DEVELOPMENT OF BASIC FILIPINO SIGN LANGUAGE USING MACHINE LEARNING TECHNIQUES

Capstone Project
Submitted to the faculty of the
Department of Information Technology
Cavite State University – Silang Campus
Biga 1, Silang, Cavite

In partial fulfillment
of the requirements for the degree
Bachelor of Science in Information Technology

PADILLA, LEANIEL MAE M.
TALLADA, MICHAEL
ZAMORA, MICHAEL ANGELO
JULY 2023

BIOGRAPHICAL DATA

Ms. Leaniel Mae M. Padilla was born on January 27, 2000 in Dasmariñas, Cavite. She is 23 years of age and resides permanently in Barangay Sampaloc 4, Dasmarinas City, Cavite. She is the 6th child of Mr. Archangelo C. Padilla and Mrs. Leonarda M. Padilla.

She graduated from elementary school at St. Mary's Academe Inc. in Dasmarinas City, Cavite, in 2013. In her Junior High School, she was enrolled at St. Mary's Academe Inc. as well and had her moving-up year in 2017.

She enrolled in her Senior High School at Philippine Nautical and Technological Colleges, took the Bachelor of Science in Marine Transportation under the Technical-Vocational-Livelihood Track, and graduated in 2019.

The same year, she took the Bachelor of Science in Information Technology at Cavite State University's Silang Campus.

In 2023, she successfully completed her college degree.

.

BIOGRAPHICAL DATA

Mr. Michael Tallada was born on March 11, 1998 in Cavite City. He is 25 years old and presently resides at Bella Vista Subdivision, Barangay Santiago GTC, General Trias, Cavite. He is the child of Mrs. Rosalinda L. Tallada and Mr. Rolando Ponsones Esguerra, Jr.

He completed his primary education in San Francisco Elementary School Silang Cavite, in the year 2012.

In his secondary school year, he attended Gov. Ferrer Memorial National Highschool and finished in the year 2016.

In 2016-2018, he took a Bachelor of Science in Information Technology at STI College – Dasmariñas Campus.

In 2019, he began his journey in Cavite State University – Silang Campus and took Bachelor of Science in Information Technology.

In 2023, he successfully completed his college degree.

.

BIOGRAPHICAL DATA

Mr. Michael Angelo Zamora was born on January 17, 2000 in Makati City. He is 23 years old and presently resides at Goldenville 2, Barangay Sabang, Dasmariñas, Cavite. He is the 1st child of Mr. Michael Capricho and Mrs. Zandra Zamora.

He completed his primary at Prince Aris Christian School in Dasmariñas, Cavite in the year 2013. He attended the same school for his secondary education and had his moving up on 2017.

In his Senior High School year, he attended Philippine Christian University, and took ICT under Technical-Vocational-Livelihood Track, and graduated in 2019. In the same year, he took the course Bachelor of Science in Information Technology at Cavite State University – Silang Campus.

In 2023, he successfully completed his college degree.

ACKNOWLEDGMENT

This thesis represents a formidable undertaking that requires the invaluable support and assistance of several individuals. The proponents would like to express their sincere gratitude to the following:

First and foremost, recognition is extended to God Almighty for bestowing them with knowledge, strength, good health, and peace of mind throughout the course of this research.

Acknowledgment is also owed to Cavite State University – Silang Campus, whose guidance, information, and assistance played a crucial role in the successful completion of this project.

Mr. Rodel Antang, as the thesis adviser, deserves special appreciation for displaying remarkable patience and dedication in meticulously reviewing the documents. His knowledge, advice, and suggestions significantly contributed to the improvement of this research.

The proponents are grateful to their friends, whose support and assistance in the development of this research made their college experience enjoyable despite juggling hectic schedules and dealing with diverse circumstances.

Lastly, the family receives heartfelt gratitude for the love and care shown during challenging times. Their unwavering support provided the fortitude, inspiration, and essential financial, moral, and emotional backing necessary to pursue their dreams and achieve their aspirations.

LEANIEL MAE M. PADILLA
MICHAEL TALLADA
MICHAEL ANGELO ZAMORA

ABSTRACT

TALLADA, MICHAEL, PADILLA, LEANIEL MAE M., ZAMORA, MICHAEL ANGELO, Development of Basic Filipino Sign Language Using Machine Learning Techniques. Capstone Project. Bachelor of Science and Information Technology. Cavite State University, Silang, Cavite. January 2023. Adviser: Mr. Rodel M. Antang

Communication is essential for human existence, enabling the exchange of ideas, feelings, and opinions. However, a significant portion of the global population lacks this ability due to hearing loss, speech impairment, or both. When a child becomes deaf-mute, their language learning ability is hindered, leading to language impairment or hearing mutism. The study entitled Basic Filipino Sign Language Using Machine Learning created an automatic sign language to text conversion system. This system will involve using a digital camera to capture sign language signs, and an underlying software will interpret the meaning of the captured images. The development of this computer-based system relies on the application of pattern recognition concepts, including image processing techniques. The system helped the owner and staff with accurate, valid, reliable, and efficient transaction records and productive ways to manage the customers and order information data.

The tools and software used in developing the system were Python Code for system coding, Visual Studio, TensorFlow, OpenCV, MediaPipe, LSTM and Microsoft word 2019 for system documentation. The methodology used in the development of the system is Modified Waterfall Model to discuss the system's connection to this model. This model has five phases: system planning, system analysis, system design, system implementation, and system testing. The researcher performed a system evaluation with 40 respondents. The result of the evaluation from the respondents is Highly Acceptable. It met the requirements specified in the ISO 25010-2011 Software Quality Metrics standard, such as functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

DEVELOPMENT OF BASIC FILIPINO SIGN LANGUAGE USING MACHINE LEARNING TECHNIQUES

Tallada, Michael

Padilla, Leaniel Mae M.

Zamora, Michael Angelo

An undergraduate thesis manuscript submitted to the faculty of the Department of Information Technology, Cavite State University-Silang Campus, Silang, Cavite in partial fulfilment of the requirements for the degree Bachelor of Science in Information Technology with Contribution No. _____. Prepared under the supervision of Mr. Rodel M. Antang.

INTRODUCTION

Communication is a necessary tool in human existence. It is a fundamental and effective method of exchanging ideas, feelings, and opinions. However, a significant proportion of the world's population lacks this ability (El-Din & El-Ghany, 2020). Many people are affected by hearing loss, speech impairment, or both. Hearing loss is defined as a partial or complete inability to hear in one or both ears. Mute, on the other hand, is a disability that impairs speaking and renders the affected individuals unable to speak. If a child becomes deaf-mute, their language learning ability is hampered, resulting in language impairment, also known as hearing mutism. These conditions are among the most common disabilities.

Deaf people communicate primarily through sign language, which is their native language. They use multiple complementary channels to convey information as visual languages. This includes manual features like hand shape, movement, and pose, as well as non-manual features like facial expression, mouth, and head, shoulders, and

torso movement. The objective of sign language translation is to either create a video of written text being signed or to take a sentence that is being signed and translate it into spoken language. It is impossible for people with speech and hearing impairments to converse with those who are normal, and vice versa. The only means of communication are through sign language. However, a gadget is needed to translate a sign into a language that the average person can understand. Visual representations of hand gestures, finger movements, facial expressions, body movement, etc. are used in sign languages.

The authors of this research will create a system that would automatically translate sign language into text. Digital cameras are needed by the system to catch the signs, and the underlying software decodes their meaning. Such a system will be created using pattern recognition concepts and image processing methods.

Statement of the Problem

The ineffective communication and high communication barriers faced by mute and deaf individuals, particularly children, create significant challenges in their daily lives as well for the parents. These individuals rely on sign language as their primary means of communication, which poses difficulties when interacting with community members who do not understand sign language or individuals who are unfamiliar with specific sign language variations. This communication barrier issue frequently arises when speech-impaired individuals converse from people who lack knowledge of their particular sign language.

Although some efforts have been made to address this issue, such as the employment of human translators, the success has been limited. However, advancements in technology, particularly in machine learning, offer promising solutions. Specifically, specialized algorithms can be developed to translate sign

language into comprehensible written text. However, further research is needed to determine the most effective machine learning model for accurately translating human motions and recognizing various sign languages.

By designing and comparing the performance of multiple machine learning models, we can significantly enhance communication effectiveness between speech-impaired individuals, those who uses sign language and individuals who doesn't know how to sign and understand Filipino sign language.

Objectives of the Study

The objective of the study is to develop basic Filipino sign language using machine learning techniques. Specifically, the study aims to:

1. To develop an automatic conversion from sign language signs to text.
2. To develop a computer-based system, pattern recognition concept including image processing techniques
3. To help bridge the communication gap between hearing-impaired individuals and the general population specifically the children with hearing impairments to express themselves and interact more easily with others.

The system will require a digital camera to capture the sign language and the underlying software will interpret the meaning of the image.

Significance of the Study

This system will redound to the benefit of the following:

PWD, particularly the deaf and mute in early stage particularly in 0-3 years old- Children are visual learners from an early age, so seeing words in motion helps them

remember knowledge and form longer sentences. Signing also helps kids become more conscious of other people's gestures, as they begin to understand what hand gestures mean. This helps them remember knowledge and form longer sentences. This system will aid them as they interact with normal people.

Individuals who are hearing and speech capable - Individuals without disabilities often struggle to comprehend signs and gestures used in sign language. Therefore, technologies like this system that can identify various signs and provide information to the general population can greatly facilitate their communication with individuals who are unable to speak or hear.

Scope and Limitations

The study is about a machine learning model for sign language interpretation. Study aims to build an efficient machine learning model for sign language interpretation using camera images to detect and translate hand gestures to written text.

What the system can do:

The system will collect data from a computer camera using a computer vision algorithm and extracting key points, including hands, face, and pose. As a sequence, these key points can then be passed along to detect and decode actions and sign language.

What the system cannot do:

The system cannot train in the interface or in GUI (Graphical User Interface). The system can train only through the back end of the system.

Definition Of Terms

Machine Learning refers to a branch of artificial intelligence (AI) and computer science which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy.

Graphical User Interface or GUI refers to a type of user interface that allows users to interact with electronic devices through graphical icons and audio indicators such as primary notation. This is what will be used for the system to function as needed.

Computer-based refers to a computer-based system is an organized combination of human resources, hardware, and software technologies created to deliver fast, comprehensive, accurate information for decision-making.

Pattern Recognition refers to a technique for data analysis that employs machine learning algorithms to find patterns and regularities automatically. This is what we'll employ to accomplish the system's necessary functions.

Sign Language Recognition (SLR) refers to a computational task that involves recognizing actions from sign languages. This is an essential problem to solve especially in the digital world to bridge the communication gap that is faced by people with hearing impairments.

LSTM – Long Short-Term Memory refers to a type of recurrent neural network capable of learning order dependence in sequence prediction problems. This is a behavior required in complex problem domains like machine translation, speech recognition, and more.

Python refers to a computer programming language often used to build websites and software, automate tasks, and conduct data analysis. Python is a general-purpose language, meaning it can be used to create a variety of different programs and isn't specialized for any specific problems.

Conceptual Framework

This section provides an overview of the approaches applied in this research to solve the problem of sign language recognition. In addition, the variables considered in this research are identified and their expected relationships are established.

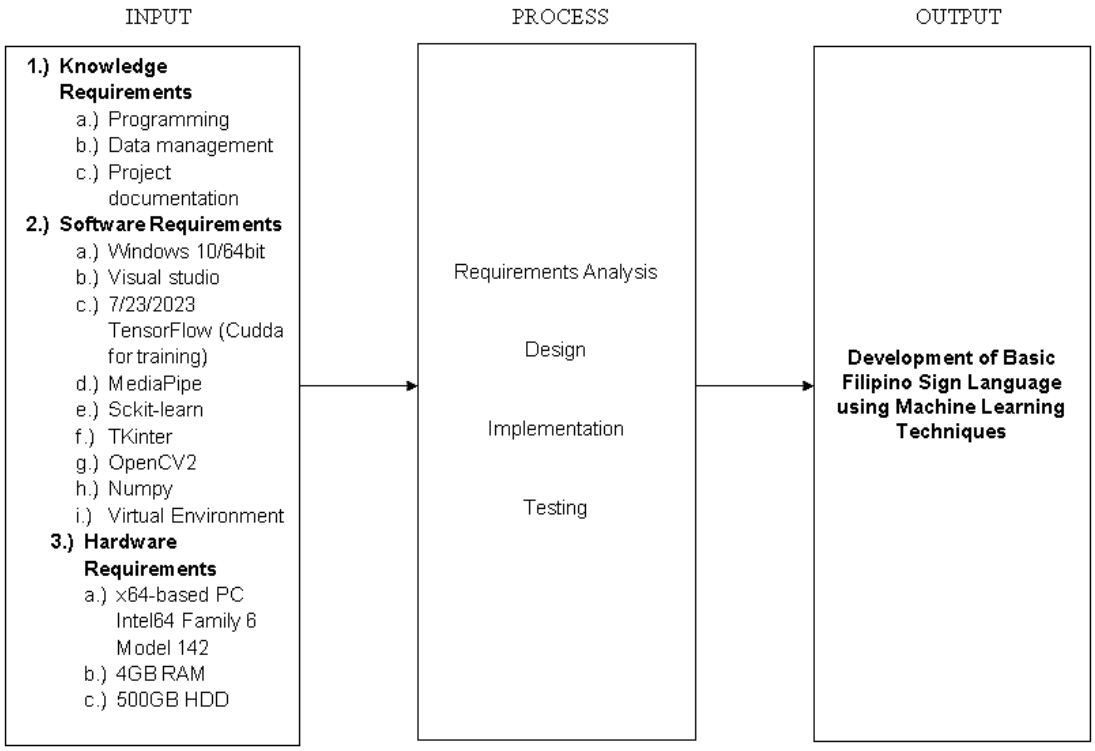


Figure 1. Conceptual Framework

REVIEW OF RELATED LITERATURE

The task of sign language recognition is still one of the most challenging and important problems since it takes a lot of effort, energy, and voluntariness to present the finished product. Researchers, professionals, and students have recently used their work to improve automatic sign language translation and sign language recognition. There are several studies in literature that presents the use of a system in demonstrating sign language. We are able to gather many data from different literature that supports the effectiveness of our proposed system.

Venugopalan, A. and Reghunadhan R. (2021) states that the detection and systematic translation of various sign language movements into a language that the general public can understand, such as words, symbols, or speech, is known as sign language recognition (SLR). Hearing aids and other alternatives have long been the main focus of the attempt to close the communication gap between the hearing and deaf communities (Brour, M.; Benabbou, A., 2021). The conduct-based model and the vision-based model are the two main approaches that have been used to build sign language and human action recognition models over time (Abraham, A.; Rohini, V., 2018). The conduct-based system uses technology or sensors that are in close vicinity to the communicator to record human actions and sign language motions. The capture signals are transmitted to a computer or collection of computer hardware installations, where they are then decoded using a unique programmed method.

The glove-based device created more than three decades ago is an excellent illustration of these approaches (Abraham, A.; Rohini, V., 2018). There are a lot of issues with this device. For instance, the sensor continually makes inaccurate predictions, resulting in very low translation accuracy. The wearable technology didn't cater to unique users; instead, it recognized movements and translated them into text for established settings. They lacked a method for saving sensor values for use in expanded data processing in the future (Abraham, A.; Rohini, V., 2018). An enhanced

conduct-based sign language prediction model was created that converted the recorded motions to speech using similar ideas and arterial neural networks (Abraham, A.; Rohini, V., 2018).

In this model, the wearer's gestures were recognized using flex sensors that were attached to a customized glove. The voltage was adjusted by the flex sensors using numerous resistance values that were adjusted using the angles created by different flex motions. Multiple mechanisms were used to display various values (Abraham, A.; Rohini, V., 2018). It was discovered that this enhanced model was prone to several mistakes. As different flex angles for the same motion may fluctuate from person to person and even within a single person due to numerous causes, the model appears to be too complex to create. It has been noted by different scholars, scientists, and engineers that conduct-based models usually apply relatively expensive and complex hardware setups. According to Narayan, S. and Sajja (2021) vision-based models seem to be a more reliable, relatively inexpensive, and efficient approach that best fits sign language recognition. In this approach, sign language gestures are captured using a camera attached on a computer, such as a webcam, then decoded using machine learning principles.

