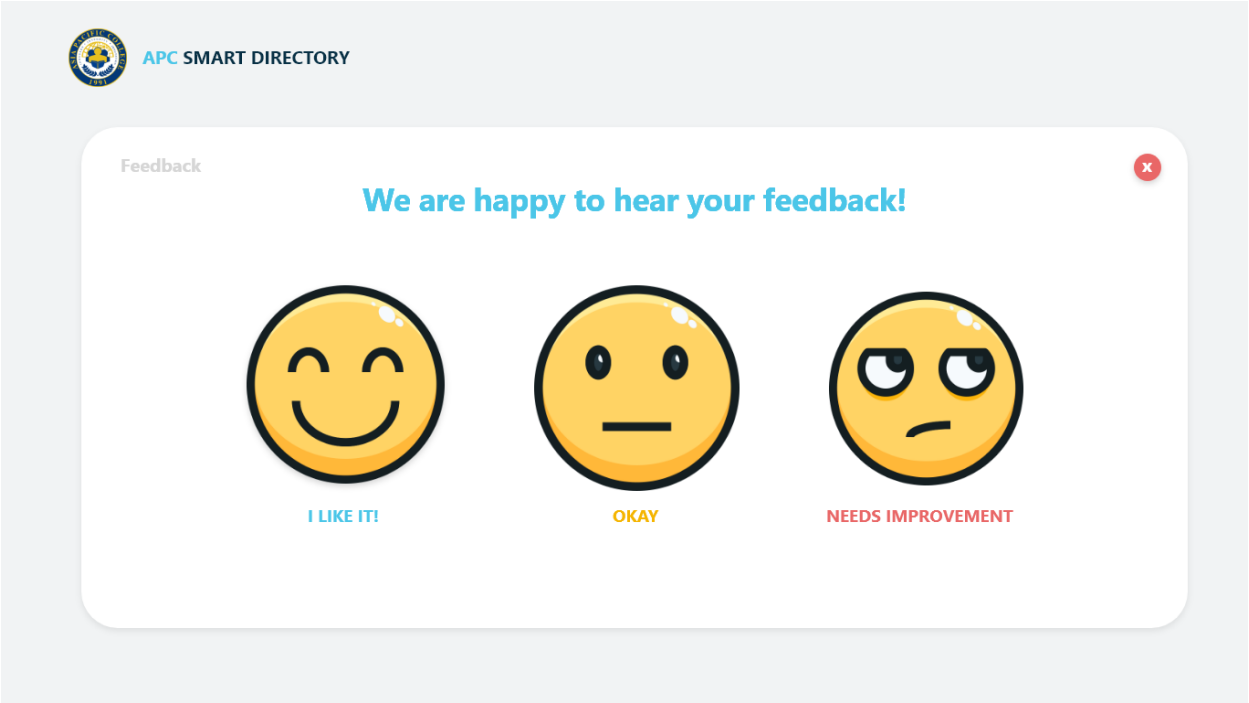


Figure 3.9 Feedback Page Design Concept

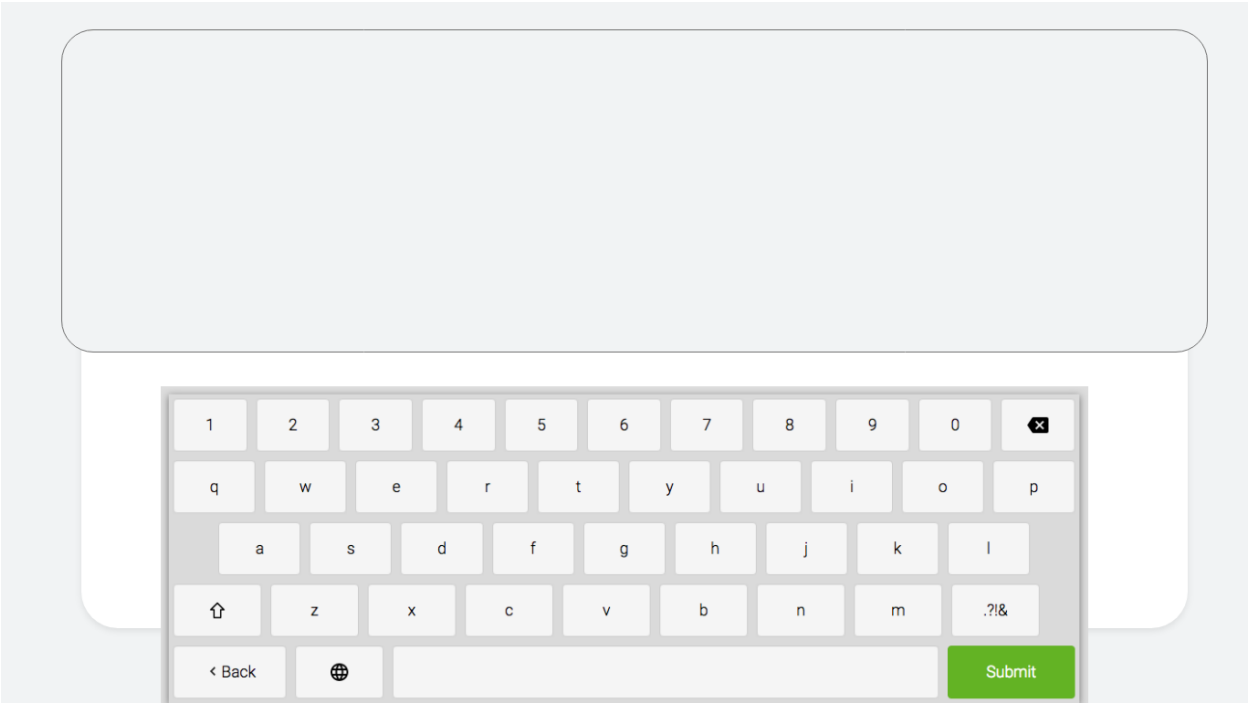


Figure 3.10 Feedback Text Page Design Concept

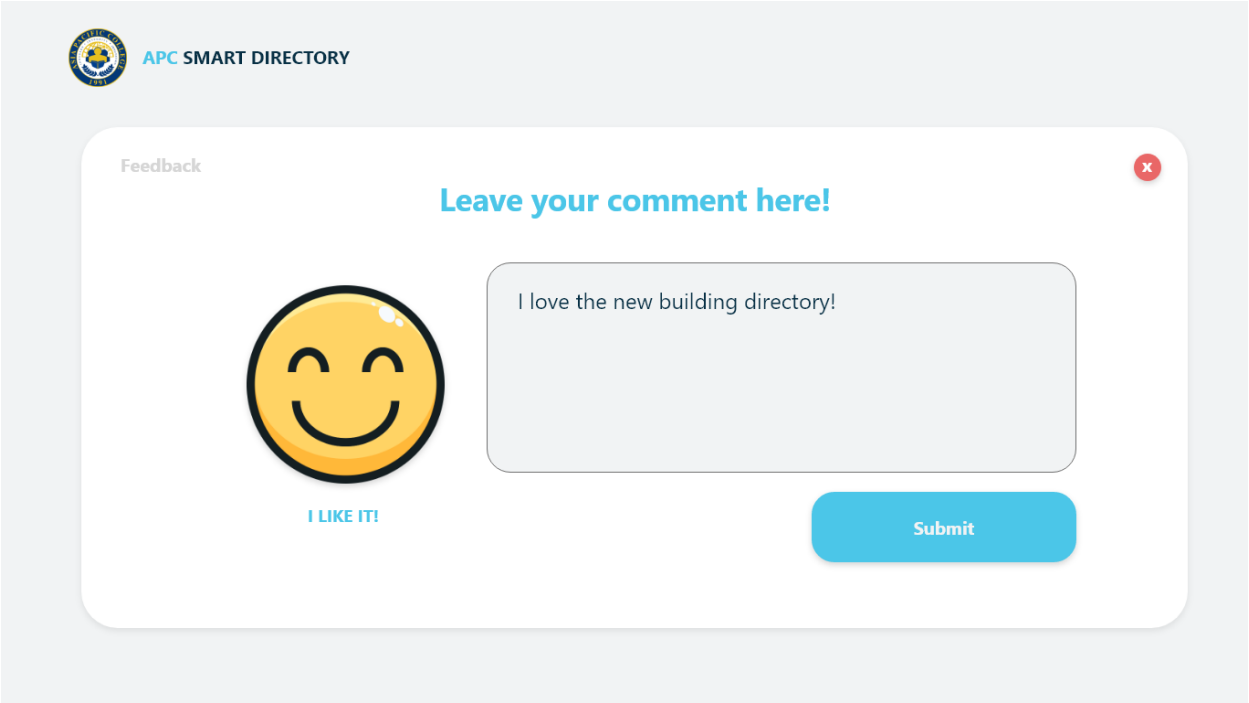


Figure 3.11 Comment Page Design Concept

In figures 3.9, 3.10, 3.11 shows the feedback menu of the system. The user will be able to report or provide feedback on the system. This feedback option will help in maintaining and improvement of the system, which will be beneficial for the future of the APC building directory.

3.5.2 System block diagram

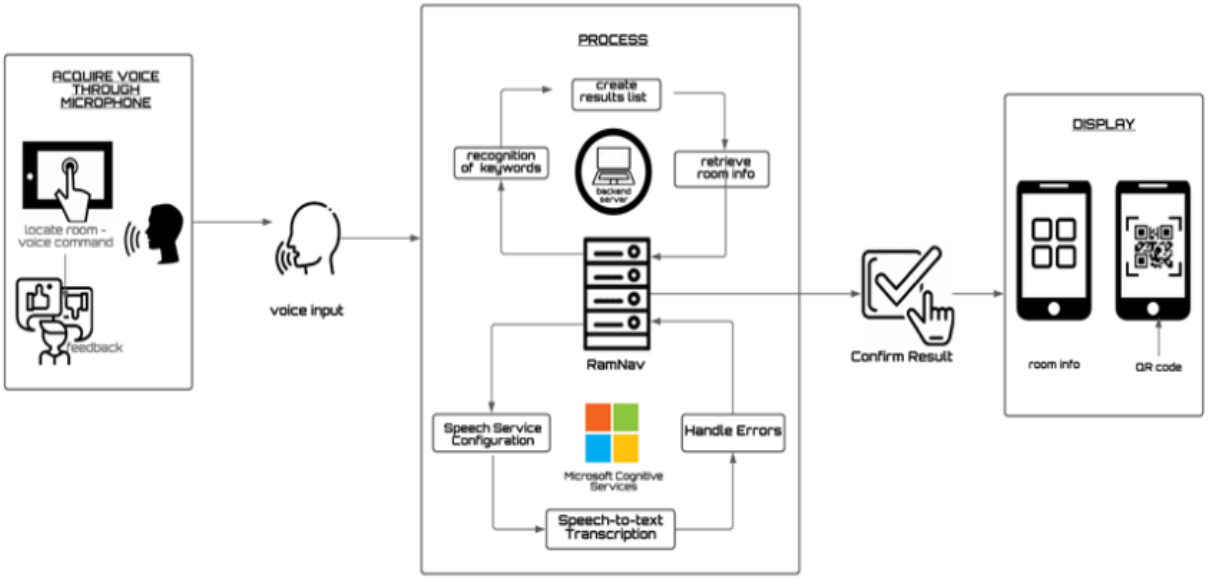


Figure 3.12 System Block Diagram

Figure 3.12 shows the flow of the input of the design project output. Acquire voice through microphone will be our input parameter which will be queried to the server after being acquired using voice command. The information collected from the user will be processed via three primary stages by the system. The technology will first transcribe the user's speech to text before recognizing the precise keyword that the user requested. The keyword will be transferred to the backend server when the initial operation is completed, where it will be matched with the keywords in the Word Bank. Finally, once the algorithm has found the right keyword, the room data is returned to the frontend and is ready to be displayed. The information about the room will be displayed, as well as a QR code that the user can scan. An image will be transferred to the user's smartphone, which they can use to search for the room.

3.5.3 Consideration Rubrics

Table 3.8. Design Consideration Table

Design Consideration	Project Application
A. Economic	Propose a budget for the school's building directory
B. Social	Accessible and easy to be used by the user
C. Public Health and Safety	Lessen human contact for safety protocols given the current state
D. Ethics	By acquiring the voice query of the user, we are getting the user's personal data which violates their privacy if used against them
E. Sustainability	The ability of the system to be easily modified in the future

Table 3.8 displays the Social, Economic, Health, Ethics, and Sustainability for the project consideration. These considerations are important to the research so that it help the system address the uncertain things that might occur.

Table 3.9. Design Process in Relation to Design Consideration Table

Design Process	Description	Design Consideration				
		A	B	C	D	E
Define the Problem	According to the results of the researchers' survey, 58 percent of respondents found it difficult to find a certain room during their first visit to APC.	x			x	
Gather Information Related to the System	The studies gathered are mostly relevant and important concepts that the researchers would require to correctly implement the system properly. In addition, these studies will be used to avoid having to create some things from scratch when there are already existing repositories or frameworks that the group may use to reduce the workload if the project is executed.		x	x		x
Analyze Problem and Generate Solution	The researchers aim to develop an advanced, responsive, and complete directory that will allow people to use speech recognition to find a specific room or office in the APC building and provide the information they require.	x	x	x	x	x
Designing and Programming of the System	The designing and programming phase of the system is going to be the vital stage of the design process. This phase will affect the final outcome of the system.	x		x		x
Test and Implement the System	Testing will be essential to the system since it will allow the researchers to restructure the system, which will help in the system's implementation.	x	x	x	x	x

Table 3.9 shows the design process of the research. Each corresponding design procedure serves a purpose to complete the research. The X symbol represents what must be accomplished by the team.

Table 3.10. Design Consideration Rubrics

Consideration	Parameters	1	2	3	4	Function/Means
Economic	Determine the proposed budget for the project	The budget for the project is around P10,000	The budget for the project is between P10,000 - P20,000	The budget for the project is between P20,000 - P30,000	The budget for the project exceeds P30,000	Selection Process
Social	Determine if the system is accessible and user-friendly	The system is accessible and user-friendly	The system is not accessible, but user-friendly	The system is accessible, but not user-friendly	The system is not accessible and not user-friendly	Realtime voice acquisition, Query result
Public Health and Safety	Assure that the speech recognition feature will lessen human contact	The system can fully operate hands-free	Most of the system feature are hands-free	Some of the system feature are hands-free	None of the system feature are hands-free	Realtime voice acquisition
Ethics	Group's responsibility for the data being collected	The system will collect and store personal data from the user	The system will collect but not store personal data from the user	The system will both not collect and store personal data from the user		Realtime voice acquisition
Sustainability	The ability of the system to be easily maintained in the future	All of the system features can be easily maintained	Most of the system features can be easily maintained	Some of the system features can be easily maintained	None of the system features can be easily maintained	Voice acquisition, Transcription, Keyword Recognition, and Output Result

Table 3.10 indicates all the parameters that will be considered in the design process of the project. The 1-4 columns are the ratings that will be based on the performance of the system on each of the appropriate parameters. The highest rating is 1, which means that it is the most ideal design of the project in that aspect.

For the economic parameter, the team selected number 2 due to the price of the device where the building directory system would run, and of course, the other means needed for the accomplishment of the project.

For social, the team aim to make the RamNav accessible and user-friendly especially for the user querying feature since it is the main feature that will be used most of the time.

Next, the health and safety parameters have been included by the team due to the current situation of the society regarding the COVID-19. Although it is not indicated as one

of the main focuses in the problem statement, the team strongly believes that it is also one of the points that they can consider for the design of the project.

For ethics, the system will be designed in a way that it would collect a personal data from the user which is their voice since it is needed for the voice recognition. However, other than the fact that the voice recognition feature is optional, that personal data would not be stored by the system. Once the voice query is done, the voice input from the user would already be disregarded by the system.

Lastly, the sustainability parameter which pertains to how the system would be designed in a way that it would be easy to maintain and do some modifications with it in the future. The team decided that only some of its features would only be sustainable and not all of it. The team would mostly focus on the sustainability of the room information data since it is more integral and sensible than prioritizing the sustainability of the system's front-end design.

3.6 Project Development

Table 3.11. Gantt Chart

Gantt Chart (DESPRO1)

Activities	2021-2022																
	November				December				January				February			March	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Setup of External Resources																	
Chapter 4 Initial Draft																	
User Interface Creation																	
Setup Database																	
Speech Input																	
Program Speech Recognition																	
Text Query Processing																	
Finalize Chapter 4																	

Gantt Chart (DESPRO2)

Activities	2022													
	March		April				May				June			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Display Result														
Testing for System Functions														
Troubleshooting														
Chapter 5&6 Draft														
Accuracy Testing														
Reliability Testing														
User-Friendly Testing														
Accessibility Testing														
Chapter 5 & 6 Finalization														

Table 3.11 shows the Gantt chart of the project development. The researchers based the scheduling of each different tasks on the succeeding academic term of the researchers. Before the start of any programming related work, the researchers will first setup the external resources needed for the system. After the first week, the researchers are expecting to start creating the system as well as finishing chapter 4, from UI creation to text query processing for DESPRO1. By the start of DESPRO2, the researchers are expecting to have a working speech to text algorithm. Displaying the query result, as well as all the troubleshooting will going to be done for the rest of the term. All the finalizations will be done in DESPRO2, as well as the completion of the Chapter 5 & 6 of the research paper.

Table 3.12. Work Breakdown Structure

Work Breakdown Structure (DESPRO1)

Activities	Responsible	Deliverable	Materials	Inclusive Date	Week No.
Setup of External Resources	Pardiñas	Hardware Setup	PC, External Microphone	**Nov 26 - 29**	Term 2 - Wk. 1
Chapter 4 Initial Draft	NextGen	Chapter 4 Draft	MS Word	**Nov 29 – Dec 10**	Term 2 - Wk. 2-3
User Interface Creation					
Menu	Chua, Maño	Main Menu UI	PC	**Dec 13 - Dec 31**	Term 2 - Wk. 4-6
Display of query result (PC)	Maño	Query Result UI in PC	PC	**Dec 13 - Dec 31**	Term 2 - Wk. 4-6
Display of query result (smartphone)	Pardiñas, Maño	Query Result UI in Smartphone	PC	**Dec 13 - Dec 31**	Term 2 - Wk. 4-6
Setup Database					
Setup MySQL	Pardiñas, Chua	MySQL	PC	**Dec 20 – Jan 7**	Term 2 - Wk. 5-7
Apply word bank	Pardiñas	Word Bank in Database	PC	**Dec 20 – Jan 7**	Term 2 - Wk. 5-7
Create room information	Pardiñas, Chua	Complete Room Information	PC	**Dec 20 – Jan 7**	Term 2 - Wk. 5-7
Store images of the building layout	Pardiñas	Images Available in the Database	PC	**Dec 20 – Jan 7**	Term 2 - Wk. 5-7
Speech Input					
Input Signal Filter	Maño, Silvio	Recognize Voice	PC	**Jan 10 – Jan 28**	Term 2 - Wk. 8-10
Speech-to-text conversion	Chua, Silvio	Convert Audio to Text	PC	**Jan 10 – Jan 28**	Term 2 - Wk. 8-10
Program Speech Recognition					
Integrate Microsoft Speech SDK	Silvio	Microsoft Speech SDK in System	PC	**Jan 31 – Feb 18**	Term 2 - Wk. 11-13
Transcribed text separation	Silvio	Text Split into Individual Word	PC	**Jan 31 – Feb 18**	Term 2 - Wk. 11-13
Store each word in a list	Silvio, Maño	Word Stored in a List	PC	**Jan 31 – Feb 18**	Term 2 - Wk. 11-13
Text Query Processing					
Disregard filler words	Silvio, Maño	Remove Words Not Found in Word Bank	PC	**Feb 21 – Mar 18**	Term 2 - Wk. 14-17
Recognize keyword	Silvio	Keyword Recognition	PC	**Feb 21 – Mar 18**	Term 2 - Wk. 14-17
Retrieve room information	Silvio, Pardinas	Get Room Information	PC	**Feb 21 – Mar 18**	Term 2 - Wk. 14-17
Finalize Chapter 4	NextGen	Chapter 4 Final	MS Word	**Mar 7 – Mar 18**	Term 2 - Wk. 16-17

Work Breakdown Structure (DESPRO2)

Activities	Responsible	Deliverable	Materials	Inclusive Date	Week No.
Display Result					
Program room confirmation menu	Silvio	Code for Room Confirmation Menu	PC	**Mar 21 – Apr 15**	Term 3 - Wk. 1-4
Show suggested result	Maño	Display Suggested Result	PC	**Mar 21 – Apr 15**	Term 3 - Wk. 1-4
Show QR Code	Maño	Display QR Code	PC	**Mar 21 – Apr 15**	Term 3 - Wk. 1-4
Room Location Image	Chua	Display Image of Room Location	Smartphone, PC	**Mar 21 – Apr 15**	Term 3 - Wk. 1-4
Floor level and number	Chua	Display Floor Level and Number	Smartphone, PC	**Mar 21 – Apr 15**	Term 3 - Wk. 1-4
Nearby room	Chua	Display Nearby Room	Smartphone, PC	**Mar 21 – Apr 15**	Term 3 - Wk. 1-4
Testing for System Functions					
Testing of Full System Simulation - Input Voice - Speech processing - Text query processing - Display result	NextGen	Building Directory Functions	Smartphone, PC	**Apr 18 – May 6**	Term 3 – Wk. 5-7
Troubleshooting	NextGen		Smartphone, PC	**May 9 – May 27**	Term 3 – Wk. 8-10
Chapter 5 & 6 Initial Draft	NextGen	Chapter 5-6 Draft	MS Word	**May 30 – Jun 10**	Term 3 – Wk. 11-12
Accuracy Testing	Maño	Conclusive and metric results	RamNav	**Jun 13 – Jun 24**	Term 3 – Wk. 12-13
Reliability Testing	Silvio	Conclusive and metric results	RamNav	**Jun 13 – Jun 24**	Term 3 – Wk. 12-13
User-friendly Testing	Pardiñas	Conclusive and metric results	MS Forms	**Jun 13 – Jun 24**	Term 3 – Wk. 12-13
Accesibility Testing	Chua	Conclusive and metric results	MS Forms	**Jun 13 – Jun 24**	Term 3 – Wk. 12-13
Chapter 5 & 6 Finalization	NextGen	Final Project Documentation	MS Word	**Jun 20 – Jun 28**	Term 3 – Wk. 13-14

Table 3.12 illustrates the Work Breakdown Structure of the project that proposed by the researchers. The researchers divided the WBS into many parts with different tasks so that researchers may work in smaller groups and complete the tasks one at a time. From November 6 through March 18, the database and system will be the target until Chapter 4 is completed. And the months of March through June were placed for function testing of each system, as it requires extensive testing since it requires both a PC and a smartphone. The Building Directory Functions are included in the Final Project Documentation.

Table 3.13. Budget Proposal

Item	Price per Piece	Quantity	Total Price
Xiaokoa Condenser Microphone	PHP 499	1	PHP499
Anmite 15-inch Touch Screen Monitor	PHP 8,800	1	PHP 8,800
Azure Cognitive Service – Speech to Text w/ Custom Speech Model	PHP 8,800	PHP 50 per hour of transcription	PHP 8,800
Azure Cognitive Service – Key Phrase Extraction	PHP 1,125	PHP 37.5 per 1000 text records	PHP 1,125
		GROSS TOTAL	P19,224
		- - Alternative Microphone & Monitor	- P9,299
		- - Free $100 Azure Credit	- P5,000
		NET TOTAL	P4,925

The table above shows the estimated computational breakdown for the development of the project. Currently, the team have alternative resources for the items mentioned above such as the external microphone and the monitor. For the Microsoft API services, the group aims to utilize the free trial offers by Microsoft before using the actual paid subscription.

3.7 Functional and Test Cases

3.7.1 Test Process

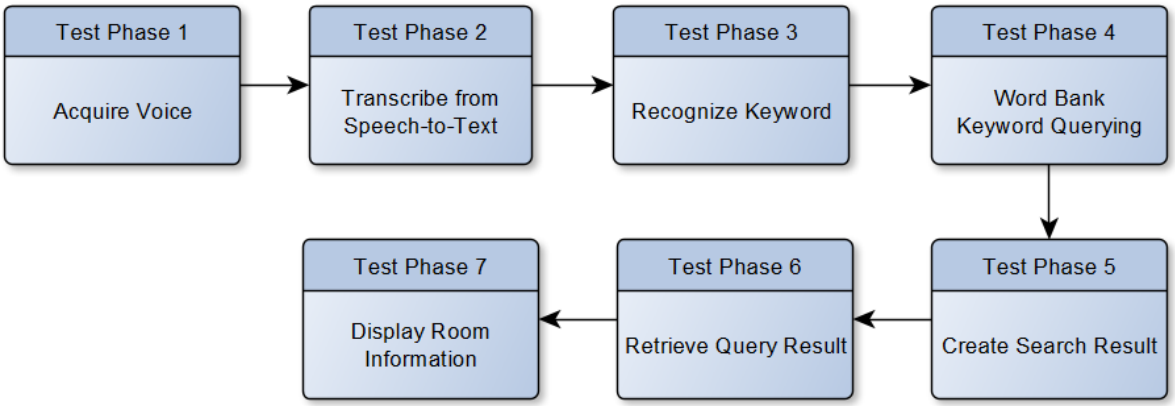


Figure 3.13 Function Test Phase

Figure 3.13 shows the test phase for each function. The test phase starts with acquiring the voice, then to speech-to-text transcription. Recognizing the keyword is the next function followed by the Word Bank keyword querying. Next function is creation of search result to retrieving the query result. Lastly, displaying the room information for the output testing.

Table 3.14. Function Test Case Table

Test Case	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7
1	Successfully Acquire Voice	Successfully Transcribed from Speech-to-Text	Successfully Recognized Keyword	Successfully Queried Keyword from the Word Bank	Successfully Created Search Result	Successfully Retrieved Query Result	Successfully Displayed Room Information
2	Failed to Acquire Voice	Failed to Transcribe from Speech-to-Text	Failed to Recognize Keyword	Failed to Query Keyword from the Word Bank	Failed to Create Search Result	Failed to Retrieve Query Result	Failed to Display Room Information

Table 3.14 shows the test cases and test phases of each function. In Test Phase 1, the voice must be successfully acquired to move to Phase 2. After successfully transcribed from speech-to-text the team can now move to test phase 3, the keyword recognition. Test phase 4 is Word Bank keyword querying. Test phase 5 is create search result. Test phase 6 is retrieve query result. Lastly, test phase 7 is display room information. The test cases in test phase must be successful to be able to proceed to the next test phases.

Table 3.15. Acquire Voice (Test Phase 1)

Test Case	Background Noise		Speaker		Distance		Room Search Triggered		Remarks
	High	Low	Male	Female	Far	Near	Yes	No	
1	✓		✓		✓				
2	✓		✓			✓			
3	✓			✓	✓				
4	✓			✓		✓			
5		✓	✓		✓				
6		✓	✓			✓			
7		✓		✓	✓				
8		✓		✓		✓			

Table 3.15 shows the different test cases when acquiring the voice input from the user. The team will test this function considering 3 different scenarios: background noise, speaker's gender, and distance from the system. A high background noise is greater than 30 decibels while a low background noise is less than 30 decibels. For the distance, a near scenario is being at least 6 inches away from the device, while a far scenario means being more than 10 inches away from the device. The content shown above are examples. This could change once the team conduct the testing.

Table 3.16. Transcribe from Speech-to-Text (Test Phase 2)

Test Case	Background Noise		Speaker		Distance		Convert speech to text		Remarks
	High	Low	Male	Female	Far	Near	Yes	No	
1	✓		✓		✓				
2	✓		✓			✓			
3	✓			✓	✓				
4	✓			✓		✓			
5		✓	✓		✓				
6		✓	✓			✓			
7		✓		✓	✓				
8		✓		✓		✓			

Table 3.16 shows the test cases for speech-to-text transcription. Since this function is just to transcribe from speech-to-text, accuracy of the transcription is not the priority. The goal is to just display a text from the voice input. The scenarios are also the same as the table above.

Table 3.17. Recognize Keyword (Test Phase 3)

Test Case	Query Method	Keywords Recognized			Filler Words Deleted			Remarks
		All	Some	None	All	Some	None	
1	Room Name							
2	Room Number							
3	Room Keyword							
4	Mixed							

Table 3.17 shows the test cases for keyword recognition. In this function, the system must be able to delete fillers from the transcribed text and retain the important keywords only. There is only 1 scenario that is being considered in this testing, which is the query method that the user will use. That will produce 4 different test cases for this function.

Table 3.18. Word Bank Keyword Querying (Test Phase 4)

Test Case	Query Method	Exists in Word Bank		Response		Remarks
		Yes	No	TRUE	FALSE	
1	Room Name	✓				
2	Room Name		✓			
3	Room Number	✓				
4	Room Number		✓			
5	Room Keyword	✓				
6	Room Keyword		✓			

Table 3.18 shows the test cases for Word Bank keyword querying. If the keyword does not exist in the Word Bank, that word should be discarded and vice versa. This test phase would be successful when the system is able to identify and retain only the keywords that exists in the Word Bank. There are 2 different scenarios being considered in this function test which is the query method and the keyword existence in the Word Bank. The team will not just simply use keywords that are in the Word Bank. They would also try to use synonymous keywords that are not in the Word Bank to test if the system would rightly discard those words.

Table 3.19. Create Search Result (Test Phase 5)

Test Case	Keywords Found		Room/s Matched		Rooms in Search Result			Remarks
	Single	Multiple	Single	Multiple	All	Some	None	
1	✓		✓					
2	✓			✓				
3		✓	✓					
4		✓		✓				

Table 3.19 shows the test cases for the creation of search result. There is a chance that the keywords recognized would have multiple matches so this test phase would be successful once the system correctly display the list of search results based on the keywords. There are 2 scenarios being considered in this function test: quantity of the keywords found, and quantity of the rooms matched in the query. The goal is to display all the rooms matched in the created search result.

Table 3.20. Retrieve Query Result (Test Phase 6)

Test Case	Search Results		Correct Info Retrieved			Info Stored		Remarks
	Single	Multiple	All	Some	None	Yes	No	
1	✓							
2		✓						

Table 3.20 shows the test cases for retrieving query result. This test phase would be successful when the system is able to retrieve the necessary details of the room picked by the user from the search result. Despite only having 1 scenario to consider, there are 2 outputs to be tested in this function. First is the correctness of the info retrieved from the database, and the second is whether that information were successfully stored in a variable.

Table 3.21. Display Room Information (Test Phase 7)

Test Case	Search Results		Displayed Info		Remarks
	Single	Multiple	Correct	Incorrect	
1	✓				
2		✓			

Table 3.21 shows the test cases for the output result, display room information. This test phase would be successful when the system is able to display the correct room information queried by the user. For instances where there are multiple search results, the user would just select one from the list of results.

3.8 System Test

3.8.1 Test Process

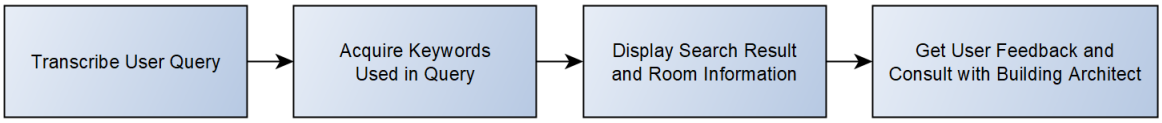


Figure 3.14 System Test Phase

Figure 3.14 shows the overall system test phase. It represents the flow for testing the system's overall accuracy, user-friendliness, consistency, and responsiveness. After the system test phase is completed, the system's output will decide whether the goal has been met.

Table 3.22. Accuracy Table Testing

No.	Accuracy Test	Checklist		Remarks
		Yes	No	
1	Able to transcribe user voice query with low background noise.			
2	Able to transcribe user voice query with high background noise.			
3	Able to transcribe user voice query for male speaker.			
4	Able to transcribe user voice query for female speaker.			
5	Able to transcribe user voice query from near distance.			
6	Able to transcribe user voice query from far distance.			

Table 3.22 shows the system testing to meet the objective for accuracy. The team must evaluate whether the user speech input query was successfully transcribed considering the different scenarios mentioned above.

Table 3.23. Reliability Table Testing

No.	Reliability Test	Checklist		Remarks
		Yes	No	
1	Able to recognize above 90% of room names in the Word Bank.			
2	Able to recognize above 90% of room numbers in the Word Bank.			
3	Able to recognize above 90% of room keywords in the Word Bank.			

Table 3.23 shows the system testing to meet the objective for reliability. The team must evaluate whether the keywords can be successfully recognized by the system given the different scenarios.

Table 3.24. User-Friendliness Testing

No.	User Friendly Test	Checklist		Remarks
		Yes	No	
1	Search result image is appealing and comprehensible.			
2	Navigation labels are clear.			
3	Navigation labels are concise.			
4	Information is clear, accurate, and uncluttered.			
5	Buttons and images are properly and clearly represented.			

Table 3.24 shows the system testing to meet the objective for user-friendliness. The testing focuses on the functionality of the UI to ensure that its functions work as intended and provides clarity and distinguishability for users to easily navigate throughout the process of querying.

Table 3.25. Accessibility Testing

No.	Accessibility Test	Checklist		Remarks
		Yes	No	
1	The system can be located easily in the building.			
2	The system is being used by its intended users.			
3	The system can provide the appropriate information queried by the users.			

Table 3.25 shows the system testing to meet the objective for accessibility. The testing focuses on system's openness and accessibility to the intended users. It also includes the location of the system, the usage, and the completeness of its functionalities.

3.9 Evaluation Procedure and Criteria for Overall System

Table 3.26. Evaluation of the Objectives of the Study for Accuracy

Objective	Number of Trials	Word Error Rate (Based on Table 3.22)	Accuracy Rate (Based on Table 3.22)	System Rating
Ability of the system to correctly recognize the words said by the user	30	*Criterion 1*	*Criterion 1*	
		Criterion 2	*Criterion 2*	
		Criterion 3	*Criterion 3*	
		Criterion 4	*Criterion 4*	
		Criterion 5	*Criterion 5*	
		Criterion 6	*Criterion 6*	

$$Accuracy\ Evaluation = \frac{\sum Accuracy\ Rate\ per\ Criterion}{Total\ Number\ of\ Criterion} * 100\%$$

Equation 3.1 Accuracy Evaluation

Table 3.26 shows the evaluation of the system's accuracy. It is connected based on the criterion/scenarios mentioned in Table 3.22 for measuring the accuracy of the system's speech-to-text feature. All the accuracy rates in those criterions would be averaged to get the overall accuracy of the system. The trials would be coming from 3 females and 3 males with 5 trials each. The number of trials is based on the Filipino Speech-to-Text System by Dabo, J., Lagunay, K., et al.

Table 3.27. Evaluation of the Objectives of the Study for Reliability

Objective	Number of Trials	Num. of Successful Trials (Based on Table 3.23)	Recognition Rate	System Rating
Ability to system to recognize the keywords in the Word Bank	5 per keyword	*Criterion 1*	*Criterion 1*	
		Criterion 2	*Criterion 2*	
		Criterion 3	*Criterion 3*	

$$Reliability\ Evaluation = \frac{\sum Number\ of\ Successful\ Trials}{5 * \ Total\ \#\ of\ keywords\ in\ Word\ Bank} * 100\%$$

Table 3.27 shows the evaluation for the reliability of the system to successfully recognize the keyword within the Word Bank. For this table, there would be 5 trials for each keyword in the Word Bank. Then, the total number of successful trials based on Table 3.23 criteria would be listed. Lastly, the reliability of the system would be calculated by dividing the total number of successful trials over the total number of keywords in the word bank multiplied by 5 since there would be 5 trials per keyword.

Table 3.28. Evaluation of the Objectives of the Study for User-friendliness

Objective	Number of Respondents	Average Rating per Criterion (Based on Table 3.24)	System Rating
The ability of the user to easily navigate and understand the GUI	40	*Criterion 1*	
		Criterion 2	
		Criterion 3	
		Criterion 4	
		Criterion 5	

$$\frac{\sum x}{n};\ x = Average\ user\ rating\ per\ criterion, n = \ Num\ of\ Criterion$$

Table 3.28 evaluates the user-friendliness of the system. The computation of this will be based on the also in the survey once it is already up. Then, each of the ratings from the users will be averaged to get the user-friendliness scale of the system. There would be 40 target respondents since there are 4 categories for the system users: guests, students, faculty, and staff. There would be 10 respondents for each category. Then, the criteria mentioned in table 3.24 would also be the primary basis for this survey. For the user-friendliness evaluation, each average score per criterion would be summed up and divided with the total number of criterions, which is 5 in this case.

Table 3.29. Evaluation of the Objectives of the Study for Accessibility

Objective	Number of Respondents	Average Rating per Criterion (Based on Table 3.25)	System Rating
Pertains to the system's openness and accessibility to the intended users	40	*Criterion 1*	
		Criterion 2	
		Criterion 3	

$$\frac{\sum x}{n};\ x = x = Average\ user\ rating\ per\ criterion, n = \ Num\ of\ Criterion$$

For the evaluation of the system's accessibility, it is the same with user-friendliness of the system. It will be based on the users' feedback when the system is running. For its computation, each average score per criterion would be summed up and divided with the total number of criterions, which is 3 in this case. The criterions are based on Table 3.25.

Chapter 4

DESIGN COMMUNICATION

4.1 Project Design

This section refers to both the hardware and software design applied by the team for this project. The hardware design section focuses on how the hardware technology works and connected. Meanwhile, the software design section discusses the logic of the software application and how the programmed functions are working with each other.

4.1.1 Hardware Design

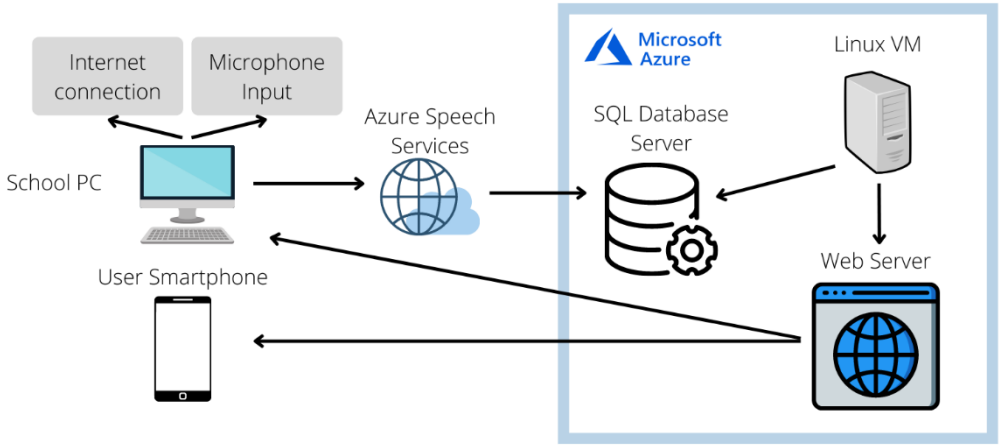


Figure 4.1 Hardware Design

For RamNav's hardware design, there are a couple of important components that the group is utilizing. The client-side will be using a desktop to run the main application, but the users can also use their mobile phones to view the search result by scanning the QR code provided by the application. For the server-side, the group is currently using a virtual machine powered by Microsoft Azure. It is running in a Linux environment and is used for the SQL database server and a web host for the project.

Personal Computer (PC)

The PC would be the primary equipment or platform on which the application will run. It is preferred that the PC would use a Windows OS and install all the software needed for the application to run properly. Also, the application needs an internet connection to fully use all its features. Lastly, this hardware requires a microphone input device connected for its voice acquisition feature.

Linux Virtual Machine

The Linux Virtual Machine used by the team for this project was provided by Microsoft Azure. This is where the images of the rooms are stored so that the application can call those pictures through a web link. This also contains the dictionary file that is being used for the project.

User Smartphone

The user smartphone is an optional hardware that can be used for the system's workflow. After capturing the query of the user and displaying its result, the application provides a real-time generated QR code in which the user can scan to also view the image result of their query in their phone. However, this will require an internet connection on the user's smartphone to load the image.

4.1.2 Software Design

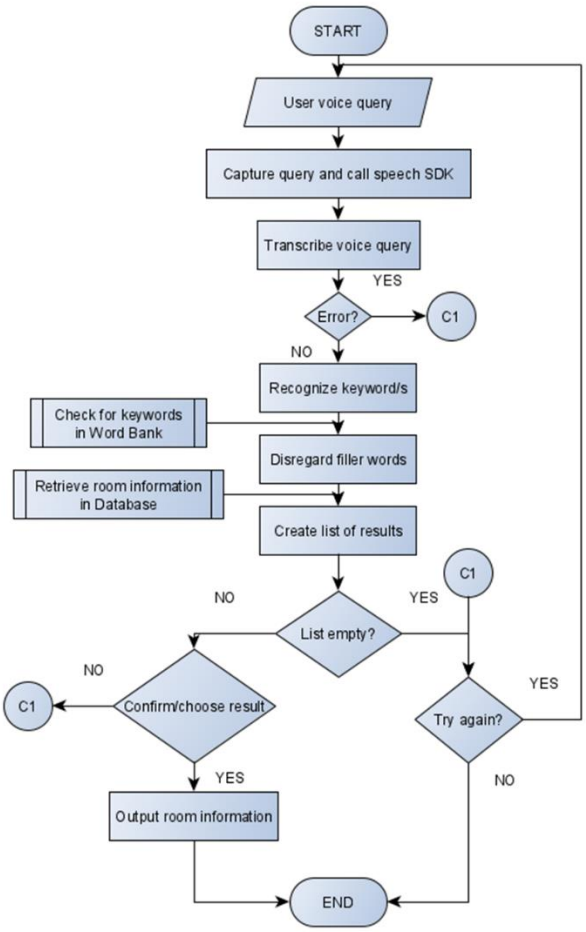


Figure 4.2 Program Flowchart

Once the RamNav application is started, the app will wait until the user says the key phrase "Hey, RamNav". Then, once it detects the key phrase, it would prompt the user to say their query. The system will capture the voice input and send to the Microsoft Speech SDK for processing the transcription. If an error occurs, the system will let the user rephrase their query. If there are no errors, the app will proceed to scan the dictionary for the possible keywords. The system will prompt the user to try again If the list is empty, which means that there were no keywords recognized. If the algorithm detects that the user is referring to only one single room, it will directly show the result based on the database query. If there are possible rooms being described by the user, then it would ask to specify a certain room. Once

the result is shown, it would just go back to the key phrase waiting phase until a user triggers the system again.

Core Algorithms

1. **Voice Acquisition**
    - An external microphone will be used to capture the user's voice query.
2. **Speech-to-text Transcription**
    - With the help of Microsoft Azure Speech Services, user's voice query will be transcribed into a text format.
3. **Keyword Recognition**
    - RamNav will detect the keywords from the voice query and will delete all filler words. The keywords are used for querying in the system's dictionary.
4. **Retrieving Query Result**
    - A list of possible results will be created from the user's query. Once the user confirms, the output will display the result of their desired room query.

4.2 Project Development

During the implementation of the system, the team used Sprint Planning as seen on Figure 4.3. The team started the development of the system by using the console for the output to test the initial program. After the deployment and review of the system using console, the team planned the next step which is to add the basic user interface. In this part, simple buttons were added and implemented using the same algorithm. Next, the team created an initial prototype with GUI. Speech Software Development Kit from Azure was also implemented to help with the accuracy for speech recognition part of the system. Additional features are to be added upon the request of the panelists. Lastly, final implementation of the system will be done once all the requirements from the panelists are fulfilled. The process of designing, developing, testing, deploying, reviewing, and launching repeats until a new plan is designed for the improvement of the system.

4.2.1 Software Development Life Cycle Model

Figure 4.3 Scrum Methodology: Sprint Model

Figure 4.3 shows what model the team followed which is Sprint Planning in Scrum Methodology. In the figure, the number of the sprints are just for illustration purposes. Sprints are the tasks or iterations of the system to be completed in a span of time. Since this process is a continuous development, more sprints are to be added when necessary.

Sprint 1: Console

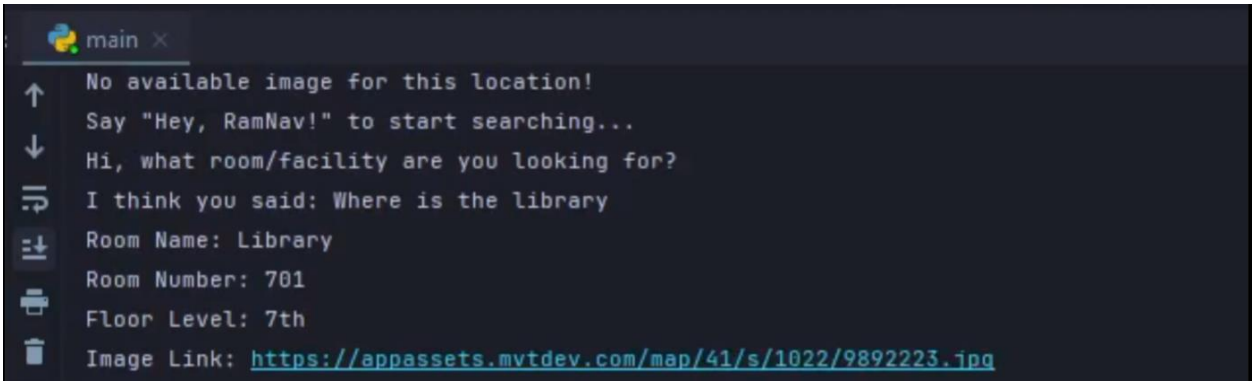


Figure 4.4 Sentence Query in Console Application

Figure 4.4 shows the console application where all outputs are text-based. When the user says “Hey, RamNav!”, the system will ask the user on what room is he looking for. The user will then ask the system of his desired room. After detecting the keyword from the user’s voice input, the system will output its corresponding room name, room number, floor level, and image link in text format.

```
main
Image Link: https://appassets.mytdev.com/map/41/s/1022/9892223.jpg
Say "Hey, RamNav!" to start searching...
Hi, what room/facility are you looking for?
I think you said: Cafeteria library
Your query returned multiple possible results:
1. cafeteria
2. library
Which one do you choose? (Say the name): 1
Room Name: Cafeteria
Room Number: 101
Floor Level: 1st
Image Link: Some-Link
No available image for this location!
```

Figure 4.5 Multiple Rooms Keyword Query in Console Application

Figure 4.5 shows when the system detects multiple keywords from the user's voice input. The system will show the possible results and will let the user choose his desired destination from the list. The output would be the user's chosen destination.

```
Say "Hey, RamNav!" to start searching...
Hi, what room/facility are you looking for?
I think you said: Auditorium
Room Name: Auditorium
Room Number: 1101
Floor Level: 11th
Image Link: Some-Link
No available image for this location!
```

Figure 4.6 Room Keyword Query in Console Application

Figure 4.6 shows when the user's voice input is directly the name of the room he is looking for. Unlike in Figure 4.4 where the user's input was in a sentence, in this figure it is just the keyword said by the user which was detected by the system.

Sprint 2: Basic User Interface

Figure 4.7 Basic User Interface's Start Screen

In Sprint 2, the team started creating the basic user interface. In Figure 4.7, a simple user interface is shown with the buttons search, report, update, and close. The search button is used when the user prefers to click the button rather than saying the keyword "Hey, RamNav!" to trigger the search of the user's voice input. Whenever the user encounters an error, he can use the report button to notify the admin. The update button is for the admin side where he can update the room's information. Close button is used when the user wants to exit the system. The algorithm in sprint 1 is the same as the one used in this sprint.

(a) (b)

Figure 4.8 Basic User Interface: (a) Query (b) Room Queried

In Figure 4.8 (a), the displayed text is shown once the system detects the keyword "Hey, RamNav!" from the user's voice input or once the user clicks the search button. In here, the system will prompt the user for their room or facility query. Shown in Figure 4.8 (b) is the room queried by the user.

Figure 4.9 Room Information in Basic User Interface

In this figure, the room information queried by the user is shown which includes the room name, room number, floor level, and the image link of the room's location.

Sprint 3: Initial Prototype

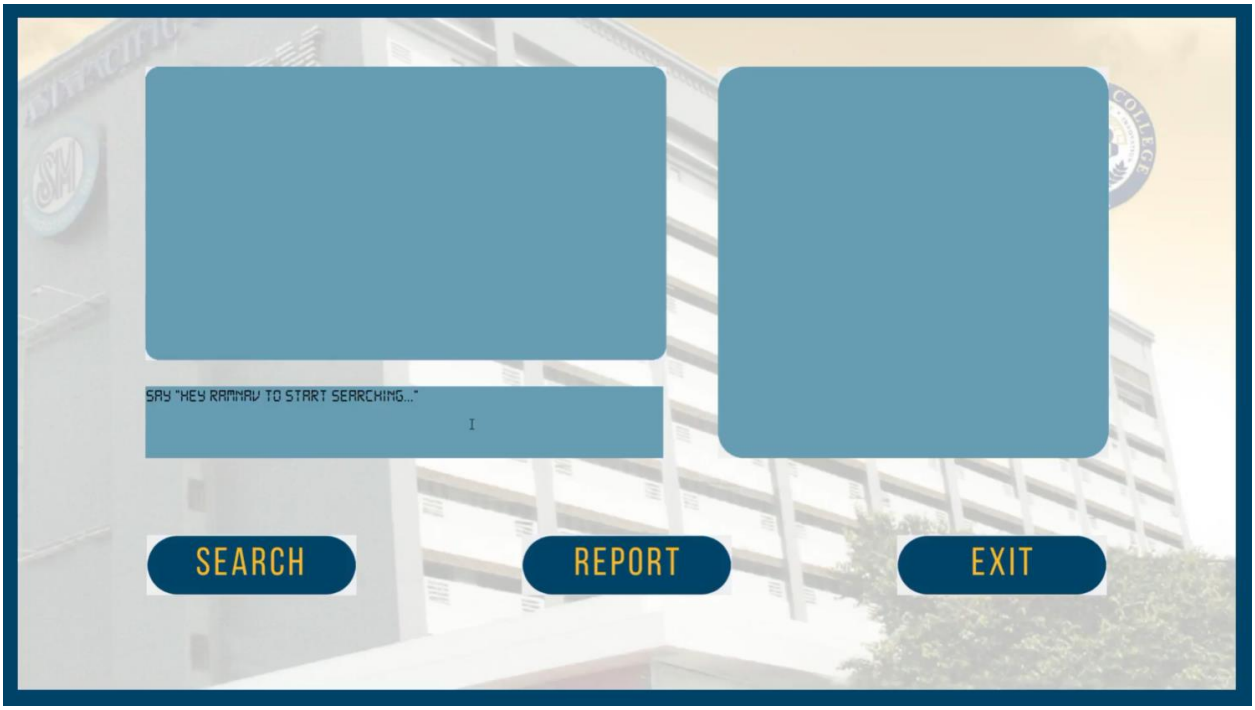


Figure 4.10 Initial Prototype: (a) Start Screen

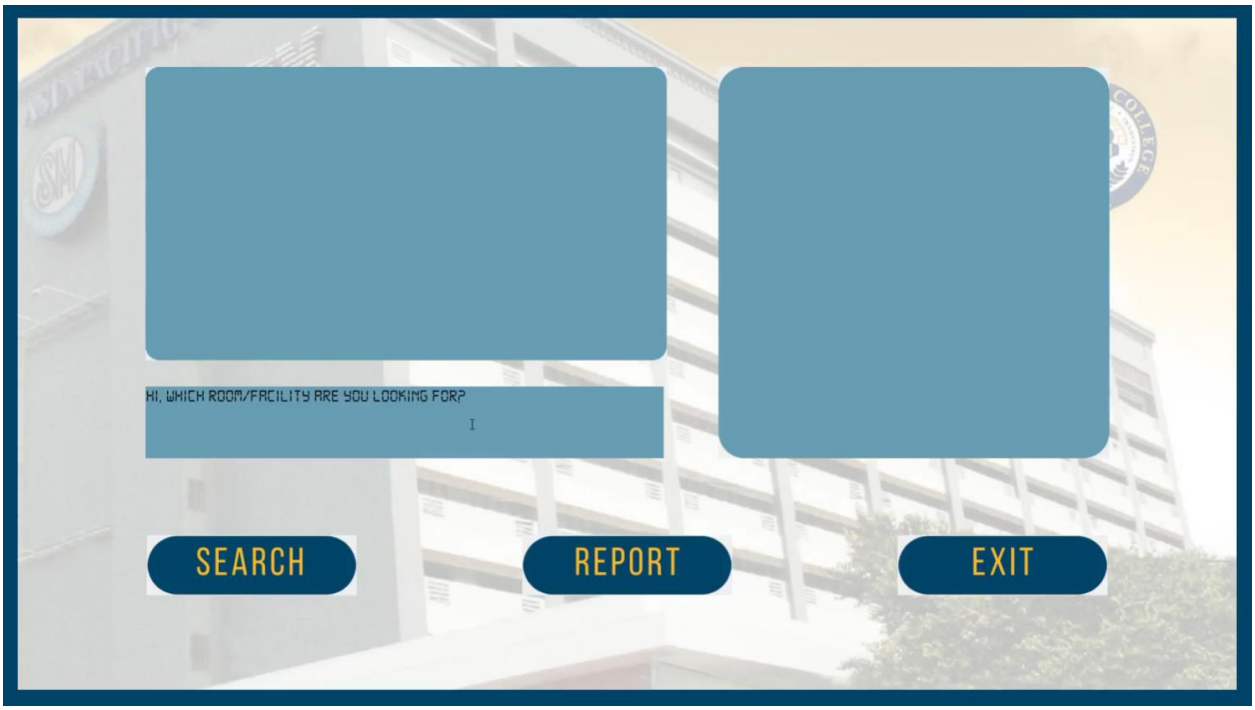


Figure 4.10 Initial Prototype: (b) Query Screen

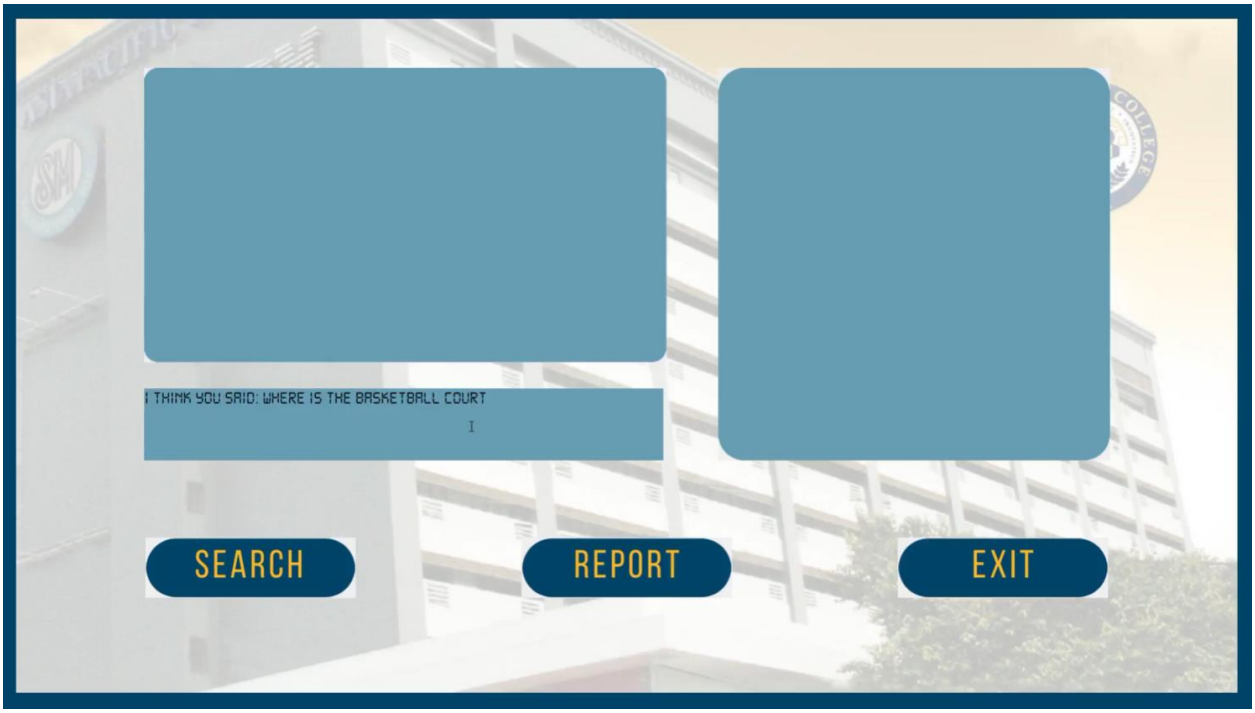


Figure 4.10 Initial Prototype: (c) Queried Keyword Detected

In Sprint 3, an initial prototype was created by the team. In here, the user interface design was incorporated to make the system more appealing. The update button from the second sprint is not displayed here in sprint 3 since that would be part of the admin side. Report button is for the user to notify the admin of any errors encountered. Exit button will be used once the user wants to close the system. In figure 4.10 (a), this is the start screen once RamNav application is opened. In figure 4.10 (b), this is the screen shown to the user once the system detects the keyword “Hey, RamNav!” from the user’s voice input or when the search button is clicked. Figure 4.10 (c) is shown once the system recognizes the keyword from the room queried by the user.

Figure 4.11 Room Queried Result

In this figure, the room queried by the user is shown. A map of the floor of the room queried is displayed for the user to visualize where he is headed to. In this figure, only a sample image was displayed to test its functionality. A QR code is also displayed for the user to scan on his personal device which also contains the map so that he can look at it on the way to his desired room without the need to remember it.

Project Management Tool

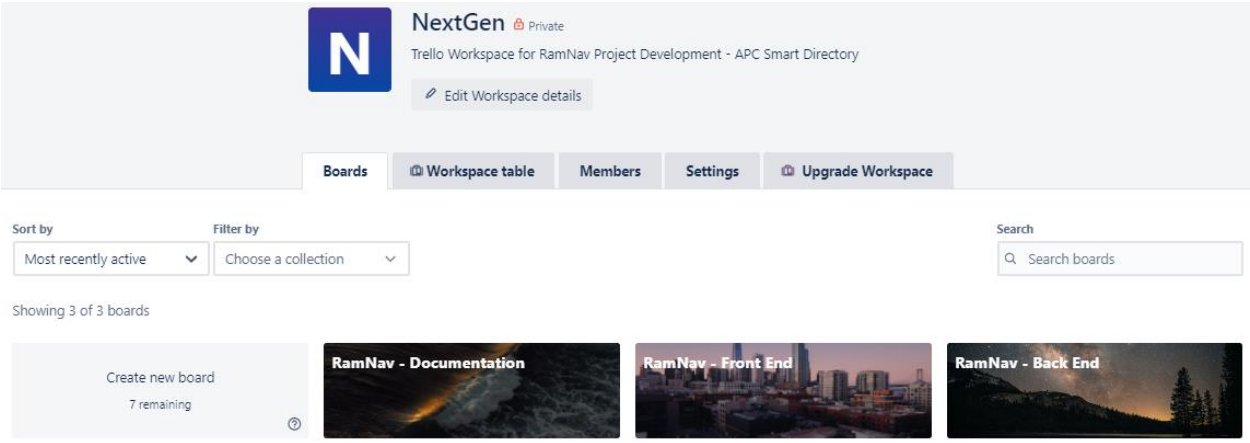


Figure 4.12 Trello Board

The team used Trello to keep track of the assigned tasks in project management. Three boards were created in Trello which are Documentation, Front End, and Back End. The Documentation board is for the paperwork. Front end is for the UI designs and Back End is for the database and programming. The four tabs that separate our job for these boards are To Do, Doing, For Review, and Done. This is where the task lists are placed and assigned to each member on the To Do list. The next step is to create a Doing list where you may list the duties you've been assigned to so that everyone knows what to do next. And for the Review list, the leader will assess the progress and make recommendations on areas where the documentation should be improved or where updates are required. Finally, there is a Done list where the team put completed tasks and go back to the To Do list until everything is done. Trello makes working online more convenient by allowing the team to easily collaborate and for the repository of files.

4.2.2 Prototype Design

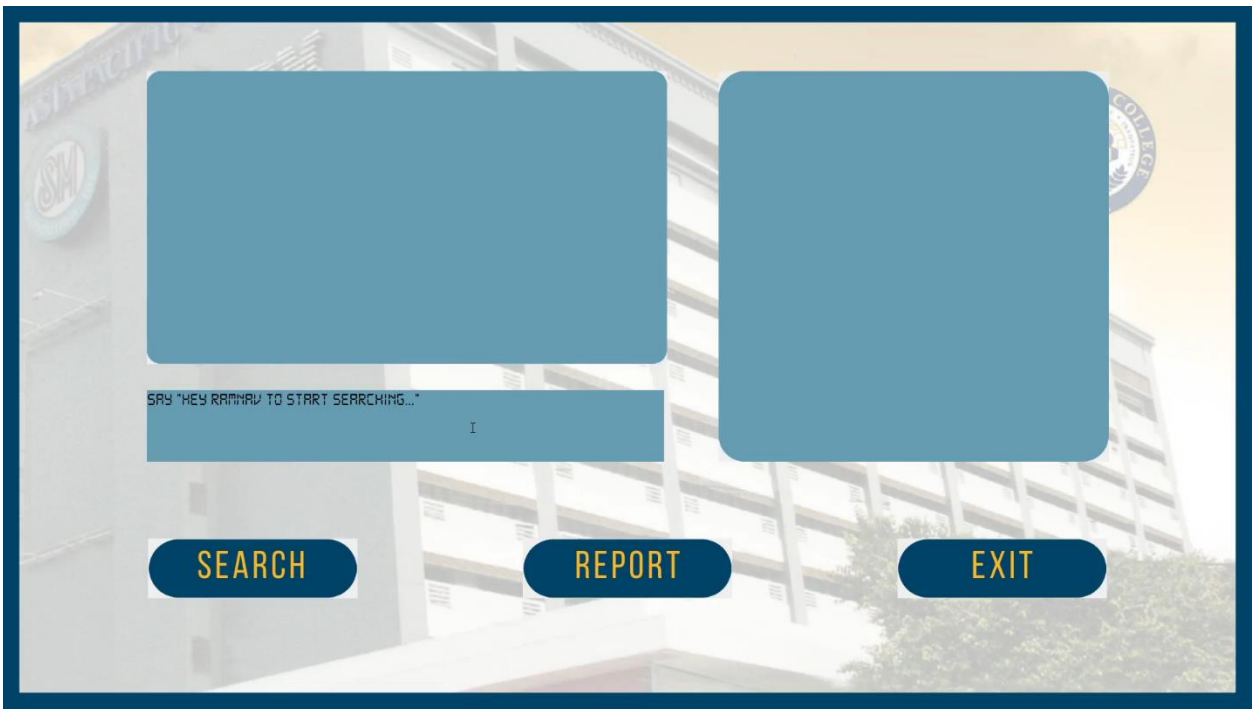


Figure 4.13 Start Screen Prototype Design

Shown in this figure is the first thing that the user will see when using RamNav. This is the main screen where the user will see the instruction seen on the lower right box. There are also three buttons which would be discussed in the following figures.

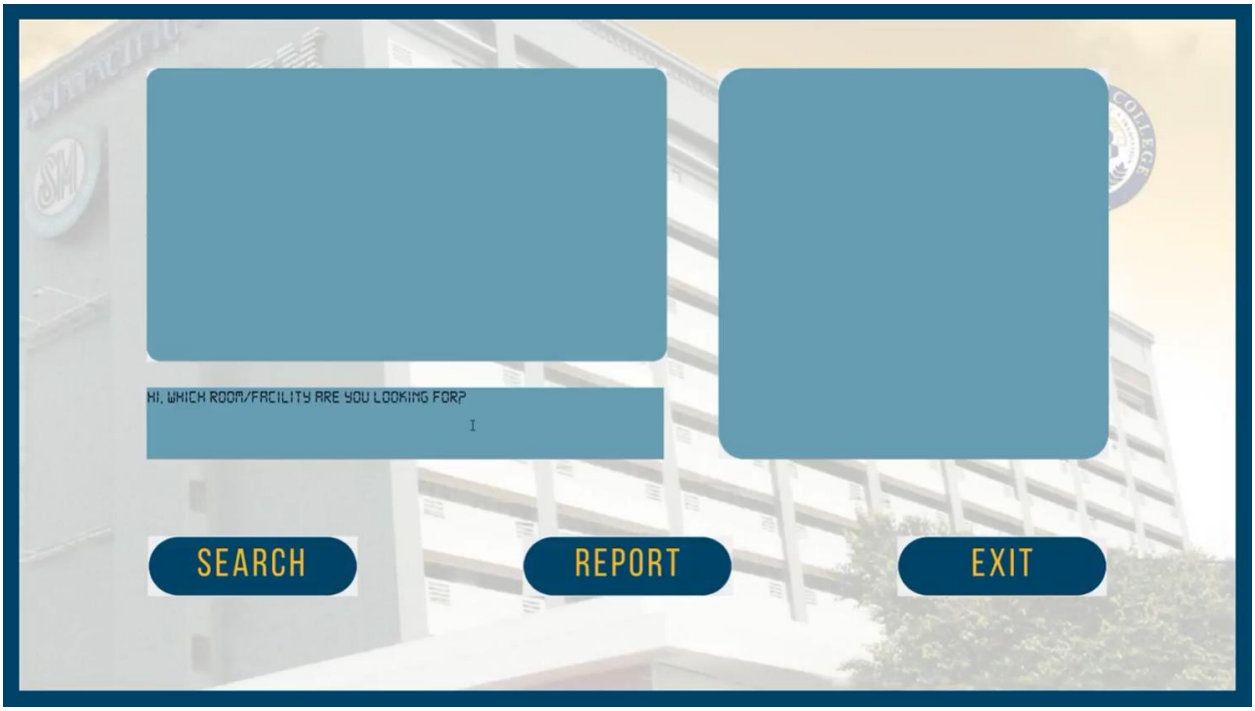


Figure 4.14 User Query Page Prototype Design

After the system detects the key phrase “Hey, RamNav!” from the user’s voice input or when the user clicks the search button, the system will ask which room or facility the user is looking for to proceed as shown in this figure.

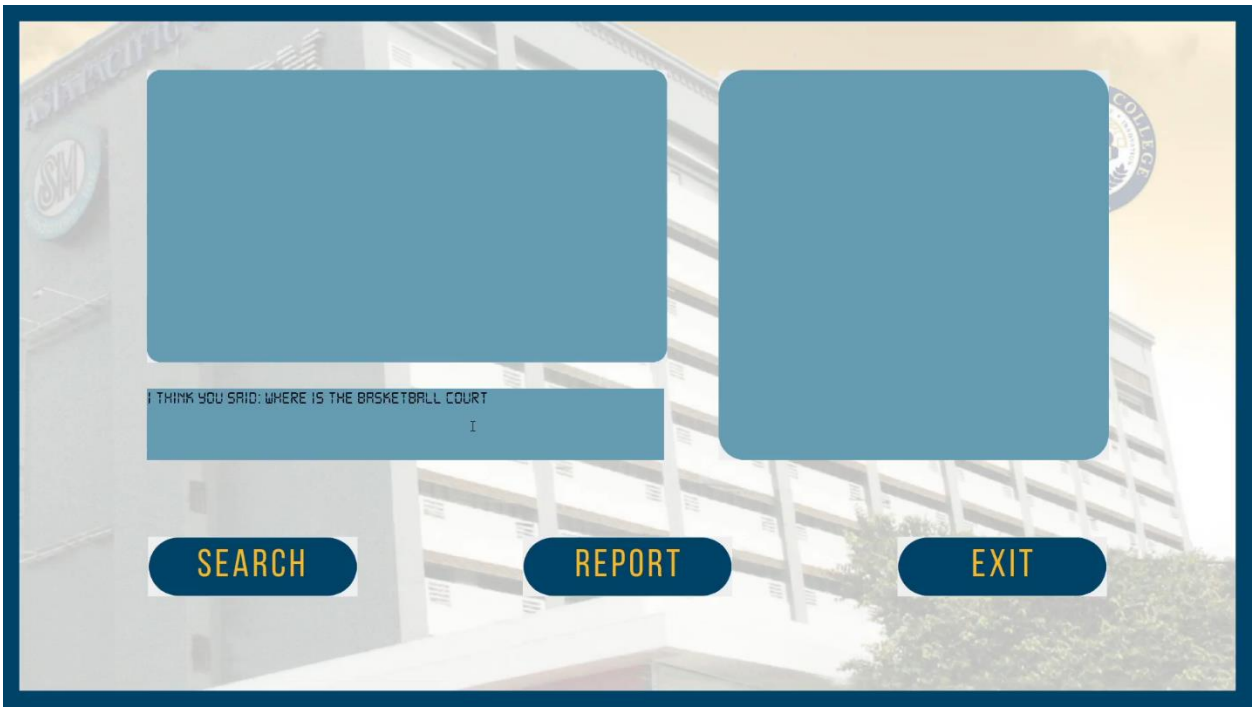


Figure 4.15 Display User's Query Page Prototype Design

Once the system detects the keyword from the user query, the room or facility name detected will be displayed as shown in Figure 4.15.

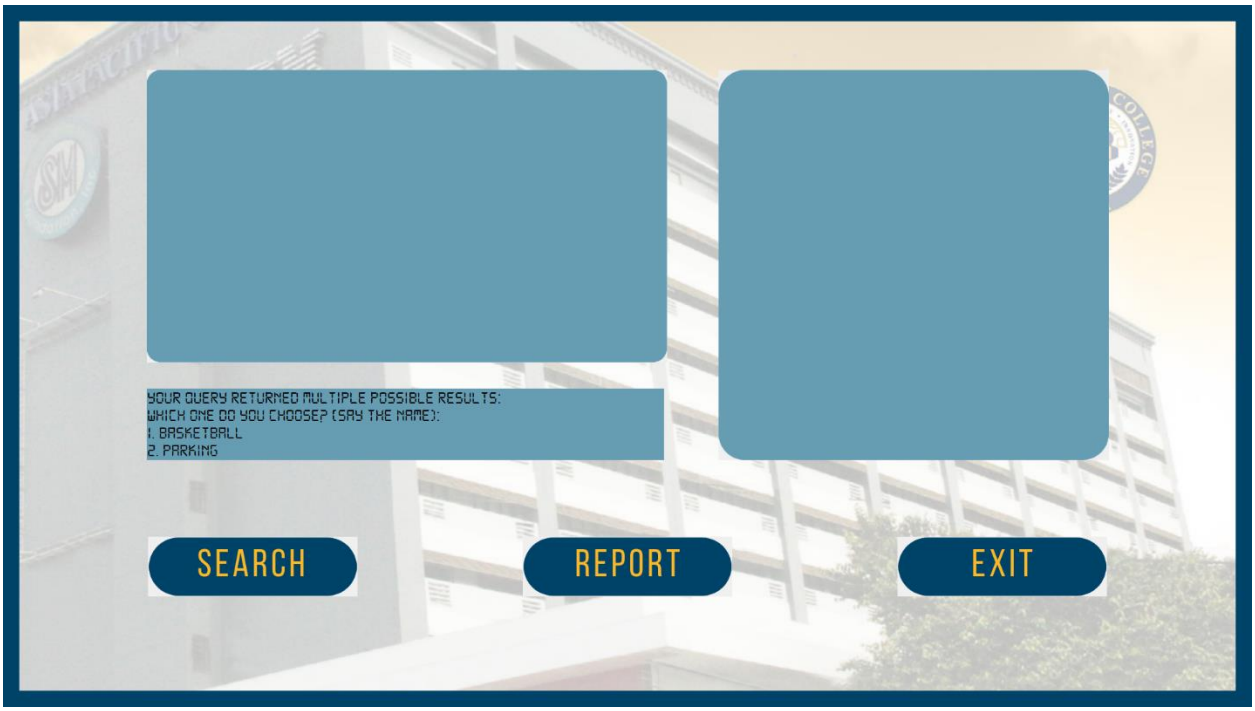


Figure 4.16 Multiple Results Page Prototype Design

In Figure 4.16, the system detected multiple results from the user's query. The program will provide possible results whenever it detects multiple keywords, so that the user can select which facility or room they are looking for.