Different scholars, scientists, and engineers have explored several vision-based models to establish the most reliable and efficient model. For translating southern Indian sign language, a vision-based real-time sign language recognition system was proposed (Rajam, P.S.; Balakrishnan, G., 2019), while a finger spelling method was developed in (Marjusalinah, A.D.; Samsuryadi, S.; Buchari, M.A., 2021). P.S. Rajam and G. Balakrishnan (2019) used 32 signs to represent finger positions defined by binary representations of "UP" and "DOWN." The sign language captured in the images was converted into text using fingertip positions. The model was developed and tested by a single individual. The proposed model achieved 98.125 accuracy after testing 50% of the 320 images used in training. The authors proposed

that more accurate measurement of angular movements of various gestures could be used to improve the system's accuracy.

Recently, a conceptual video-based SLT system was developed (Mark Borg and Kenneth P Camilleri, 2019). A study by Xiujuan Chai et al. (2020) proposed recognizing signs in isolation and then using a language model to construct sentences. However, until recently, end-to-end SLT from video had not been realized. The most significant barrier to vision-based SLT research has been the lack of suitable datasets. It takes time and effort to curate and annotate continuous sign language videos with spoken language translations. Datasets from linguistic sources (Adam Schembri et al., 2013) and sign language interpretations from broadcasts are available (Neva Cherniavsky et al., 2018).

Another vision-based sign language recognition system for automatic translation of Arabic sign language from signs to text has been developed. The system had four major stages: hand segmentation using a dynamic skin detector, tracking, feature extraction, and data classification. The experiment's results showed a 97% signer-independent recognition rate and surpassed the pre-existing models by accurately defining the hand and head positions, respectively. Deep learning CNN or Convolutional Neural Network has recently gained popularity in data science research, including the use of deep learning for vision-based hand gesture recognition for sign language interpretation (Sharma, P.; Anand, R.S., 2021). A Deep Learning-based CNN specifically designed for sign language recognition was used in one study. In the study, VGG-11 and VGG-16 were trained and tested for model performance evaluation. The authors used a large Indian sign language collection, which included 2150 images captured with an RGB camera and an ASL data set. The accuracy of the Indian sign language model was 99.96%, while the accuracy of the ASL model was 100%. Aside from accuracy, other efficiency tests were performed on the model to compare it to the most advanced approaches. The results of the tests revealed that

the study model outperformed the existing models and had a greater potential for improvement than the others. Therefore, they proposed that future research focus on optimizing hand gesture recognition as well as on additional comparisons and improvements to the architecture intended to minimize errors.

Pigou, L. et al. (2015) conducted research on sign language recognition to bridge the communication gap between the deaf and hearing communities. In their study, they used Microsoft Kinect CNN models with GPU acceleration. CNN models were used to automate feature construction (Pigou, L. et al.,2015). Twenty different Italian sign language gestures were recognized with high accuracy using the model. The predictive model's cross-validation accuracy was 91.7% based on general user surroundings that did not occur during training. During the Chalearn spotting competition in 2014, the model received a score of 0.789 on the Jaccard index, which involved the detection of people's gestures. The study concluded that CNN could perform accurately when using indifferent sign language recognition with some users and environments that were not involved in training. The authors therefore recommended the use of CNN models for automatic sign language recognition. Similarly, a CNN was used in the development of Bhutanese sign language digits (Wangchuk, K. et al. 2018). This model used about 20,000 sign images for Bhutanese sign language recognition of ten static digits obtained voluntarily from a different participant.

The authors suggested that future research focus on the dynamic gestures and alphabets of Bhutanese sign language. Similarly, Sharma, P., and Anand, R.S. (2021) created a CNN-based sign language recognition model to translate Indian sign language to text. This research was the first comprehensive analysis of Indian sign language. The study proposed using a three-layer CNN Model which was trained from an absolute initial machine learning state and attained a recognition accuracy of 99.8% on the Indian sign language numerals and 97.8% on the alphabet. The study

recommends the future research to focus on using comparative analysis to select suitable sign language recognition models.

An Arabic sign language classification system was proposed by Abdul, W. et al. (2021), their proposed model consisted of a Convolutional Neural Network integrated with an attention mechanism for retrieving spatial features and bio-inspired deep learning with Long Short-Term Memory (BI-LSTM). For the extraction of temporal features, the BI-LSTM was employed. In order to test this model, a number of highly variable factors were used, including various lighting situations, various outfits, and various distances from the camera. Due to the processing of fewer deep learning layers and parameters, the model that was produced required less processing time than the alternatives. The authors suggested that future studies test their proposed models in several additional areas, such as image categorization and EEG. A high thermal picture taken with a light-independent thermal camera and producing an array of 19,200 pixels with 160 20 resolutions has been updated to match to the 0-9 sign language digits in the low thermal image dataset, which was compiled from multiple authors with 160 x 20 resolution (Yeduri, S.R et al., 2022). The study conducted by Breland, D.S. et al., 2021, addresses the use of CNNs and thermal infrared pictures for hand 340 gesture identification.

Synthesis

One of the key findings from the mentioned study above is that conduct-based sign language recognition methods are not the best option. This is due to the fact that they demand quite expensive and complex hardware installations (Narayan, S.; Sajjan, V.S., 2021). This explains why vision-based models have been preferred by the majority of researchers. Although there have been several studies in this area, it is clear that the creation of sign language recognition models is still a challenging area of study. The most difficult part is creating a model that works well for handling continuous sign problems that don't depend on the signer (Kamal, S.M. et al., 2019 and Gao, W. et al., 2004). The construction of a model with high accuracy and that is continuous from one model to another is made difficult by the significant variance in duration, speed, and background from one signer to the next (Abdul, W. et al., 2021).

Research on CNN-related models has received a variety of recommendations from various researchers. Choosing the optimal model to adopt and enhance, though, is a challenge since it takes into account how different models are interdependent with regard to the optimization of tuning parameters (Sharma, P.; Anand, R.S., 2021).

It is clear from the above literature review that the majority of RNN models to far have been created for sign languages such as Indian, Arabic, and Chinese. However, there hasn't been a lot of research on RNN and LSTM-based Filipino sign language recognition development. There are no research comparing the effectiveness of LSTM and RNN models for the recognition of Filipino Sign language. This demonstrates the necessity for research into the best model to use, as well as the best technique to control the influencing parameters to boost the accuracy of future models. As a result, the goal of this research is to create a RNN and LSTM-based system for Filipino sign language recognition that also controls the affecting parameters to maximize accuracy.

METHODOLOGY

The proposed research was aimed at developing a more efficient understanding through a machine learning model for accurate detection, decoding, mapping, and translation of Filipino sign language into a text and text-to-speech message format.

The proposed model uses a specially coded computer vision algorithm to detect sign language gestures from a suitable source. The collected data Key points or landmarks are then processed in sequence for action detection and decoding of Filipino sign language.

A model was developed and optimized by a RNN, TensorFlow, and an LSTM object recognition model. The model was used to evaluate using a multi-labeled classification model, a supervised learning prototype in which data are assigned various labels from a predefined set of labels through data set landmarks.

Research Design

In this experiment, the required data were about 27 alphabet signs, number signs from 1-10, greetings such as magandang umaga, magandang hapon, magandang gabi, kamusta, paalam and basic words such as mama, papa, oo, hindi, salamat, used in Filipino sign language.

The signs were based on hand gesture signs. This experiment's major objective was to create an LSTM model that could predict Filipino sign language in many frames and the action that was being exhibited in real time. The hands, face, and body were the primary points from which data was first gathered and saved. The machine learning model was trained using an LSTM layer in the following stage,

allowing the prediction of temporal components and action prediction from a set number of frames.

The last step involves using openCV to anticipate activities using a computer webcam in real time. The first requirement for achieving these main goals was the installation and exportation of dependencies in the Python code, followed by the extraction of key points using MediaPipe holistic. The extraction of key point values (for example, joints with the hands or body) was then determined to represent a different frame at a point in time for the LSTM model. After that, the keypoint values were collected for testing and training. These data were prepossessed, and sequences were created by creating labels and features.

Materials

For the development of the system, the proponents used the following hardware specification: Windows 11 x64-based PC, Intel64 Family 6 Model 142 Stepping 12 GenuineIntel ~ 2501 Mhz, 20 GB RAM and 500 GB Capacity Hard Disk Drive. For the software specification: Visual Studio Code, Python, TensorFlow, MediaPipe, Pygui, Jupyter Notebook and Conda.

Software Method

The developers will use Modified Waterfall Method in the Sign Language using Machine Learning. This will be developed using the modified waterfall mode as a guide in creating the system which includes six stages. The stages involved in the modified waterfall method are as follows.

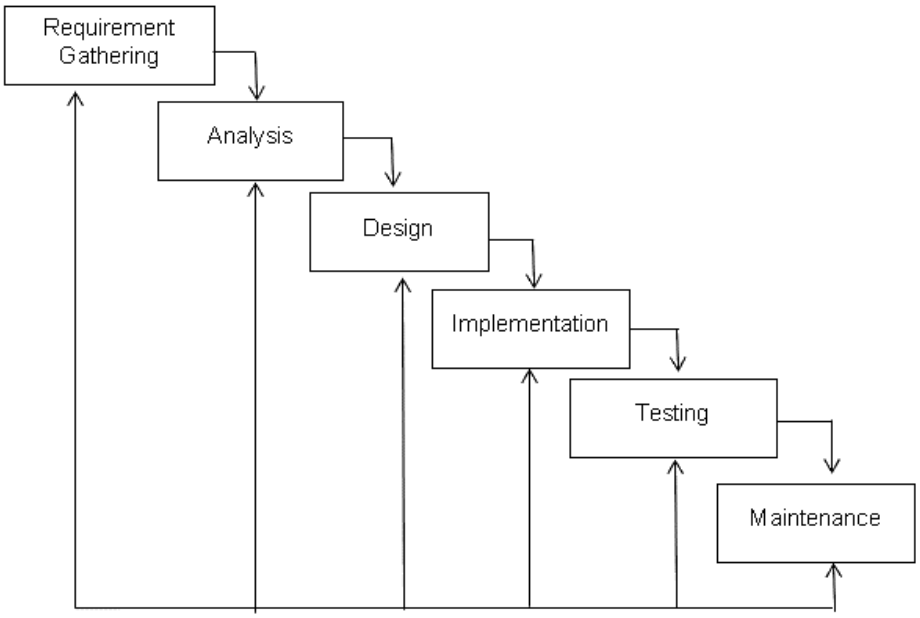


Figure 2. Modified Waterfall Method

As described by Shelly and Rosenblatt (2012), the Waterfall Model consists of five phases: system requirement, system analysis, system design, system implementation and testing. As shown in the figure it allows repetition of the processes until the process succeeded. This paradigm permits a rollbackto a prior phase if specific tasks in the current phase fail. In the chart, the solid arrow moving downward denotes progression to the next phase, but the broken arrow pointing upward indicates a reversion to the previous stage if specified tasks in the current stage fail.

Requirement Gathering. This is the phase where in the process used as the framework for software development. In this phase the researchers investigate the tasks and goals of audiences to establish functional and usability objectives for the application.

Analysis. In this phase, the researchers took a lot of time analyzing the concept needed. They documented the inputs, outputs, processing and algorithm.

Design. This phase is the stage where the researchers do the design sketches in order to visualize the interface and the flow of the system.

Implementation. This phase belongs to the programmer in the Waterfall method. The programmers, they will utilize the project requirements and specifications to code the application.

Testing. To check the module for bugs, faults, and other errors, a number of tests and test cases will be run as part of the software testing process. Incorrect programs will be rebuilt and tested again until the desired outcome is reached. The researchers will conduct testing following additional adjustments in their system to see whether the changes are applicable or not to the program.

Population Frame and Sampling

This research paper will use purposive sampling to select participants who possess specific expertise and knowledge relevant to the study. This will involve targeting three key groups: parents who use sign language, subject matter experts in sign language communication, and IT experts familiar with machine learning technologies. By purposefully selecting participants with these qualifications, the study aims to gather valuable insights and perspectives from individuals who can contribute their expertise to the development and evaluation of the sign language translation system.

Research Instrument

To get the appropriate data, the study will be using the standardized questionnaire for testing the quality of the system, ISO 25010-2011. All the questions that will answer by the evaluators are based on what is the study requirements.

The Evaluators will be requested to choose the number of response modes to indicate his/her degree of agreement based on the indicators by using a 5-point scale:

5 – Highly Acceptable. This indicates that the Client, IT Experts, and Subject Matter are very satisfied that the application requirements and functionalities are perfectly working and met all the needed requirements.

4 – Acceptable. This indicates that the Client, IT Experts, and Subject matter are satisfied that the application function is working very well and meeting only the minimum requirements.

3 – Moderately Acceptable. This indicates that the Client, IT Experts, and Subject Matter are quite satisfied to the application functions are working well but could be improved and met just some of the requirements needed.

2 – Fairly Acceptable. This indicates that the Client, IT Experts, and Subject Matter are enough satisfied but not totally Un-satisfied with the required functions of the application, it is working but while running they encounter a problem and needs minor improvement.

1 – Unacceptable. This indicates that the Client, IT Experts, and Subject Matter are not satisfied and required functions are needing major improvements.

The mean ratings will be interpreted and described based on their level of perception of the given indicators as follows: 4.51- 5.00; Highly Acceptable, 3.51- 4.50; Acceptable, 2.51- 3.50; Moderately Acceptable 1.51- 2.50; Fairly Acceptable, 1.00- 1.50; Unacceptable.

Data Analysis

The data that is collected will be recorded, analyzed, tabulated, and interpreted. To describe the scores given the study will be using Mean to the system in terms of Visual Design and User Interaction, Functionality, Compatibility, Performance and Stability, and Security.

Mean is the calculated central value or average of all numbers by adding up all the numbers and dividing by how many numbers are presented. The researcher utilized the mean in the study to determine the average score from the respondents during the evaluation, which they then interpreted.

Where: $$\bar{x} = \frac{\sum fx}{N}$$

$\bar{x}$	=	weighted mean
$\sum fx$	=	sum of the products of frequencies and weight
N	=	total number of respondents

Standard deviation measures how spread the number is. It uses the sigma sign (σ)(Math is Fun, 2018) and calculated as:

Where: $$\text{Standard Deviation} = \frac{\sqrt{\sum_{i=1}^{n} (x_i - \bar{x})^2}}{n-1}$$

X_i	=	Value of the th point in the data set
$\bar{x}$	=	The mean value of the data set
n	=	The number of data points in the data set

Frequency is the count of the appearance of one value inside the dataset. The study, breakdowns the number of the respondents based on its category to be interpreted by the researchers.

The percentage was used to standardize the size to indicate the frequency of occurrence of a category per 100 cases. In the study, it is used to determine how many per cent does the category contributed to the whole sample.

$$\text{Percent (\%)} = 100 \times \frac{f}{n}$$

wher

e: f = frequency of occurrence

n = total number of cases in the distribution

RESULTS AND DISCUSSIONS

Specific Objective:

To develop an automatic conversion from sign language signs to text.

Results and Discussions

The developed automatic conversion system for sign language signs to text has demonstrated efficiency. Through machine learning techniques, the system is able to translate sign language gestures into written text in real-time. Testing and evaluation have shown that the system achieves reliability in recognizing basic Filipino sign language and converting them into corresponding textual representation.

As a result, this system significantly enhances communication accessibility for individuals who are deaf or hard of hearing. It empowers them to effortlessly communicate with non-sign language users, bridging the gap between different communication modalities. The automatic conversion system can facilitate effective communication in everyday conversations between an individual and a child aging between 0-3 years old in early stage of speaking in sign language.

Although this system for sign language has made significant progress, there are ongoing efforts to make it even better. We are working to improve its accuracy and expand the range of words it can translate. These enhancements will ensure more reliable and precise translations, enabling a wider variety of sign language conversations to be accurately converted into written text.

In terms of the results of the survey per category, the Development of Basic Filipino Sign Language Using Machine Learning Techniques has a total of 40 evaluators. It showed that the majority of them are potential users with a frequency of 14 or 35% of end-user respondents out of the total number of evaluators. Only 9 or 22.5% of IT experts respondents were recorded while 17 or 42.5% for SME.