Figure 4.17 Output Page Prototype Design

After selecting a specific facility or room, the program will provide a QR code in which the user can scan using his personal device so that the search result can also be accessed on their phone. The QR code contains the map that is shown in this figure so that the user will not forget where he is headed to. If the user encounters error or problems with the system, the user can click the report button to notify the admin.

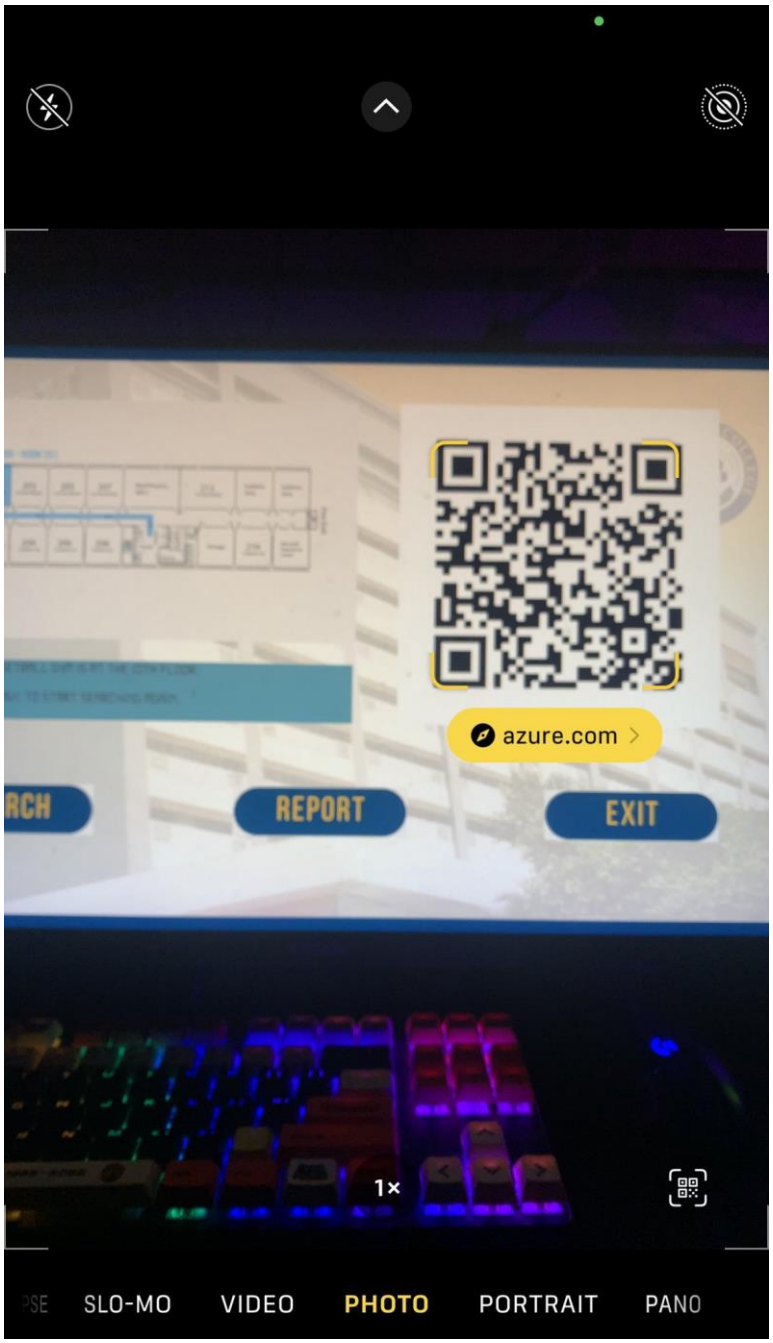


Figure 4.18 Screenshot once QR code is Scanned

This figure is a sample screenshot once the phone scans the QR code shown in the result. By clicking the link, it will direct the user to a browser which will show the image of the map of his queried room or facility location. When the user wants to close RamNav and go back to the main screen, he can click the exit button.

4.2.3 Graphical User Interface

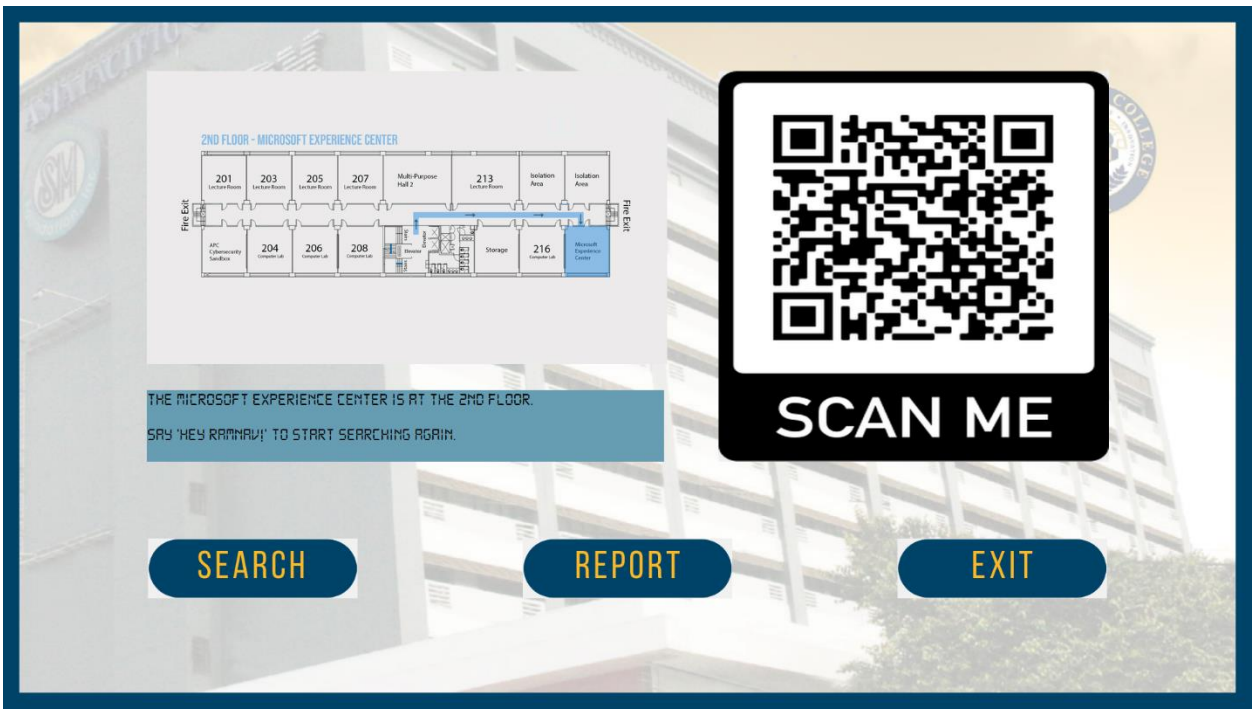


Figure 4.19 RamNav Application

RamNav's Graphical User Interface (GUI) is inspired by the colors of Asia Pacific College (APC) since the system is for its building directory. Three boxes were placed on the middle part of the screen which are for the display of map, display of text instructions, and display of QR code. Three buttons were placed in the bottom part of the screen which are the search, report, and exit buttons.

4.2.4 Database Set-up

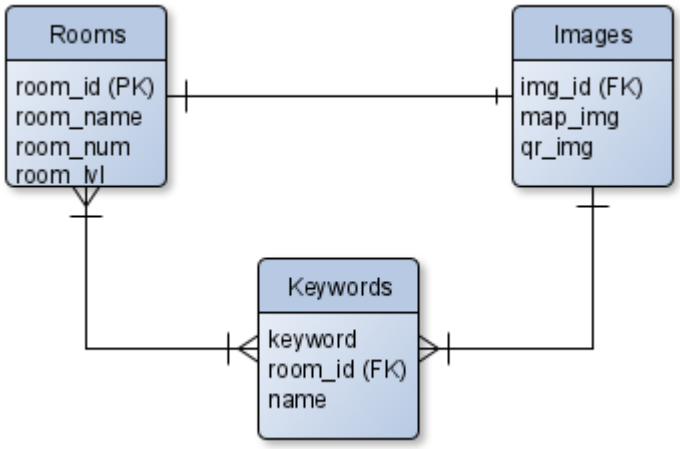


Figure 4.20 Database Set-up

This is the initial draft of the RamNav database. There are currently 3 tables: Rooms, Images, and Keywords. The “Rooms” table contains the basic information needed for each room in the APC building. Since not all rooms or offices in APC have a designated room number, the group designated a separate column for the primary key of this table.

For the “Images” table, it has 2 attributes containing the image links for the QR codes and the map images that will be used for the main application. The image ID is a foreign key referencing to the room ID since each room has unique map and QR image links.

Lastly, the “Keywords” table is made for storing all the keywords that will be used by the application. It has 3 attributes. The Room ID is also a foreign key referencing the Room ID attribute from the “Rooms” table. Then, the name attribute pertains to the room name, and the keywords are the 3 different keywords allotted for each individual room that will be in separate columns.

4.2.5 System Security Set-up

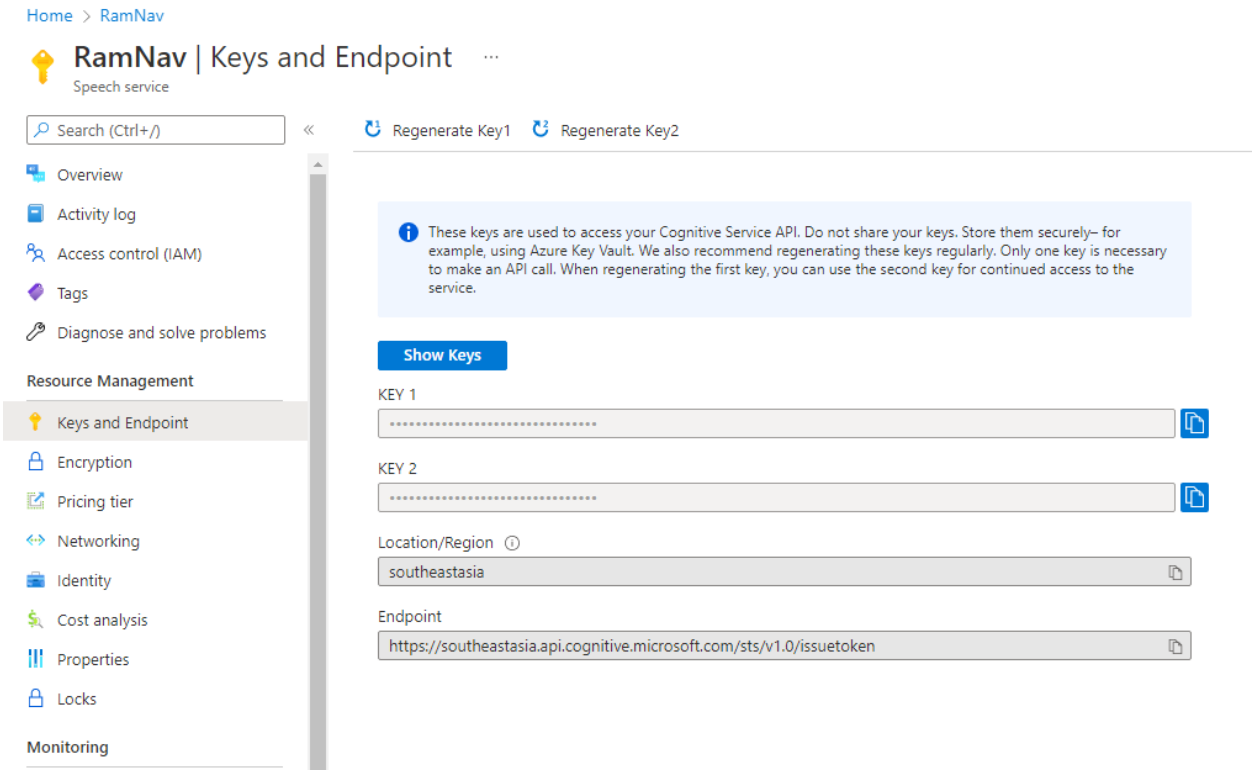


Figure 4.21 System Security Set-up

The figure above shows the security configuration setup for the Microsoft Speech API that is being used for the project. The group has a private key that is coded in the Python application to enable the instantiation of the needed Microsoft Speech SDK resources.

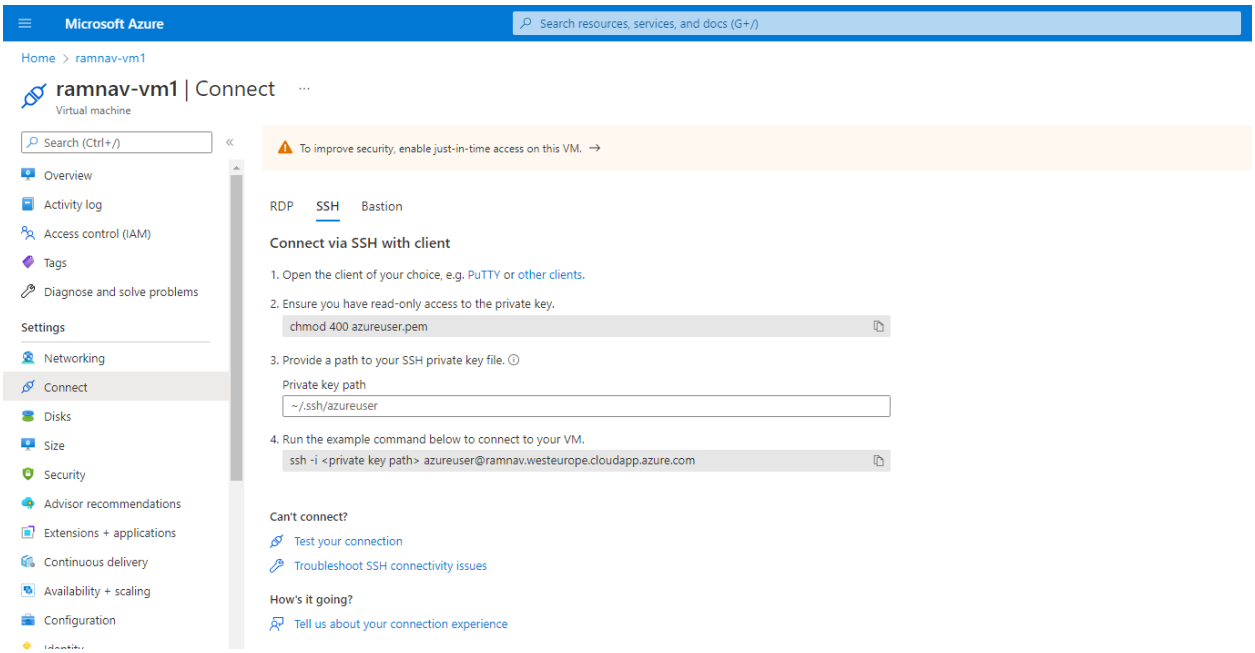


Figure 4.22 Configuration Safely Connected to Linux Virtual Machine

The figure above shows the configuration of safely connecting to the Linux virtual machine that we have set up in Azure. Microsoft provided the group with a private key file that is being imported every time we are trying to connect to the virtual machine via an SSH tunnel.

4.3 Testing Procedures and Analysis

Actual specifications are indicated in the table below from the proposed specifications in chapter 3 after the team developed the prototype. The table below also shows the status of each function.

4.3.1 Functional Testing Analysis

The following tables shows the testing results for each function of the system. The team' procedures for testing each function are indicated below.

Table 4.1. Testing Results for Acquiring Voice

Test Case	Background Noise		Speaker		Distance		Room Search Triggered		Remarks
	High	Low	Male	Female	Far	Near	Yes	No	
1	✓		✓		✓		✓		Multiple attempts and requires adjustment of user's voice
2	✓		✓			✓	✓		Successful first attempt with default threshold
3	✓			✓	✓		✓		Multiple attempts and requires adjustment of user's voice
4	✓			✓		✓	✓		Successful first attempt with default threshold
5		✓	✓		✓		✓		Adjusted mic threshold settings for varying distance
6		✓	✓			✓	✓		Successful first attempt with default threshold
7		✓		✓	✓		✓		Adjusted mic threshold settings for varying distance
8		✓		✓		✓	✓		Successful first attempt with default threshold

Table 4.1 shows the testing procedures for acquiring the user's voice. The team tested in a loud and quiet environment, different pitches of voice, and how far or near the mic when acquiring the voice. A loud environment has a background noise of greater than 30 decibels while a quiet environment has a noise of less than 30 decibels. The distance of the microphone from the user was tested where a far scenario is more than 10 inches away, while a near scenario is at least 6 inches nearer from the microphone. Testing all these different scenarios, the team were still able to trigger the room search.

Table 4.2. Testing Results for Speech-to-Text Transcription

Test Case	Background Noise		Speaker		Distance		Convert speech to text		Remarks
	High	Low	Male	Female	Far	Near	Yes	No	
1	✓		✓		✓		✓		Successful at first attempt with no error
2	✓		✓			✓	✓		Successful at first attempt with no error
3	✓			✓	✓		✓		Successful at first attempt with no error
4	✓			✓		✓	✓		Successful at first attempt with no error
5		✓	✓		✓		✓		Successful at first attempt with no error
6		✓	✓			✓	✓		Successful at first attempt with no error
7		✓		✓	✓		✓		Successful at first attempt with no error
8		✓		✓		✓	✓		Successful at first attempt with no error

Table 4.2 shows the testing procedures for speech-to-text transcription. The team were able to test whether the system can convert the user's voice query into text in the same scenarios seen on table 4.1. The system was able to display a text from the voice input.

Table 4.3. Testing Results for Keyword Recognition

Test Case	Query Method	Keywords Recognized			Filler Words Deleted			Remarks
		All	Some	None	All	Some	None	
1	Room Name	✓			✓			Successful
2	Room Number	✓			✓			Successful
3	Room Keyword	✓			✓			Successful
4	Mixed	✓			✓			Successful

Table 4.3 shows the testing procedures for keyword recognition. From the transcribed text, the system was able to delete all the filler words and retain only the necessary keywords. The team followed the testing for keyword recognition using the four test cases indicated in the table. The team tested using different room names, room numbers, room keywords, and a mix of the three. Some examples of the tested rooms were Auditorium, room number 202, and "enroll" keyword. All the test cases tested by the team were successful in terms of keywords recognized and deleted filler words from the user's query.

Table 4.4. Testing Results for Word Bank Keyword Querying

Test Case	Query Method	Exists in Word Bank		Response		Remarks
		Yes	No	TRUE	FALSE	
1	Room Name	✓		✓		Successful
2	Room Name		✓		✓	Successful
3	Room Number	✓		✓		Successful
4	Room Number		✓		✓	Successful
5	Room Keyword	✓		✓		Successful
6	Room Keyword		✓		✓	Successful

Table 4.4 shows the testing procedures for word bank keyword querying. The team were able to test the function for word bank keyword querying wherein it discards keywords that does not exist in the word bank or dictionary and only retains the keywords that are in the dictionary. Some room names, numbers, and keywords tested were room 1213, where the system returned false since this room number does not exist in the word bank. There is only one room in the 12th floor which is room number 1201 or the Auditorium. Another is "Where can I isolate myself?" where the system recognized the keyword isolate that directed the user to the isolation room.

Table 4.5. Testing Result for Search Result Creation

Test Case	Keywords Found		Room/s Matched		Rooms in Search Result			Remarks
	Single	Multiple	Single	Multiple	All	Some	None	
1	✓		✓		✓			Successful
2	✓			✓	✓			Successful
3		✓	✓		✓			Successful
4		✓		✓	✓			Successful

Table 4.5 shows the testing procedures for search result creation. After testing the different test cases, the rooms associated with the keywords were successfully displayed in the search result. Refer to figure 4.23 as an example of the test result for search result creation.

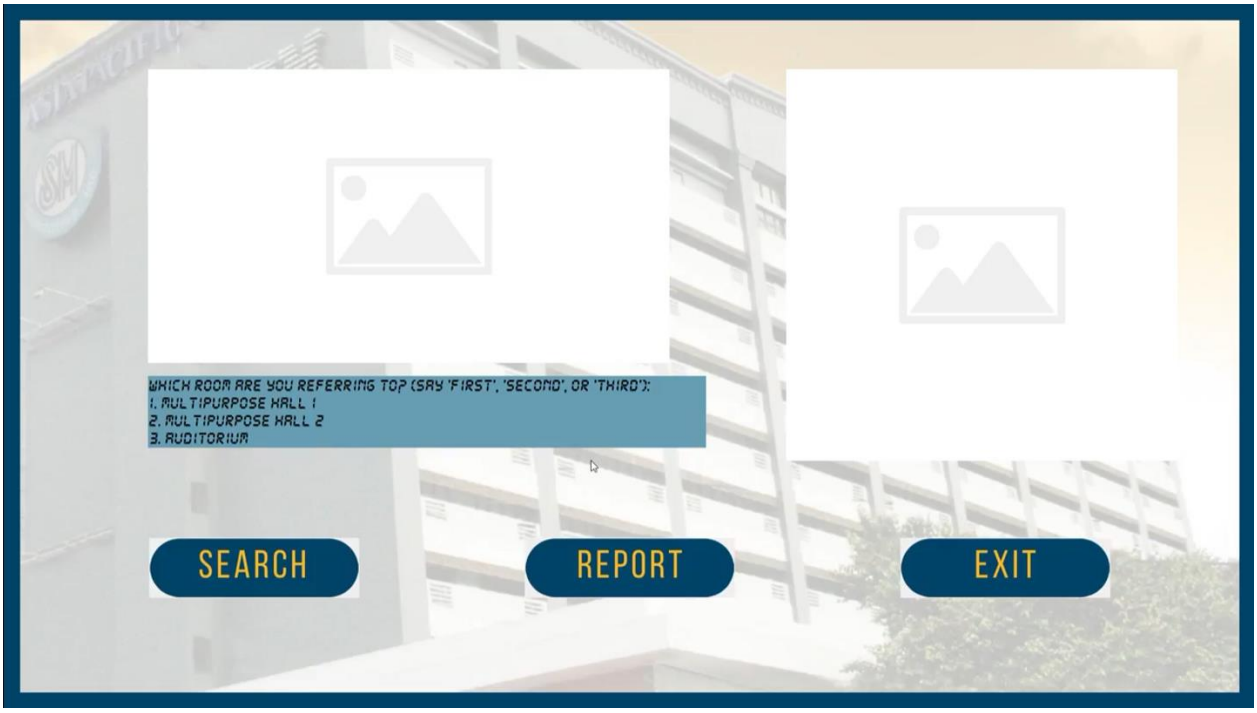


Figure 4.23 Search Result Creation

Figure 4.23 shows the search result creation from the phrase “Where is the event?” where the system detected the keyword “event” that displayed multiple and possible results where an event usually takes place as seen on the figure.

Table 4.6. Testing Result for Retrieving Query Result

Test Case	Search Results		Correct Info Retrieved			Info Stored		Remarks
	Single	Multiple	All	Some	None	Yes	No	
1	✓		✓			✓		Successful
2		✓	✓			✓		Successful

Table 4.6 shows the testing procedures for retrieving query result. The system was able to retrieve the correct information of the room from the database based on the room picked by the user from the search result. Refer to figure 4.24 as an example of the test result for retrieving query result.

Figure 4.24 Query Result Retrieval

Figure 4.24 shows the query result retrieval from what room the user picked from figure 4.23. The user picked the first one which is the multipurpose hall 1 that correctly displayed as seen on the figure.

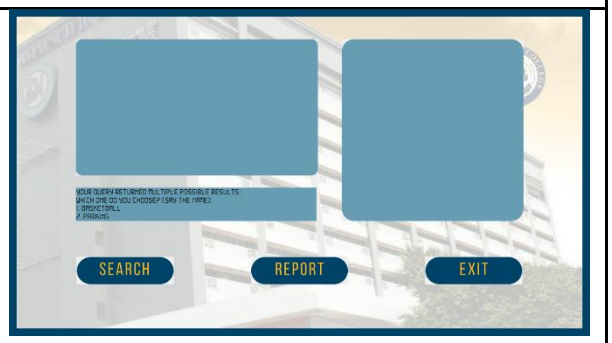
Table 4.7. Testing Result for Displaying Room Information

Test Case	Search Results		Displayed Info		Remarks
	Single	Multiple	Correct	Incorrect	
1	✓		✓		Successful
2		✓	✓		Successful

Table 4.7 shows the testing procedures for displaying room information. The system was able to display the information of the desired room queried by the user. When there are multiple search results, the user will pick from the list, and it would still display the correct room information.

Table 4.8 Proposed Specifications vs. Actual Specifications

Function	Type	Proposed Specification	Actual Specification
Realtime Voice Acquisition	Principal	This function will be done with the use of an external microphone to capture the voice query by the user.	An external microphone was used to capture the user's voice query.
Speech-to-text Transcription	Principal	The voice query from the user will be transcribed into a text format using an online SDK.	User's voice query was transcribed to text using the Speech Services of Microsoft Azure.
Keyword Recognition	Principal	The system would delete all the filler words in the user's query and only the keywords would remain. The keywords would be used for querying in the system's Word Bank	The system disregards the filler words and only focuses on the keywords from the user's voice query with the help of Microsoft Azure services.
Retrieving Query Result	Principal	The system would create a list of possible results from the user's query. Once they've confirmed, it will show the result of their query.	The system will create possible list results from the user's query, then will output the queried room once confirmed.
Keyword List Creation	Secondary	Once the voice query is already in a text format, this function would separate the words of the text individually to serve as the initial list of keywords.	Keywords are created from the words transcribed to text and are separated into individual text.

Word Bank Keyword Querying	Secondary	This is the part where the system will check if the keywords exist in the system's Word Bank. If not, they will be discarded.	The system will check if the keywords are part of the Dictionary. If the keywords do not exist, it will be discarded.
Search Result Creation	Secondary	Keywords that have a match on the system's word bank would be considered as the final keyword for the search query. There are possibilities of one (1) or more keywords that are recognized in the user's query so the user will select and confirm which room/result they are looking for.	 The system can detect multiple keywords from the user's voice query. The possible results will be displayed, and the user can choose which room or facility they are looking for.
Room Information Retrieval	Secondary	This function is to retrieve all the necessary details of the room that will be shown in the search result. It will be stored in a variable for easy access.	The details of the room are retrieved from the database that will be shown in the search result.

Output Result	Secondary	The system will display the room information on the user's end, and there would be an option to go back to the main screen or do another room query.	 The system will display a map contaning the location of the room queried. The room information is also available in text format seen below the map. The QR code is for the user to save the map on his phone. Once the exit button is pressed, the user will go back to the main screen where he can do another room query. A report button is also visible when the user encounters an error with RamNav.

Table 4.8 shows the proposed versus actual specifications per function. The actual specifications of each function did not differ much from the proposed specifications. Images were added to further understand the specifications indicated.

Chapter 5

RESULTS AND DISCUSSION

5.0 Changes on Testing and Evaluation

5.0.1 Public Testing Sampling Method

Due to limited time uncontrolled variables in finding participants for the public testing like unwilling people, language barrier, etc., the team have decided to change the sampling method from stratified random sampling to convenient sampling. Below are the details of the former and actual sampling methods.

Stratified Random Sampling (Former)

The original selection process was to invite a random passerby in the APC lobby if they are willing to test out the system. There are 4 strata being considered—students, faculty, staff, and guests. 10 volunteers for each stratum and a total of 40 participants.

Convenience Sampling (Revised)

The revised selection process was to invite a random passerby in the APC lobby if they are willing to test out the system. Due to the limitation in time, behavior, and other uncontrolled factors, the proportion will be 28 students, 5 faculty, 5 staff, and 2 guests. This will still gather a total of 40 participants.

5.0.2 Accuracy Testing Scenario Variable

As per the indicated dB-A level of the System Accuracy Testing for scenario 1 and 2, the different background noise level classifications are: <30 decibels for low background noise and >30 decibels for high background noise. Upon further research, the team realized that the more ideal classification for low background noise is <60 decibels while high background noise starts at >60 decibels.

5.1 System Testing and Evaluation

5.1.1 Additional Procedure for APC Public Testing

One of the testing procedures was to gather feedback from the target audience about the user-friendliness and accessibility of the system by conducting a public beta test in the APC Lobby. With that, the team have decided to also manually log the testing scenarios to measure the accuracy and reliability score. There were around 180 attempts/queries recorded from 40 different persons during the whole testing period. The background noise level is at 70-80 dB-A and the distance to the microphone is near (around 6 inches away).

5.1.2 RamNav Public Testing Results in APC Lobby

For the transcription accuracy, the system got an average of 37% for word error rate and 63% for accuracy. Meanwhile, it attained a score of 93.10% keyword recognition rate. The team inferred that the main factors of getting a low transcription accuracy was due to the background noise level of the location and the number of words that the testers are using which can easily make the transcription score sensitive. Refer to Appendix J for the results.

5.1.3 Team's System Testing Results

This is the system testing checklist for the accuracy objective of the project. The 6 different scenarios should ideally get at least 90% recognition rate for it to be deemed successful. There were 3 male and 3 female testers. Each scenario was tested 30 times each, 5 queries per tester. For the male and female speaker scenario, 10 queries per male tester and 10 queries per female tester were accomplished.

Table 5.1 Accuracy Table Testing

No.	Accuracy Test	Checklist		Remarks
		Yes	No	
1	Able to transcribe user voice query with low background noise.	✓ 99.53%		Successful – Excellent Rating
2	Able to transcribe user voice query with high background noise.	✓ 98.27%		Successful – Excellent Rating
3	Able to transcribe user voice query for male speaker.	✓ 94.73%		Successful – Excellent Rating
4	Able to transcribe user voice query for female speaker.	✓ 100.00%		Successful – Excellent Rating
5	Able to transcribe user voice query from near distance.	✓ 99.17%		Successful – Excellent Rating
6	Able to transcribe user voice query from far distance.	✓ 97.03%		Successful – Excellent Rating

For the accuracy checklist, the system has passed all the criterion based on the team' testing results. It means that the system got at least an accuracy rating of at least 90% for each scenario, which was the ideal target for this objective. You can refer to Appendix L for the complete testing log for this objective.

5.1.3.1 System Accuracy Testing Results Breakdown

This table shows the complete breakdown of each scenario's Word Error Rate and Transcription Accuracy scores. The test was conducted by 3 males and 3 females. Each scenario has 30 trials, and a total of 180 trials for all 6 scenarios. Refer to Appendix L for complete breakdown of the testing results.

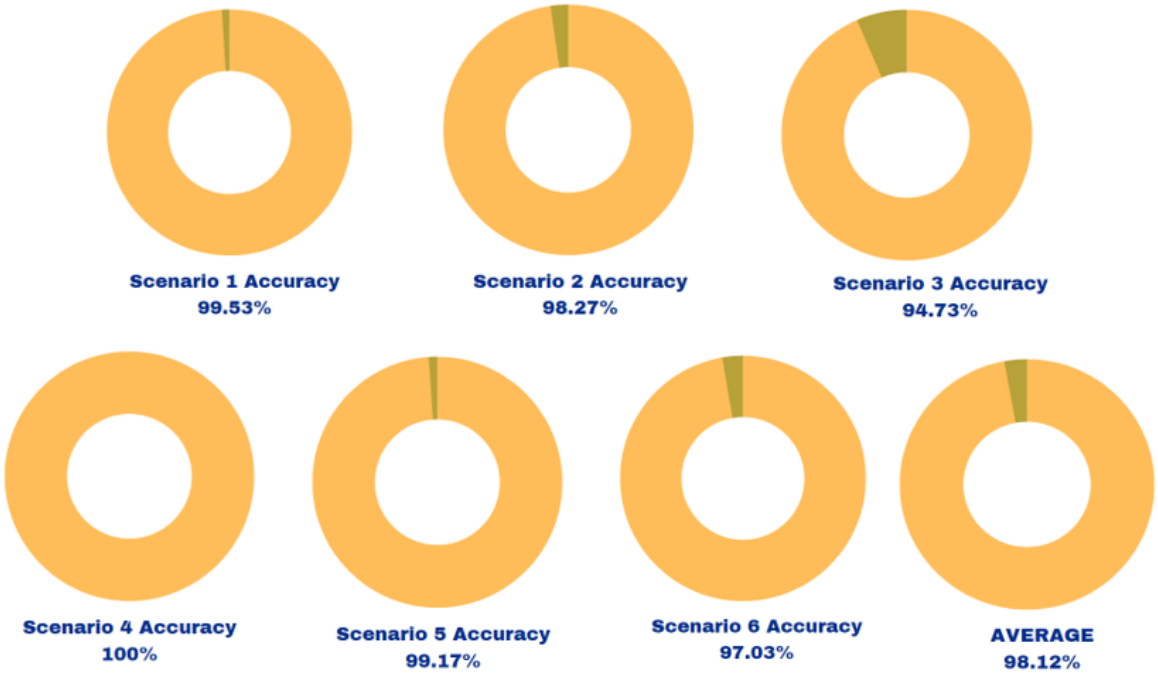


Figure 5.1 Accuracy Testing Results Visualization

From these results, the team observed that there is only 1 scenario that has a significantly high Word Error Rate compared to the others—the transcription for male speakers. The factors for this result might be the Azure Speech-to-Text API used for the system and the difference in voice modulation. Overall, the team were able to get a score of 98.12% accuracy rating. You can refer to the appendices for the complete testing log for this objective.

Table 5.2 is the system testing checklist for the reliability objective of the project. The 3 different scenarios should ideally get at least 90% recognition rate for it to be deemed successful. Each of the words in the dictionary were tested 5 times each.

Table 5.2 Reliability Table Testing

No.	Reliability Test	Checklist		Remarks
		Yes	No	
1	Able to recognize above 90% of room names in the Word Bank.	✓ 92.52%		Successful – Excellent Rating
2	Able to recognize above 90% of room numbers in the Word Bank.	✓ 100.00%		Successful – Excellent Rating
3	Able to recognize above 90% of room keywords in the Word Bank.	✓ 98.14%		Successful – Excellent Rating

For the reliability checklist, the system has passed all the criterion based on the team' testing results. It means that the system got at least an accuracy rating of at least 90% for each scenario, which was the ideal target for this objective. You can refer to Appendix M for the complete testing log of for this objective.

5.1.3.2 System Reliability Testing Results for Room Names

This shows the system reliability testing results for room names. There was a total of 139 room names that were tested 5 times each. All the rooms from 1st to 12th floor of the APC building not including the rest rooms were included in the system based on the document sent by the Building Admin last October 18, 2021. Refer to Appendix M for the table.

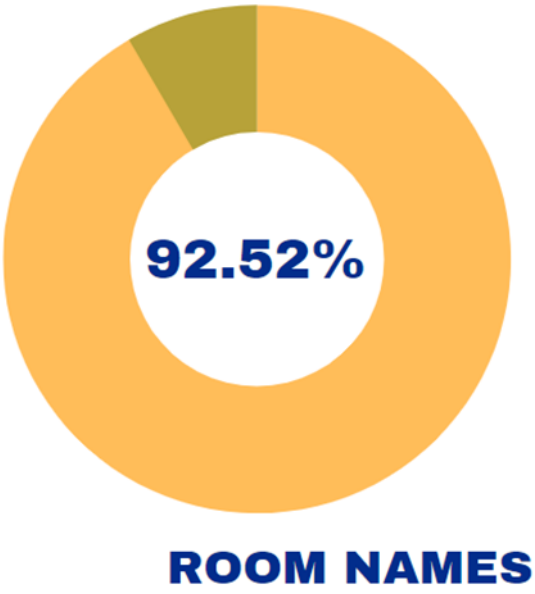


Figure 5.2 Reliability Testing Results Visualization for Room Names

From the result above, the system was able to hit the target score of at least 90%. This recognition rate means that during the testing period, there were 695 instances of user queries using room names, but the system did not recognize the room name in 52 of those instances.

5.1.3.3 System Reliability Testing Results for Room Numbers

This shows the system reliability testing results for room numbers. There was a total of 119 room numbers that were tested 5 times each. Since the team were not able to identify a corresponding room number for some rooms, they were left blank and cannot be tested. Refer to Appendix M for the table.

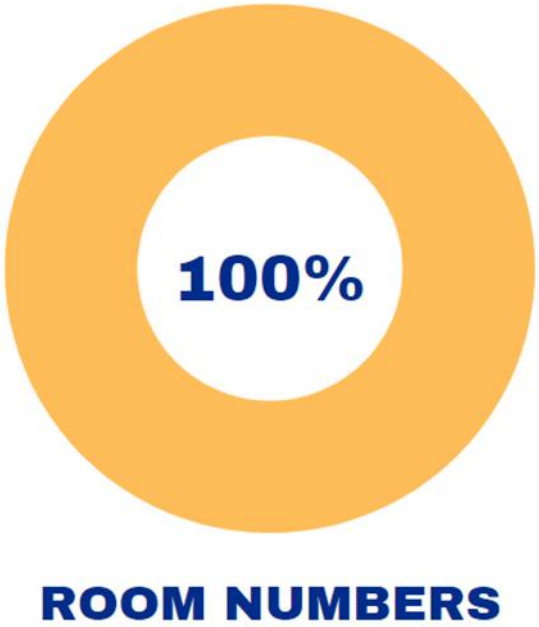


Figure 5.3 Reliability Testing Results Visualization for Room Numbers

From the result above, the system was able to hit the target score of at least 90%. This recognition rate means that during the testing period, there were 595 instances of user queries using room names, and the system did an excellent job of being able to correctly identify all those queries.

5.1.3.4 System Reliability Testing Results for Room Keyword

This shows the system reliability testing results for the number of keywords. There is a total of 258 keywords in the dictionary that were tested 5 times each. All of the rooms were given 3 keywords each. Refer to Appendix M for the table.

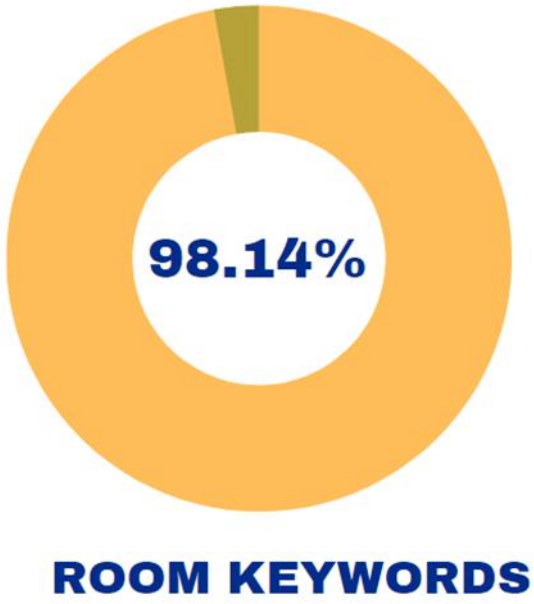


Figure 5.4 Reliability Testing Results Visualization for Room Keywords

From the result above, the team were also impressed and satisfied with the testing results for each of the room keywords. It was a very long and challenging testing process due to the huge number of keywords and trials which is 1290 instances.

For the user-friendliness testing of the system, the team measured it by using Likert scale via an online survey during the public system testing of the project in the APC Lobby. There were 40 respondents randomly selected via convenience sampling.

Table 5.3 User-Friendliness Testing

No.	User Friendly Test	Checklist		Remarks
		Yes	No	
1	Search result image is appealing and comprehensible.	✓ 4.68		Satisfied
2	Navigation labels are clear.	✓ 4.73		Satisfied
3	Navigation labels are concise.	✓		Satisfied

		4.73		
4	Information is clear, accurate, and uncluttered.	✓ 4.50		Satisfied
5	Buttons and images are properly and clearly represented.	✓ 4.67		Satisfied

Based on the survey results, the system got an average score of at least 4 out of 5 rating for each of the criteria mentioned above. The system was able to satisfy the standards of the testers in terms of user-friendliness. You can refer to Appendix N for the complete breakdown of the survey results for this objective.

This shows the breakdown of the system's average score for each user-friendliness criterion based on the online survey conducted by the team during the public testing period in APC Lobby. The highest score is 5, while 1 is the lowest.

Table 5.3.1 User-Friendliness Testing Averages

Search result image is appealing and comprehensible	Navigation labels are clear	Navigation labels are concise	Information is clear, accurate, and uncluttered	Buttons and images are properly and clearly represented.
4.68	4.73	4.73	4.50	4.67

From the results above, the team infer that the most positive component in the system's interface was the navigation labels due to the high rating. In contrary, the priority for improvement should be on the display of information which might be unclear texts, fonts are too small, or inaccurate information at times.

The team measured the accessibility objective using Likert scale via an online survey during the public system testing of the project in the APC Lobby. There were 40 respondents randomly selected via convenience sampling.

Table 5.4 Accessibility Testing

No.	Accessibility Test	Checklist		Remarks
		Yes	No	
1	The system can be located easily in the building.	✓ 4.60		Satisfied
2	The system is being used by its intended users.	✓ 4.90		Satisfied
3	The system can provide the appropriate information queried by the users.	✓ 4.60		Satisfied

Based on the survey results, the system got an average score of at least 4 out of 5 rating for each of the criteria mentioned above. The system was able to satisfy the standards of the testers in terms of accessibility. You can refer to Appendix O for the complete breakdown of the survey results for this objective.

This shows the breakdown of the system's average score for each accessibility criterion based on the online survey conducted by the team during the public testing period in APC Lobby. The highest score is 5, while 1 is the lowest.

Table 5.4.1 Accessibility Testing Averages

The system can be located easily in the building	The system is being used by its intended users	The system can provide the appropriate information queried by the users
4.60	4.90	4.60

From the survey results, the most positively rated criterion is the system's accessibility to its intended or target users. There are 4 different clusters of this project's target users: Students, Faculty, Staff, and Visitors which were all present in the project's public testing.

5.2 Evaluation Procedure and Criteria for Overall System

Table 5.5 Evaluation of the Objectives of the Study for Accuracy

Objective	Number of Trials	Word Error Rate (Based on Table 3.22)	Accuracy Rate (Based on Table 3.22)	System Rating
Ability of the system to correctly recognize the words said by the user	30	0.47%	99.53%	98.12%
		1.73%	98.27%	
		5.27%	94.73%	
		0.00%	100.00%	
		0.83%	99.17%	
		2.97%	97.03%	

Table 5.5 shows the detailed breakdown and computation of the overall system accuracy testing based on the different criterion mentioned on Table 5.2. Based on the Scale Measurement table of the project objectives, the accuracy of the system's keyword recognition is excellent since it has surpassed the 95% accuracy mark. As mentioned earlier, the scenario for male speaker has the most significant word error rate of 5.27% which makes it the priority if there will be any action for improvement.

Table 5.6 Evaluation of the Objectives of the Study for Reliability

Objective	Number of Trials	Num. of Successful Trials (Based on Table 3.23)	Recognition Rate	System Rating
Ability to system to recognize the keywords in the Word Bank	5 per keyword	643/695	92.52%	97.05%
		595/595	100%	
		1266/1290	98.14%	

Table 5.6 shows the detailed breakdown and computation of the overall system reliability testing based on the different criterion mentioned on Table 5.2. Based on the Scale Measurement table of the project objectives, the reliability of the system's keyword recognition for room names is good but can still be further improved for excellence.

Table 5.7 Evaluation of the Objectives of the Study for User-friendliness

Objective	Number of Respondents	Average Rating (Based on Table 3.24)	System Rating
The ability of the user to easily navigate and understand the GUI	40	4.68	4.66
		4.73	
		4.73	
		4.50	
		4.67	

Table 5.7 shows the detailed breakdown and computation of the overall system user-friendliness testing based on the different criterion mentioned on Table 5.3. Based on the

Likert rating scale, the target users of this project are satisfied with the user-friendliness objective of RamNav.

Table 5.8 Evaluation of the Objectives of the Study for Accessibility

Objective	Number of Respondents	Average Rating per Criterion (Based on Table 3.25)	System Rating
Pertains to the system's openness and accessibility to the intended users	40	4.60	4.70
		4.90	
		4.60	

Table 5.8 shows the detailed breakdown and computation of the overall system accessibility testing based on the different criterion mentioned on Table 5.4. Based on the Likert rating scale, the target users of this project are satisfied with the accessibility objective of RamNav.

Review of Engineering Design Constraints

Table 5.9 Design Consideration Rubrics

Consideration	Parameters	4	3	2	1
Economic	Determine the proposed budget for the project	The budget for the project is less than P10,000	The budget for the project is between P10,000 - P20,000	The budget for the project is between P20,000 - P30,000	The budget for the project exceeds P30,000
Social	Determine if the system is accessible and user-friendly	The system is accessible and user-friendly	The system is not accessible, but user-friendly	The system is accessible, but not user-friendly	The system is not accessible and not user-friendly
Public Health and Safety	Assure that the speech recognition feature will lessen human contact	The system can fully operate hands-free	The main system features are hands-free	Some of the system feature are hands-free	None of the system feature are hands-free
Ethics	Group's responsibility for the data being collected	The system will both not collect and store personal data from the user	The system will collect but not store personal data from the user	The system will collect and store personal data from the user	
Sustainability	The ability of the system to be maintained in the future	All of the system features can be modified and adjusted	Most of the system features can be modified and adjusted	Some of the system features can be easily modified and adjusted	None of the system features can be modified and adjusted

During the system testing, the team have reviewed and reassessed the engineering design constraints that were applied for the project. There are still 5 parameters being considered. First, the economic refers to the overall budget that the group allotted until its completion. Most of the tools for the project was software-based, and the team used alternatives for the needed hardware which was the reason for the low budget costing for this project. The social parameter defines how the project is accessible and easy to use for its intended users. The team have based their ratings for this constraint on the user-friendliness and accessibility testing results which are 2 of the project's specific objectives.

Public Health and Safety parameter in the context of this project defines how much human contact is needed for the intended users when using this application. Then, the ethics

parameter refers to how much the group is responsible due to the data being collected by the application. Lastly, sustainability parameter refers to the features of the system that can be modified, adjusted, and expanded. This is specifically applicable to the system's database. This parameter will make it easier for the future researchers to build upon this same topic. The following are the results for each design constraint:

Economic

The team took advantage of the different software and hardware options to use for the project development. With that, they were able to use the Microsoft Azure for 1 year free. For the hardware tools, the team used alternatives for the monitor, speaker, and microphone to test the system. Overall, the team were able to allocate a budget of way less than P10,000 since the start of the project until its completion. Below is the detailed breakdown of the project development costs:

- Azure Speech Services (Speech-to-Text API, Custom Keyword Recognition) – FREE
- Azure Linux Virtual Machine – FREE
- Azure Public IP Address - $2.59/month or P152/month
- Azure MySQL Server – FREE
- Borrowed Laptop with Touchscreen Monitor – FREE
- Borrowed External Microphone and Speaker – FREE

Social

Based on the testing results and user feedback survey, the system was able to meet the highest rating for the social engineering constraints parameter. This was defined based on whether the system's overall rating for the accessibility and user-friendliness. The team were able to attain the target score of at least 4 out of 5 rating for each of those objectives. For user-friendliness, the average system rating is 4.66. While the accessibility got an average system rating of 4.70.

Public Health and Safety

Another engineering constraint parameter that the proponent's targeted is to create a system that will lessen human contact. With that, the ideal goal is to make all of the system features fully hands-free. However due to limitations, the team were only able to make the main features of the system contactless for the users. The other features such as the user report feature can only be used by clicking and typing. Also, the custom keyword model of the trigger key phrase, "Hello RamNav", may not always be effective which will require the user to touch the screen or click the button to start the search function.

Ethics

The ethical constraint parameter of the project pertains to the responsibility of the group with regards to the personal data being collected and/or stored by the system. The highest rating can be attained if the system will not collect and store any personal data from the user. But with the voice recognition features of the application, it is considered to be collecting, but not storing, personal data from the user which is their voice.

Sustainability

The last engineering constraint parameter for this project is the sustainability. This parameter refers to how easily maintainable the structure of the system features is. The point of emphasis for this parameter is the modification of the system's room database. With that, the team also developed a separate application, a web app, that will serve as the administrators' facility for modifying the said database by having the ability to create, update, and delete room information anytime. That is also where the administrators can view the user feedback and reports so that they can consider some improvements or fixes in the future.

5.3 Strengths and Weaknesses of the Final Design

After testing and evaluating, the team were able to identify the strengths and weaknesses of RamNav. The strengths are the significant accomplishment achieved by RamNav while the weaknesses are the areas where RamNav can still improve on.

5.3.1 Strengths

- The reliability testing for identifying room numbers attained an excellent rating of 100%.
- RamNav's dataset is scalable.
- The system's keyword recognition rate is excellent at an average of 97.05%.
- The system is economical because the team utilized the free cloud services of Microsoft Azure.
- The system is 93.2% user-friendly (Satisfied) and 94% accessible (Satisfied) based on the feedback of its intended users.

5.3.2 Weaknesses

- Some of the users pointed out that the system's user interface can still be improved in such a way as making the labels and images bigger.
- The system's transcription accuracy is lower when the background noise is greater than 70 decibels.
- The system maintenance facility website does not have the ability to reconfigure the application settings such as the background images, mic sensitivity threshold, and so on which is a part of the sustainability design constraint parameter.

Chapter 6

SUMMARY OF FINDINGS, CONCLUSION, AND RECOMMENDATIONS

6.1 Summary of Findings

The team aim to develop a voice-activated building directory system for the faculty, staff, students, and guests of Asia Pacific College. The researchers must fulfill the objectives of the study: accuracy of the system to recognize the queried words, reliability of the system to recognize the keywords in the word bank, user-friendliness of the user interface to easily navigate and understand, and accessibility of the system to its intended users.

Table 6.1. Summary of Findings

Objective	Measured Parameter			Scale	Rating
	Minimum	Maximum	Average		
Accuracy (%)	94.73	100	98.12	Above 95%	Excellent
Reliability (%)	92.52	100	97.05	Above 95%	Excellent
User-Friendliness	4.50	4.73	4.66	4-4.99	Satisfied
Accessibility	4.60	4.90	4.70	4-4.99	Satisfied

Table 6.1 shows the summary of findings after the series of tests conducted by the team. The objective, measured parameter, scale and rating are indicated. For the accuracy test results, the system was able to recognize the queried words at an average of 98.12% which is under the scale of “Above 95%” with a rating of Excellent. For the reliability test results, the system was able to recognize the keywords from the word bank at an average of 97.05% which is under the scale of “Above 95%” with a rating of Excellent. For the user-friendliness survey results, the respondents rated the system’s user interface at an average of 4.66 which falls under the scale of “4-4.99” with a rating of Satisfied. For the accessibility survey results, the respondents rated the system’s accessibility at an average of 4.66 which falls under the scale of “4-4.99” with a rating of Satisfied.

Table 6.2. Engineering Design Constraints Results

Consideration	Parameter	Rating	Description
Economic	Determine the proposed budget for the project	4 out of 4	The budget for the project is less than P10,000
Social	Determine if the system is accessible and user-friendly	4 out of 4	The system is accessible and user-friendly
Public Health and Safety	Assure that the speech recognition feature will lessen human contact	3 out of 4	The main system features are hands-free
Ethics	Group's responsibility for the data being collected	3 out of 4	The system will collect but not store personal data from the user
Sustainability	The ability of the system to be maintained in the future	3 out of 4	Most of the system features can be modified and adjusted

Table 6.2 shows the ratings of each design constraint applied in the project. For the economic consideration, the rating is 4 out of 4 since the budget allocation is less than P10,000 throughout the duration of the project. For the social constraint parameter, the rating is 4 out of 4 as well since the system is accessible and user-friendly based on the intended users from the public testing. For the public health and safety constraint parameter, the rating is 3 out of 4 since only the main features are hands-free and some features still needs human contact like the report button. For the ethics constraint parameter, the rating is 3 out of 4 since the system collects the user's voice but does not store any personal data. Lastly for the sustainability constraint parameter, the rating is 3 out of 4 as well since the database can be modified and adjusted through the use of the RamNav maintenance web application.

6.2 Conclusion

Given the information from the evaluation, the design and functions were put into practice in relation to the study's goals and were successful in producing a product that was both essential and pleasing. There are 4 major objectives identified that are vital for our system's result. The following are Accuracy, Reliability, User-Friendliness, and Accessibility. The system's performance in achieving each of the mentioned objectives is evaluated using a unique mathematical model for each of the objectives which helps us get the result precisely.

As for the test and evaluation of the project, the results show that the system was able to acquire the voice of the user speaking from the range of the minimum of 6 inches and as far as 10 inches away from the microphone with an ease. Going on to the speech-to-text transcription, we were able to test the system can transcribe the speech into text successfully in its first attempt without an error. As for the keyword recognition, the system was able to delete all the filler words and retain only the necessary keywords. All the test cases tested by the team were successful in terms of keywords recognized and deleted filler words from the user's query. When it comes to the word bank querying, we were able to test the function for querying wherein it discards keywords that does not exist in the word bank and only retains the keywords that are in the dictionary. Lastly, after testing different test cases, the rooms associated with the keywords were successfully displayed in the search result.

RamNav has been exceptional in acquiring and processing the speech of the user even on different environment situations. These results have satisfied all the general objectives and specific objectives. The detailed result of the proponent's specific objectives and engineering design constraints can be seen below and were able to conclude the following:

- With 30 trials per test and 5 tested queries per test, RamNav has an accuracy score percentage for each of the 6 testers of over 90%, which is considered successful.

- Ideally, the scenarios below should ideally get at least 90% recognition rate for it to be deemed successful, the following results are:
    - There was a total of 139 room names that were tested 5 times each. The recognition rate is 92.52% for the testing of room names.
    - There was a total of 119 room numbers that were tested 5 times each. The recognition rate is 100% for the testing of room numbers.
    - There was a total of 258 keywords that were tested 5 times each. The recognition rate is 98.14% for the testing of keywords.
- The average score for each question in the user-friendliness survey conducted by the team is 4.66 out of 5 which falls under satisfied.
- The average score for each question in the accessibility survey is 4.70 out of 5 which falls under satisfied.
- The team were able to attain the highest rating for the economic design constraint parameter which is to allocate a budget of less than P10,000 for the project. It was done by using alternative hardware that the team already have and by utilizing free trial cloud services of Azure.
- The highest rating for social parameter of the design constraint was attained since the system were able to pass the target score for the accessibility and user-friendliness objective based on the public testing survey results.
- The main feature of the system, which is the actual searching of rooms, is hands-free. This is a great feature to lessen the human contact, which is a consideration parameter for the design project.
- The project got the second highest rating for the ethical parameter of the engineering design constraints. Ideally, there should be no collection and storage of the user's personal information, as much as possible. However, the speech-to-text feature is already considered as collecting personal data from the user.
- The team aimed to make a system that can be easily maintained in the future, which is the sustainability parameter of the engineering design constraints. With that, they were able to also develop a maintenance application that will let the administrators

modify and customize the system's room database and the feedback from the users. However, the team also believe that there are still more potential features that the said maintenance application can have in the future.

6.3 Recommendations

The project's team have made observations about how the designed project might be improved while developing and testing it. Due to a lack of time and expertise of other coding components, there are a few small bugs that weren't handled during development. The team advised future researchers to consider the references given below as a study when creating a similar engineering design for further advancement.

- Improve the overall UI of the system by redesigning the assets used.
- Integration of the RamNav application settings to the Maintenance Web Application.
- Addition of public events schedule that can be searched by the users through the application.
- Use of Natural Language Processing in Azure as the main algorithm for better system interpretation of user queries.

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APPENDIX A

(OFCM Table)

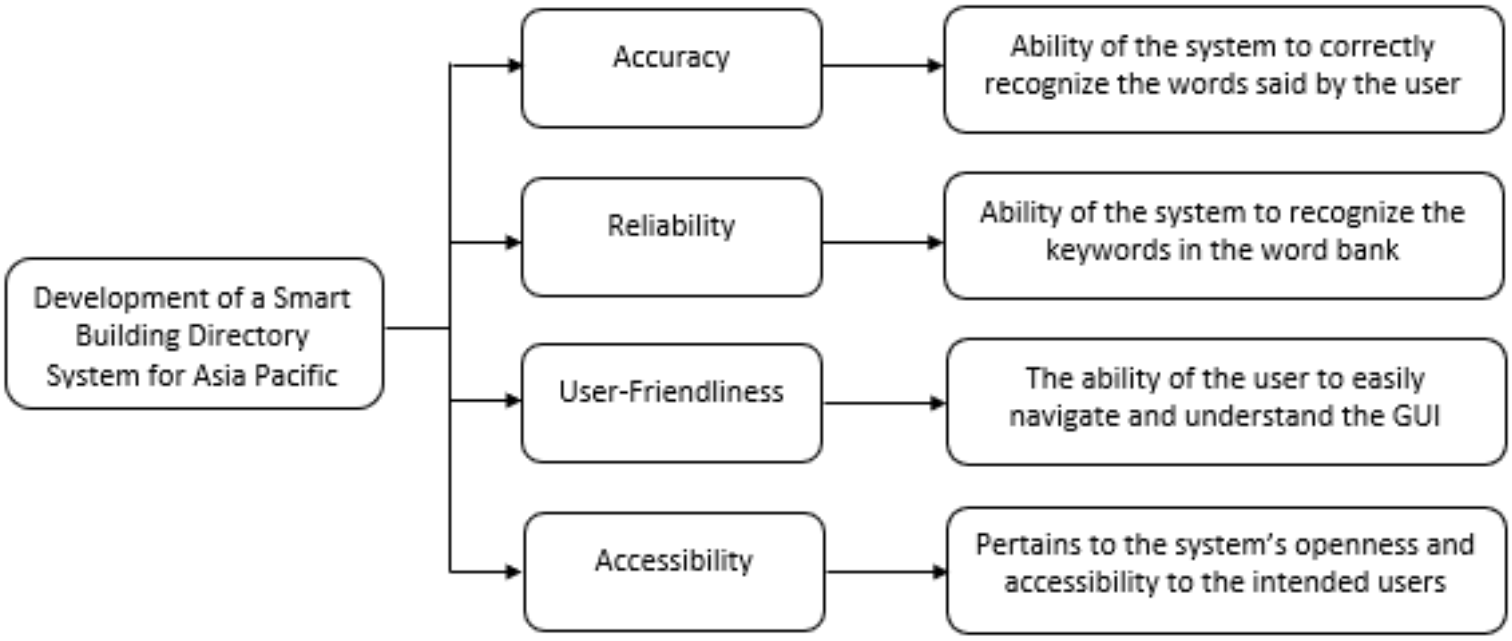
OCFM Table

Characteristic		Objectives	Constraints	Functions	Means
An accurate smart building directory system		X			
A reliable system for the Asia Pacific College building directory		X			
A user-friendly graphical user interface (GUI) for the system		X			
A building directory system that is accessible		X			
An application that would integrate speech recognition feature for user queries			X		
An application that would utilize QR codes for the user to transfer the search result to their device			X		
User query detection				X	
Speech-to-text transcription				X	
Transcribed text separation				X	
Store each word in a list				X	
Keyword recognition found in the wordbank				X	
List suggested results				X	
Retrieve relevant room information				X	
Show the result (QR code, room location image, floor level and number, and nearby room labels)				X	
Internet connection					X
Computer (w/ touchscreen monitor)					X
External Microphone					X
Python Programming Language					X
Microsoft Speech SDK					X

APPENDIX B

(Objective Tree)

Objective Tree



APPENDIX C

(Team Charter)

Team Charter

Team Purpose

The team committed a design project which is smart building directory system with a speech recognition feature as a requirement in BS Computer Engineering.

Duration and Time Commitment

The team enrolled for 3 terms from CpE Reaserch and Methodology (CPEMETS) to Design Project (DESPRO1-DESPRO2).

Scope

The scope of the study is defined by the approved design scope in CpE Research and Methodology class.

Members

Silvio, Elisha P.

Maño, John Albert C.

Chua, Veronica Elyse D.

Pardiñas, Rizzi Joy H.

Desired End Result

The team aims to develop a responsive system for the APC building directory that includes speech recognition in order to make the system more accessible.

Supporting Resources

The team utilized the use of tablet hosting the frontend application and PC acting as the backend server of the system.

Reporting Plan

The team provides weekly reports to their adviser and client to present their progress of their weekly tasks.

Deliverables

The team presents the design prototype as a PC-based application for a smart building directory system that uses speech recognition and QR codes to allow users to transfer search results to mobile devices with proper documentation.

Links

The team effort will link to the Design Project class. It is their requirement for their degree.

Composition and Roles

Elisha Silvio is responsible for:

- Ensuring this Team Charter is abided by
- Providing support and assistance to individual team members
- Planning and designing the system and Android application
- Developing the frontend and backend system
- Managing the day-to-day operations of the team and the deliverables

John Albert Maño is responsible for:

- Ensuring this Team Charter is abided by
- Planning and designing the system and Android application
- Developing the frontend and backend system

Veronica Elyse Chua is responsible for:

- Ensuring this Team Charter is abided by
- Researching and documenting the study
- Planning and designing the system and Android application
- Managing the budget

Rizzi Joy Pardiñas is responsible for:

- Ensuring this Team Charter is abided by
- Researching and documenting the study
- Planning and designing the system and Android application

APPENDIX D

(Work Breakdown Structure)

Work Breakdown Structure (DESPRO1)

Activities	Responsible		Deliverable	Materials	Inclusive Date	Week No.
Setup of External Resources	Pardiñas		Hardware Setup	PC, External Microphone	**Jan 3 – Jan 6**	Term 2 - Wk. 6
Setup Database						
Setup MySQL	Pardiñas, Chua		MySQL	PC	**Jan 6 – Jan 24**	Term 2 - Wk. 6-9
Apply word bank	Pardiñas		Word Bank in Database	PC	**Jan 6 – Jan 24**	Term 2 - Wk. 6-9
Create room information	Pardiñas, Chua		Complete Room Information	PC	**Jan 6 – Jan 24**	Term 2 - Wk. 6-9
Store images of the building layout	Pardiñas		Images Available in the Database	PC	**Jan 6 – Jan 24**	Term 2 - Wk. 6-9
Speech Input						
Input Signal Filter	Maño, Silvio		Recognize Voice	PC	**Jan 24 – Feb 16**	Term 2 - Wk. 9-12
Speech-to-text conversion	Chua, Silvio		Convert Audio to Text	PC	**Jan 24 – Feb 16**	Term 2 - Wk. 9-12
Program Speech Recognition						
Integrate Microsoft Speech SDK	Silvio		Microsoft Speech SDK in System	PC	**Jan 28 – Feb 19**	Term 2 - Wk. 9-12
Transcribed text separation	Silvio		Text Split into Individual Word	PC	**Jan 28 – Feb 19**	Term 2 - Wk. 9-12
Store each word in a list	Silvio, Maño		Word Stored in a List	PC	**Jan 28 – Feb 19**	Term 2 - Wk. 9-12
Text Query Processing						
Disregard filler words	Silvio, Maño		Remove Words Not Found in Word Bank	PC	**Feb 19 – March 15**	Term 2 - Wk. 12-16
Recognize keyword	Silvio		Keyword Recognition	PC	**Feb 19 – March 15**	Term 2 - Wk. 12-16
Retrieve room information	Silvio, Pardinas		Get Room Information	PC	**Feb 19 – March 15**	Term 2 - Wk. 12-16
User Interface Creation						
Menu	Chua, Maño		Main Menu UI	PC	**April 10 – April 28**	Term 3 - Wk. 4-6
Display of query result (PC)	Maño		Query Result UI in PC	PC	**April 10 – April 28**	Term 3 - Wk. 4-6
Display of query result (smartphone)	Pardiñas, Maño		Query Result UI in Smartphone	PC	**April 10 – April 28**	Term 3 - Wk. 4-6
Chapter 4 Initial Draft	NextGen		Chapter 4 Draft	MS Word	**April 18 – May 5**	Term 3 - Wk. 5-7
Display Result						
Program room confirmation menu	Silvio		Code for Room Confirmation Menu	PC	**Apr 11 – May 6**	Term 3 - Wk. 4-7
Show suggested result	Maño		Display Suggested Result	PC	**Apr 11 – May 6**	Term 3 - Wk. 4-7

Show QR Code	Maño		Display QR Code	PC	**Apr 11 – May 6**	Term 3 - Wk. 4-7
Room Location Image	Chua		Display Image of Room Location	Smartphone, PC	**Apr 11 – May 6**	Term 3 - Wk. 4-7
Floor level and number	Chua		Display Floor Level and Number	Smartphone, PC	**Apr 11 – May 6**	Term 3 - Wk. 4-7
Nearby room	Chua		Display Nearby Room	Smartphone, PC	**Apr 11 – May 6**	Term 3 - Wk.4-7
Finalize Chapter 4	NextGen		Chapter 4 Final	MS Word	**May 10 – June 16**	Term 2 - Wk. 8-13

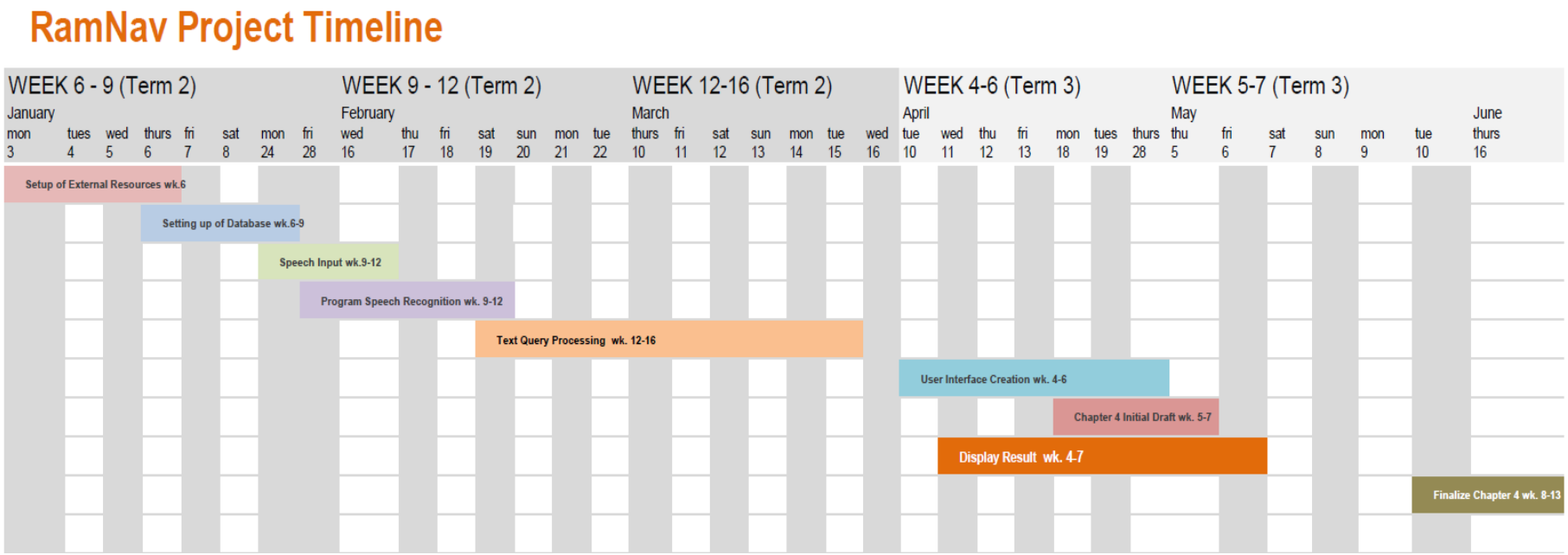
Work Breakdown Structure (DESPRO2)

Activities	Responsible	Deliverable	Materials	Inclusive Date	Week No.
Testing for System Functions					
Testing of Full System Simulation - Input Voice - Speech processing - Text query processing - Display result	NextGen	Building Directory Functions	Smartphone, PC	**Apr 18 – May 6**	Term 3 – Wk. 5-7
Troubleshooting	NextGen		Smartphone, PC	**May 9 – May 27**	Term 3 – Wk. 8-10
Chapter 5 & 6 Initial Draft	NextGen	Chapter 5-6 Draft	MS Word	**May 30 – Jun 10**	Term 3 – Wk. 11-12
Accuracy Testing	Maño	Conclusive and metric results	RamNav	**Jun 13 – Jun 24**	Term 3 – Wk. 12-13
Reliability Testing	Silvio	Conclusive and metric results	RamNav	**Jun 13 – Jun 24**	Term 3 – Wk. 12-13
User-friendly Testing	Pardiñas	Conclusive and metric results	MS Forms	**Jun 13 – Jun 24**	Term 3 – Wk. 12-13
Accesibility Testing	Chua	Conclusive and metric results	MS Forms	**Jun 13 – Jun 24**	Term 3 – Wk. 12-13
Chapter 5 & 6 Finalization	NextGen	Final Project Documentation	MS Word	**Jun 20 – Jun 28**	Term 3 – Wk. 13-14

APPENDIX E

(Project Timeline)

Project Timeline



APPENDIX F

(SURVEY QUESTIONNAIRE AND RESPONSES)

Survey Questionnaire and Responses

A. Survey Questionnaire

Online Survey About APC's Current Directory System

Good day! We are a group of 3rd year SoE students in Asia Pacific College, and we would like to conduct a survey to support our research regarding the directory system in the APC building. This survey is only recommended for people who have already been to the APC building before.

1. Have you ever noticed if there are any kind of directory system in APC? *

- Yes
- No

2. Did you find it easy to notice, or do you think that the APC directory can still be improved? *

- Yes, it can be improved.
- No, it's already good as it is.