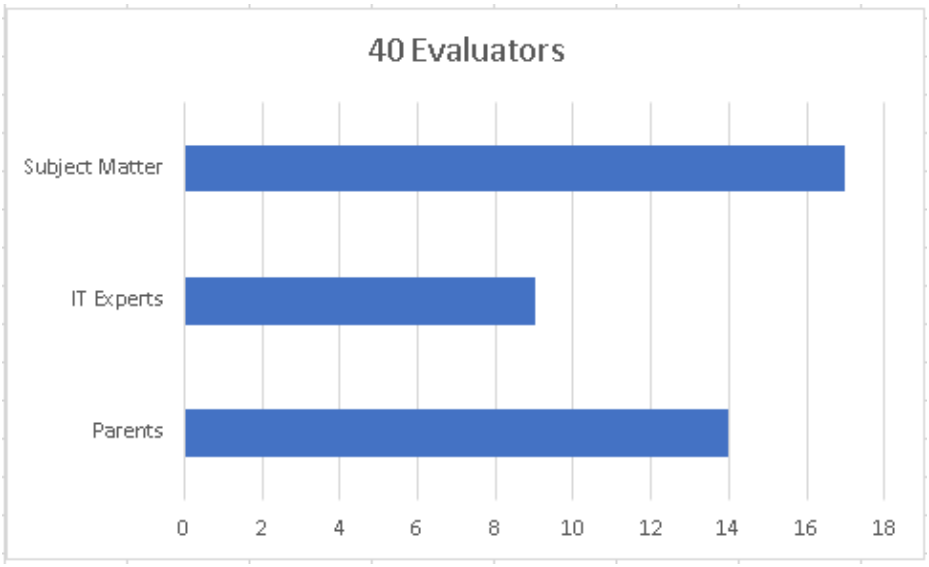


Figure 3. Development of Basic Filipino Sign Language Using Machine Learning Techniques Evaluators

Table 1. Development of Basic Filipino Sign Language Using Machine Learning Techniques

A. Security

CRITERION	MEAN	STANDARD DEVIATION	VERBAL INTERPRETATION
Confidentiality	3.97	0.97	Moderately Acceptable
Integrity	3.75	0.92	Moderately Acceptable
Non-repudiation	3.66	0.90	Moderately Acceptable
Accountability	3.66	0.90	Moderately Acceptable
Composite Score	**3.76**	**0.92**	**Moderately Acceptable**

Scale: 4.50-5.00=highly acceptable , 3.50-4.49=moderately acceptable, 2.50-3.49=acceptable , 1.50-2.49=Fairly unacceptable, 1.00-1.49=unacceptable

According to Table 1, the Development of Basic Filipino Sign Language Using Machine Learning Techniques achieved a composite mean score of 3.76, indicating a moderately acceptable level with a standard deviation of 0.92. The highest mean score in terms of security was obtained by Confidentiality, scoring 3.97 with a standard

deviation of 0.97, also considered moderately acceptable. On the other hand, the lowest mean score for security was Accountability and Non-repudiation, scoring 3.66 with a standard deviation of 0.90, which falls under the moderately acceptable category as well.

These results suggest that the system has met certain standards for Confidentiality, Integrity, Non-repudiation, and Accountability. This is evident from the positive rating of "Good" given by the three sets of user respondents. The success can be attributed to the fact the system effectively fulfills its intended purpose. Consequently, it ensures protection, allowing only authorized users to access and modify files and data within their respective records.

Table 2. Development of Basic Filipino Sign Language Using Machine Learning Techniques

B. Maintainability

CRITERION	MEAN	STANDARD DEVIATION	VERBAL INTERPRETATION
Modularity	3.66	1.00	Moderately Acceptable
Reusability	3.88	0.98	Moderately Acceptable
Analysability	3.81	1.09	Moderately Acceptable
Modifiability	3.84	1.17	Moderately Acceptable
Testability	3.40	1.00	Moderately Acceptable
Composite Score	**3.82**	**1.04**	**Moderately Acceptable**

Scale: 4.50-5.00=highly acceptable , 3.50-4.49=moderately acceptable, 2.50-3.49=acceptable , 1.50-2.49=Fairly unacceptable, 1.00-1.49=unacceptable

Based on Table 2, the Development of Basic Filipino Sign Language Using Machine Learning Techniques achieved a composite mean score of 3.82 in terms of

Maintainability, indicating a moderately acceptable level, with a standard deviation of 1.04. The highest mean score for Maintainability was obtained by Reusability, scoring 3.88 with a standard deviation of 1.00, which is also considered moderately acceptable. On the other hand, the lowest mean score for Maintainability was observed in Testability scoring 3.40 with a standard deviation of 1.00, falling under the moderately acceptable category as well.

According to the results, the system has met specific standards in terms of modularity, reusability, analyzability, modifiability, and testability. This is reflected in the positive rating of "Good" given by all three groups of evaluators. The success can be attributed to the fact that the system performs as intended. Consequently, the efficiency and speed at which the system can be restored after a breakdown are measured.

Table 3. Development of Basic Filipino Sign Language Using Machine Learning Techniques

C. Functional Suitability

CRITERION	MEAN	STANDARD DEVIATION	VERBAL INTERPRETATION
Function Completeness	3.81	1.00	Moderately Acceptable
Function Correctness	3.97	1.06	Moderately Acceptable
Functional Appropriateness	3.88	1.10	Moderately Acceptable
Composite Score	**3.89**	**1.04**	**Moderately Acceptable**

Scale: 4.50-5.00=highly acceptable , 3.50-4.49=moderately acceptable, 2.50-3.49=acceptable , 1.50-2.49=Fairly unacceptable, 1.00-1.49=unacceptable

Based on Table 3, the Development of Basic Filipino Sign Language Using Machine Learning Techniques achieved a composite mean score of 3.89 in terms of

Functional Appropriateness, indicating a moderately acceptable level, with a standard deviation of 1.04. The highest mean score for Functional

Appropriateness was obtained in Functions Correctness, scoring 3.97 with a standard deviation of 1.06, also considered moderately acceptable. On the other hand, the lowest mean score for Functional Appropriateness was observed in Function Completeness, scoring 3.81 with a standard deviation of 1.00, falling under the moderately acceptable category as well.

The results suggest that the system has successfully met specific criteria resulting in a positive rating of "Good" from both groups of assessors. This achievement can be attributed to the fact that the system functions as intended.

Table 4. Development of Basic Filipino Sign Language Using Machine Learning Techniques

D. Performance Efficiency

CRITERION	MEAN	STANDARD DEVIATION	VERBAL INTERPRETATION
Time Behavior	3.81	0.90	Moderately Acceptable
Resource Utilization	3.63	1.10	Moderately Acceptable
Capacity	3.63	0.91	Moderately Acceptable
Composite Score	**3.69**	**0.97**	**Moderately Acceptable**

Scale: 4.50-5.00=highly acceptable , 3.50-4.49=moderately acceptable, 2.50-3.49=acceptable , 1.50-2.49=Fairly unacceptable, 1.00-1.49=unacceptable

Based on Table 4, the Development of Basic Filipino Sign Language Using Machine Learning Techniques achieved a composite mean score of 3.69 in terms of Performance Efficiency, indicating a moderately acceptable level, with a standard deviation of 0.97. The highest mean score for Performance Efficiency was obtained in

Time Behavior, scoring 3.81 with a standard deviation of 0.90, also considered moderately acceptable. On the other hand, the lowest mean score for Performance Efficiency was observed in Resource Utilization and Capacity, scoring 3.63 with standard deviations of 1.10 and 0.91 respectively, falling under the moderately acceptable category as well.

The results suggest that the system has successfully met standards, particularly in terms of Capacity, Time Behavior, and Resource Utilization, as indicated by the evaluators' positive rating of "Good". This accomplishment can be attributed to the fact that the E-commerce website effectively serves its intended purpose.

Table 5. Development of Basic Filipino Sign Language Using Machine Learning Techniques

E. Compatibility

CRITERION	MEAN	STANDARD DEVIATION	VERBAL INTERPRETATION
Co-existence	3.59	0.91	Moderately Acceptable
Interoperability	3.97	0.97	Moderately Acceptable
Composite Score	**3.78**	**0.95**	**Moderately Acceptable**

Scale: 4.50-5.00=highly acceptable , 3.50-4.49=moderately acceptable, 2.50-3.49=acceptable , 1.50-2.49=Fairly unacceptable, 1.00-1.49=unacceptable

According to Table 5, the Development of Basic Filipino Sign Language Using Machine Learning Techniques achieved a composite mean score of 3.78 in terms of Compatibility, indicating a moderately acceptable level, with a standard deviation of 0.95. The highest mean score for Compatibility was obtained in Interoperability, scoring 3.97 with a standard deviation of 0.97, also considered moderately acceptable. On the other hand, the lowest mean score for Compatibility was observed in Co-

existence, scoring 3.59 with a standard deviation of 0.91, falling under the moderately acceptable category as well.

The findings suggest that the system adhered to specific standards, particularly in terms of coexistence and interoperability, resulting in an excellent rating from the groups of assessors evaluating the system.

Table 6. Development of Basic Filipino Sign Language Using Machine Learning Techniques

F. Usability

CRITERION	MEAN	STANDARD DEVIATION	VERBAL INTERPRETATION
Appropriate Recognizability	2.80	0.97	Acceptable
Learnability	3.84	0.95	Moderately Acceptable
Operability	3.94	0.98	Moderately Acceptable
User Error Protection	3.88	0.91	Moderately Acceptable
Accessibility	2.67	.93	Acceptable
Composite Score	**3.74**	**0.96**	**Moderately Acceptable**

Scale: 4.50-5.00=highly acceptable , 3.50-4.49=moderately acceptable, 2.50-3.49=acceptable , 1.50-2.49=Fairly unacceptable, 1.00-1.49=unacceptable

Based on Table 6, the Development of Basic Filipino Sign Language Using Machine Learning Techniques has achieved a composite mean score of 3.74 in terms of Usability, indicating a moderately acceptable level, with a standard deviation of 0.96. The highest mean score for Usability was obtained in Operability, scoring 3.94 with a standard deviation of 0.98, also considered moderately acceptable. On the other hand, the lowest mean score for Usability was observed in Accessibility, scoring 2.67 with a standard deviation of 0.93, falling under the acceptable category as well.

The findings suggest that the system adhered to specific standards, including Appropriate Recognizability, Learnability, Operability, User Error Protection, and Accessibility, resulting in a good rating from the groups of assessors evaluating the system. This accomplishment can be attributed to the fact that the system effectively serves its intended purpose. It demonstrates appropriate recognition, ease of learning, operability, protection against user errors, and accessibility to users.

Table 7. Development of Basic Filipino Sign Language Using Machine Learning Techniques

G. Reliability

CRITERION	MEAN	STANDARD DEVIATION	VERBAL INTERPRETATION
Maturity	3.84	1.05	Moderately Acceptable
Availability	4.00	0.92	Moderately Acceptable
Fault Tolerance	3.88	0.87	Moderately Acceptable
Recoverability	3.78	1.01	Moderately Acceptable
Composite Score	**3.88**	**0.96**	**Moderately Acceptable**

Scale: 4.50-5.00=highly acceptable , 3.50-4.49=moderately acceptable, 2.50-3.49=acceptable , 1.50-2.49=Fairly unacceptable, 1.00-1.49=unacceptable

Based on Table 7, the Development of Basic Sign Language Using Machine Learning Techniques achieved a composite mean score of 3.88 in terms of Reliability, indicating a moderately acceptable level, with a standard deviation of 0.96. The highest mean score for Reliability was obtained in Availability, scoring 4.00 with a standard deviation of 0.92, also considered moderately acceptable. On the other hand, the lowest mean score for Reliability was observed in Recoverability, scoring 3.78 with a standard deviation of 1.01, falling under the moderately acceptable category as well.

The results of the researcher's findings suggest that the system adhered to specific standards related to Maturity, Availability, Fault Tolerance, and Recoverability. This resulted in a positive rating of "Good" across the three groups of system evaluators. The success can be attributed to the fact that the system is functioning according to their intended purpose. Consequently, they provide transparency in sourcing information and help readers gain a deeper understanding of the topic, relying less on opinion pieces or second-hand news.

Table 8. Development of Basic Filipino Sign Language Using Machine Learning Techniques

H. Portability

CRITERION	MEAN	STANDARD DEVIATION	VERBAL INTERPRETATION
Adaptability	4.03	1.00	Moderately Acceptable
Installability	2.50	0.95	Acceptable
Replaceability	3.81	0.97	Moderately Acceptable
Composite Score	**3.60**	**0.97**	**Moderately Acceptable**

Scale: 4.50-5.00=highly acceptable , 3.50-4.49=moderately acceptable, 2.50-3.49=acceptable , 1.50-2.49=Fairly unacceptable, 1.00-1.49=unacceptable

According to Table 8, the Portability of the Development of Basic Filipino Sign Language Using Machine Learning Techniques achieved a composite mean score of 3.60, accompanied by a standard deviation of 0.97. This composite mean score falls within the category of Moderately Acceptable. Among the different aspects of Portability, Adaptability received the highest mean score of 4.03, with a standard deviation of 1.00, also classified as Moderately Acceptable. On the other hand, Replaceability obtained the lowest mean score of 3.81, with a standard deviation of 0.97, also considered Moderately Acceptable.

Table 9. Overall Evaluation of the Development of Basic Filipino Sign Language Using Machine Learning Techniques

CRITERION	MEAN	STANDARD DEVIATION	VERBAL INTERPRETATION
Security	3.76	0.92	Moderately Acceptable
Maintainability	3.82	1.04	Moderately Acceptable
Functional Suitability	3.89	1.04	Moderately Acceptable
Performance Efficiency	3.69	0.97	Moderately Acceptable
Compatibility	3.78	0.95	Moderately Acceptable
Usability	3.91	0.96	Moderately Acceptable
Reliability	3.88	0.96	Moderately Acceptable
Portability	3.90	0.97	Moderately Acceptable
Composite Score	**3.83**	**0.98**	**Moderately Acceptable**

Based on Table 9, the Overall results of the Development of Basic Filipino Sign Language Using Machine Learning Techniques yielded a composite mean score of 3.83, along with a standard deviation of 0.98. The verbal interpretation for this composite mean score is Moderately Acceptable. Among the different aspects of Overall Results, Usability achieved the highest mean score of 3.91, with a standard deviation of 0.96, also categorized as Moderately Acceptable. On the other hand, Performance Efficiency obtained the lowest mean score of 3.69, with a standard deviation of 0.97, also classified as Moderately Acceptable.

In general, the researchers found that the Development of Basic Filipino Sign Language Using Machine Learning Techniques has fulfilled the requirements for safety and security, maintainability, functional appropriateness, performance effectiveness,

compatibility, applicability, and other aspects, receiving positive evaluations from three groups of the system evaluators. This can be attributed to the fact that the system specifically caters to the functions and purposes they were designed for. Therefore, this research study fulfills the specifications and needs of system and web application assessors.

Regarding the evaluation by Information Technology experts, only the compatibility characteristic received a positive response rate of 31%. However, for end users, all quality characteristics garnered positive response rates exceeding 51.7%. Subject matter users obtained positive response rates of 24.1%. A total of 32 respondent evaluators participated in the evaluation of the Development of Basic Filipino Sign Language Using Machine Learning Techniques.

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Summary of Findings

Our specific objective is to create an automatic conversion system that can transform basic Filipino sign language signs into written text using machine learning techniques.

- The Development of Basic Filipino Sign Language Using Machine Learning Techniques was evaluated by 40 persons composed of Subject Matter, IT experts and End User.

3.1 Security

The assessment of the Basic Filipino Sign Language Using Machine Learning Techniques achieved a weighted mean of 55.65% and was deemed Good in terms of security.

3.2 Maintainability

The evaluation of the Basic Filipino Sign Language Using Machine Learning Techniques attained a weighted mean of 52.26%, indicating a good level of maintainability.

3.3 Functional Suitability

The evaluation the Basic Filipino Sign Language Using Machine Learning Techniques resulted in a weighted mean of 46.27%, signifying a good level of functional suitability.

3.4 Performance Efficiency

The assessment of the Basic Filipino Sign Language Using Machine Learning Techniques yielded a weighted mean of 57.5%, indicating a good level of performance efficiency.

3.5 Compatibility

The evaluation of the Basic Filipino Sign Language Using Machine Learning Techniques obtained a weighted mean of 56.6%, reflecting compatibility.

3.6 Usability

The evaluation of the Basic Filipino Sign Language Using Machine Learning Techniques achieved a weighted mean of 48.7%, indicating a good level of usability.

3.7 Reliability

The evaluation of the Basic Filipino Sign Language Using Machine Learning Techniques obtained a weighted mean of 47.15%, signifying a good level of reliability.

3.8 Portability

The assessment of the Basic Filipino Sign Language Using Machine Learning Techniques resulted in a weighted mean of 51.6%, reflecting a good level of portability.

3.9 Overall

The evaluation the Basic Filipino Sign Language Using Machine Learning Techniques obtained a weighted mean of 51.97%, indicating an overall good performance.