3. During your first time in APC, did you find it hard to look for certain rooms/offices? *

- Yes
- No

4. What did you do to navigate through the building easier? *

- Ask someone for the location of the room/office.
- Look for the directory.
- Wandered around the building until you found it.
- Other

5. Would you rather have one directory system in the APC lobby or have several directories in different APC building floors? *

- One Directory
- Multiple Directories

6. Rate the idea of APC having a smart directory system that can also recognize speech, like Siri or Alexa. (1 = Bad, 5 = Amazing) *

☆ ☆ ☆ ☆ ☆

7. Do you have any comments or suggestions for our project idea to help the APC become a SMART and GREEN building? *

Enter your answer

B. Survey Responses

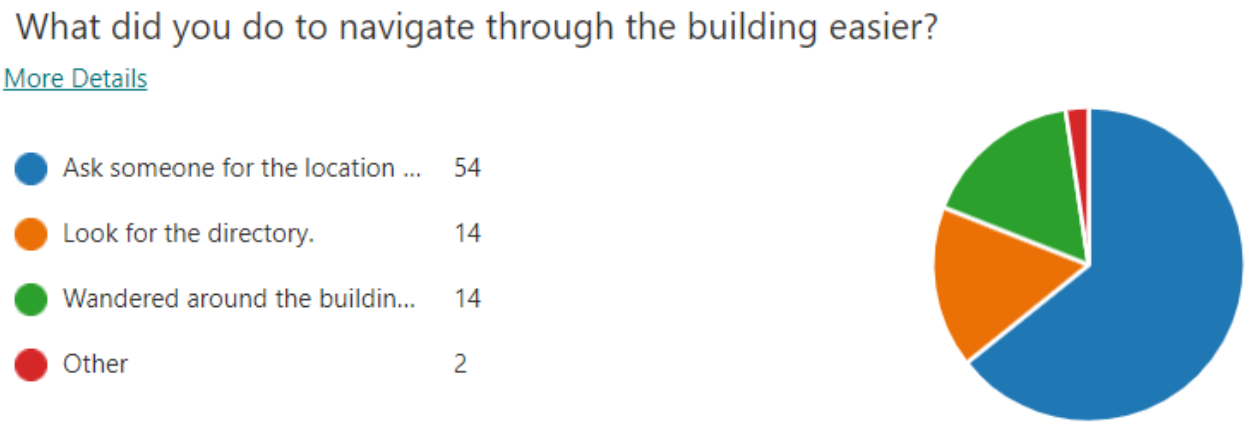


Figure 1.1. Respondents action when looking for a room/office

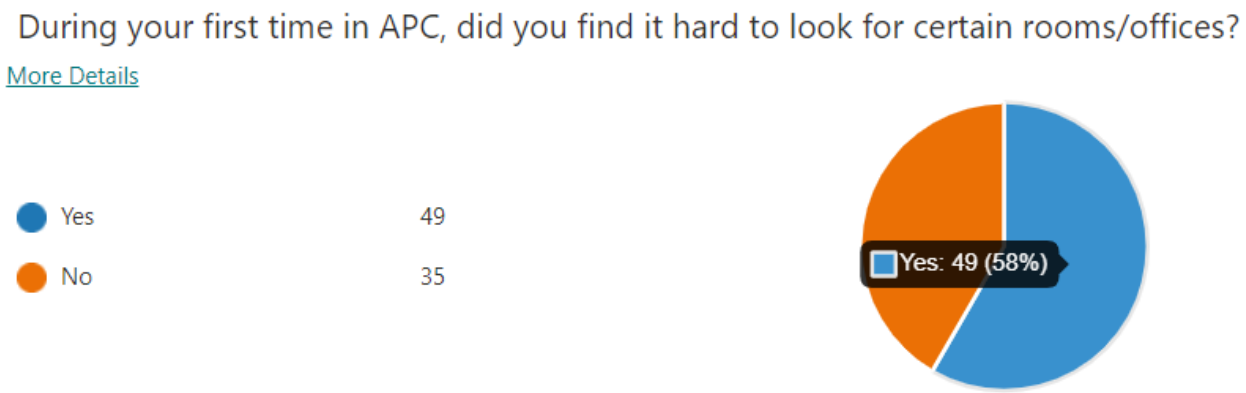


Figure 1.2. Respondents first visit in APC

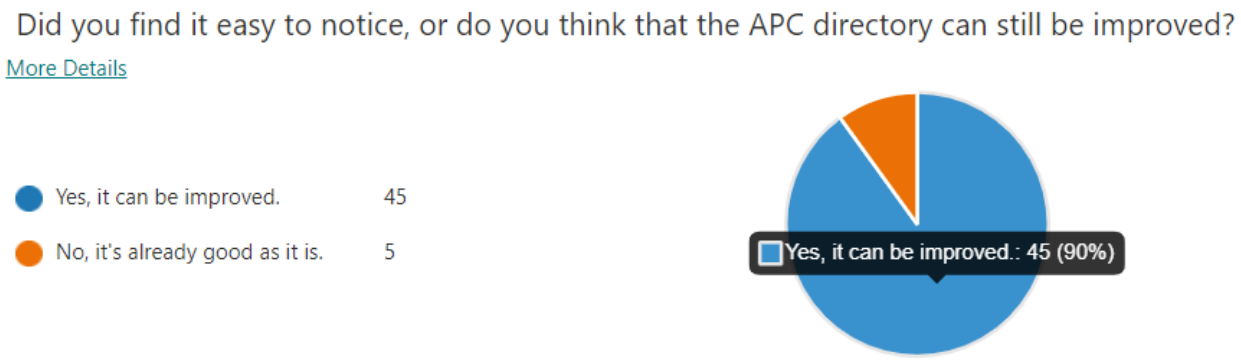


Figure 1.3. Improvement of the building directory

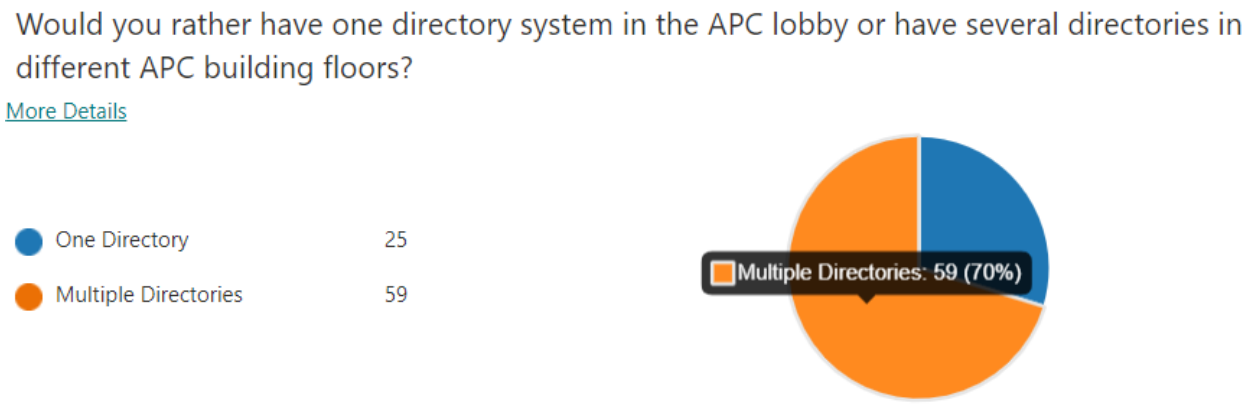


Figure 1.4. Suggestion on the directory system

APPENDIX G

(Dictionary)

Room #	Room Name	Room Type	Keyword 1	Keyword 2	Keyword 3
		1st Floor			
	Clinic	Office	Nurse	Medication	First Aid
	Chapel	Facility	Mass	Baccalaureate	Pray
	Multi-Purpose Hall 1	Facility	Event	Assembly	Gather
	Admissions Office	Office	Enroll	Inquire	Application
	Guard Lobby	Facility	Desk	Assistance	Service
	Cafeteria	Facility	Food	Eat	Order
		2nd Floor			
201	Lecture Room	Classroom	N/A	N/A	N/A
202	APC Cybersecurity Sandbox	Facility	Cybersecurity	Advance	IT
203	Lecture Room	Classroom	N/A	N/A	N/A
204	Computer Laboratory	Laboratory	N/A	N/A	N/A
205	Lecture Room	Classroom	N/A	N/A	N/A
206	Computer Laboratory	Laboratory	N/A	N/A	N/A
207	Lecture Room	Classroom	N/A	N/A	N/A
208	Computer Laboratory	Laboratory	N/A	N/A	N/A
209	Multi-Purpose Hall 2	Facility	Event	Assembly	Gather
213	Lecture Room	Classroom	N/A	N/A	N/A
214	Storage	Facility	Storage	Store	Equipment
215	Isolation Area A	Facility	Isolate	Covid	Sick
216	Computer Laboratory	Laboratory	N/A	N/A	N/A
217	Isolation Area B	Facility	Isolate	Covid	Sick
218	Microsoft Experience Center	Facility	Microsoft	Hub	Electronics
		3rd Floor			
301	Student Lounge	Facility	Gather	Leisure	Students
302	Computer Laboratory	Laboratory	N/A	N/A	N/A
303	Student Lounge / SAO	Facility	Extra-Curricular	SAO	Activities
304	Computer Laboratory	Laboratory	N/A	N/A	N/A
305	Lecture Room	Classroom	N/A	N/A	N/A
306	Computer Laboratory	Laboratory	N/A	N/A	N/A
307	Lecture Room	Classroom	N/A	N/A	N/A
308	Computer Laboratory	Laboratory	N/A	N/A	N/A
309	Lecture Room	Classroom	N/A	N/A	N/A
313	Lecture Room	Classroom	N/A	N/A	N/A
314	Computer Laboratory	Laboratory	N/A	N/A	N/A
315	Lecture Room	Classroom	N/A	N/A	N/A
316	Computer Laboratory	Laboratory	N/A	N/A	N/A
317	Lecture Room	Classroom	N/A	N/A	N/A
318	Computer Laboratory	Laboratory	N/A	N/A	N/A

		4th Floor			
401	President's Office	Office	President	Administrator	Head
403	Director's Offices	Office	Director	Head	Program
405	Director's Offices	Office	Director	Head	Program
406	Faculty Area	Facility	Teachers	Professors	Faculty
407	Boardroom	Facility	Board Room	Meeting	Board
409	Lecture Room	Classroom	N/A	N/A	N/A
411	Accounting and Finance Office	Office	Payment	Balance	Tuition
413	Registrar's Office	Office	Records	Documents	Request
414	Open Laboratory	Laboratory	Homework	Computer	Print
415	Isolation Area	Facility	Isolate	Covid	Sick
416	Lecture Room	Classroom	N/A	N/A	N/A
417	Lecture Room	Classroom	N/A	N/A	N/A
418	Lecture Room	Classroom	N/A	N/A	N/A
		5th Floor			
501	I.T. Resource Office	Office	Equipment	Computer	ID
502	Networking Laboratory	Laboratory	Networking	Networks	Cisco
504	Consulting Services Office	Office	Consult	Services	Consultant
505	Linux Laboratory	Laboratory	Linux	Computer	N/A
506	Game Studio	Facility	Entertainment	Game	Video Game
	Human Resources Office	Office	HR	Staff	Employee
507	Documentation Room	Office	Documentation	Albums	Magazines
	Discussion Room A	Classroom	Discussion	Meeting	N/A
508	Discussion Room B	Classroom	Discussion	Meeting	N/A
509	APC Techonology Center	Facility	Technology	Experience	Advance
	Career & Placement Office	Office	Internship	OJT	Work
	NSTP Office	Office	Volunteer	Social	Skills
514	Director, Student Services	Office	Director	Student Services	
515	2D Animation Laboratory	Laboratory	Graphics	Animation	Film
	Foley Recording Studio	Facility	Sound	Effects	Audio
516	Music Recording Studio	Facility	Music	Record	Sound
518	Video & Photography Room	Facility	Photo	Video	MMA

		6th Floor			
601	Lecture Room	Classroom	N/A	N/A	N/A
602	Graphic Design & Sound Lab	Laboratory	Graphic Design	Design	Sound
603	Lecture Room	Classroom	N/A	N/A	N/A
604	Animation Lab	Laboratory	Animate	Graphics	Film
605	Lecture Room	Classroom	N/A	N/A	N/A
606	Game Lab	Laboratory	Video Game	Play	Game
607	Lecture Room	Classroom	N/A	N/A	N/A
608	Video Editing Laboratory	Laboratory	Film	Editing	Movie
	Small Room A	Classroom	Meeting	Defense	Proposal
	Small Room B	Classroom	Meeting	Defense	Proposal
609	Small Room C	Classroom	Meeting	Defense	Proposal
611	Lecture Room	Classroom	N/A	N/A	N/A
612	Psychology Lab	Laboratory	Psychology	Psych	Study
613	Lecture Room	Classroom	N/A	N/A	N/A
614	Lecture Room	Classroom	N/A	N/A	N/A
615	Lecture Room	Classroom	N/A	N/A	N/A
616	Lecture Room	Classroom	N/A	N/A	N/A
617	Lecture Room	Classroom	N/A	N/A	N/A
618	Lecture Room	Classroom	N/A	N/A	N/A

		7th Floor			
	Library Phase 1	Facility	Books	Read	Open
	Discussion Room A	Classroom	Meeting	Defense	Proposal
	Discussion Room B	Classroom	Meeting	Defense	Proposal
	Discussion Room C	Classroom	Meeting	Defense	Proposal
	SHS Faculty	Office	Teachers	Professors	Faculty
	Audio Visual Room	Facility	Experience	Audio	Visual
	Technical Library	Facility	Techincal	Librarian	Books
	Library Office	Office	Librarian	Borrow	Information
	Research Room	Classroom	Research	Books	Documents
	Library Phase 2	Facility	Books	Librarian	Read
	Math & English Resource Center	Facility	Resource	Math	English
		8th Floor			
801	Digital Electronics Lab	Laboratory	Digital	Equipment	Science
802	National Instruments Lab	Laboratory	Instruments	Equipment	Science
803	Engineering & Science Lab Office	Office	Engineering	Logistics	Equipment
805	Electronics & Circuits Lab	Laboratory	Circuits	Science	Electronics
806	Physics Lab	Laboratory	Physics	Experiment	Science
807	Networking & Communcation Lab	Laboratory	Network	Communication	Cisco
	Project Lab / Rooms - A	Classroom	Project	Thesis	Study
808	Project Lab / Rooms - B	Classroom	Project	Thesis	Study
809	Lecture Room	Classroom	N/A	N/A	N/A
811	Lecture Room	Classroom	N/A	N/A	N/A
813	Lecture Room	Classroom	N/A	N/A	N/A
814	Project Lab / Rooms	Classroom	Project	Thesis	Study
815	Lecture Room	Classroom	N/A	N/A	N/A
816	Lecture Room	Classroom	N/A	N/A	N/A
817	Lecture Room	Classroom	N/A	N/A	N/A
818	Lecture Room	Classroom	N/A	N/A	N/A
		9th Floor			
	Dormitory	Facility	Dorm	Student	Room
	Dormitory Lounge	Facility	Dorm	Student	Lounge

		10th Floor			
	Fitness Center	Facility	Gym	Instructor	Workout
1004	Table Tennis Area	Facility	Table Tennis	Ping Pong	Sports
1007	Female Shower Room	Facility	Shower	Bath	Wash
1008	Male Shower Room	Facility	Shower	Bath	Wash
	Purchasing & Logistics	Office	Locker	Uniform	Inventory
1009	Discipline Office	Office	Counseling	Violation	Discipline
	Building Maintenance Office	Office	Equipment	Locker	Building
1011	Kitchen	Facility	Cook	Serve	Food
1013	Lecture Room	Classroom	N/A	N/A	N/A
1014	Lecture Room	Classroom	N/A	N/A	N/A
1015	Lecture Room	Classroom	N/A	N/A	N/A
1016	Lecture Room	Classroom	N/A	N/A	N/A
1017	Lecture Room	Classroom	N/A	N/A	N/A
1018	Lecture Room	Classroom	N/A	N/A	N/A
		11th Floor			
1109	Gymnasium	Facility	Sports	Court	Basketball
1110	Guidance Office	Office	Counseling	Interview	Consultation
1111	Chemical Storage	Laboratory	Chemicals	Elements	Storage
1113	Chemistry Lab	Laboratory	Chemistry	Experiment	Science
1114	Art Studio	Facility	Creative	Painting	Drawing
1115	Lecture Room	Classroom	N/A	N/A	N/A
	Art Studio	Facility	Creative	Painting	Drawing
1116	Project Laboratory	Laboratory	Project	Thesis	Study
1117	Lecture Room	Classroom	N/A	N/A	N/A
	Band Practice Room	Facility	Instruments	Music	Band
1118	Mock Travel Counter	Facility	Tourism	Travel	Mock
		12th Floor			
	Auditorium	Facility	Event	Assembly	Speaker

***Subject to change or improvement during the project development. The table can also be edited by the owner of the application.**

APPENDIX H

(Adviser's Recommendation Sheet)

ADVISER'S RECOMMENDATION SHEET

The design project entitled

RamNav

Development of a Smart Building Directory System for Asia Pacific College

designed by:

NextGen

Chua, Veronica Elyse D.

Maño, John Albert C.

Pardiñas, Rizzi Joy H.

Silvio, Elisha P.

and submitted in partial fulfillment of the requirements in CPEDES1: CpE Design Project 1, has been examined and recommended for technical defense.

Stanley Glenn E. Brucal

Adviser

May 4, 2022

Date

APPENDIX I

(Initial and Final Status Report)

(Initial/Final) Status of the Prototype

****

Design Project Short Title: RamNav
Design Project Technical Title: Development of a Smart Building Directory for Asia Pacific College

Date of Title Defense: May 7. 2022

Proponents (Family Name, Given Name, Middle Initial / Student ID No./Signature) :

1. **Chua, Veronica Elyse D. / 2019-100024 /** _____
2. **Maño, John Albert C. / 2019-100071 /** _____
3. **Pardiñas, Rizzi Joy H. / 2019-100125 /** _____
4. **Silvio, Elisha P. / 2019-100030 /** _____

Client's Name and Signature: Engr. Stanley Glenn E. Brucal /_____

Panelists:

1. **Engr. Sergio R. Peruda Jr. (Chair)**
2. **Engr. Luigi Carlo M. De Jesus (Lead Panelist)**
3. **Engr. Leonardo A. Samaniego Jr. (Member 1)**
4. **Engr. Einstein D. Yong (Member 2)**

SPECIFIC OBJECTIVES (SO) & FUNCTIONS (F)	STATUS REPORT *(COMPLETE/INCOMPLETE/NOT DONE/OMITTED)* *Include necessary justifications, if necessary*
Basic Requirement	
1. Create an accurate Building Directory System (SO)	**Complete**
2. Develop a reliable system for the APC Building Directory (SO)	**Complete**
3. Design a user-friendly graphical user interface (GUI) for the system (SO)	**Complete**
4. Make the APC building Directory System more accessible (SO)	**Complete**
5. Realtime voice acquisition (PF)	**Complete**
6. Speech-to-text transcription (PF)	**Complete**
7. Keyword Recognition (PF)	**Complete**

8. Retrieving Query Result (PF)	Complete
9. Keyword List Creation (SF)	Complete
10. Word Bank Keyword Querying (SF)	Complete
11. Search Result Creation (SF)	Complete
12. Room Information Retrieval (SF)	Complete
13. Output Result (SF)	Complete
Supplementary Requirements	
1. N/A	
2	
Summary of Comments *(as indicated on the verdict forms)*	
1. Consider using the api or library to autogenerate the QR code from the string before viewing it.	Complete
2. Just complete the functional test to cover all rooms in APC.	Complete
3. The robot should be capable of asking another question to the user if there are several options about the query	Complete
Summary of Revisions (as indicated on the verdict forms)	
1. Accomplish Functional Testing based on your Approved Conceptual Design	Complete
2. Make sure that all keywords (or number of required keywords) are accomplished before functional testing	Complete
3. Documentation of Hardware Design: Discuss in details. include specifications and other matters related to hardware	Complete
4. Documentation of Software Design: Present System and/or Program Flowchart. Present core algorithms and discuss its purpose/functionality	Complete
5. Proposed vs Actual Specification	Complete
Summary of Additional Requirements *(as indicated on the verdict forms)*	
1. N/A	
2	
3	

****

APPENDIX J

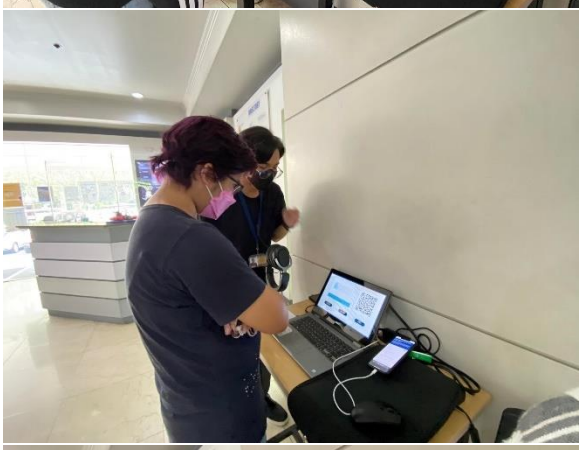
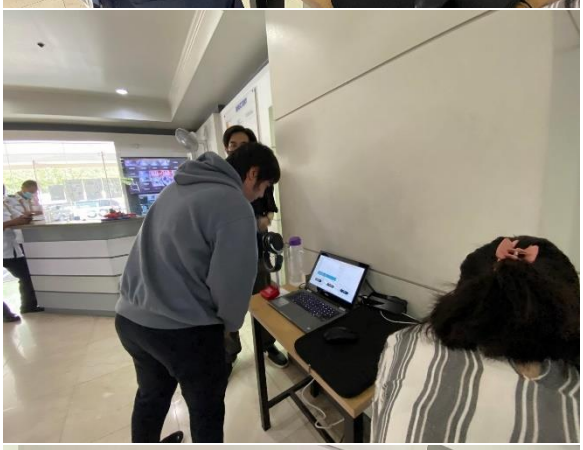
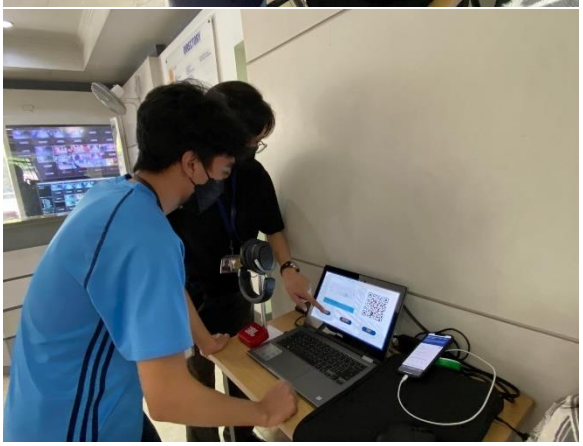
(RamNav Public Testing Results in APC Lobby)

Name	Query	Transcribed	Result	WER (%)	Accuracy (%)	# of Keywords Used	Keywords Recognized
Michelle Joy	registrars office	registrars office	correct	0.00	1.00	1	1
	where is eugene	where is eugene	no result	0.00	1.00	0	
	811	811	correct	0.00	1.00	1	1
RJ	foley recording studio	poly recording studio	multiple result	0.33	0.67	1	1
	foley recording studio	poly recordings better	no result	0.66	0.34	0	0
	foley recording studio	foley recording studio	multiple result	0.00	1.00	1	1
	recording studio	recording studio	multiple result	0.00	1.00	1	1
	foley	foley	correct	0.00	1.00	1	1
	project laboratory	project laboratory	no result	0.00	1.00	1	0
	robert besana	robert besana	no result	0.00	1.00	0	0
	itro	I tro	no result	1.00	0.00	0	0
	where is the itro	where is the itro	correct	0.00	1.00	1	1
Angeline	room 215	rooom 215	correct	0.00	1.00	1	1
	auditorium	auditorium	correct	0.00	1.00	1	1
Lucky	dormitory - second	dormitory	invalid	0.50	0.50	1	1
	dormitory - second	dormitory	invalid	0.50	0.50	1	1
	finance	finance	correct	0.00	1.00	1	1
	gym	jim	no results	1.00	0.00	0	0
Carlo	clinic	clinic	correct	0.00	1.00	1	1
	faculty room	apple berry	no results	1.00	0.00	0	0
	faculty room - first	faculty room	invalid	0.33	0.67	1	1
Danni	library	library	multiple results	0.00	1.00	1	1
	library phase 1	library face	no results	0.66	0.34	1	0
	room 314	room 314	correct	0.00	1.00	1	1
ny	im going to lobby guard	im going to lobby guard	correct	0.00	1.00	2	2
	itro	eight years old	no results	3.00	-2.00	0	0
	im going to 501	im going to 501	correct	0.00	1.00	1	1
Juan Miguel	where is eslo	where is estonia	invalid	0.33	0.67	0	0
	where is eslo	where is esl lol	invalid	0.50	0.50	0	0
	where is room 809	various room 809	correct	0.75	0.25	1	1
	where is physics laboratory	where is physics laboratory	multiple results	0.00	1.00	1	1
Jervis	514 - third	514	invalid	0.50	0.50	1	1
	514 - third	514	invalid	0.50	0.50	1	1
	library	liberty	no results	1.00	0.00	0	0
	faculty room	that will give you	no results	2.00	-1.00	0	0
	faculty room - first	faculty room	invalid	0.33	0.67	1	1
	dormitory - first	dormitory	correct	0.00	1.00	1	1
	microsoft hub	microsoft hub	correct	0.00	1.00	2	2
Jasmine	1016	then 16	incorrect	2.00	-1.00	0	0
	1016	1016	correct	0.00	1.00	1	1
	audio visual room - second	audio with visual room	invalid response	0.50	0.50	2	2
	registrars office	registrars office	correct	0.00	1.00	1	1
Del Gabriel	room 612	room 612 I know	no room	1.00	0.00	0	0
	room 314	room 314	correct	0.00	1.00	1	1
Christine Joy	where is the animation studio - first	where is the animation studio	invalid response	0.17	0.83	2	2
	where is the 2d animation laboratory	where is the 2d animation laboratory	value error code	0.00	1.00	2	0
Mary Sunday	eslo	slow	no results	1.00	0.00	0	0
	eslo	slow	no results	1.00	0.00	0	0
	811	the case number 811	correct	3.00	-2.00	1	1
	eslo	estella	no results	1.00	0.00	0	0
	where is the eslo	where is the eslo	correct	0.00	1.00	1	1
Clarissa	where is the auditorium	where is the auditorium	correct	0.00	1.00	1	1
	where is the clinic	where is the clinic	correct	0.00	1.00	1	1
munoz	room 816	1/6	no results	1.00	0.00	0	0
	room 186	room	no results	0.50	0.50	0	0
	room 816	room 816	correct	0.00	1.00	1	1
	auditorium	auditorium	correct	0.00	1.00	1	1
Jouie	room 1114	room	no results	0.50	0.50	0	0
	room 1114	room and have been	no results	1.50	-0.50	0	0
	614	614	correct	0.00	1.00	1	1
Jan Lorenzo	room 610	room 610	no room	0.00	1.00	0	0
	room 601	room 601	correct	0.00	1.00	1	1
	faculty room - second	faculty room - second	correct	0.00	1.00	1	1
Louise	room 604	room 604	correct	0.00	1.00	1	1
Jake Angelu	gymnasium - second	gymnasium - first	correct	0.50	0.50	1	1
Kyle	chapel	chapel	correct	0.00	1.00	1	1
	parking	no parking	no results	1.00	0.00	0	0
	gym	what is your body	no results	4.00	-3.00	0	0
	itro	I tro	no results	2.00	-1.00	0	0
	cafeteria	cafeteria	correct	0.00	1.00	1	1
	registrars office	registrars office	correct	0.00	1.00	1	1

Rasheed	609-b	609-b	no results	0.00	1.00	1	0
	guidance	any guidance	correct	1.00	0.00	1	1
Kerwin	looking for room 208	looking for room 208	correct	0.00	1.00	1	1
	building maintenance office	building	correct	0.66	0.34	1	1
Danica Ashley	where is room 308	where is room 308	correct	0.00	1.00	1	1
	cafeteria	cafeteria	correct	0.00	1.00	1	1
Reneloppe	registrar office	registrar office	no result	0.00	1.00	0	0
	registrars office	registrars office	correct	0.00	1.00	1	1
Katrina	where is the basketball court	where is the basketball court	correct	0.00	1.00	2	2
Edward	admissions office	admissions office	correct	0.00	1.00	1	1
Rhea Shiny	room 618	room 618	correct	0.00	1.00	1	1
Kyle	library	library	multiple results	0.00	1.00	1	1
	auditorium	auditorium	correct	0.00	1.00	1	1
Francesca Nicolle	hello, where is the library	where is the library	multiple results	0.20	0.80	1	1
	hello, where is the clinic	hello where is the clinic	correct	0.00	1.00	1	1
Jameiya	where is room 1117	where is room 111 7	no results	0.25	0.75	0	0
	room 1117	room 1117	correct	0.00	1.00	1	1
Ann Elizabeth	finance	finance	correct	0.00	1.00	1	1
Mariah	cafeteria	cafeteria	correct	0.00	1.00	1	1
Franchesca	eslo	estonia	incorrect	1.00	0.00	0	0
	e s l o	eslo	correct	0.00	1.00	1	1
Ely	where is the lobby guard	where is the lobby guard	correct	0.00	1.00	2	2
	I want to go to palo alto	I want to go to palo alto	correct	0.00	1.00	2	2
	I want to go to the registrars office	I want to go to the registrars office	correct	0.00	1.00	1	1
	im going to finance	going into finance	correct	0.25	0.75	1	1
Eugene	room 803	room 803	correct	0.00	1.00	1	1
	where is the eslo	where is the eslo	correct	0.00	1.00	1	1
Jane	library	library	multiple results	0.00	1.00	1	1
	art studio	art studio	multiple results	0.00	1.00	1	1
Luke	room 204	room 204	correct	0.00	1.00	1	1
Hannah	where is the admissions office	where is the admissions office	correct	0.00	1.00	1	1
Jojo	finance office	finance office	correct	0.00	1.00	1	1
Matthew	where is the gym - first	where is the gym - first	correct	0.00	1.00	1	1
			Scores:	0.37	0.63	87	81
			Recognition Rate(%):	93.10			

APPENDIX K

(Proof of Testing)

APPENDIX L

(Accuracy Testing Results)

System Accuracy Testing Results Breakdown

Scenario	WER	Accuracy
1	0.47%	99.53%
2	1.73%	98.27%
3	5.27%	94.73%
4	0.00%	100.00%
5	0.83%	99.17%
6	2.97%	97.03%
Total:	1.88%	98.12%

Accuracy Testing Results – Low Background Noise Scenario

Male Testers: Elisha, Jeremy, Genesis Female Testers: Veronica, Rizzi, Vernice					
Low Background Noise					
Tester	Original Query	Transcribed Query	Other Scenario	Word Error Rate	Accuracy Rate
Elisha	Where can we borrow ping pong racket and ball	Where can we borrow ping pong racket and ball	far	0%	100%
Elisha	Where can I get coffee	Where can I get coffee	near	0%	100%
Elisha	Where is the microwave located	Where is the microwave located	far	0%	100%
Elisha	Where can I reserve a project laboratory	Where can I reserve a project laboratory	near	0%	100%
Elisha	Where can I get my diploma	Where can I get my diploma	far	0%	100%
Jeremy	Where is the table tennis area	Where is the table tennis area	near	0%	100%
Jeremy	Where to get a hot water	Where to get a hot water	far	0%	100%
Jeremy	Where can I buy utensils	Where can I buy utensils	near	0%	100%
Jeremy	Where can I work on my circuits activity	Where can I work on my circuits activity	far	0%	100%
Jeremy	Where can I see the Microsoft room	Where can I see the Microsoft room	near	0%	100%
Genesis	Where is the basketball court	Where is the basketball court	far	0%	100%
Genesis	Where can I heat my food	Where can I heat my food	near	0%	100%
Genesis	Where can I borrow equipments for our thesis	Where can I borrow equipments for our thesis	far	0%	100%
Genesis	Where to request for an official receipt	Where to request for an official receipt	near	0%	100%
Genesis	Where can I request for good moral certificate	Where can I request for good moral certificate	far	0%	100%
Veronica	Where is the BMO	Where is the BMO	near	0%	100%
Veronica	Where can I pay my tuition	Where can I pay my tuition	far	0%	100%
Veronica	The film showing at the auditorium	The film is showing at the auditorium	near	14%	86%
Veronica	A room where I can play instruments	A room where I can play instruments	far	0%	100%
Veronica	The APC cybersecurity room	The APC cyber security room	near	0%	100%
Rizzi	I want to inquire	I want to inquire	far	0%	100%
Rizzi	The event at MPH2	The event at MPH2	near	0%	100%
Rizzi	Going to room 811	Going to room 811	far	0%	100%
Rizzi	Where can I play ping pong	Where can I play ping pong	near	0%	100%
Rizzi	I'm gonna go to the chapel	I'm gonna go to the chapel	far	0%	100%
Vernice	I want to go to the lost and found	I want to go to the lost and found	near	0%	100%
Vernice	I have an inquiry	I have an inquiry	far	0%	100%
Vernice	I have an appointment with the admissions	I have an appointment with the admissions	near	0%	100%
Vernice	Where is the gym for my PE class	Where is the gym for my PE class	far	0%	100%
Vernice	Where can I eat snacks	Where can I eat snacks	near	0%	100%

Accuracy Testing Results – High Background Noise Scenario

Male Testers: Elisha, Jeremy, Genesis Female Testers: Veronica, Rizzi, Vernice					
High Background Noise					
Tester	Original Query	Transcribed Query	Other Scenario	Word Error Rate	Accuracy Rate
Elisha	Where can we book a discussion room	Where can we book a discussion room	near	0%	100%
Elisha	Where is the art studio	Where is the art studio	far	0%	100%
Elisha	Is there a soundproof room	Is there a soundproof room	near	0%	100%
Elisha	Where can I hold a movie event	Where can I hold a movie event	far	0%	100%
Elisha	Where can I see the tenants of APC	Where can I see the tenants of a PC	near	25%	75%
Jeremy	Where is the Student's Activities Office	Where is the Student's Activities Office	far	0%	100%
Jeremy	Where can I sign up for gym	Where can I sign up for gym	near	0%	100%
Jeremy	Where can I find the photography room with green screen	Where can I find the photography room with green screen	far	0%	100%
Jeremy	Where can I inquire for enrollment	Where can I inquire for enrollment	near	0%	100%
Jeremy	Where can we find the shuttle	Where can we find the shuttle	far	0%	100%
Genesis	Where can I attend a church mass	Where can I attend a church mass	near	0%	100%
Genesis	Where can I retrieve my lost item	Where can I retrieve my lost item	far	0%	100%
Genesis	Where can I borrow a monitor	Where can I borrow a monitor	near	0%	100%
Genesis	Where can I hold an exhibit	Where can I hold an exhibit	far	0%	100%
Genesis	Where can I find the maintenance room	Where can I find the maintenance room	near	0%	100%
Veronica	Where can I take a bath	Can I take a bath	far	17%	83%
Veronica	Where can I take a rest	Where can I take a rest	near	0%	100%
Veronica	Where can I play sports	Where can I play sports	far	0%	100%
Veronica	Where is the board room	Where is the boardroom	near	0%	100%
Veronica	Where can I play video games	Where can I play video games	far	0%	100%
Rizzi	Where is the art studio	Where is the art studio	near	0%	100%
Rizzi	Where can I see the works of the mma students	Where can I see the works of the mma	far	10%	90%
Rizzi	Where can I borrow equipment	Where can I borrow equipment	near	0%	100%
Rizzi	Where can I reserve a room	Where can I reserve a room	far	0%	100%
Rizzi	Where can I replace my ID	Where can I replace my ID	near	0%	100%
Vernice	Where can I enroll	Where can I enroll	far	0%	100%
Vernice	Where is the library	Where is the library	near	0%	100%
Vernice	Where can I print documents	Where can I print documents	far	0%	100%
Vernice	Where is the clinic	Where is the clinic	near	0%	100%
Vernice	Where can I consult my professor	Where can I consult my professor	far	0%	100%