Conclusion

In general, the conclusion highlights the importance of effective communication for individuals with hearing and speech impairments who rely on sign language. It emphasizes the role of technology, specifically machine learning, in bridging the communication gap between sign language users and those unfamiliar with sign language.

It also acknowledges the potential of sign language translation systems to enhance communication effectiveness and facilitate interaction between speech-impaired individuals and the general population specifically the children with hearing and speech impairments.

Moving forward, the next steps in sign language translation technology involve improving its accuracy and speed, expanding the vocabulary it recognizes, and integrating it into different digital platforms and devices. Collaboration between IT professionals, linguists, and sign language experts will ensure accurate and culturally sensitive translations. User feedback and user-centered design approaches will enhance usability. Overall, the future of sign language translation technology looks promising in empowering individuals with hearing and speech impairments and promoting inclusive communication.

The study on sign language translation technology contributes to advancements in IT practices by improving accessibility and inclusivity. By developing machine learning algorithms and computer vision techniques, IT professionals can create accurate and reliable systems that translate sign language into written text. This innovation enhances communication for individuals with hearing and speech impairments, making digital content and services more accessible. Additionally, incorporating sign language translation technology into human-computer interaction research improves the usability of digital interfaces for these individuals. Furthermore,

the study's focus on technological innovation in machine learning and computer vision can inspire advancements in other IT fields. Overall, this research drives the development of inclusive digital experiences and fosters a more accessible digital landscape.

Recommendations

There are things that can still be improved on the overall functionality and efficiency of the system such as widening the range of vocabulary of the sign language to input on the system, since we only catered 0-3 years old due to lack of enough time to train a wider range of sign language users. Aside from this, we can improve the system’s accuracy in interpreting the written representation of the sign language being demonstrated by adding more frames to the trained words.

Recommendation would be to invest in the further development and implementation of sign language translation technology. This includes supporting research efforts to improve accuracy and speed, expand vocabulary recognition, and integrate the technology into various digital platforms and devices. Collaboration between IT professionals and sign language experts should be encouraged to ensure effective translations. Additionally, soliciting user feedback and adopting user-centered design approaches will enhance the usability and effectiveness of the technology. By prioritizing these advancements, we can promote inclusive communication and empower individuals with hearing and speech impairments.

REFERENCES

Barham, A., Chen, J., et al. *TensorFlow: A System for Large-scale Machine Learning. In Proceedings of the 12th Symposium on Operating Systems Design and Implementation,2016.*
https://www.usenix.org/system/files/conference/osdi16/osdi16-abadi.pdf

Afouras, T., Joon, S. C., et al. *Deep Audio-visual Speech Recognition. IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI), 2018.*

https://ieeexplore.ieee.org/document/8585066

Shipman, F., Duggina, S., et al. *Speed-Accuracy Tradeoffs for Detecting Sign Language Content in Video Sharing Sites. In Proceedings of the International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS), 2017.*

https://dl.acm.org/doi/abs/10.1145/3132525.3132559

Thad S., Weaver, J., et al., *Real-time American Sign Language Recognition using Desk and Wearable Computer Based Video. IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI), 20(12), 1998.*

http://luthuli.cs.uiuc.edu/~daf/courses/Signals%20AI/Papers/HMMs/00735811.pdf

Stein, D., Schmidt, C., et al., *Analysis, Preparation, and Optimization of Statistical Sign Language Machine Translation. Machine Translation, 26(4), 2012.*

https://link.springer.com/article/10.1007/s10590-012-9125-1

Stoll, S., Camgoz, N. C., et al., *Sign Language Production using Neural Machine Translation and Generative Adversarial Networks. In Proceedings of the British Machine Vision Conference (BMVC), 2018.*

http://personal.ee.surrey.ac.uk/Personal/R.Bowden/publications/2018/Stoll_BMVC2018pp.pdf

Camgoz, N.C, Hadfield, A., et al., *Subunets: End-to-end hand shape and continuous sign language recognition. In IEEE International Conference on Computer Vision (ICCV), 2017.*

https://ieeexplore.ieee.org/document/8237594

Yue-Hei, J. N., Hausknecht N., et al., Beyond short snippets: Deep networks for video classification. *In Proceedings of the IEEE conference on Computer Vision and Pattern Recognition, pages 4694–4702, 2015.*

https://ieeexplore.ieee.org/document/9878615

Rymanowicz K., Cox, F*., Baby sign language: A helpful communication tool, 2020.*

https://www.canr.msu.edu/news/baby_sign_language_a_helpful_communication_tool#:~:text=Teaching%20babies%20sign%20language%20can,between%206%20to%209%20months.

Kumar, P., Roy L., et al., *Independent Bayesian classifier combination based sign language recognition using facial expression. Information Sciences, 428:30–48, 2018.*

https://www.sciencedirect.com/science/article/abs/pii/S0020025516307897

Liu, Z., Huang, F., et al., *Real-time sign language recognition with guided deep convolutional neural networks. In Proceedings of the 2016 Symposium on Spatial User Interaction, pages 187–187. ACM, 2016.*

https://dl.acm.org/doi/10.1145/2983310.2989187

Mitchell, R. E., Young, T. A., et al., *How many people use asl in the united states? Why estimates need updating. Sign Language Studies, 6(3):306–335, 2006.*

https://psycnet.apa.org/record/2006-07176-003

Koller, O., Forster, J., *“Continuous sign language recognition: Towards large vocabulary statistical recognition systems handling multiple signers,” Computer Vision and Image Understanding, vol. 141, pp. 108–125, 2015.*

https://www.i6.informatik.rwthaachen.de/publications/download/996/KollerOscarForsterJensNeyHermannContinuoussignlanguagerecognitionTowardslargevocabularystatisticalrecognitionsystemshlingmultiplesigners--2015.pdf

Cooper, H., Holt, B., *“Sign language recognition,” in Visual Analysis of Humans. Springer, 2011, pp. 539–562.*

https://link.springer.com/chapter/10.1007/978-0-85729-997-0_27

Kadous, M.W., et al., *“Machine recognition of auslan signs using powergloves: Towards large-lexicon recognition of sign language,” in Proceedings of the Workshop on the Integration of Gesture in Language and Speech, vol. 165, 1996.*

https://www.researchgate.net/publication/2828963_Machine_Recognition_of_Auslan_Signs_Using_PowerGloves_Towards_Large-Lexicon_Recognition_of_Sign_Language

Wang, C., Liu, Z., et al., “Superpixel-based hand gesture recognition with kinect depth camera,” IEEE transactions on multimedia, vol. 17, no. 1, pp. 29–39, 2014.

https://ieeexplore.ieee.org/document/6965622#:~:text=The%20depth%20and%20skeleton%20information,the%20gestures%20to%20be%20recognized.

Simard, P. Y., *Best practices for convolutional neural networks applied to visual document analysis, August 2003. Seventh International Conference on Document Analysis and Recognition.*

https://ieeexplore.ieee.org/document/1227801

APPENDICES

Appendix G

Research Questionnaire

Republic of the Philippines
CAVITE STATE UNIVERSITY
Silang Campus
Biga I, Silang, Cavite
☏ 046 513-5706 ☏ 046 513-3965
✉ cvsusilang@cvsu.edu.ph

Research Title: Development of Basic Filipino Sign Language Using Machine Learning Techniques

Researcher/s: Michael Tallada, Leaniel Mae M. Padilla, Michael Angelo Zamora

Part I. Respondents' Profile
Direction: Supply the information requested below by writing on the space or by checking (☐) the appropriate box, which corresponds on your profile.
Name (Optional):
Age (as of last birthday):
Gender: Male ☐ Female ☐
Participant's Category ☐I.T. Expert ☐Subject Matter Expert ☐End-User _____ _____ (Please Specify specific position both for IT Expert and End User)

Part II. Web Assessment Tool
Direction: Please accomplish this questionnaire carefully, honestly and accurately as you can. Indicate your assessment on the software by checking (☐) the box opposite of each item based on the given rating scale.
Legend: 5 – Highly Acceptable 4 - Acceptable 2 – Fairly Acceptable 3 – Moderately Acceptable 1 – Unacceptable

A. Security					
1. **Confidentiality**-Degree to which a product or system ensures that data are accessible only to those authorized. (**Pagiging kompidensyal**)- antas ng isang produkto o sistema na kung saan ang isang datus ay nababasa/naeedit/nababura lamang ng mga taong may kapangyarihan o may permiso.)					

2. **Integrity**- Degree to which a system, product or component prevents unauthorized to, or modification of computer programs or data. (**Integridad**- antas ng isang produkto o sistema kung saan hindi maaaring maitago ang isang datus ng walang permiso. Ito ay kung saan ang isang indibidwal na walang kakayahan ay hindi makakagawa ng kahit anong pagbabago, na naturang datus.)					
3. . **Non-repudiation**- Degree to which actions or events can be proves to have taken place, so that the events or actions cannot be repudiated later. (**Hindi Maitatanggi**- antas ng isang produkto o sistema kung saan hindi maaaring ilipat ang isang datus ng walang permiso.)					
4. **Accountability**- Degree to which the actions of an entity can be traced uniquely to the entity. (**Pananagutan** – antas ng isang produkto o sistema kung saan madali itong mahanap kung sino ang may kapananagutan o may gawa.)					
B. Maintainability					
1. Modularity-Degree to which a system or computer program is composed of discrete components such that a change to one component thus minimal impact on other components. (**Pagiging modyular** – antas ng produkto o sistema kung saan tanging maliit na bagay lang ang nababago o napapalitan.)					
2. **Reusability**-Degree to which asset can be used in more than one system, or in building other assets. (**Paggamit muli** – Paggamit muli ng mga features ng app.					
3. **Analysability**-Degree of affectiveness and efficiency with which it is possible to assess the impact on a product or system of an intended change to one or more of it's part, or diagnose product for deficiencies or causes of failures, or to identify parts to be modified. (**Malalim na Pagsusuri**- antas kung saan ang isang bagay, produkto o sistema ay madaling masuri at malaman kung gaano kabigat ang pagbabago sa sistema kapag ito ay ginamit. Masusuri din kung saan ang bawat depekto at kung paano marereselbahan ang nasabi.)					
4. **Modifiability**- Degree to which a product or system can be effectively and efficiently modified without introducing defects or degrading existing product quality. (**Madaling baguhin**- antas ng produkto o sistema kung saan ito ay madaling mabago ng maayos at walang tatamaang ibang bagay o sistema na maaaring ikababa ng dekalidad nito.)					

5. **Testability**- Degree of effectiveness and efficiency with which test criteria can be established for a system, product or component and tests can be performed to determine wether those criteria have been met. (**Pagtesting/ madaling masuri**- antas ng produkto o sistema kung saan madaling masuri ang bawat gamit, component, sistema, at iba pang bagay na nkapaloob sa asset. Eto ay madaling masuri at malaman kung mayroong depekto o may hindi maayos sa component sa loob ng sistema.					
C. Functional Suitability					
1. **Function Completeness**- Degree to which the set of functions cover all the specified tasks and user objectives. (Antas ng produkto kung saan ang mga natakdang Gawain ay naisagawa.)					
2. **Function Correctness**- Degree to which the product/system provide the correct results with the needed degree of precision. (Ang antas ng produkto ay nagbibigay ng kompleto at wastong resulta.)					
3. **Functional Appropriateness**- Degree to which the function facilitate the accomplishment of the specified task and objective. (Antas ng produkto na nasakatuparan ang mga nkatakdang tungkulin at layunin.)					
D. Performance Efficiency					
1. **Time Behavior**- Degree to which the response and processing times and through put rates of a product/system, when performing its function, meet requirements. (Antas kung saan ang naayon na rsponde, proseso at rato ng produkto tuwing nagsasagawa ng mga nkatakdang Gawain ay nasasakatupran.) 2. **Resource Utilization**- Degree to which the amount and types of resources used by a product or system, when performing it's functions, meet requirements. (Antas kung saan ang ibat ibang pinagmulan ng kaalaman na ginamit sa system ay nasakatuparan ang mga nakatakdang Gawain.) 3. **Capacity**- Degree to which the maximum limits of a product or system parameter meet requirements. (Antas kung saan ang pinakamataas na limitasyon ng parametro ay nasakatuparan ng mga nakatakdang Gawain ng system.)					
E. COMPATIBILITY					
1. **Co-existence** – Degree to which a product can perform its required functions efficiently while sharing a common environmental and resources with other products, without detrimental impact on any other product. (**Kahalintulad ng Karaniwan**- antas ng isang produkto na kayang magsagawa ng kanyang mga kailangan na Gawain ng mahusay habang nagbabahagi sa karaniwang kapaligiran at kayamanan sa ibang system na walang pinsalang dala sa ibang system.)					

2. **Interoperability** – Degree to which two or more systems, products or Components can exchange information and use the information that has been exchanged. (**Kakayahang Mapagsabay**- antas na kung saan ang dalawa o higit pang sistema, produkto o mga bahagi ay kayang magpalit ng impormasyon at gamitin ang impormasyon na naibahagi.					
F. USABILITY					
1. **Appropriate Recognizability**- Degree to which users can recognize whether a product of system is appropriate for their need. (**Tamang Pagkilala**- Antas kung saan nalalaman ng gumagamit kung angkop ang produkto sa kanilang pangangailangan.)					
2. **Learnability**- Degree to which a product or system can be used as specified users to achieve specified goals of learning and use the product or the system with effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use. (**Gaano kadaling Pagaralan** –Antas na kung saan ang produkto o sistema ay maaring gamitin sa tiyak na taga-gamit upang makamit ang tiyak na adhikain sa pagaaral at magamit ang produkto o sistema na epektibo, mabisa, ligtas sa anumang kapahamakan at kasiyahan sa paggamit ng tiyak na nilalaman.)					
3. **Operability**- Degree to which a product or system has attributes that make it easy to operate and control. (Operability- Antas na kung saan ang produkto o sistema ay mayroong tinatanggi na kung saan madali itong gamitin.)					
4. **User Error Protection**- Degree to which a system protects users against making errors. (**Protektahan sa kamalian ang taga-gamit**- Antas na kung saan ang sistema ay pinoprotektahan ang taga-gamit na makagawa ng mali.)					
5. **Accessibility** – Degree to which a product or system can be used by people with the wildest range of characteristics and capabilities to achieve a specified goal in a specified context of use. (**Madaling Paggamit**- Antas na kung saan ang produkto o sistema ay maaring gamitin ng mga tao sa pinakamalawak na hanay ng katangian at kakayahan para makamit ang iyak na adhikain sa natatanging paggamit ng nilalaman.)					
G. Reliability					
1. **Maturity**- Degree to which a product, system, or component meets needs of for reliability under normal operaion. (**Maturidad**- Antas kung saan ang produkto o bahagi ng sistema ay natutugon kung maasahan ba ang sistema habang ginagamit ang produkto.					
2. **Availability**- Degree to which a product, system, or component is operational and accessible to use. (**Availability**- Antas kung saan ang produkto o bahagi ng sistema ay nagagamit at magagamit kapag kailangan gamitin.)					

3. **Fault Tolerance**- Degree to which a product, system. Or component operates as intended despite the presence of hardware and software faults. (**Pagpapahintulot ng Mali**- Antas kung saan ang produkto o bahagi ng sistema ay nagagamit sa kabila ng presensya ng kamalian sa hardware o software.					
4. **Recoverability** –Dergree to which in the event of an interruption of a failure, a product or system can rcover the data directly affected and re-establish he desired state of the system. (**Recoveralabilty**- antas kung saan, sa kaganapan ng pagkagambala sa sistema ng mali, ang produkto o sistema ay kayang ibalik and datus ng direkta at itatag muli sa gusting estado ng sistema.)					
H. Portability					
1. **Adaptability** – Degree to which a product or system can effectively and efficiently be adapted for different or evolving hardware, software or other operational or usage environments. (**Pakikibagay**- Antas na kung saan ang produkto o sistema ay epektibo at mahusay na nagagamit sa iba o sa ebolusyon ng hardware, software o iba pang operasyon o gamit sa kapaligiran.)					
2. . **Installability**- Degree of effectiveness and efficiency with which a product or system can be successfully installed and/or uninstalled in a specified environment. (**Installability**- Antas ng pagiging epektibo at mahusay na kung saan ang produkto o sistema ay matagumpay nan a-install at/o na-uninstalled sa isang tiyak na kpaligiran.)					
3. **Replaceability**- Degree to which a product can replace another specified software product for the same purpose in the same environment. (**Maaaring Palitan**- Antas na kung saan ang isang produkto ay maaaring palitan ng ibang tiyak na software product para sa kaparehas na layunin sa kaparehas na kapaligiran.)					

COMMENTS/SUGGESTIONS

_____
_____
_____
_____
_____

_____
Signature

Appendix H

Sample Evaluation Form of End-User

Republic of the Philippines
CAVITE STATE UNIVERSITY
Silang Campus
Biga I, Silang, Cavite
☎ 046 513-5706 ☎ 046 513-3965
✉ cvsusilang@cvsu.edu.ph

Research Title: Development of Basic Filipino Sign Language Using Machine Learning Techniques

Researcher/s: Michael Tallada, Leaniel Mae M. Padilla, Michael Angelo Zamora

Part I. Respondents' Profile
Direction: Supply the information requested below by writing on the space or by checking (☐) the appropriate box, which corresponds on your profile.
Name (Optional):
Age (as of last birthday):
Gender: Male ☐ Female ☑
Participant's Category ☐I.T. Expert ☐Subject Matter Expert ☑End-User Parent using sign language (Please Specify specific position both for IT Expert and End User)

Part II. Web Assessment Tool
Direction: Please accomplish this questionnaire carefully, honestly and accurately as you can. Indicate your assessment on the software by checking (☐) the box opposite of each item based on the given rating scale.
Legend: 5 – Highly Acceptable 4 - Acceptable 2 – Fairly Acceptable 3 – Moderately Acceptable 1 – Unacceptable

A. Security	1	2	3	4	5
1. **Confidentiality**-Degree to which a product or system ensures that data are accessible only to those authorized. (**Pagiging kompidensyal**)- antas ng isang produkto o sistema na kung saan ang isang datus ay nababasa/naeedit/nabubura lamang ng mga taong may kapangyarihan o may permiso.)				✓	

2. **Integrity-** Degree to which a system, product or component prevents unauthorized to, or modification of computer programs or data. (**Integridad-** antas ng isang produkto o sistema kung saan hindi maaaring maitago ang isang datus ng walang permiso. Ito ay kung saan ang isang indibidwal na walang kakayahan ay hindi makakagawa ng kahit anong pagbabago, na naturang datus.)					✓
3. **. Non-repudiation-** Degree to which actions or events can be proves to have taken place, so that the events or actions cannot be repudiated later. (**Hindi Maitatanggi**- antas ng isang produkto o sistema kung saan hindi maaaring ilipat ang isang datus ng walang permiso.)					✓
4. **Accountability-** Degree to which the actions of an entity can be traced uniquely to the entity. (**Pananagutan** – antas ng isang produkto o sistema kung saan madali itong mahanap kung sino ang may kapananagutan o may gawa.)					✓
B. Maintainability	1	2	3	4	5
1. Modularity-Degree to which a system or computer program is composed of discrete components such that a change to one component thus minimal impact on other components. (**Pagiging modyular** – antas ng produkto o sistema kung saan tanging maliit na bagay lang ang nababago o napapalitan.)					✓
2. **Reusability**-Degree to which asset can be used in more than one system, or in building other assets. (**Paggamit muli** – Paggamit muli ng mga features ng app.					✓
3. **Analysability**-Degree of affectiveness and efficiency with which it is possible to assess the impact on a product or system of an intended change to one or more of it's part, or diagnose product for deficiencies or causes of failures, or to identify parts to be modified. (**Malalim na Pagsusuri**- antas kung saan ang isang bagay, produkto o sistema ay madaling masuri at malaman kung gaano kabigat ang pagbabago sa sistema kapag ito ay ginamit. Masusuri din kung saan ang bawat depekto at kung paano marereselbahan ang nasabi.)				✓	
4. **Modifiability-** Degree to which a product or system can be effectively and efficiently modified without introducing defects or degrading existing product quality. (**Madaling baguhin**- antas ng produkto o sistema kung saan ito ay madaling mabago ng maayos at walang tatamaang ibang bagay o sistema na maaaring ikababa ng dekalidad nito.)					✓
5. **Testability-** Degree of effectiveness and efficiency with which test criteria can be established for a system, product or component and tests can be performed to determine wether those criteria have been met. (**Pagtesting/ madaling masuri-** antas ng produkto o sistema kung saan madaling masuri ang bawat gamit, component, sistema, at iba pang bagay na nkapaloob sa asset. Eto ay madaling masuri at malaman kung mayroong depekto o may hindi maayos sa component sa loob ng sistema.					✓
C. Functional Suitability	1	2	3	4	5

1. **Function Completeness**- Degree to which the set of functions cover all the specified tasks and user objectives. (Antas ng produkto kung saan ang mga natakdang Gawain ay naisagawa.)					✓
2. **Function Correctness**- Degree to which the product/system provide the correct results with the needed degree of precision. (Ang antas ng produkto ay nagbibigay ng kompleto at wastong resulta.)					✓
3. **Functional Appropriateness**- Degree to which the function facilitate the accomplishment of the specified task and objective. (Antas ng produkto na nasakatuparan ang mga nkatakdang tungkulin at layunin.)					✓
D. Performance Efficiency	1	2	3	4	5
1. **Time Behavior**- Degree to which the response and processing times and through put rates of a product/system, when performing its function, meet requirements. (Antas kung saan ang naayon na rsponde, proseso at rato ng produkto tuwing nagsasagawa ng mga nkatakdang Gawain ay nasasakatupran.) 2. **Resource Utilization**- Degree to which the amount and types of resources used by a product or system, when performing it's functions, meet requirements. (Antas kung saan ang ibat ibang pinagmulan ng kaalaman na ginamit sa system ay nasakatuparan ang mga nakatakdang Gawain.) 3. **Capacity**- Degree to which the maximum limits of a product or system parameter meet requirements. (Antas kung saan ang pinakamataas na limitasyon ng parametro ay nasakatuparan ng mga nakatakdang Gawain ng system.)				✓	
E. COMPATIBILITY	1	2	3	4	5
1. **Co-existence** – Degree to which a product can perform its required functions efficiently while sharing a common environmental and resources with other products, without detrimental impact on any other product. (**Kahalintulad ng Karaniwan**- antas ng isang produkto na kayang magsagawa ng kanyang mga kailangan na Gawain ng mahusay habang nagbabahagi sa karaniwang kapaligiran at kayamanan sa ibang system na walang pinsalang dala sa ibang system.)					✓
2. **Interoperability** – Degree to which two or more systems, products or Components can exchange information and use the information that has been exchanged. (**Kakayahang Mapagsabay**- antas na kung saan ang dalawa o higit pang sistema, produkto o mga bahagi ay kayang magpalit ng impormasyon at gamitin ang impormasyon na naibahagi.					✓
F. USABILITY	1	2	3	4	5
1. **Appropriate Recognizability**- Degree to which users can recognize whether a product of system is appropriate for their need. (**Tamang Pagkilala**- Antas kung saan nalalaman ng gumagamit kung angkop ang produkto sa kanilang pangangailangan.)					✓

2. **Learnability**- Degree to which a product or system can be used as specified users to achieve specified goals of learning and use the product or the system with effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use. (**Gaano kadaling Pagaralan** –Antas na kung saan ang produkto o sistema ay maaring gamitin sa tiyak na taga-gamit upang makamit ang tiyak na adhikain sa pagaaral at magamit ang produkto o sistema na epektibo, mabisa, ligtas sa anumang kapahamakan at kasiyahan sa paggamit ng tiyak na nilalaman.)					✓
3. **Operability**- Degree to which a product or system has attributes that make it easy to operate and control. (Operability- Antas na kung saan ang produkto o sistema ay mayroong tinatanggi na kung saan madali itong gamitin.)					✓
4. **User Error Protection**- Degree to which a system protects users against making errors. (**Protektahan sa kamalian ang taga-gamit**- Antas na kung saan ang sistema ay pinoprotektahan ang taga-gamit na makagawa ng mali.)				✓	
5. **Accessibility** – Degree to which a product or system can be used by people with the wildest range of characteristics and capabilities to achieve a specified goal in a specified context of use. (**Madaling Paggamit**- Antas na kung saan ang produkto o sistema ay maaring gamitin ng mga tao sa pinakamalawak na hanay ng katangian at kakayahan para makamit ang iyak na adhikain sa natatanging paggamit ng nilalaman.)				✓	
G. Reliability	1	2	3	4	5
1. **Maturity**- Degree to which a product, system, or component meets needs of for reliability under normal operaion. (**Maturidad**- Antas kung saan ang produkto o bahagi ng sistema ay natutugon kung maasahan ba ang sistema habang ginagamit ang produkto.					✓
2. **Availability**- Degree to which a product, system, or component is operational and accessible to use. (**Availability**- Antas kung saan ang produkto o bahagi ng sistema ay nagagamit at magagamit kapag kailangan gamitin.)					✓
3. **Fault Tolerance**- Degree to which a product, system. Or component operates as intended despite the presence of hardware and software faults. (**Pagpapahintulot ng Mali**- Antas kung saan ang produkto o bahagi ng sistema ay nagagamit sa kabila ng presensya ng kamalian sa hardware o software.					✓
4. **Recoverability** –Dergree to which in the event of an interruption of a failure, a product or system can rcover the data directly affected and re-establish he desired state of the system. (**Recoveralabilty**- antas kung saan, sa kaganapan ng pagkagambala sa sistema ng mali, ang produkto o sistema ay kayang ibalik and datus ng direkta at itatag muli sa gusting estado ng sistema.)					✓
H. Portability	1	2	3	4	5

1. **Adaptability** – Degree to which a product or system can effectively and efficiently be adapted for different or evolving hardware, software or other operational or usage environments. (**Pakikibagay-** Antas na kung saan ang produkto o sistema ay epektibo at mahusay na nagagamit sa iba o sa ebolusyon ng hardware, software o iba pang operasyon o gamit sa kapaligiran.)					✓
2. . **Installability**- Degree of effectiveness and efficiency with which a product or system can be successfully installed and/or uninstalled in a specified environment. (**Installability**- Antas ng pagiging epektibo at mahusay na kung saan ang produkto o sistema ay matagumpay nan a-install at/o na-uninstalled sa isang tiyak na kpaligiran.)					✓
3. **Replaceability**- Degree to which a product can replace another specified software product for the same purpose in the same environment. (**Maaaring Palitan**- Antas na kung saan ang isang produkto ay maaaring palitan ng ibang tiyak na software product para sa kaparehas na layunin sa kaparehas na kapaligiran.)					✓

COMMENTS/SUGGESTIONS

Very helpful. it would be nice to have Application

Signature

Appendix I

Sample Evaluation Form of Subject Matter Expert

Republic of the Philippines
CAVITE STATE UNIVERSITY
Silang Campus
Biga I, Silang, Cavite
☏ 046 513-5706 ☏ 046 513-3965
✉ cvsusilang@cvsu.edu.ph

Research Title: Development of Basic Filipino Sign Language Using Machine Learning Techniques

Researcher/s: Michael Tallada, Leaniel Mae M. Padilla, Michael Angelo Zamora

Part I. Respondents' Profile
Direction: Supply the information requested below by writing on the space or by checking (☐) the appropriate box, which corresponds on your profile.
Name (Optional):
Age (as of last birthday):
Gender: Male ☑ Female ☐
Participant's Category ☐I.T. Expert ☑Subject Matter Expert ☐End-User (Please Specify specific position both for IT Expert and End User)

Part II. Web Assessment Tool
Direction: Please accomplish this questionnaire carefully, honestly and accurately as you can. Indicate your assessment on the software by checking (☐) the box opposite of each item based on the given rating scale.
Legend: 5 – Highly Acceptable 4 - Acceptable 2 – Fairly Acceptable 3 – Moderately Acceptable 1 – Unacceptable

A. Security	1	2	3	4	5
1. **Confidentiality**-Degree to which a product or system ensures that data are accessible only to those authorized. (**Pagiging kompidensyal**)- antas ng isang produkto o sistema na kung saan ang isang datus ay nababasa/naeedit/nabubura lamang ng mga taong may kapangyarihan o may permiso.)				✓	

2. **Integrity-** Degree to which a system, product or component prevents unauthorized to, or modification of computer programs or data. (**Integridad-** antas ng isang produkto o sistema kung saan hindi maaaring maitago ang isang datus ng walang permiso. Ito ay kung saan ang isang indibidwal na walang kakayahan ay hindi makakagawa ng kahit anong pagbabago, na naturang datus.)					✓
3. **. Non-repudiation-** Degree to which actions or events can be proves to have taken place, so that the events or actions cannot be repudiated later. (**Hindi Maitatanggi-** antas ng isang produkto o sistema kung saan hindi maaaring ilipat ang isang datus ng walang permiso.)					✓
4. **Accountability-** Degree to which the actions of an entity can be traced uniquely to the entity. (**Pananagutan** – antas ng isang produkto o sistema kung saan madali itong mahanap kung sino ang may kapananagutan o may gawa.)					✓
B. Maintainability	1	2	3	4	5
1. **Modularity**-Degree to which a system or computer program is composed of discrete components such that a change to one component thus minimal impact on other components. (**Pagiging modyular** – antas ng produkto o sistema kung saan tanging maliit na bagay lang ang nababago o napapalitan.)					✓
2. **Reusability-**Degree to which asset can be used in more than one system, or in building other assets. (**Paggamit muli** – Paggamit muli ng mga features ng app.					✓
3. **Analysability**-Degree of affectiveness and efficiency with which it is possible to assess the impact on a product or system of an intended change to one or more of it's part, or diagnose product for deficiencies or causes of failures, or to identify parts to be modified. (**Malalim na Pagsusuri-** antas kung saan ang isang bagay, produkto o sistema ay madaling masuri at malaman kung gaano kabigat ang pagbabago sa sistema kapag ito ay ginamit. Masusuri din kung saan ang bawat depekto at kung paano marereselbahan ang nasabi.)				✓	
4. **Modifiability-** Degree to which a product or system can be effectively and efficiently modified without introducing defects or degrading existing product quality. (**Madaling baguhin**- antas ng produkto o sistema kung saan ito ay madaling mabago ng maayos at walang tatamaang ibang bagay o sistema na maaaring ikababa ng dekalidad nito.)				✓	
5. **Testability-** Degree of effectiveness and efficiency with which test criteria can be established for a system, product or component and tests can be performed to determine wether those criteria have been met. (**Pagtesting/ madaling masuri-** antas ng produkto o sistema kung saan madaling masuri ang bawat gamit, component, sistema, at iba pang bagay na nkapaloob sa asset. Eto ay madaling masuri at malaman kung mayroong depekto o may hindi maayos sa component sa loob ng sistema.					✓
C. Functional Suitability	1	2	3	4	5

1. **Function Completeness**- Degree to which the set of functions cover all the specified tasks and user objectives. (Antas ng produkto kung saan ang mga natakdang Gawain ay naisagawa.)					/
2. **Function Correctness**- Degree to which the product/system provide the correct results with the needed degree of precision. (Ang antas ng produkto ay nagbibigay ng kompleto at wastong resulta.)					/
3. **Functional Appropriateness**- Degree to which the function facilitate the accomplishment of the specified task and objective. (Antas ng produkto na nasakatuparan ang mga nkatakdang tungkulin at layunin.)					/
D. Performance Efficiency	1	2	3	4	5
1. **Time Behavior**- Degree to which the response and processing times and through put rates of a product/system, when performing its function, meet requirements. (Antas kung saan ang naayon na rsponde, proseso at rato ng produkto tuwing nagsasagawa ng mga nkatakdang Gawain ay nasasakatupran.) 2. **Resource Utilization**- Degree to which the amount and types of resources used by a product or system, when performing it's functions, meet requirements. (Antas kung saan ang ibat ibang pinagmulan ng kaalaman na ginamit sa system ay nasakatuparan ang mga nakatakdang Gawain.) 3. **Capacity**- Degree to which the maximum limits of a product or system parameter meet requirements. (Antas kung saan ang pinakamataas na limitasyon ng parametro ay nasakatuparan ng mga nakatakdang Gawain ng system.)					/
E. COMPATIBILITY	1	2	3	4	5
1. **Co-existence** – Degree to which a product can perform its required functions efficiently while sharing a common environmental and resources with other products, without detrimental impact on any other product. (**Kahalintulad ng Karaniwan**- antas ng isang produkto na kayang magsagawa ng kanyang mga kailangan na Gawain ng mahusay habang nagbabahagi sa karaniwang kapaligiran at kayamanan sa ibang system na walang pinsalang dala sa ibang system.)				/	
2. **Interoperability** – Degree to which two or more systems, products or Components can exchange information and use the information that has been exchanged. (**Kakayahang Mapagsabay**- antas na kung saan ang dalawa o higit pang sistema, produkto o mga bahagi ay kayang magpalit ng impormasyon at gamitin ang impormasyon na naibahagi.			/		
F. USABILITY					
1. **Appropriate Recognizability**- Degree to which users can recognize whether a product of system is appropriate for their need. (**Tamang Pagkilala**- Antas kung saan nalalaman ng gumagamit kung angkop ang produkto sa kanilang pangangailangan.)				/	