Accuracy Testing Results – Near Distance Scenario

Male Testers: Elisha, Jeremy, Genesis Female Testers: Veronica, Rizzi, Vernice					
Near Distance					
Tester	Original Query	Transcribed Query	Other Scenario	Word Error Rate	Accuracy Rate
Elisha	Where can I get coffee	Where can I get coffee	low	0%	100%
Elisha	Where can I reserve a project laboratory	Where can I reserve a project laboratory	low	0%	100%
Elisha	Where can we book a discussion room	Where can we book a discussion room	high	0%	100%
Elisha	Is there a sound proof room	Is there a sound proof room	high	0%	100%
Elisha	Where can I see the tenants of APC	Where can I see the tenants of a PC	high	25%	75%
Jeremy	Where is the table tennis area	Where is the table tennis area	low	0%	100%
Jeremy	Where can I buy utensils	Where can I buy utensils	low	0%	100%
Jeremy	Where can I see the Microsoft room	Where can I see the Microsoft room	low	0%	100%
Jeremy	Where can I sign up for gym	Where can I sign up for gym	high	0%	100%
Jeremy	Where can I inquire for enrollment	Where can I inquire for enrollment	high	0%	100%
Genesis	Where can I heat my food	Where can I heat my food	low	0%	100%
Genesis	Where to request for an official receipt	Where to request for an official receipt	low	0%	100%
Genesis	Where can I attend a church mass	Where can I attend a church mass	high	0%	100%
Genesis	Where can I borrow a monitor	Where can I borrow a monitor	high	0%	100%
Genesis	Where can I find the maintenance room	Where can I find the maintenance room	high	0%	100%
Veronica	Where can I pay the remaining balance of my tuition	Where can I pay the remaining balance of my tuition	high	0%	100%
Veronica	Where is the project laboratory	Where is the project laboratory	low	0%	100%
Veronica	Where can I reserve a schedule for the basketball court	Where can I reserve a schedule for the basketball court	high	0%	100%
Veronica	Where is room 816	Where is room 816	low	0%	100%
Veronica	Where is the eslo	Where is the eslo	high	0%	100%
Rizzi	Where is the physics laboratory	Where is the physics laboratory	low	0%	100%
Rizzi	Where can we work on our thesis projet	Where can we work on our thesis projet	high	0%	100%
Rizzi	Where is the sound recording studio	Where is the sound recording studio	low	0%	100%
Rizzi	Where can I cancel my blue slip violation	Where can I cancel my blue slip violation	high	0%	100%
Rizzi	Where is the 2D animation laboratory	Where is the 2D animation laboratory	low	0%	100%
Vernice	Where can I isolate myself	Where can I isolate myself	high	0%	100%
Vernice	Where is the SHS faculty	Where is the SHS faculty	low	0%	100%
Vernice	Where is the student lounge	Where is the student lounge	high	0%	100%
Vernice	Where is the auditorium	Where is the auditorium	low	0%	100%
Vernice	Where is the open laboratory	Where is the open laboratory	high	0%	100%

Accuracy Testing Results – Far Distance Scenario

Male Testers: Elisha, Jeremy, Genesis Female Testers: Veronica, Rizzi, Vernice					
Far Distance					
Tester	Original Query	Transcribed Query	Other Scenario	Word Error Rate	Accuracy Rate
Elisha	Where can we borrow ping pong racket and ball	Where can we borrow ping pong racket and ball	low	0%	100%
Elisha	Where is the microwave located	Where is the microwave located	low	0%	100%
Elisha	Where can I get my diploma	Where can I get my diploma	low	0%	100%
Elisha	Where is the art studio	Where is the art studio	high	0%	100%
Elisha	Where can I hold a movie event	Where can I hold a movie event	high	0%	100%
Jeremy	Where to get a hot water	Where to get a hot water	low	0%	100%
Jeremy	Where can I work on my circuits activity	Where can I work on my circuits activity	low	0%	100%
Jeremy	Where is the Student's Activities Office	Where is the Student's Activities Office	high	0%	100%
Jeremy	Where can I find the photography room with green screen	Where can I find the photography room with green screen	high	0%	100%
Jeremy	Where can we find the shuttle	Where can we find the shuttle	high	0%	100%
Genesis	Where is the basketball court	Where is the basketball court	low	0%	100%
Genesis	Where can I borrow equipments for our thesis	Where can I borrow equipments for our thesis	low	0%	100%
Genesis	Where can I request for good moral certificate	Where can I request for good moral certificate	low	0%	100%
Genesis	Where can I retrieve my lost item	Where can I retrieve my lost item	high	0%	100%
Genesis	Where can I hold an exhibit	Where can I hold an exhibit	high	0%	100%
Veronica	Where is the mock travel counter for tourism students	Where is the mock travel counter for tourism students	low	0%	100%
Veronica	Where can I see the librarian for an inquiry	Where can I see the librarian for an inquiry	low	0%	100%
Veronica	Where is the film showing	Where is the film showing	high	0%	100%
Veronica	Where can I shower	Where can I shower	high	0%	100%
Veronica	I want to go to the foley recording studio	I want to go to the fully recording studio	high	13%	87%
Rizzi	I need to see the nurse	I need to see the nurse	low	0%	100%
Rizzi	Where is the library phase one	Where is the library phase one	low	0%	100%
Rizzi	Is there a student lounge in school	Is there a student lounge in school	low	0%	100%
Rizzi	I want to get a locker	I want to get my locker	high	17%	83%
Rizzi	Where is the basketball court	Where is the basketball court	high	0%	100%
Vernice	Where is the DO	Where is the DOJ	low	25%	75%
Vernice	Is there a kitchen in APC	Is there a kitchen in ATC	high	17%	83%
Vernice	I want to borrow books from the library	I want to borrow books from the library	low	0%	100%
Vernice	Where is the APC dorm located	Where is the APC door located	high	17%	83%
Vernice	Where is the general assembly for senior high school	Where is the general assembly for senior high school	low	0%	100%

Accuracy Testing Results – Male Speaker Scenario

Male Testers: Elisha, Jeremy, Genesis Female Testers: Veronica, Rizzi, Vernice					
Male Speaker					
Tester	Original Query	Transcribed Query	Other Scenario	Word Error Rate	Accuracy Rate
Elisha	Where can I get coffee	Where can I get coffee	low - near	0%	100%
Elisha	I want to pee	Want to pee	low - far	25%	75%
Elisha	Where is the auditorium	Where is the auditorium?	high - near	0%	100%
Elisha	basketball court	basketball	high - far	50%	50%
Elisha	Where can I reserve a project laboratory	Where can I reserve a project laboratory	low - near	0%	100%
Elisha	ESLO	eslo	low - far	0%	100%
Elisha	I want to pay my tuition	I want to pay my tuition	high - near	0%	100%
Elisha	Parking	Parking	high - far	0%	100%
Elisha	I want to eat	I want to eat	low - near	0%	100%
Elisha	Place to sleep	Place to sleep	high - near	0%	100%
Jeremy	Location of dormitory	Location of dormitory	low - near	0%	100%
Jeremy	I want to buy some food	I want to buy food	low - far	17%	83%
Jeremy	Registrar's office	Registrars office	high - near	0%	100%
Jeremy	I can't find room 401	Find room 401	high - far	0%	100%
Jeremy	Multipurpose Hall 1	Multipurpose Hall One	low - near	33%	67%
Jeremy	Where to get a hot water	Where to get a hot water	low - far	0%	100%
Jeremy	Engineering department	Engineering department	high - near	0%	100%
Jeremy	I want to get my diploma	I want to get my diploma	high - far	0%	100%
Jeremy	Listen to music	Listen to music	high - near	0%	100%
Jeremy	Computer Laboratory	Computer Laboratory	high - far	0%	100%
Genesis	Where can I heat my food	Where can I heat my food	low - near	0%	100%
Genesis	Where is the basketball court	Where is the basketball court	low - far	0%	100%
Genesis	Where can I attend a church mass	Where can I attend a church mass	high - near	0%	100%
Genesis	Where can I retrieve my lost item	Where can I retrieve my lost item	high - far	0%	100%
Genesis	Where to request for an official receipt	Where to request for an official receipt	low - near	0%	100%
Genesis	Request for good moral certificate	Request for good moral certificate	low - far	0%	100%
Genesis	I want to borrow monitor	I want to borrow monitor	high - near	0%	100%
Genesis	Where can I hold an exhibit	I hold an exhibit	high - far	33%	67%
Genesis	Guard lobby	Guard lobby	low - near	0%	100%
Genesis	Where is the gym	Where is the gym	high - near	0%	100%

Accuracy Testing Results – Female Speaker Scenario

Male Testers: Elisha, Jeremy, Genesis Female Testers: Veronica, Rizzi, Vernice					
Female Speaker					
Tester	Original Query	Transcribed Query	Other Scenario	Word Error Rate	Accuracy Rate
Veronica	Place to eat	Place to eat	low - near	0%	100%
Veronica	Where to park	Where to park	low - far	0%	100%
Veronica	Where can I inquire about the internship	Where can I inquire about the internship	high - near	0%	100%
Veronica	Where is the palo alto	Where is the palo alto	high - far	0%	100%
Veronica	Where is the dormitory lounge	Where is the dormitory lounge	low - near	0%	100%
Veronica	Where can I play table tennis	Where can I play table tennis	low - far	0%	100%
Veronica	I want to film a video	I want to film a video	high - near	0%	100%
Veronica	Where can I request for an excuse letter	Where can I request for an excuse letter	high - far	0%	100%
Veronica	Where can I withdraw	Where can I withdraw	low - near	0%	100%
Veronica	Where can I surrender lost things I found	Where can I surrender lost things I found	high - near	0%	100%
Rizzi	Where to hang out	Where to hang out	low - near	0%	100%
Rizzi	Where is the bathroom	Where is the bathroom	low - far	0%	100%
Rizzi	I want to consult the guidance counselor	I want to consult the guidance counselor	high - near	0%	100%
Rizzi	Where to eat lunch	Where to eat lunch	high - far	0%	100%
Rizzi	Where can I request a table	Where can I request a table	low - near	0%	100%
Rizzi	I want to print my project	I want to print my project	low - far	0%	100%
Rizzi	Where can I find my missing item	Where can I find my missing item	high - near	0%	100%
Rizzi	Where can I record my music	Where can I record my music	high - far	0%	100%
Rizzi	Where can I use a computer	Where can I use a computer	high - near	0%	100%
Rizzi	Is there a smoking area	Is there a smoking area	high - far	0%	100%
Vernice	Where is the water fountain	Where is the water fountain	low - near	0%	100%
Vernice	Where is the discussion room	Where is the discussion room	low - far	0%	100%
Vernice	Where can I request for a sticker for my laptop	Where can I request for a sticker for my laptop	high - near	0%	100%
Vernice	Where to buy food	Where to buy food	high - far	0%	100%
Vernice	Where is the Microsoft Experience Center	Where is the Microsoft Experience Center	low - near	0%	100%
Vernice	Where to request documents	Where to request documents	low - far	0%	100%
Vernice	Where can I store my things	Where can I store my things	high - near	0%	100%
Vernice	Where can I buy toiletries	Where can I buy toiletries	high - far	0%	100%
Vernice	I want to borrow a book	I want to borrow a book	low - near	0%	100%
Vernice	I want to get medicine for my wound	I want to get medicine for my wound	high - near	0%	100%

APPENDIX M

(Reliability Testing Results)

System Reliability Testing Results for Room Names

Total Success	Total Fail	Recognition Rate (%)	No. Room Names
643	52	92.52	139

System Reliability Testing Results for Room Numbers

Total Success	Total Fail	Recognition Rate (%)	No. Room Numbers
595	0	100	119

System Reliability Testing Results for Room Keyword

Total Success	Total Fail	Recognition Rate (%)	No. Keywords
1266	24	98.14	258

Total Recognition Rate:

	Success	Fail	Rate (%)
Total Recog:	2504	76	97.05

Reliability Testing Results – Room Names

		Query 1	Query 2	Query 3	Query 4	Query 5		
Room ID	Room Name	"Where is the [place]?"	"I want to go to [place]"	"Is there a [place]?"	"Location of [place]"	"[place]"	Number of Successe	Number of Fails
101	Clinic						5	0
102	Chapel						5	0
103	Multi-Purpose Hall 1						5	0
104	Admissions Office						5	0
105	Guard Lobby						5	0
106	Cafeteria						5	0
201	Lecture Room						5	0
202	APC Cybersecurity Room	x	x	x	x		1	4
203	Lecture Room						5	0
204	Computer Laboratory						5	0
205	Lecture Room						5	0
206	Computer Laboratory						5	0
207	Lecture Room						5	0
208	Computer Laboratory						5	0
209	Multi-Purpose Hall 2						3	2
210	Lecture Room						5	0
211	Storage Room						5	0
212	Isolation Area						5	0
213	Computer Laboratory						5	0
214	Isolation Area						5	0
215	Microsoft Experience Center						5	0
301	Student Lounge						5	0
302	Computer Laboratory						5	0
303	Student Activities Office						5	0
304	Computer Laboratory						5	0
305	Lecture Room						5	0
306	Computer Laboratory						5	0
307	Lecture Room						5	0
308	Computer Laboratory						5	0
309	Lecture Room						5	0
310	Lecture Room						5	0
311	Computer Laboratory						5	0
312	Lecture Room						5	0
313	Computer Laboratory						5	0
314	Lecture Room						5	0
315	Computer Laboratory						5	0
401	President's Office						5	0
402	Director's Office						5	0
403	Director's Office						5	0
404	Faculty Area						5	0
405	Board Room						5	0
406	Lecture Room						5	0
407	Accounting and Finance Office						5	0
408	Registrar's Office	x					4	1
409	Open Laboratory						5	0
410	Isolation Area						5	0
411	Lecture Room						5	0
412	Lecture Room						5	0
413	Lecture Room						5	0
501	IT Resource Office						5	0
502	Networking Laboratory						5	0
503	Consulting Services Office						5	0
504	Linux Laboratory						5	0
505	Game Studio						5	0
506	Human Resources Office						5	0
507	Documentation Room						5	0
508	Discussion Room A						5	0
509	Discussion Room B						5	0
510	APC Technology Center						5	0
511	Career and Placement Office						5	0
512	NSTP Office						5	0
513	Student Services	x	x	x	x	x	0	5
514	2D Animation Laboratory						5	0
515	Foley Recording Studio						5	0
516	Music Recording Studio						5	0
517	Video and Photography Room						5	0
601	Lecture Room						5	0
602	Graphic Design and Sound Laboratory						5	0
603	Lecture Room						5	0
604	Animation Laboratory						5	0
605	Lecture Room						5	0
606	Game Laboratory						5	0
607	Lecture Room						5	0
608	Video Editing Laboratory						5	0
609	Small Room A						5	0
610	Small Room B						5	0
611	Small Room C						5	0
612	Lecture Room						5	0
613	Psychology Laboratory						5	0
614	Lecture Room						5	0
615	Lecture Room						5	0
616	Lecture Room						5	0
617	Lecture Room						5	0
618	Lecture Room						5	0
701	Library Phase 1						0	5
702	Discussion Room A						5	0
703	Discussion Room B						5	0
704	Discussion Room C						0	5
705	SHS Faculty						5	0
706	Audio Visual Room						5	0
707	Technical Library						5	0
708	Library Office						5	0
709	Research Room						5	0
710	Library Phase 2						0	5
711	Math and English Resource Center						5	0
801	Digital Electronics Laboratory						5	0
802	National Instruments Laboratory						5	0
803	Engineering and Science Laboratory Office						0	5
804	Electronics and Circuits Laboratory						5	0

805	Physics Laboratory						5	0
806	Networking and Communication Laboratory						5	0
807	Project Laboratory A						0	5
808	Project Laboratory B						0	5
809	Lecture Room						5	0
810	Lecture Room						5	0
811	Lecture Room						5	0
812	Project Laboratory C						0	5
813	Lecture Room						5	0
814	Lecture Room						5	0
815	Lecture Room						5	0
816	Lecture Room						5	0
901	Dormitory						5	0
902	Dormitory Lounge						5	0
1001	Fitness Center						5	0
1002	Table Tennis Area						5	0
1003	Female Shower Room						5	0
1004	Male Shower Room						5	0
1005	Purchasing and Logistics Office						5	0
1006	Discipline Office						5	0
1007	Building Maintenance Office						5	0
1008	Kitchen						5	0
1009	Lecture Room						5	0
1010	Lecture Room						5	0
1011	Lecture Room						5	0
1012	Lecture Room						5	0
1013	Lecture Room						5	0
1014	Lecture Room						5	0
1101	Gymnasium						5	0
1102	Guidance Office						5	0
1103	Chemical Storage						5	0
1104	Chemistry Laboratory						5	0
1105	Art Studio						5	0
1106	Lecture Room						5	0
1107	Art Studio						5	0
1108	Project Laboratory						0	5
1109	Lecture Room						5	0
1110	Band Practice Room						5	0
1111	Mock Travel Counter						5	0
1201	Auditorium						5	0

Reliability Testing Results – Room Numbers

		Query 1	Query 2	Query 3	Query 4	Query 5		
Room Name	Room Number	"Where is [room number]?"	"I w ant to go to [room number]"	"Is there a [room number]?"	"Location of [room number]"	"[room number]"	Number of Successe	Number of Fails
Clinic								
Chapel								
Multi-Purpose Hall 1								
Admissions Office								
Guard Lobby								
Cafeteria								
Lecture Room	201						5	0
APC Cybersecurity Room	202						5	0
Lecture Room	203						5	0
Computer Laboratory	204						5	0
Lecture Room	205						5	0
Computer Laboratory	206						5	0
Lecture Room	207						5	0
Computer Laboratory	208						5	0
Multi-Purpose Hall 2	209						5	0
Lecture Room	213						5	0
Storage Room	214						5	0
Isolation Area	215						5	0
Computer Laboratory	216						5	0
Isolation Area	217						5	0
Microsoft Experience Center	218						5	0
Student Lounge	301						5	0
Computer Laboratory	302						5	0
Student Activities Office	303						5	0
Computer Laboratory	304						5	0
Lecture Room	305						5	0
Computer Laboratory	306						5	0
Lecture Room	307						5	0
Computer Laboratory	308						5	0
Lecture Room	309						5	0
Lecture Room	313						5	0
Computer Laboratory	314						5	0
Lecture Room	315						5	0
Computer Laboratory	316						5	0
Lecture Room	317						5	0
Computer Laboratory	318						5	0
President's Office	401						5	0
Director's Office	403						5	0
Director's Office	405						5	0
Faculty Area	406						5	0
Board Room	407						5	0
Lecture Room	409						5	0
Accounting and Finance Office	411						5	0
Registrar's Office	413						5	0
Open Laboratory	414						5	0
Isolation Area	415						5	0
Lecture Room	416						5	0
Lecture Room	417						5	0
Lecture Room	418						5	0
IT Resource Office	501						5	0
Networking Laboratory	502						5	0
Consulting Services Office	504						5	0
Linux Laboratory	505						5	0
Game Studio	506						5	0
Human Resources Office	507						5	0
Documentation Room	507						5	0
Discussion Room A	508						5	0
Discussion Room B	508						5	0
APC Technology Center	509						5	0
Career and Placement Office	514						5	0
NSTP Office	514						5	0
Student Services	514						5	0
2D Animation Laboratory	515						5	0
Foley Recording Studio	516						5	0
Music Recording Studio	516						5	0
Video and Photography Room	518						5	0
Lecture Room	601						5	0
Graphic Design and Sound Laboratory	602						5	0
Lecture Room	603						5	0
Animation Laboratory	604						5	0
Lecture Room	605						5	0
Game Laboratory	606						5	0
Lecture Room	607						5	0
Video Editing Laboratory	608						5	0
Small Room A	609						5	0
Small Room B	609						5	0
Small Room C	609						5	0
Lecture Room	611						5	0
Psychology Laboratory	613						5	0
Lecture Room	614						5	0
Lecture Room	615						5	0
Lecture Room	616						5	0
Lecture Room	617						5	0
Lecture Room	618						5	0
Library Phase 1								
Discussion Room A								
Discussion Room B								
Discussion Room C								
SHS Faculty								
Audio Visual Room								
Technical Library								
Library Office								
Research Room								
Library Phase 2								
Math and English Resource Center								
Digital Electronics Laboratory	801						5	0
National Instruments Laboratory	802						5	0
Engineering and Science Laboratory Office	803						5	0
Electronics and Circuits Laboratory	805						5	0
Physics Laboratory	806						5	0
Networking and Communication Laboratory	807						5	0

Project Laboratory A	808						5	0
Project Laboratory B	808						5	0
Lecture Room	809						5	0
Lecture Room	811						5	0
Lecture Room	813						5	0
Project Laboratory C	814						5	0
Lecture Room	815						5	0
Lecture Room	816						5	0
Lecture Room	817						5	0
Lecture Room	818						5	0
Dormitory								
Dormitory Lounge								
Fitness Center	1004						5	0
Table Tennis Area	1004						5	0
Female Shower Room	1007						5	0
Male Shower Room	1008						5	0
Purchasing and Logistics Office	1009						5	0
Discipline Office	1009						5	0
Building Maintenance Office	1011						5	0
Kitchen	1011						5	0
Lecture Room	1013						5	0
Lecture Room	1014						5	0
Lecture Room	1015						5	0
Lecture Room	1016						5	0
Lecture Room	1017						5	0
Lecture Room	1018						5	0
Gymnasium	1109						5	0
Guidance Office	1110						5	0
Chemical Storage	1111						5	0
Chemistry Laboratory	1113						5	0
Art Studio	1114						5	0
Lecture Room	1115						5	0
Art Studio	1116						5	0
Project Laboratory	1116						5	0
Lecture Room	1117						5	0
Band Practice Room	1118						5	0
Mock Travel Counter	1118						5	0
Auditorium								

Reliability Testing Results – Room Keywords

		Query 1	Query 2	Query 3	Query 4	Query 5		
Room Name	Keyword	"Where is [keyword]?"	"I want to go to [keyword]"	"Is there a [keyword]?"	"Location of [keyword]"	"[keyword]"	Number of Sucoesse	Number of Fails
Clinic								
	Nurse						5	0
	Medicine						5	0
	First Aid						5	0
Chapel								
	Mass						5	0
	Baccalaureate						5	0
	Church						5	0
Multi-Purpose Hall 1								
	Event						5	0
	Assembly						5	0
	MPH1		x	x	x	x	1	4
Admissions Office								
	Transfer						5	0
	Inquire						5	0
	Application						5	0
Guard Lobby								
	Desk						5	0
	Assistance						5	0
	Service						5	0
Cafeteria								
	Food						5	0
	Eat						5	0
	Order						5	0
Lecture Room								
APC Cybersecurity Room								
	Cybersecurity						0	5
	Palo Alto						5	0
	I.T.							
Lecture Room								
Computer Laboratory								
Lecture Room								
Computer Laboratory								
Lecture Room								
Computer Laboratory								
Multi-Purpose Hall 2								
	Event						5	0
	Assembly						5	0
	MPH2						5	0
Lecture Room								
Storage Room								
	Storage						5	0
	Store						5	0
	Equipment						5	0
Isolation Area								
	Isolate						5	0
	Covid						5	0
	Sick						5	0
Computer Laboratory								
Isolation Area								
	Isolate						5	0
	Covid						5	0
	Sick						5	0
Microsoft Experience Center								
	Microsoft						5	0
	Hub						5	0
	Electronics						5	0
Student Lounge								
	Gather						5	0
	Leisure						5	0
	Students						5	0
Computer Laboratory								
Student Activities Office								
	Extra-Curricular						0	5
	SAO						5	0
	Activities						5	0
Computer Laboratory								
Lecture Room								
Computer Laboratory								
Lecture Room								
Computer Laboratory								
Lecture Room								
Lecture Room								
Computer Laboratory								
Lecture Room								
Computer Laboratory								
Lecture Room								
Computer Laboratory								
President's Office								
	President						5	0
	Administrator						5	0
	Head						5	0
Director's Office								
	Director						5	0
	Head						5	0
	Program						5	0
Director's Office								
	Director						5	0
	Head						5	0
	Program						5	0
Faculty Area								
	Teachers						5	0
	Professors						5	0
	Faculty						5	0
Board Room								
	Board Room						5	0
	Meeting						5	0
	Board						5	0
Lecture Room								
Accounting and Finance Office								
	Payment						5	0

	Balance						5	0
	Tuition						5	0
Registrar's Office								
	Records						5	0
	Documents						5	0
	Enroll						5	0
Open Laboratory								
	Homework						5	0
	Computer						5	0
	Print						5	0
Isolation Area								
	Isolate						5	0
	Covid						5	0
	Sick						5	0
Lecture Room								
Lecture Room								
Lecture Room								
IT Resource Office								
	Equipment						5	0
	Computer						5	0
	ITRO					x - ITRO	4	1
Networking Laboratory								
	Networking						5	0
	Networks						5	0
	Cisco						5	0
Consulting Services Office								
	Consult						5	0
	Services						5	0
	Consultant						5	0
Linux Laboratory								
	Linux						5	0
	Computer						5	0
Game Studio								
	Play						5	0
	Game						5	0
	Video Game						5	0
Human Resources Office								
	HR						5	0
	Staff						5	0
	Employee						5	0
Documentation Room								
	Documentation						5	0
	Albums						5	0
	Magazines						5	0
Discussion Room A								
	Discussion						5	0
	Meeting						5	0
Discussion Room B								
	Discussion						5	0
	Meeting						5	0
APC Technology Center								
	Techonology						5	0
	Experience						5	0
	Advance						5	0
Career and Placement Office								
	Internship						5	0
	OJT						5	0
	Work						5	0
NSTP Office								
	Volunteer						5	0
	Social						5	0
	Skills						5	0
Student Services								
	Director						5	0
	Student Services						5	0
2D Animation Laboratory								
	Graphics						5	0
	Animation						5	0
	Film						5	0
Foley Recording Studio								
	Sound						5	0
	Effects						5	0
	Audio						5	0
Music Recording Studio								
	Music						5	0
	Record						5	0
	Sound						5	0
Video and Photography Room								
	Photo						5	0
	Video						5	0
	MMA						5	0
Lecture Room								
Graphic Design and Sound Laboratory								
	Graphic Design						5	0
	Design						5	0
	Sound						5	0
Lecture Room								
Animation Laboratory								
	Animate						5	0
	Graphics						5	0
	Film						5	0
Lecture Room								
Game Laboratory								
	Video Game						5	0
	Play						5	0
	Game						5	0
Lecture Room								
Video Editing Laboratory								
	Film						5	0
	Editing						5	0
	Movie						5	0
Small Room A								
	Meeting						5	0
	Defense						5	0

	Proposal						5	0
Small Room B								
	Meeting						5	0
	Defense						5	0
	Proposal						5	0
Small Room C								
	Meeting						5	0
	Defense						5	0
	Proposal						5	0
Lecture Room								
Psychology Laboratory								
	Psychology						5	0
	Psych						5	0
	Study						5	0
Lecture Room								
Lecture Room								
Lecture Room								
Lecture Room								
Lecture Room								
Library Phase 1								
	Books						5	0
	Read						5	0
	Open						5	0
Discussion Room A								
	Meeting						5	0
	Defense						5	0
	Proposal						5	0
Discussion Room B								
	Meeting						5	0
	Defense						5	0
	Proposal						5	0
Discussion Room C								
	Meeting						5	0
	Defense						5	0
	Proposal						5	0
SHS Faculty								
	Teachers						5	0
	Professors						5	0
	Faculty						5	0
Audio Visual Room								
	Experience						5	0
	Audio						5	0
	Visual						5	0
Technical Library								
	Technical						5	0
	Librarian						5	0
	Books						5	0
Library Office								
	Librarian						5	0
	Borrow						5	0
	Information						5	0
Research Room								
	Research						5	0
	Books						5	0
	Documentation						5	0
Library Phase 2								
	Books						5	0
	Librarian						5	0
	Read						5	0
Math and English Resource Center								
	Resource						5	0
	Math						5	0
	English						5	0
Digital Electronics Laboratory								
	Digital						5	0
	Equipment						5	0
	Science						5	0
National Instruments Laboratory								
	Instruments						5	0
	Equipment						5	0
	Science						5	0
Engineering and Science Laboratory Office								
	Engineering						5	0
	ESLO		x	x	x	x	1	4
	Equipment						5	0
Electronics and Circuits Laboratory								
	Circuits						5	0
	Science						5	0
	Electronics						5	0
Physics Laboratory								
	Physics						5	0
	Experiment						5	0
	Science						5	0
Networking and Communication Laboratory								
	Network						5	0
	Communication						5	0
	Cisco						5	0
Project Laboratory A								
	Project						5	0
	Thesis						5	0
	Study						5	0
Project Laboratory B								
	Project						5	0
	Thesis						5	0
	Study						5	0
Lecture Room								
Lecture Room								
Lecture Room								
Project Laboratory C								
	Project						5	0
	Thesis						5	0
	Study						5	0
Lecture Room								
Lecture Room								

Lecture Room								
Lecture Room								
Dormitory								
	Dorm						5	0
	Student						5	0
Dormitory Lounge								
	Dorm						5	0
	Student						5	0
	Lounge						5	0
Fitness Center								
	Gym						5	0
	Instructor						5	0
	Workout						0	5
Table Tennis Area								
	Table Tennis						5	0
	Ping Pong						5	0
	Sport						5	0
Female Shower Room								
	Shower						5	0
	Bath						5	0
	Wash						5	0
Male Shower Room								
	Shower						5	0
	Bath						5	0
	Wash						5	0
Purchasing and Logistics Office								
	Locker						5	0
	Uniform						5	0
	Inventory						5	0
Discipline Office								
	DO						5	0
	Violation						5	0
	Disciplinary						5	0
Building Maintenance Office								
	BMO						5	0
	Locker						5	0
	Building						5	0
Kitchen								
	Cook						5	0
	Serve						5	0
	Food						5	0
Lecture Room								
Lecture Room								
Lecture Room								
Lecture Room								
Lecture Room								
Lecture Room								
Gymnasium								
	Sports						5	0
	Court						5	0
	Basketball						5	0
Guidance Office								
	Counseling						5	0
	Interview						5	0
	Consultation						5	0
Chemical Storage								
	Chemicals						5	0
	Elements						5	0
	Storage						5	0
Chemistry Laboratory								
	Chemistry						5	0
	Experiment						5	0
	Science						5	0
Art Studio								
	Creative						5	0
	Painting						5	0
	Drawing						5	0
Lecture Room								
Art Studio								
	Creative						5	0
	Painting						5	0
	Drawing						5	0
Project Laboratory								
	Project						5	0
	Thesis						5	0
	Study						5	0
Lecture Room								
Band Practice Room								
	Instruments						5	0
	Music						5	0
	Band						5	0
Mock Travel Counter								
	Tourism						5	0
	Travel						5	0
	Mock						5	0
Auditorium								
	Event						5	0
	Assembly						5	0
	Speaker						5	0

APPENDIX N

(User-Friendliness Survey Testing Results)

ID	Start time	Completion time	Email	Firstname :	Which type of user are you?	Search result image is appealing and comprehensible	Navigation labels are clear	Navigation labels are concise	Information is clear, accurate, and uncluttered	Buttons and images are properly and clearly represented.
1	9/6/22 12:50:05	9/6/22 12:50:47	dpgarcia2@student.a	Danica Ashley	Student	5	5	5	5	5
2	9/6/22 12:49:41	9/6/22 12:50:48	rrgallarin@student.a	Reneloppe	Student	5	5	5	5	5
3	9/6/22 12:54:28	9/6/22 12:54:44	kagonzales2@studen	katrina	Student	5	5	5	5	5
4	9/6/22 13:03:40	9/6/22 13:04:06	anonymous	Edward Mendoza	Staff	5	5	5	5	5
5	9/6/22 13:08:22	9/6/22 13:08:48	anonymous	Rhea shiny	Student	5	5	5	5	5
6	9/6/22 13:08:39	9/6/22 13:09:15	anonymous	Kyle	Student	5	5	5	5	5
7	9/6/22 13:08:57	9/6/22 13:13:34	anonymous	Francesca Nicolle	Student	5	5	5	5	5
8	9/6/22 13:13:40	9/6/22 13:23:30	anonymous	Jameiya	Student	3	2	2	3	4
9	9/6/22 13:23:36	9/6/22 13:31:40	anonymous	Ann Elizabeth	Student	5	5	5	5	5
10	9/6/22 13:31:49	9/6/22 13:35:54	anonymous	Mariah	Student	5	5	5	5	5
11	9/6/22 13:36:10	9/6/22 13:38:51	anonymous	Franchesca	Student	5	5	5	5	5
12	9/6/22 13:38:56	9/6/22 13:40:51	anonymous	Ely	Staff	5	4	4	4	4
13	9/6/22 13:40:55	9/6/22 13:44:53	anonymous	Eugene	Faculty	5	5	5	5	5
14	9/8/22 12:10:35	9/8/22 12:47:45	anonymous	Michelle Joy Ganoran	Faculty	3	5	4	5	5
15	9/8/22 12:47:58	9/8/22 12:58:52	anonymous	RJ Sy	Faculty	5	5	5	2	4
16	9/8/22 13:03:12	9/8/22 13:41:37	anonymous	Angeline	Faculty	5	5	5	5	5
17	9/8/22 13:41:42	9/8/22 13:47:50	anonymous	Lucky	Student	4	5	5	4	5
18	9/8/22 13:47:56	9/8/22 13:59:20	anonymous	Carlo	Staff	5	5	5	5	5
19	9/8/22 13:59:25	9/8/22 14:11:45	anonymous	Danni	Student	4	5	5	4	5
20	9/8/22 14:11:53	9/8/22 14:24:11	anonymous	ny	Faculty	3	2	4	2	3
21	9/8/22 14:24:18	9/8/22 14:39:45	anonymous	Juan Miguel	Faculty	5	5	5	4	5
22	9/8/22 14:39:52	9/8/22 14:48:34	anonymous	Jervis	Staff	4	4	4	4	4
23	9/9/22 13:43:23	9/9/22 14:11:02	anonymous	jasmine	Student	5	5	5	5	5
24	9/9/22 14:11:06	9/9/22 14:18:50	anonymous	Christine Joy	Student	5	5	5	5	5
25	9/9/22 14:18:53	9/9/22 14:19:27	anonymous	Del Gabriel	Guest	5	5	5	5	4
26	9/9/22 14:19:32	9/9/22 14:27:42	anonymous	Jane	Student	3	4	4	2	2
27	9/9/22 14:27:52	9/9/22 14:33:12	anonymous	Mary Sunday	Student	4	5	5	5	5
28	9/9/22 14:33:20	9/9/22 14:37:09	anonymous	Clarissa	Student	5	5	5	5	5
29	9/9/22 14:37:15	9/9/22 14:42:11	anonymous	Mikkaela Angela	Student	5	5	5	5	5
30	9/9/22 14:42:13	9/9/22 14:50:55	anonymous	Jouie Embudo Jr	Student	5	5	4	2	2
31	9/9/22 14:51:10	9/9/22 14:56:55	anonymous	jan lorenzo valencia	Student	4	3	4	5	5
32	9/9/22 14:56:59	9/9/22 14:59:24	anonymous	louise	Student	5	5	4	5	
33	9/9/22 14:59:33	9/9/22 15:04:45	anonymous	Jake Angelu	Guest	5	5	5	5	5
34	9/9/22 15:04:49	9/9/22 15:10:53	anonymous	Kyle	Student	5	5	5	5	5
35	9/9/22 15:11:36	9/9/22 15:22:33	anonymous	RASHEED	Student	5	5	5	5	5
36	9/9/22 15:22:37	9/9/22 15:31:40	anonymous	Kerwin	Student	5	5	5	4	5
37	9/9/22 15:33:18	9/9/22 15:34:09	anonymous	Luke	Student	5	5	5	5	5
38	9/9/22 15:37:12	9/9/22 15:42:09	anonymous	Hannah	Student	5	5	5	5	5
39	9/9/22 15:43:52	9/9/22 15:54:15	anonymous	Jojo	Student	5	5	5	5	5
40	9/9/22 15:58:19	9/9/22 16:05:02	anonymous	Matthew	Student	5	5	5	5	5
					Averages:	4.68	4.73	4.73	4.50	4.67
						User-Friendliness Score:	4.66			

APPENDIX O

(Accessibility Survey Testing Results)