2. **Learnability**- Degree to which a product or system can be used as specified users to achieve specified goals of learning and use the product or the system with effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use. (**Gaano kadaling Pagaralan** –Antas na kung saan ang produkto o sistema ay maaring gamitin sa tiyak na taga-gamit upang makamit ang tiyak na adhikain sa pagaaral at magamit ang produkto o sistema na epektibo, mabisa, ligtas sa anumang kapahamakan at kasiyahan sa paggamit ng tiyak na nilalaman.)					/
3. **Operability**- Degree to which a product or system has attributes that make it easy to operate and control. (Operability- Antas na kung saan ang produkto o sistema ay mayroong tinatanggi na kung saan madali itong gamitin.)					/
4. **User Error Protection**- Degree to which a system protects users against making errors. (**Protektahan sa kamalian ang taga-gamit**- Antas na kung saan ang sistema ay pinoprotektahan ang taga-gamit na makagawa ng mali.)				/	
5. **Accessibility** – Degree to which a product or system can be used by people with the wildest range of characteristics and capabilities to achieve a specified goal in a specified context of use. (**Madaling Paggamit**- Antas na kung saan ang produkto o sistema ay maaring gamitin ng mga tao sa pinakamalawak na hanay ng katangian at kakayahan para makamit ang iyak na adhikain sa natatanging paggamit ng nilalaman.)			/		
G. Reliability	1	2	3	4	5
1. **Maturity**- Degree to which a product, system, or component meets needs of for reliability under normal operaion. (**Maturidad**- Antas kung saan ang produkto o bahagi ng sistema ay natutugon kung maasahan ba ang sistema habang ginagamit ang produkto.					/
2. **Availability**- Degree to which a product, system, or component is operational and accessible to use. (**Availability**- Antas kung saan ang produkto o bahagi ng sistema ay nagagamit at magagamit kapag kailangan gamitin.)				/	
3. **Fault Tolerance**- Degree to which a product, system. Or component operates as intended despite the presence of hardware and software faults. (**Pagpapahintulot ng Mali**- Antas kung saan ang produkto o bahagi ng sistema ay nagagamit sa kabila ng presensya ng kamalian sa hardware o software.				/	
4. **Recoverability** –Dergree to which in the event of an interruption of a failure, a product or system can rcover the data directly affected and re-establish he desired state of the system. (**Recoveralabilty**- antas kung saan, sa kaganapan ng pagkagambala sa sistema ng mali, ang produkto o sistema ay kayang ibalik and datus ng direkta at itatag muli sa gusting estado ng sistema.)				/	
H. Portability	1	2	3	4	5

1. **Adaptability** – Degree to which a product or system can effectively and efficiently be adapted for different or evolving hardware, software or other operational or usage environments. (**Pakikibagay**- Antas na kung saan ang produkto o sistema ay epektibo at mahusay na nagagamit sa iba o sa ebolusyon ng hardware, software o iba pang operasyon o gamit sa kapaligiran.)					✓
2. **. Installability**- Degree of effectiveness and efficiency with which a product or system can be successfully installed and/or uninstalled in a specified environment. (**Installability**- Antas ng pagiging epektibo at mahusay na kung saan ang produkto o sistema ay matagumpay nan a-install at/o na-uninstalled sa isang tiyak na kpaligiran.)			✓		
3. **Replaceability**- Degree to which a product can replace another specified software product for the same purpose in the same environment. (**Maaaring Palitan**- Antas na kung saan ang isang produkto ay maaaring palitan ng ibang tiyak na software product para sa kaparehas na layunin sa kaparehas na kapaligiran.)					✓

COMMENTS/SUGGESTIONS

Signature

Appendix J

Sample Evaluation Form of I.T. Expert

Republic of the Philippines
CAVITE STATE UNIVERSITY
Silang Campus
Biga I, Silang, Cavite
☎ 046 513-5706 ☎ 046 513-3965
✉ cvsusilang@cvsu.edu.ph

Research Title: Development of Basic Filipino Sign Language Using Machine Learning Techniques

Researcher/s: Michael Tallada, Leaniel Mae M. Padilla, Michael Angelo Zamora

Part I. Respondents' Profile
Direction: Supply the information requested below by writing on the space or by checking (☐) the appropriate box, which corresponds on your profile.
Name (Optional): JEREMIAH VILLEGAS
Age (as of last birthday):
Gender: Male ☑ Female ☐
Participant's Category ☑I.T. Expert ☐Subject Matter Expert ☐End-User IT DEVELOPER (Please Specify specific position both for IT Expert and End User)

Part II. Web Assessment Tool
Direction: Please accomplish this questionnaire carefully, honestly and accurately as you can. Indicate your assessment on the software by checking (☐) the box opposite of each item based on the given rating scale.
Legend: 5 – Highly Acceptable 4 - Acceptable 2 – Fairly Acceptable 3 – Moderately Acceptable 1 – Unacceptable

A. Security	1	2	3	4	5
1. **Confidentiality**-Degree to which a product or system ensures that data are accessible only to those authorized. (**Pagiging kompidensyal**)- antas ng isang produkto o sistema na kung saan ang isang datus ay nababasa/naeedit/nabubura lamang ng mga taong may kapangyarihan o may permiso.)					✓

2. **Integrity**- Degree to which a system, product or component prevents unauthorized to, or modification of computer programs or data. (**Integridad**- antas ng isang produkto o sistema kung saan hindi maaaring maitago ang isang datus ng walang permiso. Ito ay kung saan ang isang indibidwal na walang kakayahan ay hindi makakagawa ng kahit anong pagbabago, na naturang datus.)					✓
3. . **Non-repudiation**- Degree to which actions or events can be proves to have taken place, so that the events or actions cannot be repudiated later. (**Hindi Maitatanggi**- antas ng isang produkto o sistema kung saan hindi maaaring ilipat ang isang datus ng walang permiso.)					✓
4. **Accountability**- Degree to which the actions of an entity can be traced uniquely to the entity. (**Pananagutan** – antas ng isang produkto o sistema kung saan madali itong mahanap kung sino ang may kapananagutan o may gawa.)					✓
B. Maintainability	1	2	3	4	5
1. **Modularity**-Degree to which a system or computer program is composed of discrete components such that a change to one component thus minimal impact on other components. (**Pagiging modyular** – antas ng produkto o sistema kung saan tanging maliit na bagay lang ang nababago o napapalitan.)				✓	
2. **Reusability**-Degree to which asset can be used in more than one system, or in building other assets. (**Paggamit muli** – Paggamit muli ng mga features ng app.				✓	
3. **Analysability**-Degree of affectiveness and efficiency with which it is possible to assess the impact on a product or system of an intended change to one or more of it's part, or diagnose product for deficiencies or causes of failures, or to identify parts to be modified. (**Malalim na Pagsusuri**- antas kung saan ang isang bagay, produkto o sistema ay madaling masuri at malaman kung gaano kabigat ang pagbabago sa sistema kapag ito ay ginamit. Masusuri din kung saan ang bawat depekto at kung paano marereselbahan ang nasabi.)				✓	
4. **Modifiability**- Degree to which a product or system can be effectively and efficiently modified without introducing defects or degrading existing product quality. (**Madaling baguhin**- antas ng produkto o sistema kung saan ito ay madaling mabago ng maayos at walang tatamaang ibang bagay o sistema na maaaring ikababa ng dekalidad nito.)					✓
5. **Testability**- Degree of effectiveness and efficiency with which test criteria can be established for a system, product or component and tests can be performed to determine wether those criteria have been met. (**Pagtesting/ madaling masuri**- antas ng produkto o sistema kung saan madaling masuri ang bawat gamit, component, sistema, at iba pang bagay na nkapaloob sa asset. Eto ay madaling masuri at malaman kung mayroong depekto o may hindi maayos sa component sa loob ng sistema.					✓
C. Functional Suitability	1	2	3	4	5

1. **Function Completeness**- Degree to which the set of functions cover all the specified tasks and user objectives. (Antas ng produkto kung saan ang mga natakdang Gawain ay naisagawa.)					✓
2. **Function Correctness**- Degree to which the product/system provide the correct results with the needed degree of precision. (Ang antas ng produkto ay nagbibigay ng kompleto at wastong resulta.)					✓
3. **Functional Appropriateness**- Degree to which the function facilitate the accomplishment of the specified task and objective. (Antas ng produkto na nasakatuparan ang mga nkatakdang tungkulin at layunin.)					✓
D. Performance Efficiency					
1. **Time Behavior**- Degree to which the response and processing times and through put rates of a product/system, when performing its function, meet requirements. (Antas kung saan ang naayon na rsponde, proseso at rato ng produkto tuwing nagsasagawa ng mga nkatakdang Gawain ay nasasakatupran.) 2. **Resource Utilization**- Degree to which the amount and types of resources used by a product or system, when performing it's functions, meet requirements. (Antas kung saan ang ibat ibang pinagmulan ng kaalaman na ginamit sa system ay nasakatuparan ang mga nakatakdang Gawain.) 3. **Capacity**- Degree to which the maximum limits of a product or system parameter meet requirements. (Antas kung saan ang pinakamataas na limitasyon ng parametro ay nasakatuparan ng mga nakatakdang Gawain ng system.)				✓	
E. COMPATIBILITY					
1. **Co-existence –** Degree to which a product can perform its required functions efficiently while sharing a common environmental and resources with other products, without detrimental impact on any other product. (**Kahalintulad ng Karaniwan**- antas ng isang produkto na kayang magsagawa ng kanyang mga kailangan na Gawain ng mahusay habang nagbabahagi sa karaniwang kapaligiran at kayamanan sa ibang system na walang pinsalang dala sa ibang system.)					✓
2. **Interoperability –** Degree to which two or more systems, products or Components can exchange information and use the information that has been exchanged. (**Kakayahang Mapagsabay**- antas na kung saan ang dalawa o higit pang sistema, produkto o mga bahagi ay kayang magpalit ng impormasyon at gamitin ang impormasyon na naibahagi.					✓
F. USABILITY					
1. **Appropriate Recognizability**- Degree to which users can recognize whether a product of system is appropriate for their need. (**Tamang Pagkilala-** Antas kung saan nalalaman ng gumagamit kung angkop ang produkto sa kanilang pangangailangan.)					✓

2. **Learnability**- Degree to which a product or system can be used as specified users to achieve specified goals of learning and use the product or the system with effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use. (**Gaano kadaling Pagaralan** –Antas na kung saan ang produkto o sistema ay maaring gamitin sa tiyak na taga-gamit upang makamit ang tiyak na adhikain sa pagaaral at magamit ang produkto o sistema na epektibo, mabisa, ligtas sa anumang kapahamakan at kasiyahan sa paggamit ng tiyak na nilalaman.)					✓
3. **Operability**- Degree to which a product or system has attributes that make it easy to operate and control. (Operability- Antas na kung saan ang produkto o sistema ay mayroong tinatanggi na kung saan madali itong gamitin.)					✓
4. **User Error Protection**- Degree to which a system protects users against making errors. (**Protektahan sa kamalian ang taga-gamit**- Antas na kung saan ang sistema ay pinoprotektahan ang taga-gamit na makagawa ng mali.)				✓	
5. **Accessibility** – Degree to which a product or system can be used by people with the wildest range of characteristics and capabilities to achieve a specified goal in a specified context of use. (**Madaling Paggamit**- Antas na kung saan ang produkto o sistema ay maaring gamitin ng mga tao sa pinakamalawak na hanay ng katangian at kakayahan para makamit ang iyak na adhikain sa natatanging paggamit ng nilalaman.)			✓		
G. Reliability	1	2	3	4	5
1. **Maturity**- Degree to which a product, system, or component meets needs of for reliability under normal operaion. (**Maturidad**- Antas kung saan ang produkto o bahagi ng sistema ay natutugon kung maasahan ba ang sistema habang ginagamit ang produkto.					✓
2. **Availability**- Degree to which a product, system, or component is operational and accessible to use. (**Availability**- Antas kung saan ang produkto o bahagi ng sistema ay nagagamit at magagamit kapag kailangan gamitin.)					✓
3. **Fault Tolerance**- Degree to which a product, system. Or component operates as intended despite the presence of hardware and software faults. (**Pagpapahintulot ng Mali**- Antas kung saan ang produkto o bahagi ng sistema ay nagagamit sa kabila ng presensya ng kamalian sa hardware o software.				✓	
4. **Recoverability** –Dergree to which in the event of an interruption of a failure, a product or system can rcover the data directly affected and re-establish he desired state of the system. (**Recoveralabilty**- antas kung saan, sa kaganapan ng pagkagambala sa sistema ng mali, ang produkto o sistema ay kayang ibalik and datus ng direkta at itatag muli sa gusting estado ng sistema.)				✓	
H. Portability	1	2	3	4	5

1. **Adaptability** – Degree to which a product or system can effectively and efficiently be adapted for different or evolving hardware, software or other operational or usage environments. (**Pakikibagay-** Antas na kung saan ang produkto o sistema ay epektibo at mahusay na nagagamit sa iba o sa ebolusyon ng hardware, software o iba pang operasyon o gamit sa kapaligiran.)				✓	
2. . **Installability**- Degree of effectiveness and efficiency with which a product or system can be successfully installed and/or uninstalled in a specified environment. (**Installability**- Antas ng pagiging epektibo at mahusay na kung saan ang produkto o sistema ay matagumpay nan a-install at/o na-uninstalled sa isang tiyak na kpaligiran.)			✓		
3. **Replaceability**- Degree to which a product can replace another specified software product for the same purpose in the same environment. (**Maaaring Palitan**- Antas na kung saan ang isang produkto ay maaaring palitan ng ibang tiyak na software product para sa kaparehas na layunin sa kaparehas na kapaligiran.)			✓		

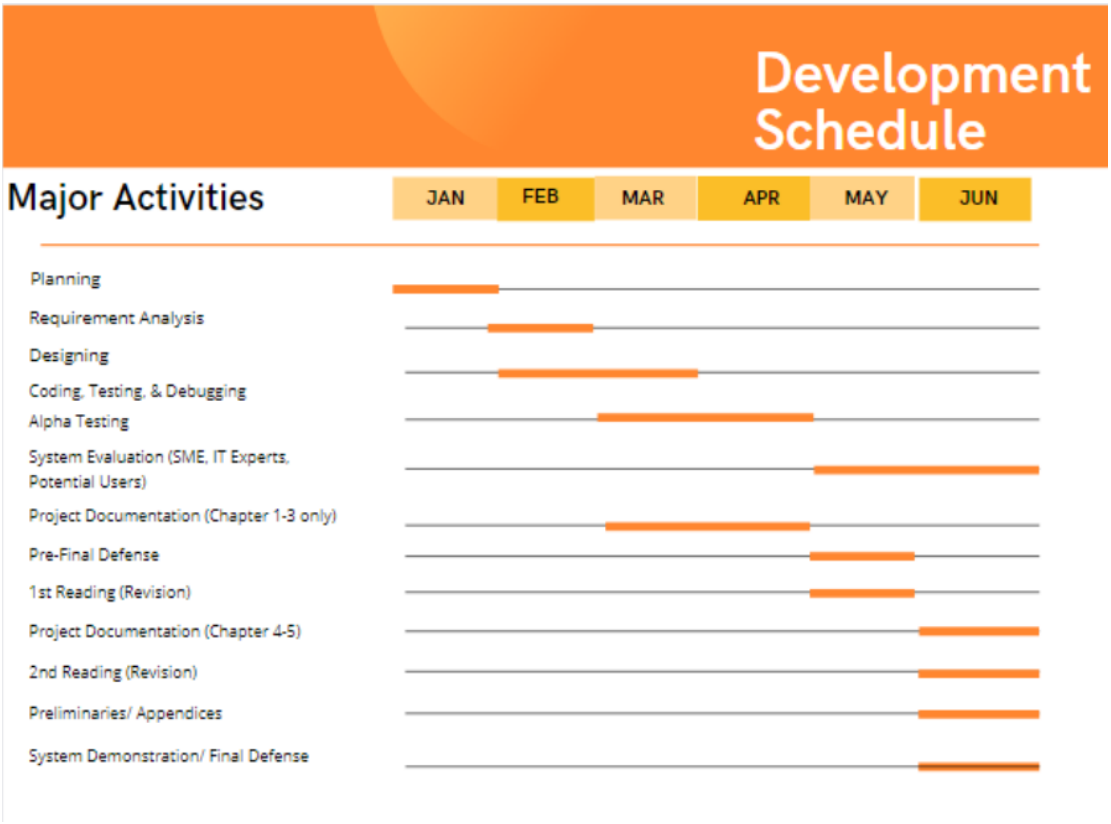
COMMENTS/SUGGESTIONS

- IMPROVE BUT
- OVERALL IS GOOD

Signature

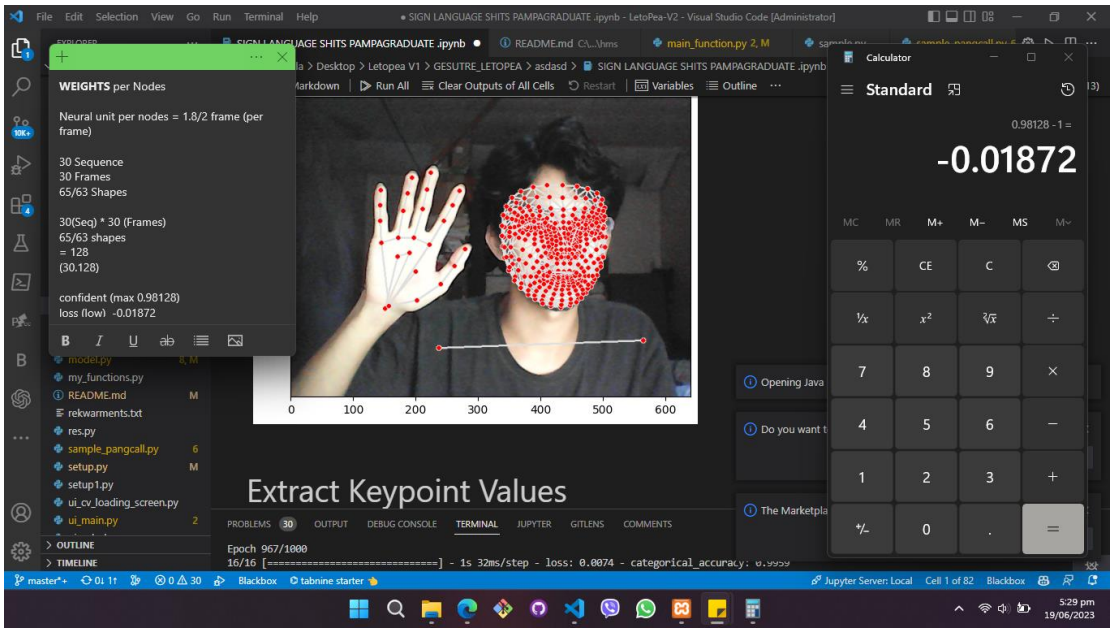
Appendix K

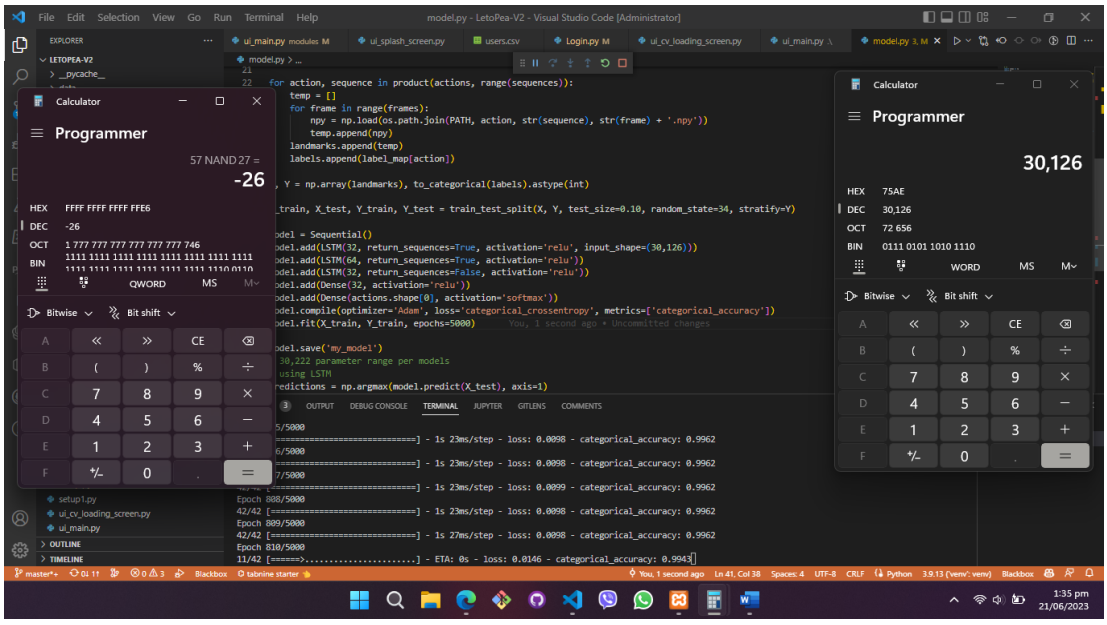
Timetable of Activities

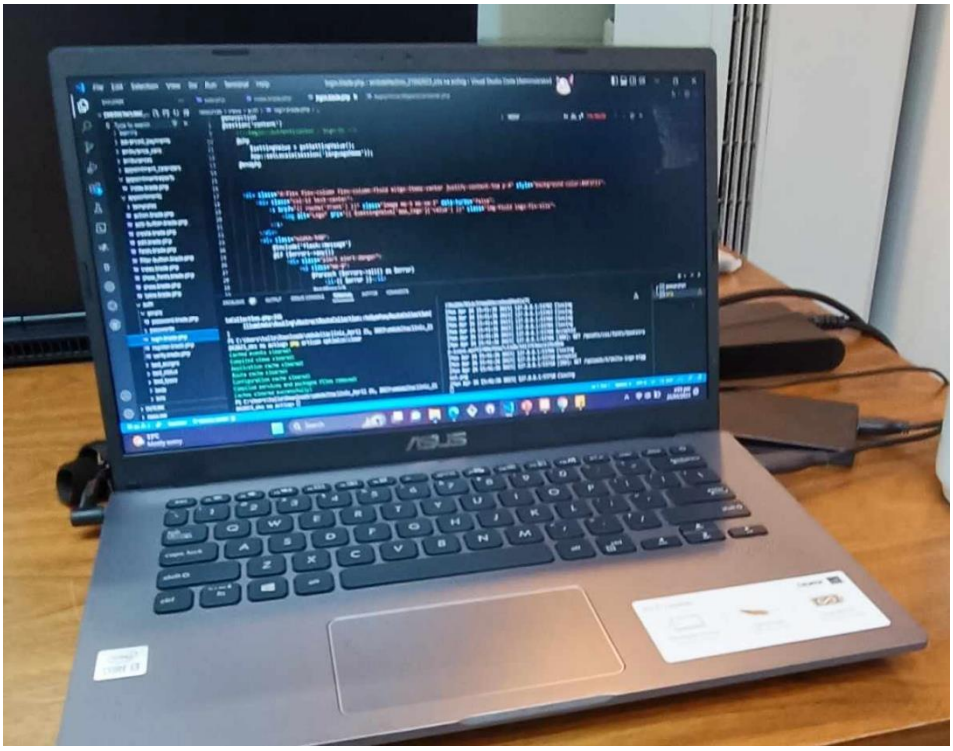


Appendix L

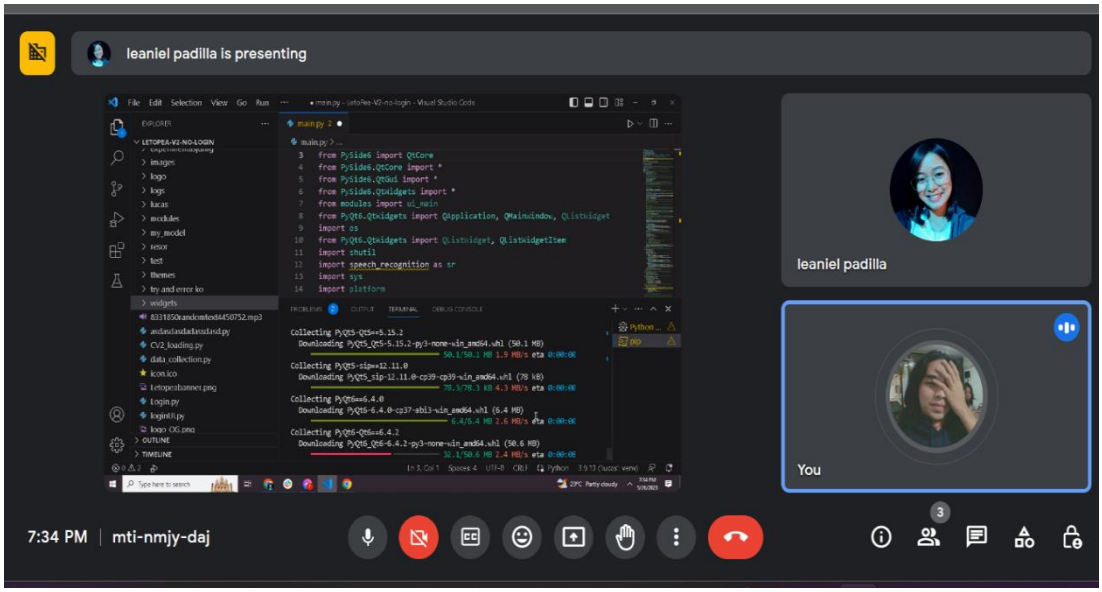
Photo Documentation

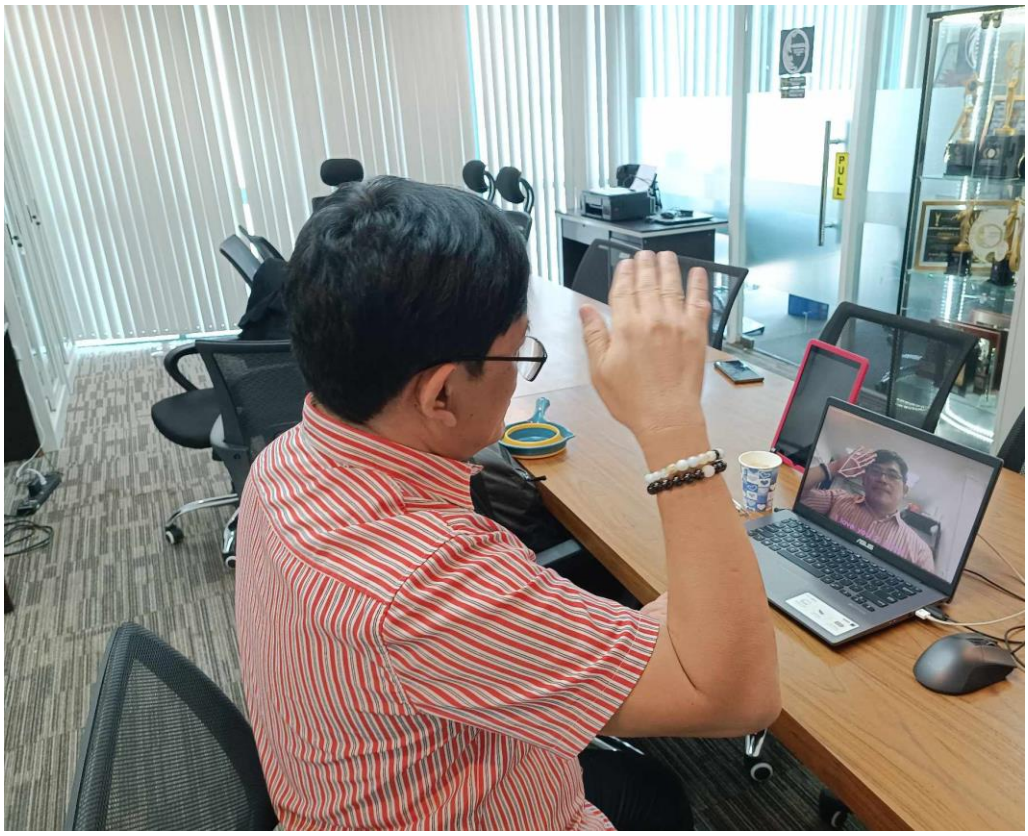


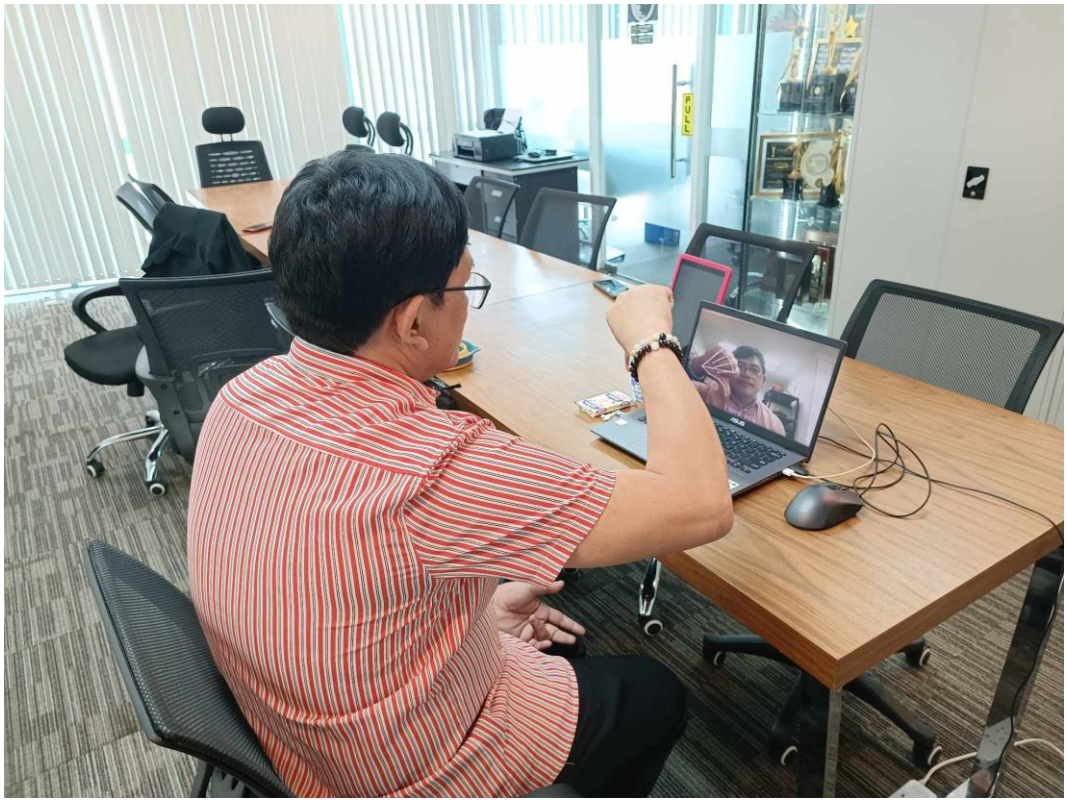





Pause.
Press "Space" when you are ready.
Button "btn_nav" pressed!
INFO: Created TensorFlow Lite XNNPACK delegate for CPU.
PHILIPS


leaniel padilla is presenting
leaniel padilla
You
7:34 PM | mti-nmjy-daj





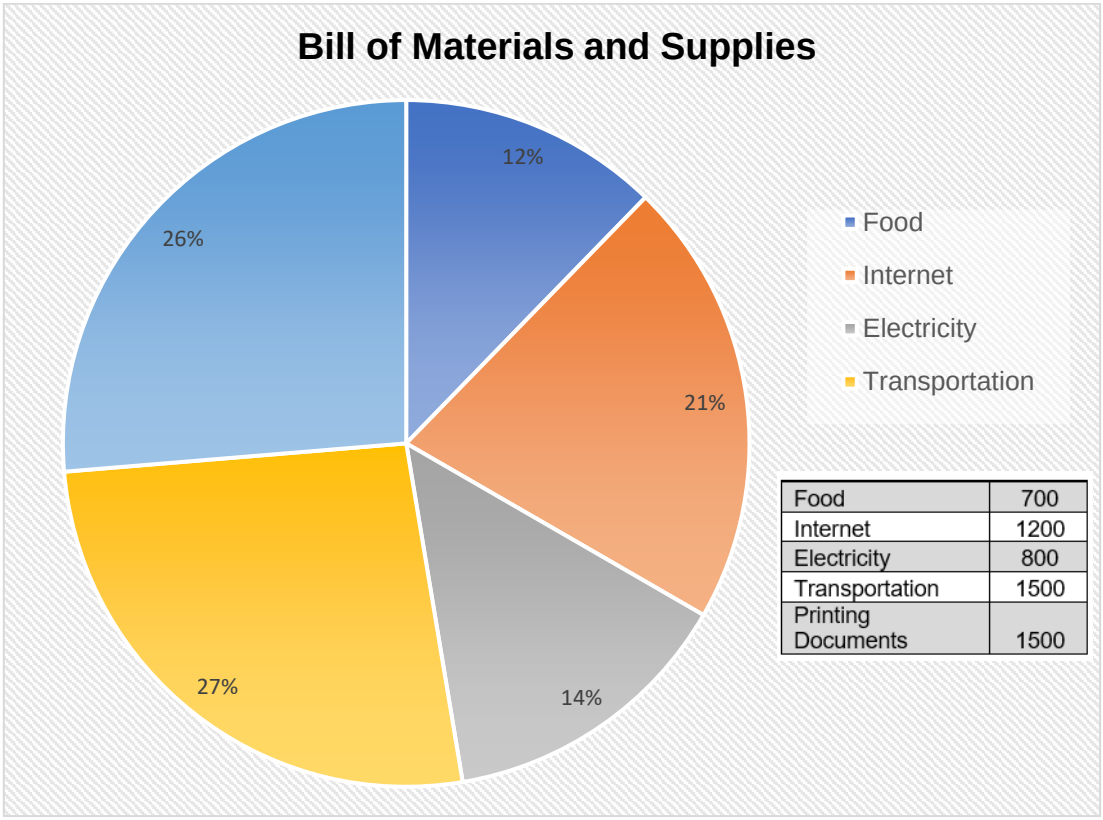

Department of Information Technology
THESIS/CAPSTONE DEFENDED!
APPROVED WITHOUT REVISION
CAVITE STATE UNIVERSITY
Silang Campus
Department of Information Technology