ID	Start time	Completion time	Email	Firstname :	Which type of user are you?	The system can be located easily in the building	The system is being used by its intended users	The system can provide the appropriate information queried by the users
1	9/6/22 12:50:05	9/6/22 12:50:47	dpgarcia2@student.a	Danica Ashley	Student	5	5	5
2	9/6/22 12:49:41	9/6/22 12:50:48	rrgallarin@student.a	Reneloppe	Student	5	5	5
3	9/6/22 12:54:28	9/6/22 12:54:44	kagonzales2@studen	katrina	Student	5	5	5
4	9/6/22 13:03:40	9/6/22 13:04:06	anonymous	Edward Mendoza	Staff	5	5	5
5	9/6/22 13:08:22	9/6/22 13:08:48	anonymous	Rhea shiny	Student	5	5	5
6	9/6/22 13:08:39	9/6/22 13:09:15	anonymous	Kyle	Student	5	5	5
7	9/6/22 13:08:57	9/6/22 13:13:34	anonymous	Francesca Nicolle	Student	5	5	5
8	9/6/22 13:13:40	9/6/22 13:23:30	anonymous	Jameiya	Student	3	3	3
9	9/6/22 13:23:36	9/6/22 13:31:40	anonymous	Ann Elizabeth	Student	5	5	5
10	9/6/22 13:31:49	9/6/22 13:35:54	anonymous	Mariah	Student	5	5	5
11	9/6/22 13:36:10	9/6/22 13:38:51	anonymous	Franchesca	Student	5	5	5
12	9/6/22 13:38:56	9/6/22 13:40:51	anonymous	Ely	Staff	5	5	3
13	9/6/22 13:40:55	9/6/22 13:44:53	anonymous	Eugene	Faculty	5	5	5
14	9/8/22 12:10:35	9/8/22 12:47:45	anonymous	Michelle Joy Ganoran	Faculty	5	5	5
15	9/8/22 12:47:58	9/8/22 12:58:52	anonymous	RJ Sy	Faculty	1	5	2
16	9/8/22 13:03:12	9/8/22 13:41:37	anonymous	Angeline	Faculty	5	5	5
17	9/8/22 13:41:42	9/8/22 13:47:50	anonymous	Lucky	Student	4	5	5
18	9/8/22 13:47:56	9/8/22 13:59:20	anonymous	Carlo	Staff	5	5	5
19	9/8/22 13:59:25	9/8/22 14:11:45	anonymous	Danni	Student	4	5	4
20	9/8/22 14:11:53	9/8/22 14:24:11	anonymous	ny	Faculty	4	5	3
21	9/8/22 14:24:18	9/8/22 14:39:45	anonymous	Juan Miguel	Faculty	5	5	5
22	9/8/22 14:39:52	9/8/22 14:48:34	anonymous	Jervis	Staff	4	4	4
23	9/9/22 13:43:23	9/9/22 14:11:02	anonymous	jasmine	Student	5	5	5
24	9/9/22 14:11:06	9/9/22 14:18:50	anonymous	Christine Joy	Student	5	5	5
25	9/9/22 14:18:53	9/9/22 14:19:27	anonymous	Del Gabriel	Guest	5	5	5
26	9/9/22 14:19:32	9/9/22 14:27:42	anonymous	Jane	Student	2	5	3
27	9/9/22 14:27:52	9/9/22 14:33:12	anonymous	Mary Sunday	Student	5	5	5
28	9/9/22 14:33:20	9/9/22 14:37:09	anonymous	Clarissa	Student	5	5	5
29	9/9/22 14:37:15	9/9/22 14:42:11	anonymous	Mikkaela Angela	Student	5	5	5
30	9/9/22 14:42:13	9/9/22 14:50:55	anonymous	Jouie Embudo Jr	Student	3	4	3
31	9/9/22 14:51:10	9/9/22 14:56:55	anonymous	jan lorenzo valencia	Student	5	5	5
32	9/9/22 14:56:59	9/9/22 14:59:24	anonymous	louise	Student	5	5	5
33	9/9/22 14:59:33	9/9/22 15:04:45	anonymous	Jake Angelu	Guest	5	5	5
34	9/9/22 15:04:49	9/9/22 15:10:53	anonymous	Kyle	Student	5	5	5
35	9/9/22 15:11:36	9/9/22 15:22:33	anonymous	RASHEED	Student	5	5	5
36	9/9/22 15:22:37	9/9/22 15:31:40	anonymous	Kerwin	Student	4	5	4
37	9/9/22 15:33:18	9/9/22 15:34:09	anonymous	Luke	Student	5	5	5
38	9/9/22 15:37:12	9/9/22 15:42:09	anonymous	Hannah	Student	5	5	5
39	9/9/22 15:43:52	9/9/22 15:54:15	anonymous	Jojo	Student	5	5	5
40	9/9/22 15:58:19	9/9/22 16:05:02	anonymous	Matthew	Student	5	5	5
					Averages:	4.60	4.90	4.60
						Accessibility Score:	4.70	

APPENDIX P

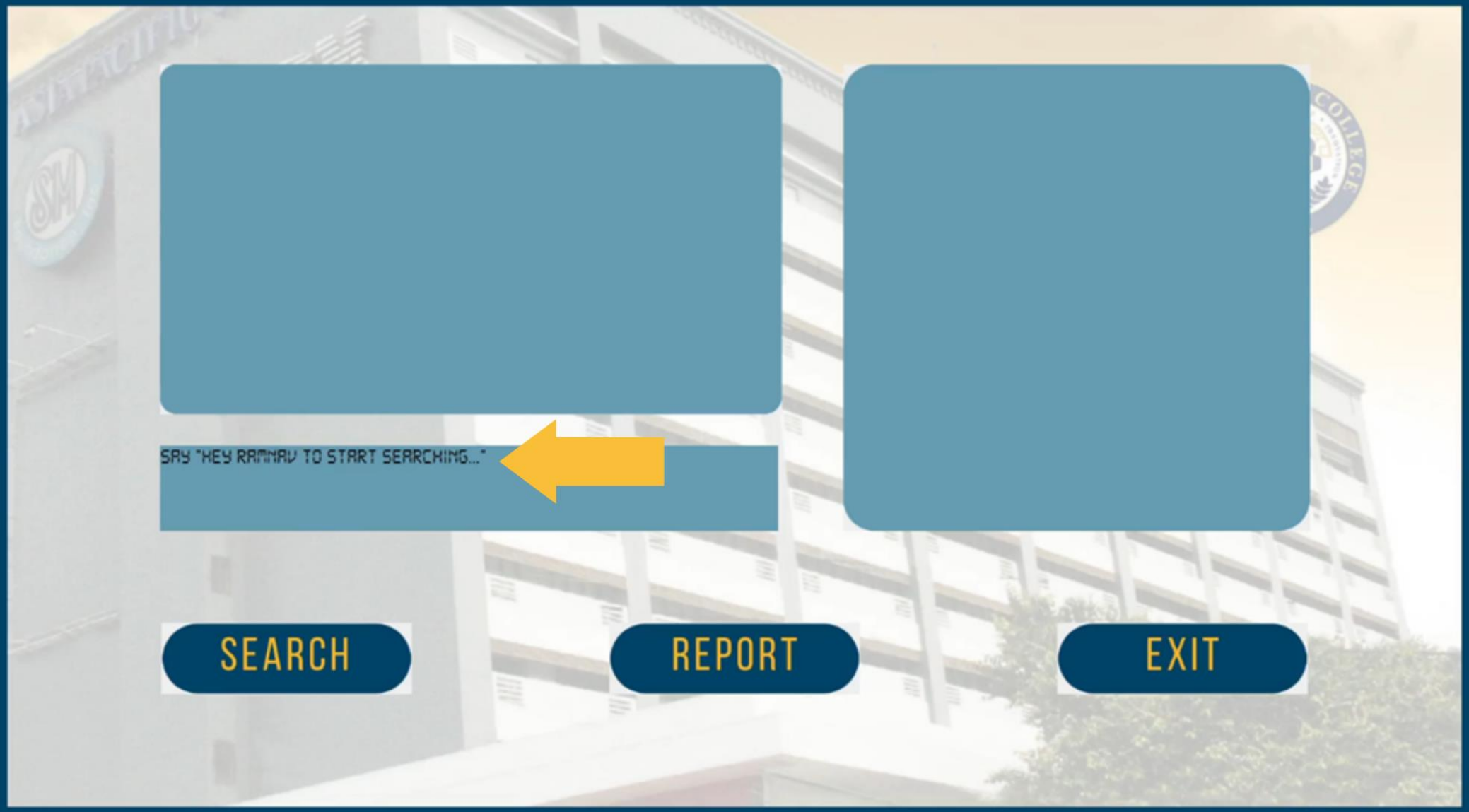
(User Manual)

Basic Requirements

- Windows 10 or newer
- Python 3.6 (Programmed on PyCharm; other IDEs acceptable)

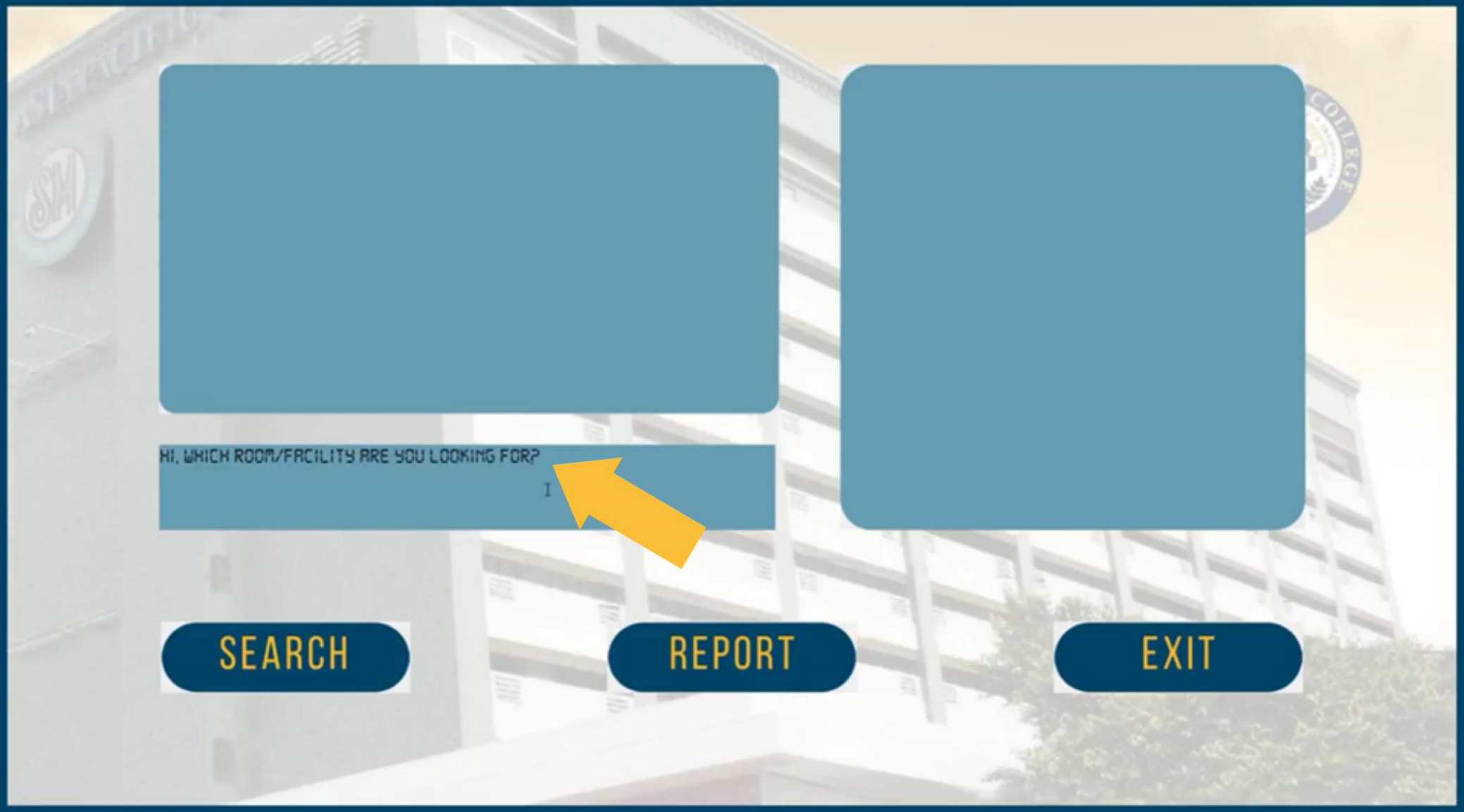
Required libraries to run RamNav on Windows Python

- Tkinter (ttk, filedialog, messagebox)
- Pillow (PIL)
- Json
- Time
- Requests
- Io (BytesIO)
- Speech_recognition (named as 'sr')
- ProcessQuerry
- GetQuery
- PlayAudioResponse
- Qrcide
- Threading
- Azure (azure.cognitiveservices.speech)



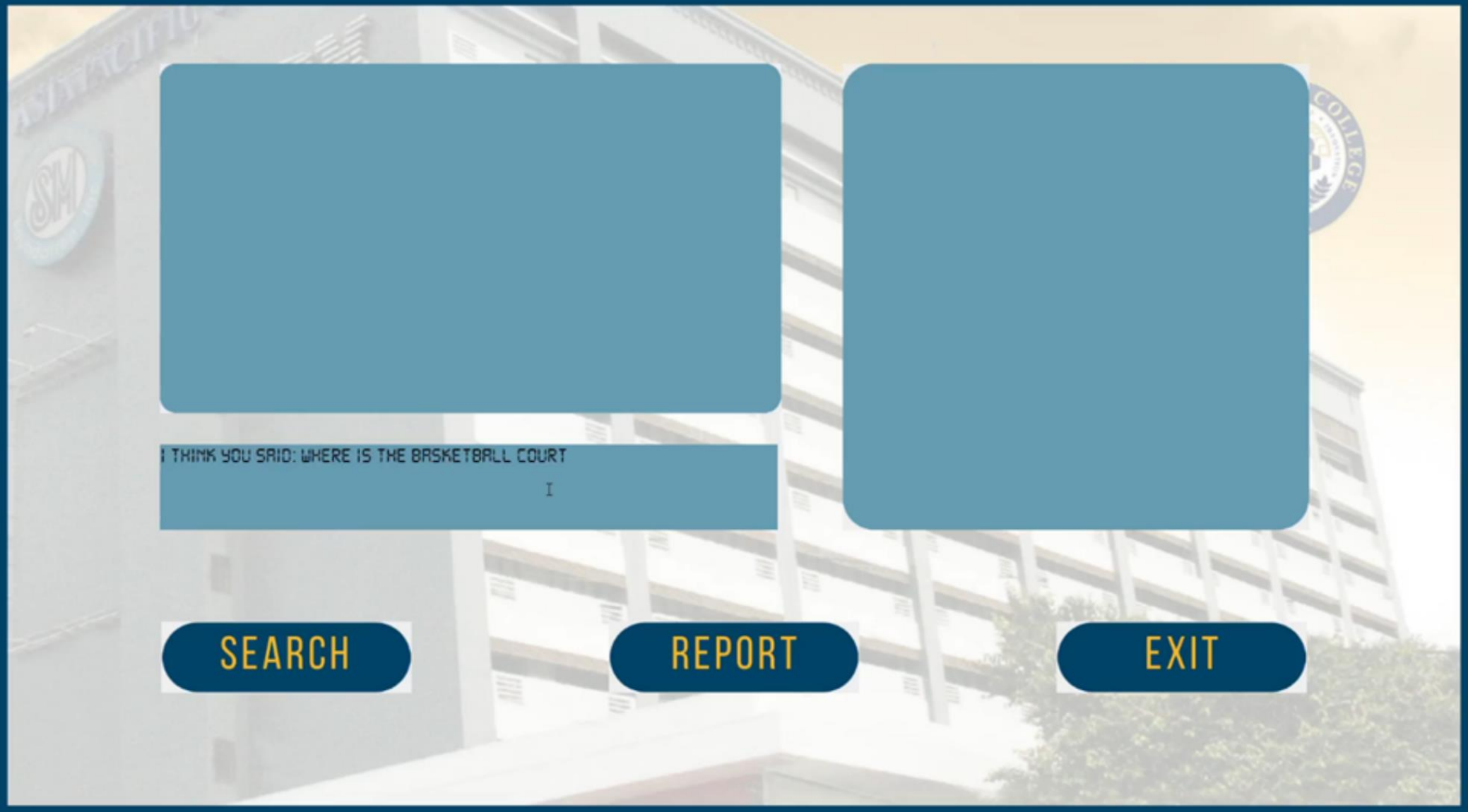
STEP 1

This is the primary screen, where the user will see the instruction in the lower right box to say "Hey RamNav" for the procedure to begin, or to touch the search button to begin.



STEP 2

Same as the first step, the user has to tell the system the room name or related keywords regarding the room. (e.g. Registrars Office, Basketball)

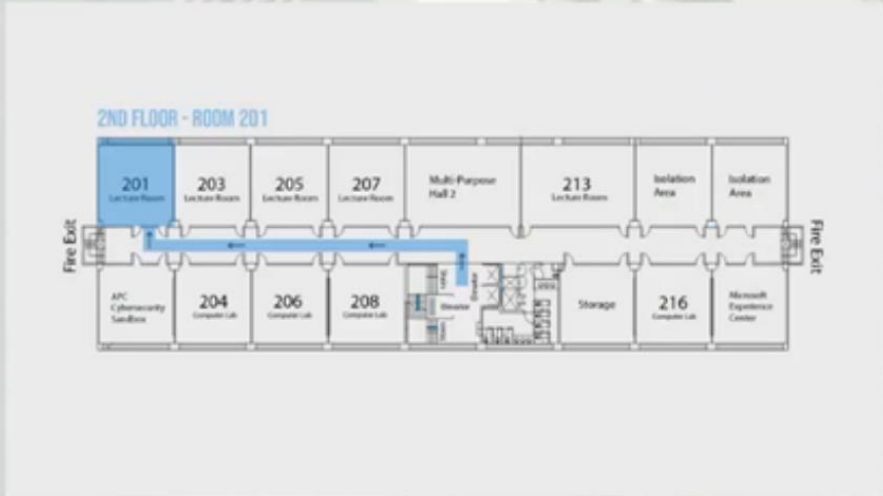


STEP 2b

The lower left panel will output what the user said to confirm if it did understood the user query.

STEP 3

At some cases, the program could return multiple results from the user query which would allow the user to manually select the room he/she is looking for.



THE ROOM BASKETBALL GYM IS AT THE 10TH FLOOR.

SAY 'HEY RAMNAVI' TO START SEARCHING AGAIN.

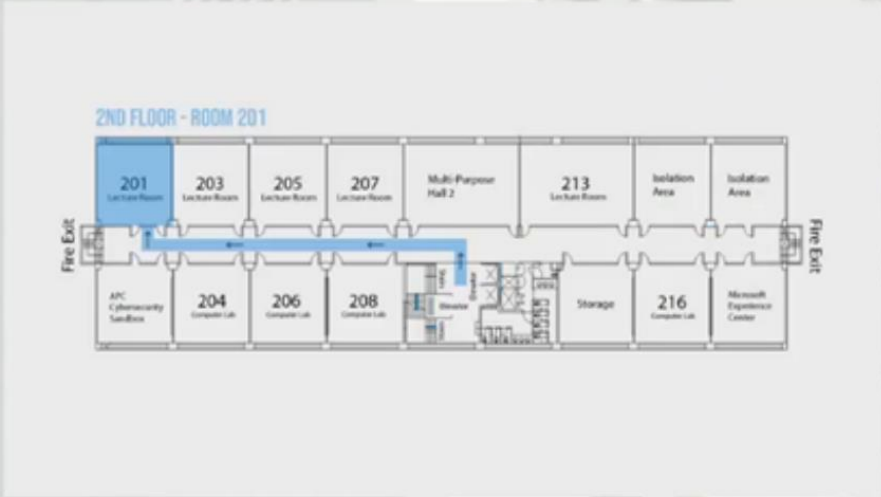
SEARCH

REPORT

EXIT

STEP 4

After the user has successfully selected from the list (Step 3), it will return a floor plan which shows the location of that specific room.



THE ROOM BASKETBALL GYM IS AT THE 10TH FLOOR.

SAY 'HEY RAMMAV!' TO START SEARCHING AGAIN.

SEARCH

REPORT

EXIT

STEP 4b

The program will also return a QR code which the user can scan so that the floor plan can be accessed from his/her mobile device.

STEP 4c

Using a mobile QR code scanner, a copy of the floor plan of the specific room can be accessed.

APPENDIX Q

(Source Code)

main_app.py

```python
import tkinter
from tkinter import *
from tkinter import ttk, filedialog, messagebox
import PIL
from PIL import ImageTk, Image
import json
import time
import requests
from io import BytesIO
import speech_recognition as sr
import ProcessQuery as PQ
import GetQuery as GQ
import PlayAudioResponse as PAR

try:
    import azure.cognitiveservices.speech as speechsdk
except ImportError:
    messagebox.showwarning("""
                           Importing the Speech SDK for Python failed.
                           Refer to
                           https://docs.microsoft.com/azure/cognitive-services/speech-service/quickstart-python for
                           installation instructions.
                           """)
    import sys

    sys.exit(1)

# GLOBAL VARIABLES
AZURE_SPEECH_KEY = "d221effb09af4c27ad2df097eb7f3cd3"
AZURELOCATION = "southeastasia"
listener = sr.Recognizer()
settings = json.load(open('assets/settings.json'))
screenW = 0
screenH = 0


class App(tkinter.Tk):
    def __init__(self):
        super().__init__()
```

```python
        self.listening = False
        self.bg_photo = PhotoImage(file="assets/bg.png")
        self.btn_bg = [PhotoImage(file="assets/search.png"), PhotoImage(file="assets/report.png"),
                       PhotoImage(file="assets/exit.png")]
        self.disp_bg = [PhotoImage(file="assets/map.png"), PhotoImage(file="assets/qr.png"),
                        PhotoImage(file="assets/txtarea.png")]
        self.title("RamNav: APC Smart Directory")
        self.attributes('-fullscreen', True)
        self.configure(background="white")
        self.resizable(False, False)
        screenW = self.winfo_screenwidth()
        screenH = self.winfo_screenheight()
        self.bg_label = Label(self, image=self.bg_photo)
        self.search_label = Label(self, image=self.btn_bg[0])
        self.report_label = Label(self, image=self.btn_bg[1])
        self.exit_label = Label(self, image=self.btn_bg[2])
        self.map_label = Label(self, image=self.disp_bg[0])
        self.qr_label = Label(self, image=self.disp_bg[1])
        self.txtarea_label = Label(self, image=self.disp_bg[2])
        self.exit_btn = Button(self, image=self.btn_bg[2], fg='white', command=self.exit_app, borderwidth=0)
        self.report_btn = Button(self, image=self.btn_bg[1], fg='white', command="", borderwidth=0)
        self.search_btn = Button(self, image=self.btn_bg[0], fg='white', command=self.check_listen, borderwidth=0)
        self.text_panel = Text(self, fg='black', bg='#669D83', height=4, width=61, borderwidth=0)
        self.map_panel = Label(self, image=self.disp_bg[0], borderwidth=0)
        self.qr_panel = Label(self, image=self.disp_bg[1], borderwidth=0)
        self.bg_label.place(x=0, y=0, relwidth=1, relheight=1)
        self.map_panel.place(x=221, y=100)
        self.qr_panel.place(x=1200, y=100)
        self.create_btns()
        self.create_txt()
        self.display_map('http://ramnav.westeurope.cloudapp.azure.com/images/map/placeholder.png')
        self.display_local_qr('assets/qr_placeholder.png')
        time.sleep(5)
        self.get_audio('Say "Hello, RamNav to start searching..."')
        self.start_listen()

    def create_btns(self):
        # Place Main Window Buttons
        self.search_btn.place(rely=0.8, anchor=CENTER)
```

```python
        self.report_btn.place(relx=0.5, rely=0.8, anchor=CENTER)
        self.exit_btn.place(relx=0.8, rely=0.8, anchor=CENTER)

    def create_txt(self):
        # System Output Panel
        text = 'Say "Hello, RamNav to start searching..."'
        self.text_panel.configure(font=('DS-Digital', 20))
        self.text_panel.insert(END, text)
        self.text_panel.place(x=221, y=570)
        self.text_panel.configure(state='disabled')

    def exit_app(self):
        self.get_audio("Good bye!")
        time.sleep(3)
        self.destroy()

    def display_text(self, msg):
        self.text_panel.configure(state='normal')
        self.text_panel.delete('1.0', END)
        self.text_panel.insert(END, ''.join(msg))
        self.text_panel.configure(state='disabled')

    def display_map(self, link):
        try:
            response = requests.get(link)
            self.map_img = Image.open(BytesIO(response.content))
            self.map_img = self.map_img.resize((800, 450), Image.ANTIALIAS)
            self.map_img = ImageTk.PhotoImage(self.map_img)
            self.map_panel.configure(image=self.map_img)
            self.map_panel.image = self.map_img
        except (PIL.UnidentifiedImageError, AttributeError):
            messagebox.showwarning("Warning", "No/Invalid file selected")

    def display_local_qr(self, img):
        try:
            self.qr_img = Image.open(img)
            self.qr_img = self.qr_img.resize((600, 600), Image.ANTIALIAS)
            self.qr_img = ImageTk.PhotoImage(self.qr_img)
            self.qr_panel.configure(image=self.qr_img)
```

```python
            self.qr_panel.configure(image=self.qr_img)
            self.qr_panel.image = self.qr_img
        except (PIL.UnidentifiedImageError, AttributeError):
            messagebox.showwarning("Warning", "No/Invalid file selected")

    def get_audio(self, script):
        play_thread = PAR.ProcessAudio(script)
        play_thread.start()
        self.play_audio(play_thread)

    def play_audio(self, thread):
        if thread.is_alive():
            # check the thread every 100ms
            self.after(100, lambda: self.play_audio(thread))
        else:
            thread.join()

    def check_listen(self):
        if self.listening is not True:
            self.search()
        else:
            print("Already listening!")

    def search(self):
        self.listening = True
        self.display_text("Hi, which room/facility are you looking for?")
        self.get_audio("Hi! Which room or facility are you looking for?")
        time.sleep(3)
        self.start_query()

    def show_defaults(self):
        self.display_map('http://ramnav.westeurope.cloudapp.azure.com/images/map/placeholder.png')
        self.display_local_qr('assets/qr_placeholder.png')
        self.display_text("Say 'Hello, RamNav' to start searching.")
        self.get_audio("Say 'Hello, RamNav' to start searching.")

    def start_listen(self):
        recog_thread = GQ.AsyncRecog(speechsdk.KeywordRecognizer(),
                                     speechsdk.KeywordRecognitionModel("RamNav-Trigger-2.table"), "Hello RamNav")
```

```
        recog_thread.start()
        self.wait_key(recog_thread)

    def wait_key(self, thread):
        if thread.is_alive():
            # check the thread every 100ms
            self.after(100, lambda: self.wait_key(thread))
        else:
            thread.join()
            if thread.response:
                self.check_listen()
            else:
                self.listening = False
                self.after(100, lambda: self.display_text("An error occured, Try again."))
                self.after(1000, lambda:self.get_audio("An error occured. Try again..."))
                self.after(3000, lambda: self.show_defaults())
                self.after(100, lambda: self.start_listen())

    def start_query(self):
        search_thread = GQ.SearchRm()
        search_thread.start()
        self.get_query(search_thread)

    def get_query(self, thread):
        if thread.is_alive():
            self.after(100, lambda: self.get_query(thread))
        else:
            thread.join()
            if thread.query is not None:
                #self.display_text("I think you said: " + thread.query)
                #time.sleep(1)
                #self.process_query(thread.query)
                self.after(100, lambda: self.display_text("I think you said: " + thread.query))
                self.after(1000, lambda: self.get_audio("I think you said: " + thread.query))
                self.after(5000, lambda: self.process_query(thread.query))
            else:
                if thread.uv:
                    self.listening = False
                    self.after(100, lambda: self.display_text("I did not understand what you said. Try again."))
```

```
                    self.after(100, lambda: self.get_audio("I did not understand what you said. Try again."))
                    self.after(3000, lambda: self.show_defaults())
                    self.after(100, lambda: self.start_listen())
                elif thread.re:
                    self.listening = False
                    self.after(100, lambda: self.display_text("Server error. Try again."))
                    self.after(100, lambda: self.get_audio("Server error. Try again."))
                    self.after(3000, lambda: self.show_defaults())
                    self.after(100, lambda: self.start_listen())

    def verify_query(self, query):
        thread = GQ.VerifyQuery(query)
        thread.start()
        self.confirm_query(thread)

    def confirm_query(self, thread):
        if thread.is_alive():
            self.after(100, lambda: self.confirm_query(thread))
        else:
            thread.join()
            if thread.confirm:
                self.process_query(thread.query)
            else:
                self.listening = False
                self.display_text("Inquiry not confirmed. Try searching again.")
                time.sleep(1)
                self.get_audio("Inquiry not confirmed. Try searching again.")
                time.sleep(3)
                self.show_defaults()
                self.start_listen()

    def process_query(self, query):
        pq_thread = PQ.ProcessQuery(query)
        pq_thread.start()
        self.get_choices(pq_thread)

    def get_choices(self, thread):
        if thread.is_alive():
            self.after(100, lambda: self.get_choices(thread))
```

```
        else:
            thread.join()
            if len(thread.result) > 1:
                if len(thread.result) > 3:
                    self.listening = False
                    self.after(100, lambda:
                        self.display_text(
                            "Your inquiry has many possible results. Please try to rephrase your inquiry."))
                    self.after(100, lambda: self.get_audio("Your inquiry has many possible results. Please try to rephrase your inquiry."))
                    self.after(5000, lambda: self.show_defaults())
                    self.after(100, lambda: self.start_listen())
                else:
                    self.show_choices(thread.result)
            elif len(thread.result) == 1:
                self.get_result(thread.result[0])
            elif len(thread.result) < 1:
                self.listening = False
                self.after(100, lambda: self.display_text("Your inquiry returned no results.\nPlease try to rephrase your inquiry."))
                self.after(100, lambda: self.get_audio("Your inquiry returned no results. Please try to rephrase your inquiry."))
                self.after(5000, lambda: self.show_defaults())
                self.after(100, lambda: self.start_listen())

    def ask_choice(self, ids):
        ak_thread = PQ.GetChoice(listener, AZURE_SPEECH_KEY, AZURELOCATION, ids)
        ak_thread.start()
        self.get_choice(ak_thread)

    def get_choice(self, thread):
        if thread.is_alive():
            self.after(100, lambda: self.get_choice(thread))
        else:
            thread.join()
            if thread.response is not None:
                self.display_text(thread.response)
                time.sleep(3)
                if thread.choice is not None:
                    self.display_text("\nGetting info of " + thread.choice[0]['name'])
                    self.get_audio("Getting info of " + thread.choice[0]['name'])
                    time.sleep(3)
```

```
                    self.get_result(thread.choice[0])
                else:
                    self.listening = False
                    self.start_listen()
                else:
                    if thread.uv:
                        self.listening = False
                        self.display_text("Unknown Value Error Occurred. Please try searching again.")
                        self.get_audio("Unknown Value error occurred. Please try searching again.")
                        time.sleep(3)
                        self.show_defaults()
                        self.start_listen()
                    elif thread.re:
                        self.listening = False
                        self.display_text("Request Error Occurred. Please try searching again.")
                        self.get_audio("Request error occurred. Please try searching again.")
                        time.sleep(3)
                        self.show_defaults()
                        self.start_listen()
                    elif thread.ie:
                        self.listening = False
                        self.display_text("Invalid choice. Please try searching again.")
                        self.get_audio("Index error occurred. Please try searching again.")
                        time.sleep(3)
                        self.show_defaults()
                        self.start_listen()

    def show_choices(self, choices):
        self.get_audio("Which room are you referring to?")
        sc_thread = PQ.ShowChoices(choices)
        sc_thread.start()
        self.disp_choices(sc_thread, choices)

    def disp_choices(self, thread, choices):
        if thread.is_alive():
            self.after(100, lambda: self.disp_choices(thread))
        else:
            thread.join()
            if thread.msg is not None:
```

```
                self.display_text(thread.msg)
                time.sleep(5)
                self.ask_choice(choices)
            else:
                self.listening = False
                self.display_text("An error occurred. Try again.")
                self.get_audio("Display result error occurred. Please try searching again.")
                time.sleep(3)
                self.show_defaults()
                self.start_listen()

    def get_result(self, room):
        gr_thread = PQ.ShowResult(room)
        gr_thread.start()
        self.show_result(gr_thread)

    def show_result(self, thread):
        if thread.is_alive():
            self.after(100, lambda: self.show_result(thread))
        else:
            thread.join()
            if thread.result is not None:
                self.listening = False
                room = thread.result
                self.display_text("The " + str(room[1]) + " is at the " + str(room[3]) + " Floor.\n\nSay 'Hello, RamNav!' "
                                  "to start searching again.")

                self.display_map(room[4])
                self.display_local_qr('qrcode.png')
                self.get_audio("The " + str(room[1]) + " is at the " + str(room[3]) + " Floor... Say 'Hello, RamNav!' to "
                               "start searching again.")

                time.sleep(3)
                self.start_listen()
            else:
                self.listening = False
                self.display_text("Your inquiry returned no results.\nPlease try to rephrase your query.\nSay 'Hello, "
                                  "RamNav' to start searching.")

                self.get_audio("Your inquiry returned no results. Please try to rephrase your query... Say 'Hello, "
                               "RamNav' to start searching.")

                time.sleep(3)
```

```
    def show_result(self, thread):
        if thread.is_alive():
            self.after(100, lambda: self.show_result(thread))
        else:
            thread.join()
            if thread.result is not None:
                self.listening = False
                room = thread.result
                self.display_text("The " + str(room[1]) + " is at the " + str(room[3]) + " Floor.\n\nSay 'Hello, RamNav!' "
                                  "to start searching again.")

                self.display_map(room[4])
                self.display_local_qr('qrcode.png')
                self.get_audio("The " + str(room[1]) + " is at the " + str(room[3]) + " Floor... Say 'Hello, RamNav!' to "
                               "start searching again.")

                time.sleep(3)
                self.start_listen()
            else:
                self.listening = False
                self.display_text("Your inquiry returned no results.\nPlease try to rephrase your query.\nSay 'Hello, "
                                  "RamNav' to start searching.")

                self.get_audio("Your inquiry returned no results. Please try to rephrase your query... Say 'Hello, "
                               "RamNav' to start searching.")

                time.sleep(3)
                self.start_listen()

    def report(self):
        self.display_text("Report Btn")

    def update(self):
        self.display_text("Update Btn")


# Instantiate RamNav App
if __name__ == "__main__":
    app = App()
    app.mainloop()
```

ProcessQuery.py

```python
import threading
import time
import json
import requests
import speech_recognition as sr
import qrcode
import string
import re

file = requests.get('http://ramnav.westeurope.cloudapp.azure.com/js/dictionary.json')
wordbank = file.json()
rooms = []
listener = sr.Recognizer()
settings = json.load(open('assets/settings.json'))


class ProcessQuery(threading.Thread):
    def __init__(self, query):
        super(ProcessQuery, self).__init__()
        self.setDaemon(True)
        self.query = query
        self.msg = None
        self.result = None
        self.ban = ["Room", "Office", "A", "B", "C", "Laboratory", "Studio"]

    def run(self):
        # Clear rooms variable
        rooms.clear()

        # Remove unwanted punctuation mark in the end and non-alphanumeric characters
        if self.query and self.query[-1] in string.punctuation:
            self.query = self.query[:-1]
        self.query = re.sub(r'[^A-Za-z0-9 ]+', '', self.query)

        # Remove common words
        for word in self.ban:
            for key in self.query.split():
                if word.lower() == key.lower():
                    self.query = self.query.lower().replace(key.lower(), '')
```

```python
        # Remove 'Where is the' problematic phrase
        if 'Where is the'.lower() in self.query.lower():
            self.query = self.query.lower().replace('where is the', '')

        # Print the preprocessed query
        print(self.query)

        # check for keywords
        counter = 0
        for room in wordbank:
            for attr in room.keys():
                if attr == 'name':
                    name = re.sub(r'[^A-Za-z0-9 ]+', '', room['name'])
                    for word in self.query.lower().split():
                        for key in name.lower().split():
                            if word == key:
                                if room in rooms:
                                    break
                                else:
                                    counter += 1
                                    room_id = room
                                    rooms.append(room_id)
                                    break
                elif 'keyword' in attr:
                    if room[attr].lower() in self.query.lower():
                        if room in rooms:
                            break
                        else:
                            counter += 1
                            room_id = room
                            rooms.append(room_id)
                            break
                elif attr != 'roomID':
                    for word in self.query.lower().split():
                        if word == room[attr].lower():
                            if room in rooms:
                                break
                            else:
```

```
                        counter += 1
                        room_id = room
                        rooms.append(room_id)
                        break

        if counter == 0:
            # Print the message if the value does not exist
            self.msg = "Sorry no keywords found in your query, please try to rephrase."
        else:
            self.msg = "Your query returned " + str(counter) + " possible results."

        self.result = rooms
        print(self.result)


class ShowChoices(threading.Thread):
    def __init__(self, choices):
        super(ShowChoices, self).__init__()
        self.setDaemon(True)
        self.choices = choices
        self.msg = None

    def run(self):
        num = 0
        tmp_msg = "Which room are you referring to? (Say 'First', 'Second', or 'Third'):\n"
        for room in rooms:
            num += 1
            tmp_msg += str(num) + ". " + str(room['name']) + "\n"
        self.msg = tmp_msg
        """for choice in self.choices:
            for key in wordbank.keys():
                tmp = key
                if tmp == choice:
                    num += 1
                    tmp_msg += str(num) + ". " + str(wordbank[key][0]['name']) + "\n"
        self.msg = tmp_msg"""


class GetChoice(threading.Thread):
```

```
    def __init__(self, recognizer, key, location, ids):
        super(GetChoice, self).__init__()
        self.setDaemon(True)
        self.recognizer = recognizer
        self.key = key
        self.location = location
        self.response = None
        self.uv = False
        self.re = False
        self.choice = None
        self.ids = ids
        self.ie = False

    def run(self):
        with sr.Microphone() as source:
            self.recognizer.energy_threshold = settings[0]['mic_threshold']
            audio = self.recognizer.listen(source)

        # write audio to a WAV file
        with open("query2.wav", "wb") as f:
            f.write(audio.get_wav_data())

        # obtain path to "results.wav" in the same folder as this script
        from os import path

        AUDIO_FILE = path.join(path.dirname(path.realpath(__file__)), "query2.wav")

        # use the audio file as the audio source
        with sr.AudioFile(AUDIO_FILE) as source:
            audio = self.recognizer.record(source)  # read the entire audio file

        try:
            query = self.recognizer.recognize_azure(audio, key=self.key, location=self.location)
            first = 0
            second = 0
            third = 0

            # Interpret query
            if 'first' in query.lower().split():
```

```python
            first = 1
        if 'second' in query.lower().split():
            second = 1
        if 'third' in query.lower().split():
            third = 1

        if first + second + third != 1:
            self.response = "Invalid response, please try to query again.\n\nSay 'Hello, RamNav' to start searching."
            self.choice = None
        else:
            try:
                if first == 1:
                    self.response = "You chose the first option! Please wait for the result..."
                    self.choice = []
                    self.choice.append(self.ids[0])
                    time.sleep(3)
                if second == 1:
                    self.response = "You chose the second option! Please wait for the result..."
                    self.choice = []
                    self.choice.append(self.ids[1])
                    time.sleep(3)
                if third == 1:
                    self.choice = []
                    self.response = "You chose the third option! Please wait for the result..."
                    self.choice.append(self.ids[2])
                    time.sleep(3)
            except IndexError:
                self.response = None
                self.ie = True
    except sr.UnknownValueError:
        self.response = None
        self.uv = True
    except sr.RequestError as e:
        self.response = None
        self.re = True


class ShowResult(threading.Thread):
    def __init__(self, id):
```

```python
        super(ShowResult, self).__init__()
        self.setDaemon(True)
        self.id = id
        self.result = None

    def run(self):
        """mydb = mysql.connector.connect(
            host="ramnav-db.mysql.database.azure.com",
            user="azureuser",
            password="Nextgen2021",
            database="ramnav-db"
        )
        mycursor = mydb.cursor()
        mycursor.execute("SELECT * FROM Rooms INNER JOIN Images ON `roomID` = `imgID` WHERE `roomID` = " + self.id[0])
        myresult = mycursor.fetchone()
        mydb.close()"""
        self.result = [self.id['roomID'], self.id['name'], self.id['roomNum'],
                       self.id['roomLvl'],
                       "http://ramnav.westeurope.cloudapp.azure.com/images/map/" + self.id['roomID'] + ".png"]
        self.create_qr(str(self.result[0]))
        rooms.clear()

    @staticmethod
    def create_qr(room):
        # Link for website
        input_data = "http://ramnav.westeurope.cloudapp.azure.com/?id=" + room
        # Creating an instance of qrcode
        qr = qrcode.QRCode(
            version=1,
            box_size=10,
            border=5)
        qr.add_data(input_data)
        qr.make(fit=True)
        img = qr.make_image(fill='black', back_color='white')
        img.save('qrcode.png')
```

GetQuery.py

```python
import threading
import time
from tkinter import messagebox
import speech_recognition as sr
import json

try:
    import azure.cognitiveservices.speech as speechsdk
except ImportError:
    messagebox.showwarning("""
                           Importing the Speech SDK for Python failed.
                           Refer to
                           https://docs.microsoft.com/azure/cognitive-services/speech-service/quickstart-python for
                           installation instructions.
                           """)
    import sys

    sys.exit(1)

AZURE_SPEECH_KEY = "d221ffb09af4c27ad2df097eb7f3cd3"
AZURELOCATION = "southeastasia"
listener = sr.Recognizer()
settings = json.load(open('assets/settings.json'))


class AsyncRecog(threading.Thread):
    def __init__(self, recognizer, model, keyword):
        super(AsyncRecog, self).__init__()
        self.setDaemon(True)
        self.sdk = recognizer
        self.speech = model
        self.key = keyword
        self.response = None

    def run(self):
        done = False

        def recognized_cb(evt):
            # Only a keyword phrase is recognized. The result cannot be 'NoMatch'
            # and there is no timeout. The recognizer runs until a keyword phrase
```

```python
            # and there is no timeout. The recognizer runs until a keyword phrase
            # is detected or recognition is canceled (by stop_recognition_async()
            # or due to the end of an input file or stream).
            result = evt.result
            if result.reason == speechsdk.ResultReason.RecognizedKeyword:
                time.sleep(0.5)

            nonlocal done
            done = True
            self.response = True

        def canceled_cb(evt):
            result = evt.result
            if result.reason == speechsdk.ResultReason.Canceled:
                self.response = False
            nonlocal done
            done = True

        # Connect callbacks to the events fired by the keyword recognizer.
        self.sdk.recognized.connect(recognized_cb)
        self.sdk.canceled.connect(canceled_cb)

        # Start keyword recognition.
        result_future = self.sdk.recognize_once_async(self.speech)
        result = result_future.get()

        # Read result audio (incl. the keyword).
        if result.reason == speechsdk.ResultReason.RecognizedKeyword:
            time.sleep(2)  # give some time so the stream is filled
            result_stream = speechsdk.AudioDataStream(result)
            result_stream.detach_input()  # stop any more data from input getting to the stream
            self.response = True


class SearchRm(threading.Thread):
    def __init__(self):
        super(SearchRm, self).__init__()
        self.setDaemon(True)
        self.recognizer = listener
        self.key = AZURE_SPEECH_KEY
```

```python
        self.key = AZURE_SPEECH_KEY
        self.location = AZURELOCATION
        self.query = None
        self.uv = False
        self.re = False

    def run(self):
        with sr.Microphone() as source:
            self.recognizer.energy_threshold = settings[0]['mic_threshold']
            audio = self.recognizer.listen(source)

        # write audio to a WAV file
        with open("query.wav", "wb") as f:
            f.write(audio.get_wav_data())

        # obtain path to "results.wav" in the same folder as this script
        from os import path

        AUDIO_FILE = path.join(path.dirname(path.realpath(__file__)), "query.wav")

        # use the audio file as the audio source
        with sr.AudioFile(AUDIO_FILE) as source:
            audio = self.recognizer.record(source)  # read the entire audio file

        try:
            self.query = self.recognizer.recognize_azure(audio, key=self.key, location=self.location)
        except sr.UnknownValueError:
            self.query = None
            self.uv = True
            print("Unknown Value Error in Query Acquisition")
        except sr.RequestError:
            self.query = None
            self.re = True
            print("Request Error in Query Acquisition")


class VerifyQuery(threading.Thread):
    def __init__(self, query):
        super(VerifyQuery, self).__init__()
        self.setDaemon(True)
```

```python
        self.recognizer = listener
        self.key = AZURE_SPEECH_KEY
        self.location = AZURELOCATION
        self.query = query
        self.uv = False
        self.re = False
        self.confirm = None

    def run(self):
        with sr.Microphone() as source:
            self.recognizer.energy_threshold = settings[0]['mic_threshold']
            audio = self.recognizer.listen(source)

        # write audio to a WAV file
        with open("confirm.wav", "wb") as f:
            f.write(audio.get_wav_data())

        # obtain path to "results.wav" in the same folder as this script
        from os import path

        AUDIO_FILE = path.join(path.dirname(path.realpath(__file__)), "confirm.wav")

        # use the audio file as the audio source
        with sr.AudioFile(AUDIO_FILE) as source:
            audio = self.recognizer.record(source)  # read the entire audio file
        try:
            query = self.recognizer.recognize_azure(audio, key=self.key, location=self.location)
            if 'yes' in query.lower():
                self.confirm = True
            elif 'no' in query.lower():
                self.confirm = False
            else:
                self.confirm = False
        except sr.UnknownValueError:
            self.query = None
            self.uv = True
            print("Unknown Value Error in Query Confirmation")
        except sr.RequestError:
            self.query = None
            self.re = True
            print("Request Error in Query Confirmation")
```

PlayAudioResponse.py

```python
import azure.cognitiveservices.speech as speechsdk
import threading

# Creates an instance of a speech config with specified subscription key and service region.
speech_key = "d221bffb09af4c27ad2df097eb7f3cd3"
service_region = "southeastasia"
speech_config = speechsdk.SpeechConfig(subscription=speech_key, region=service_region)
# Note: the voice setting will not overwrite the voice element in input SSML.
speech_config.speech_synthesis_voice_name = "en-AU-WilliamNeural"


class ProcessAudio(threading.Thread):
    def __init__(self, script):
        super(ProcessAudio, self).__init__()
        self.text = script
        # use the default speaker as audio output.
        self.speech_synthesizer = speechsdk.SpeechSynthesizer(speech_config=speech_config)
        self.result = None

    def run(self):
        self.result = self.speech_synthesizer.speak_text_async(self.text).get()
        self.text = None
        # Check result
        """if self.result.reason == speechsdk.ResultReason.SynthesizingAudioCompleted:
            print("Speech synthesized for text [{}]".format(self.text))
        elif self.result.reason == speechsdk.ResultReason.Canceled:
            cancellation_details = self.result.cancellation_details
            print("Speech synthesis canceled: {}".format(cancellation_details.reason))
            if cancellation_details.reason == speechsdk.CancellationReason.Error:
                print("Error details: {}".format(cancellation_details.error_details))"""

```

settings.json

```json
{
    "mic_threshold": 8000,
    "bg_image": "assets/bg.png",
    "exit_btn": "assets/exit.png",
    "setting_btn": "assets/report.png",
    "search_btn": "assets/search.png",
    "font": "DS-Digital"
}
```

APPENDIX R

(Researcher's Profile)

Elisha P. Silvio is currently a Computer Engineering student at Asia Pacific College. He is the Lead Programmer of the team.

Veronica Elyse D. Chua is currently a Computer Engineering student at Asia Pacific College. She is the Project Manager of the team.

Rizzi Joy H. Pardiñas is currently a Computer Engineering student at Asia Pacific College. She is the Documentation Head of the team.

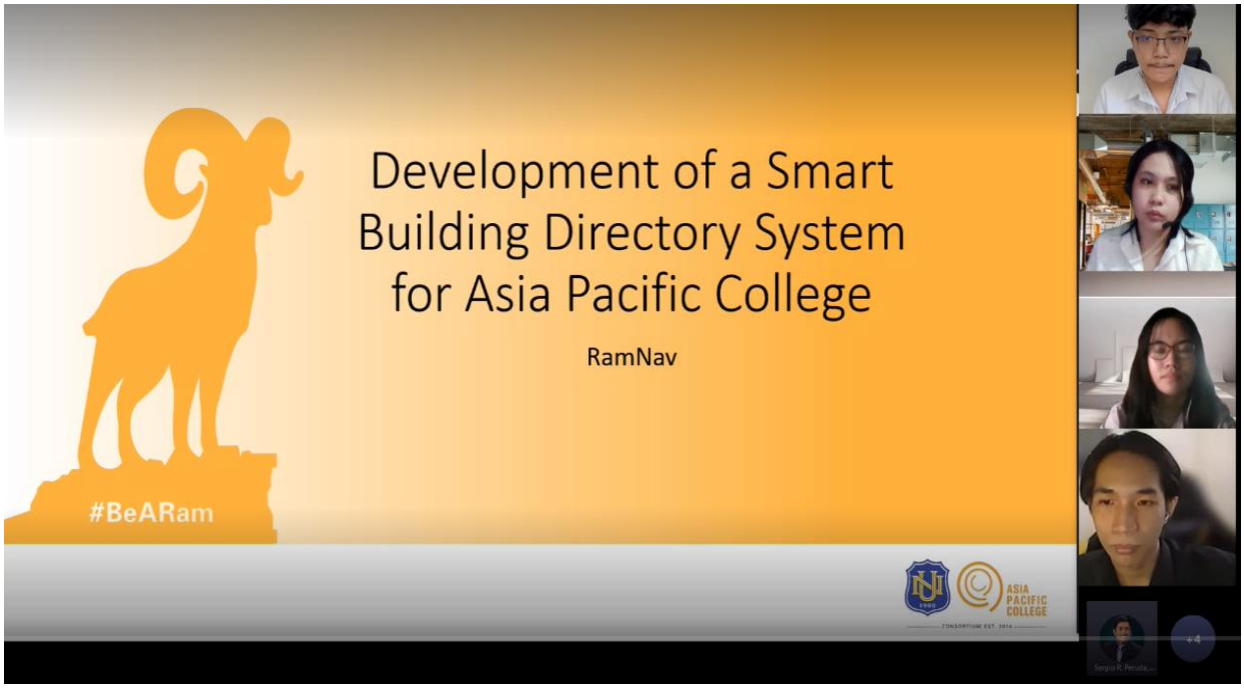
John Albert C. Maño is currently a Computer Engineering student at Asia Pacific College. He is the Creatives and QA Tester of the team.

APPENDIX S

(Photo Gallery)

CPEMETS MIDTERM DEFENSE / OCTOBER 2, 2021

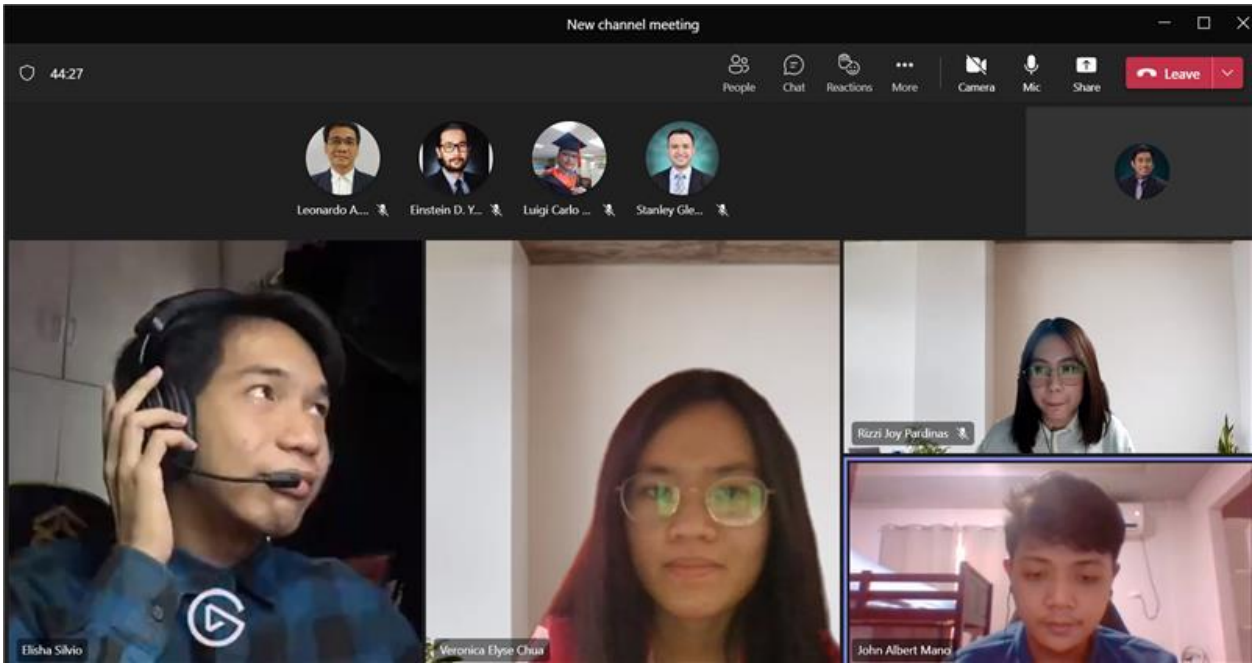
CPEMETS FINAL DEFENSE / NOVEMBER 6, 2021



CPEMETS REMEDIAL DEFENSE / NOVEMBER 18,2021

CPEDES1 MIDTERM DEFENSE / JULY 5,2022

CPEDES2 MIDTERM DEFENSE / OCTOBER



APPENDIX T

(Transmittals, Letters of Communications, Minutes of the Meeting)

TRANSMITTALS

Elisha Silvio

To: Stanley Glenn E. Brucal

Cc: Veronica Elyse Chua; Rizzi Joy Pardinas; John Albert Mano

Mon 9/6/2021 9:44 AM

Good day, sir Stanley!

We are one of the assigned groups under your supervision for CPEMETS this term. Currently, we are working on the initial draft of our problem statement and objectives for our pre-approved topic. May we ask whether you prefer a touch-base meeting tomorrow via Teams or just an email of the draft document for you to check tomorrow? Thank you and keep safe.

Elisha

Stanley Glenn E. Brucal

To: Elisha Silvio

Cc: Veronica Elyse Chua; Rizzi Joy Pardinas; John Albert Mano

Hi Elisha,

You may for the meantime send the draft, so I can get back to you after reviewing.

Please send here the common free time of your groupmates for me to identify our regular meeting schedule.

Thank you.

Stanley

...

Elisha Silvio

To: Sergio R. Peruda, Jr.; Luigi Carlo M. De Jesus; Leonardo A. Samaniego, Jr.; Einstein D. Yong

Cc: Stanley Glenn E. Brucal; Veronica Elyse Chua; John Albert Mano; Rizzi Joy Pardinas

NextGen_Title_Defense_Prop...
2 MB

Greetings, panelists!

Please refer to the attached document in this email for our group's midterm title defense proposal.

Should there be any concerns regarding our proposal, please let us know.

Thank you and keep safe!

Best,
Elisha

Elisha Silvio

To: Jose Manuel V. Garcia

Cc: Veronica Elyse Chua; Rizzi Joy Pardinas; John Albert Mano

Chapter1_Draft_APC-Smart-...
154 KB

2 attachments (610 KB) Save all to OneDrive - Asia Pacific College Download all

Good day, sir!

We are a group of students from CPE 191. Our project adviser in CPEMETS, sir Stanley, suggested that we request if you could be our client for our project.

Our project is called APC Smart Directory. You can refer to the attached files so you can review our project details.

If you agree, our group will set a meeting with you at your desired time and date to discuss your preferences or inputs for our project.

Please let us know, thank you!

Elisha

Elisha Silvio

To: Ryan Christopher P. Sumayod

Cc: Veronica Elyse Chua; Rizzi Joy Pardinas; John Albert Mano; Stanley Glenn E. Brucal

Good Morning, Sir Ryan.

I am Elisha from CPE 191, and this email is to inquire about the current APC building directory or floor plan.

In line with our current capstone project proposal for CPEMETS, our group needs a COMPLETE LIST of all the facilities inside the APC building for our research.

May we ask if we can get a copy in order to provide the necessary adjustments and revisions with our title proposal?

Thank you and keep safe,
Elisha

Stanley Glenn E. Brucal

To: Ryan Christopher P. Sumayod

Cc: Veronica Elyse Chua; Rizzi Joy Pardinas; John Albert Mano; Elisha Silvio; Jose Manuel V. Garcia

Hi Ryan,

I'm endorsing Elisha's request for APC building directory and floor plan. They need this on their project proposal of interactive building directory system.

Hoping for your kind assistance.

Thank you!
Stanley

...

Elisha Silvio

To: Ryan Christopher P. Sumayod; Stanley Glenn E. Brucal

Cc: Veronica Elyse Chua; Rizzi Joy Pardinas; John Albert Mano; Jose Manuel V. Garcia

Thank you for taking the time, sir. We appreciate it.

Get Outlook for iOS

...

R

Ryan Christopher P. Sumayod

To: Elisha Silvio; Stanley Glenn E. Brucal

Cc: Veronica Elyse Chua; Rizzi Joy Pardinas; John Albert Mano; Jose Manuel V. Garcia

Hello Elisha,

Thank you for your patience.

Most of our As-Built plans are already fading due to old age so scanned versions of them are not that readable.

Attaching here the evacuation plans of the building instead. These are more updated version of the As-builts only with evacuation directions.

Let me know if this is okay.

Evac_Diagram.zip

--

Ryan

Elisha Silvio

Mon 10/18/2021 3:53 PM

To: Sergio R. Peruda, Jr.; Luigi Carlo M. De Jesus; Einstein D. Yong; Leonardo A. Samaniego, Jr.

Cc: Veronica Elyse Chua; John Albert Mano; Rizzi Joy Pardinas; Stanley Glenn E. Brucal

Member 1_CPEMETS Title Pr... 215 KB | Lead Panel_CPEMETS Title Pr... 216 KB | Chair_CPEMETS Title Pre-app... 215 KB | NextGen_TitleProposal_Revis... 1 MB

Show all 5 attachments (2 MB) Save all to OneDrive - Asia Pacific College Download all

Good afternoon, panelists!

Please refer to the attached files for our group's revised title proposal and the approval form for CPEMETS

We have also highlighted each subchapter that had been modified from the original document.

Should you have any concerns, please let us know.

Thank you and be safe,
Elisha

Leonardo A. Samaniego, Jr.

To: Elisha Silvio

Cc: Veronica Elyse Chua; John Albert Mano; Rizzi Joy Pardinas

Member 1_CPEMETS Title Pr...
350 KB

Got this, Team NEXTGEN.

Please refer to the attached file for the signed pre-approval form.

Regards,

Sir Sam

Elisha Silvio

To: Sergio R. Peruda, Jr.; Einstein D. Yong; Luigi Carlo M. De Jesus; Leonardo A. Samaniego, Jr.

Cc: Stanley Glenn E. Brucal; Veronica Elyse Chua; Rizzi Joy Pardinas; John Albert Mano

Thu 11/4/2

NextGen_Title_Proposal.pdf 2 MB | NextGen_SOE-PMT35_-_CPE... 187 KB | SOE-PMF90-Proposal Defens... 581 KB | SOE-PMF90-Proposal Defens... 424 KB

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Greetings panelists,

Here are our group's documents for the upcoming title proposal presentation for CPEMETS on Saturday, November 6.

In case of any changes in the documentation, we will resubmit the file.

Let us know if you have any concerns.

Thank you and keep safe,
Elisha

Elisha Silvio

To: Sergio R. Peruda, Jr.; Luigi Carlo M. De Jesus; Einstein D. Yong; Leonardo A. Samaniego, Jr.

Cc: Stanley Glenn E. Brucal; Veronica Elyse Chua; Rizzi Joy Pardinas; John Albert Mano

Wed 11/17/20

SOE-PMF90-Proposal Defens... 47 KB | SOE-PMF90-Proposal Defens... 47 KB | SOE-PMF90-Proposal Defens... 57 KB | NextGen_SOE-PMT35_-_CPE... 187 KB

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Good morning panelists,

Here are our group's documents along with the grading sheets for the upcoming re-defense schedule tomorrow.

Please note that there are still improvements being done with the documentation today, and the final version will be sent tomorrow before the start of the presentation.

Thank you and keep safe!
Elisha

Elisha Silvio

To: Sergio R. Peruda, Jr.

Cc: Rizzi Joy Pardinas; Veronica Elyse Chua; John Albert Mano; Stanley Glenn E. Brucal

NextGen_Title-Proposal_112... 3 MB | NextGen_Panel_Chair_Appro... 214 KB | NextGen_Panel_Lead_Approv... 214 KB | NextGen_Panel_Member1_A... 215 KB | NextGen 215 KB

5 attachments (4 MB) Save all to OneDrive - Asia Pacific College Download all

Greetings Panelists,

Attached herewith is the revised proposal of our group for CPEMETS along with the approval forms for each of the panelists.

Please let us know if you require us to have a consultation meeting regarding the revisions so we can send a calendar invitation on your preferred date and time.

You can refer to the table below for the summary of revisions for our document.

Thank you and keep safe,
Elisha

Panelist	Comment	Proof of Revision
Sir Einstein	Revisit test cases and please identify different scenarios.	Page 59-64
Sir Einstein	Please also mention in the document how many trials per scenarios will be considered.	Page 64-65
Sir Einstein	Revise System test phase Fig 3.13. remember that the system phase should be phases how to test our system based on our objectives.	Page 62
Sir Sam	Accessibility objective was not considered in the selection process.	Page 37
Sir Sam	Lack of test cases to ensure the testing procedures to be done.	Page 59-64
Sir Sam	The budget proposed is beyond the allowed budget for the design project.	Page 57
Sir Luigi	Include the basis for the number of trials in the document.	Page 64-65
Sir Luigi	Provide a detailed explanation and revise the test phases and system test	Page 59-64
Sir Luigi	Revised some wordings on the tables for testing	Page 63
Sir Serge	Present a table that will cover your expenses	Page 57

Leonardo A. Samaniego, Jr.

To: Elisha Silvio

Cc: Veronica Elyse Chua; John Albert Mano; Rizzi Joy Pardinas

NextGen_Technical-Defense-... 561 KB

Hi, Team NextGen,

Please refer to the attached file for the signed compliance form.

Regards,

Sir Sam

...

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Elisha Silvio

To: Leonardo A. Samaniego, Jr.

Cc: Veronica Elyse Chua; John Albert Mano; Rizzi Joy Pardinas

NextGen_Documentation_Co... 12 MB | NextGen_SOE-PMF84-Techni... 68 KB

2 attachments (12 MB) Save all to OneDrive - Asia Pacific College Download all

Hi, sir.

Attached herewith are the necessary documents for our CPEDES1 final requirements. Just let us know if you have any more requests/instructions for the group.

Thanks,
Elisha

...

Elisha Silvio

To: Stanley Glenn E. Brucal

Cc: John Albert Mano; Rizzi Joy Pardinas; Veronica Elyse Chua

NextGen_Chapter-5_Draft.docx
295 KB

Good morning, sir Stan.

Please refer to the attached file above for our initial draft for Chapter 5 of our project documentation. The group aims to finish the whole chapter 5 documentation within the day.

Just let us know if there are any comments or revisions that you want us to make for the document.

Thank you and keep safe.
Elisha

Stanley Glenn E. Brucal

To: Elisha Silvio

Cc: John Albert Mano; Rizzi Joy Pardinas; Veronica Elyse Chua

NextGen_Chapter-5_Draft (1...
307 KB

Refer to my comments on the attached file.

Thank you.

Stan

Elisha Silvio

Sat 9/24/2022 11:46

To: Sergio R. Peruda, Jr.; Luigi Carlo M. De Jesus; Einstein D. Yong; Leonardo A. Samaniego, Jr.

Cc: Stanley Glenn E. Brucal; Veronica Elyse Chua; Rizzi Joy Pardinas; John Albert Mano

NextGen_SOE-PMT37 - Desi... 190 KB | SOE-PMF93-Design and Fina... 58 KB | SOE-PMF93-Design and Fina... 58 KB | SOE-PMF93-Design and Fina... 61 KB | NextGen_Documentation_Ch... 14 MB | NextGen_Documentation_Ch... 5 MB

6 attachments (19 MB) Save all to OneDrive - Asia Pacific College Download all

Greetings Panelists,

Here are our group's documents for Final Defense 1 on Saturday (October 1). Please note that the preliminaries and appendices are still currently incomplete. The group will follow up on the final versions of those sections tomorrow to finalize and append the missing parts.

Thank you for your consideration and keep safe.
Elisha.

Elisha Silvio

To: Sergio R. Peruda, Jr.; Luigi Carlo M. De Jesus; Einstein D. Yong; Leonardo A. Samaniego, Jr.
Cc: Stanley Glenn E. Brucal; Veronica Elyse Chua; Rizzi Joy Pardinas; John Albert Mano

NextGen_Documentation_Co... 20 MB | NextGen_Documentation_Co... 6 MB

2 attachments (26 MB) Save all to OneDrive - Asia Pacific College Download all

Greetings panelists,

Please refer to the attached file for the complete and updated version of our project documentation.

Thank you and keep safe,
Elisha

Reply | Reply all | Forward

Veronica Elyse Chua
To: Elisha Silvio; Sergio R. Peruda, Jr.
Cc: Rizzi Joy Pardinas; John Albert Mano

NextGen_Documentation_Ch... 7 MB

Good morning, Sir Serg.

Attached is the group's documentation in pdf format.

Regards,

Veronica

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Elisha Silvio
To: Sergio R. Peruda, Jr.
Cc: Rizzi Joy Pardinas; Veronica Elyse Chua; John Albert Mano

NextGen_Documentation_Ch... 26 MB | CPEDES2-Documentation-Ap... 226 KB

2 attachments (26 MB) Save all to OneDrive - Asia Pacific College Download all

Good Afternoon, Sir Serge.

Here is our group's revised documentation along with the approval form for CPEDES2. We have indicated the revised pages inside the approval form for each of the comments.

Please let us know if you need anything else.

Thank you and keep safe.
Elisha

Elisha Silvio

To: Sergio R. Peruda, Jr.; Leonardo A. Samaniego, Jr.; Luigi Carlo M. De Jesus; Einstein D. Yong

Cc: Stanley Glenn E. Brucal; John Albert Mano; Veronica Elyse Chua; Rizzi Joy Pardinas

NextGen_Documentation_Ch... 7 MB | NextGen_Documentation_Ch... 26 MB

2 attachments (34 MB) Save all to OneDrive - Asia Pacific College Download all

Good Day!

Please refer to the attached files for the final documentation of our project in CPEDES2. Just let us know if you have any more questions or requirements.

Thank you and keep safe.
Elisha

Leonardo A. Samaniego, Jr.

To: Elisha Silvio

Cc: Veronica Elyse Chua; Rizzi Joy Pardinas; John Albert Mano

Hello Team NextGen,

Kindly include the page number in the submitted pre-approval form, where I can find the revisions you made on my comments and recommendations.

Regards,

Sir Sam

...

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Elisha Silvio

To: Leonardo A. Samaniego, Jr.

Cc: Veronica Elyse Chua; Rizzi Joy Pardinas; John Albert Mano

CPEDES2-Documentation-Ap... 212 KB | NextGen_Documentation_Ch... 26 MB

2 attachments (26 MB) Save all to OneDrive - Asia Pacific College Download all

Good Afternoon, Sir Sam.

Here is our revised documentation for our CPEDES2 project along with the approval form. Please let us know if you need anything else.

Thank you and keep safe!
Elisha

MINUTES OF THE MEETING

Minutes of the Meeting

April 12, 2022, 3:00PM

Sir Luigi

- one server per database then naka python environment

- php can run using exec command

- escape shell command kung naka linux server. if windows, exec only

- need to code in one pc or laptop kasi fixed address (kung ano yung sinusuggest ni sir. sorry di ko masyado gets huhu)

- install xamp, htdocs nakalagay file then pag irurun sa computer mismo nag python environment

- pag full python, sa sql na dapat para kahit anong pc can access

- frontend: web based (1 computer, kahit anong specification pwede), python based (device dependent yung process)

- so far ok progress, question is did you meet the objectives

Sir Stan

- Identify specific activities in progress report to get desired output

- report back the progress in coding before even completing to check Sir Luigi and Sir Stan's inputs

- put the narrative of what you have accomplished

- week numbers 1-10 or 1-12, plan the activities for the succeeding weeks and mark the weeks

- report the working progress next week

Two requirements of Sir Stan for next week (April 19, 2022):

- Demonstrate all that you have accomplished

- Reflect all the activities that you are planning for the rest of the term to complete the functions

Minutes of the Meeting

April 19, 2022, 3:00PM

Sir Luigi

- konting modifications, keywords, related words

- related words inputted by the user should direct to the room intended - intensive na

- should have set of words para malaman yung intent

- limit to most common words then yung mag improve in the future, sila na mag train sa synonyms

- better if not “try again” sa output when the system can’t recognize the input, dapat “please inquire specific” or “please rephrase” kasi baka ulitin lang ni user yung input

Sir Stan

- present the specific keywords next meeting

- 2 ways – specific name of the office or service/venues that the system knows

- define the scope as early as now so that will serve as the predefined inputs

- robustness of the system or would there be gaps in the system (?)

- map dictionary words (part of project design or sa appendix na lang)

- clarify what you intend to cover

- synonyms will be talked about after ma-define yung scope

Requirements for next week (April 26, 2022):

- Present keywords/dictionary

- Define the scope of the system

APPENDIX U

(Project Poster)

RAMNAV

Development of a Smart Building Directory System for Asia Pacific College

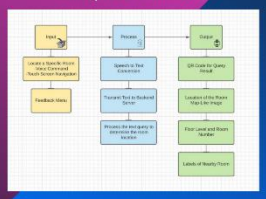
Abstract

Nowadays, almost everything is geared toward technological advancement, whether it be an individual, a small group, or even an entire company. One of this advancement is gearing towards achieving a smart building. A smart building is one that makes use of technology to enable efficient and economical resource utilization while producing a safe and comfortable environment for its occupants.Traditional building directories are commonly seen on signages, in Asia Pacific College (APC) we still use a traditional building directory where people walk pass by it barely noticing.

RamNav developed an advance, responsive, and complete directory which enables people to locate a specific room in the building through speech recognition and give the information they need. The directory system caters speech recognition feature used for performing query and output the room details for queries such as: floor level, nearby room names, map like image, and a predefined QR code that the user can scan using their phones to show a copy of query result in their mobile devices.

RamNav has been exceptional in acquiring and processing the speech of the user even on different environment situations and met all the proponents desired output.

Conceptual Framework



Results

Conclusion

As for the test and evaluation of the project, the results show that the system was able to acquire the voice of the user speaking from the range of the minimum of 6 inches and as far as 10 inches away from the microphone with an ease. Going on to the speech-to text transcription, we were able to test the system can transcribe the speech into text successfully in its first attempt without an error. As for the keyword recognition, the system was able to delete all the filler words and retain only the necessary keywords. All the test cases tested by the proponents were successful in terms of keywords recognized and deleted filler words from the user's query. When it comes to the word bank querying, we were able to test the function for querying wherein it discards keywords that does not exist in the word bank and only retains the keywords that are in the dictionary. Lastly, after testing different test cases, the rooms associated with the keywords were successfully displayed in the search result.

Adviser & Proponents

Stanley Glenn Brucal
Project Adviser

Elisha Silvio
Lead Programmer

Veronica Elyse Chua
Project Manager

Rizzi Pardiñas
Documentation Head

John Albert Maño
Creatives