Department of Information Technology
THESIS/CAPSTONE DEFENDED!
APPROVED WITHOUT REVISION
CAVITE STATE UNIVERSITY
Silang Campus
Department of Information Technology


Department of Information Technology
THESIS/CAPSTONE DEFENDED!
APPROVED WITHOUT REVISION
CAVITE STATE UNIVERSITY
Silang Campus
Department of Information Technology
University Mission

Appendix M

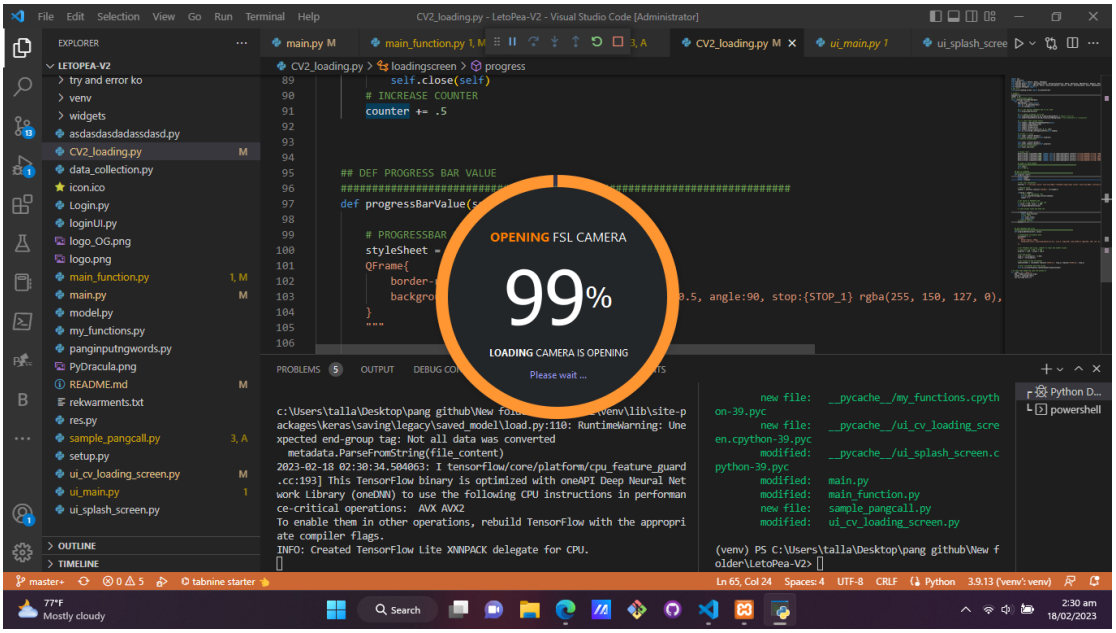
Budget Estimate

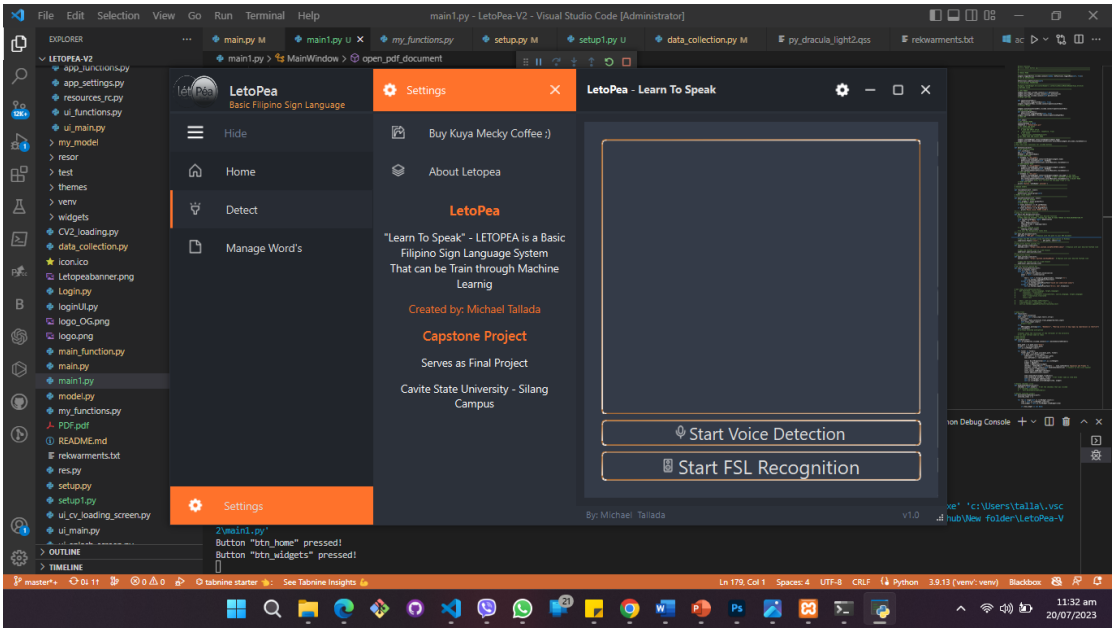


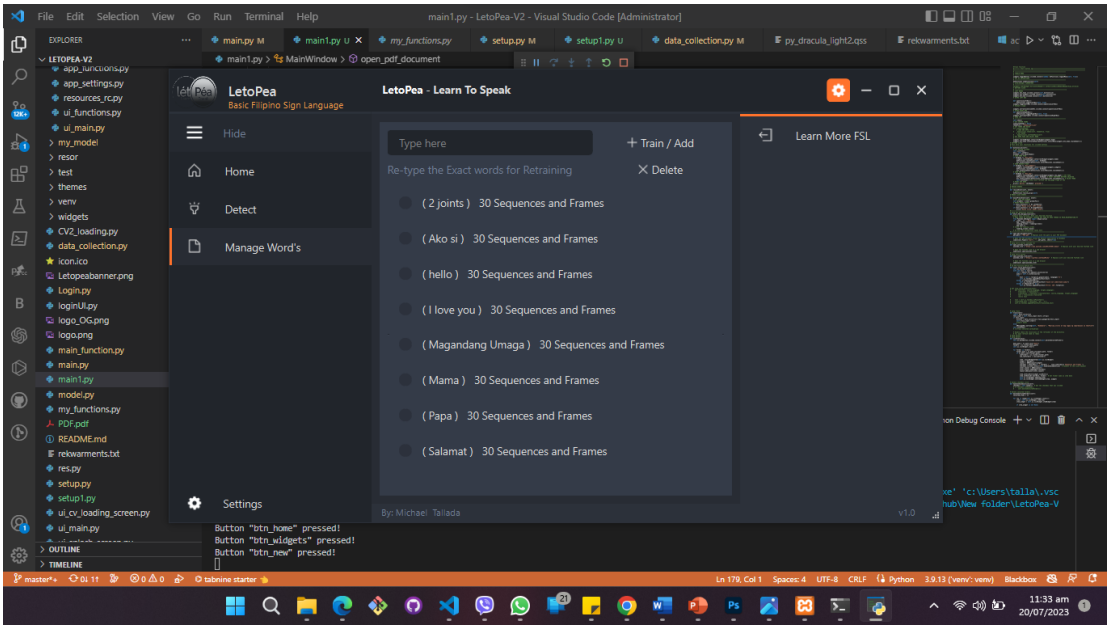
Food	700
Internet	1200
Electricity	800
Transportation	1500
Printing Documents	1500

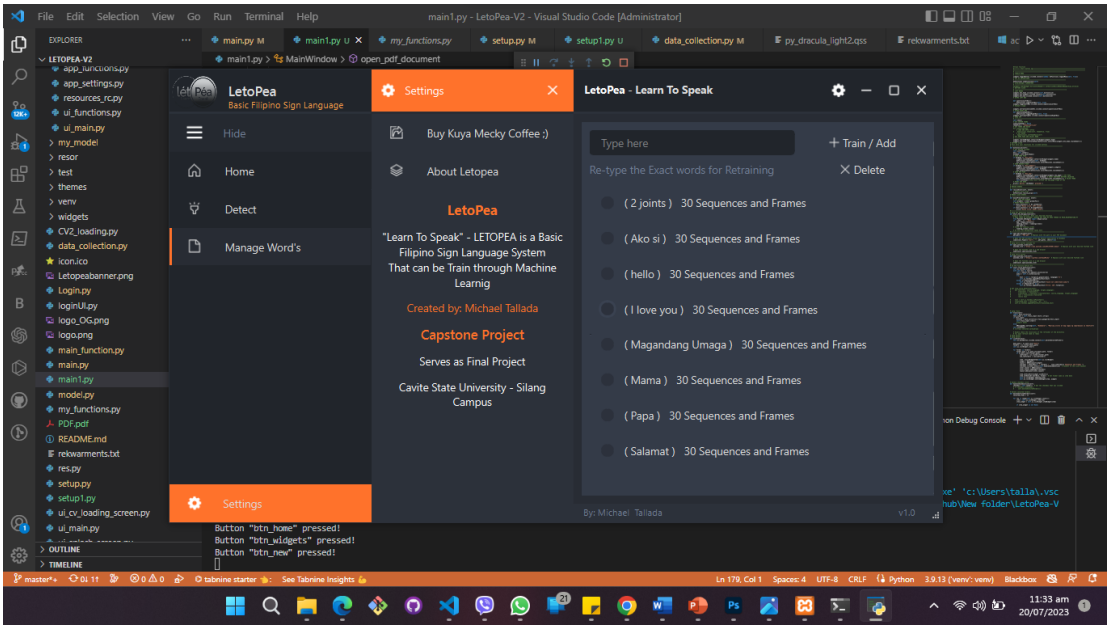
Appendix N

Screenshot of System






LetoPea
Basic Filipino Sign Language
LetoPea - Learn To Speak
Hide
Home
Detect
Manage Word's
Settings
Type here
Train / Add
Re-type the Exact words for Retraining
Delete
(2 joints) 30 Sequences and Frames
(Ako si) 30 Sequences and Frames
(hello) 30 Sequences and Frames
(I love you) 30 Sequences and Frames
(Magandang Umaga) 30 Sequences and Frames
(Mama) 30 Sequences and Frames
(Papa) 30 Sequences and Frames
(Salamat) 30 Sequences and Frames
Learn More FSL
By: Michael Tallada
v1.0


LetoPea
Basic Filipino Sign Language
Settings
Buy Kuya Mecky Coffee :)
About Letopea
LetoPea
"Learn To Speak" - LETOPEA is a Basic Filipino Sign Language System That can be Train through Machine Learnig
Created by: Michael Tallada
Capstone Project
Serves as Final Project
Cavite State University - Silang Campus
LetoPea - Learn To Speak
Type here
Train / Add
Re-type the Exact words for Retraining
Delete
(2 joints) 30 Sequences and Frames
(Ako si) 30 Sequences and Frames
(hello) 30 Sequences and Frames
(I love you) 30 Sequences and Frames
(Magandang Umaga) 30 Sequences and Frames
(Mama) 30 Sequences and Frames
(Papa) 30 Sequences and Frames
(Salamat) 30 Sequences and Frames
By: Michael Tallada
v1.0

Appendix O

Curriculum Vitae

LEANIEL MAE M. PADILLA
Blk 75 Lot 58 Naga St. Cityhomes Subd. Sampaloc IV
Dasmariñas City, Cavite
0935-8040-230
pleaniel027@gmail.com

OBJECTIVE:

To widen my knowledge and strengthen my skills through experiencing the fields in which I know I will excel. To help this company become more successful through working hard even under pressure and to use the job opportunity given to make a better way of living.

EDUCATIONAL ATTAINMENT:

2019-2021	Cavite State University Silang-Campus Biga I, Silang Cavite Bachelor of Science Major in Information Technology Tertiary Level
2017-2019	Philippine Nautical and Technological Colleges (PNTC COLLEGES) Amuntay Road Zone III, Dasmariñas City, Cavite Bachelor of Science in Marine Transportation Secondary Education
2013-2017	St. Mary's Academe Inc. Cityhomes Subd. Sampaloc IV, Dasmariñas City, Cavite Secondary Education
2007-2013	St. Mary's Academe Inc. Cityhomes Subd. Sampaloc IV, Dasmariñas City, Cavite Primary Education

SKILLS:

- Excellent in communication skills
- Computer literate
- Enthusiastic
- Sociable
- Fast learner
- Time Management

PERSONAL BACKGROUND:

Birthday:	January 27, 2000
Birth Place:	Burol I, Dasmariñas City, Cavite
Gender:	Female
Age:	22
Nationality:	Filipino
Religion:	Christian
Civil Status:	Single
Height:	4'11

WORK EXPERIENCE:

May 2022 – September 2022	**Alorica Center** Makati, Metro Manila Content Moderator
March 2021 – May 2022	**My Reliable Offer, LLC** Virtual Assistant/Cold Caller in Real Estate Lead Generation and Acquisition Specialist
November 2020 – March 2021	**Inspiro Relia Company** Quezon City, Metro Manila Customer Service Representative
September 2019 – November 2020	**IQOR Philippines** SM Pala Pala Branch Customer Service Representative

CHARACTER REFERENCES:

- Raymond P. Ubalde
  SM Pala Pala Dasmariñas
  I.T. Manager
  0932 257 1891

- Karen Del Rosario
  Teleperformance Philippines
  Assistant Manager
  0965 170 4766

- Jeremiah Viterbo
  Essilor Shared Services Philippines Inc.
  Senior Analyst Programmer-Robotic Process Automation
  0917 807 9422

Michael Tallada

Blk 78 Lot 29 Bella Vista Sub Brgy, Santiago GTC

General Trias Cavite

Tallada88@gmail.com

0909-400-3145

SUMMARY

Motivated and versatile IT professional with experience in web development, programming, and multimedia arts. Skilled in a variety of programming languages, Microsoft applications, and network administration. Able to work independently or as part of a team.

EDUCATION

Bachelor of Science in Information Technology, Cavite State University Silang campus (CVSU SILANG), expected graduation 2023

STI – College Dasmariñas, ICT-MAWD/Mobile Application and Website Development, 2018

TECHNICAL SKILLS

Web Development: PHP, CSS, JavaScript, Bootstrap, C++, C#, Java, Kotlin, Python, ASP.NET Framework, Laravel, Django, Xamarin, Cordova, VB. VS, Android Studio
Software Development: C++, C#, Java, Kotlin, Python, ASP.NET Framework, Laravel, Django, Xamarin, Cordova, VB. VS, Android Studio, Machine Learning, Deep Learning (Neural Network).
API Development: REACT, NODE JS.
Others: Microsoft Word and Excel, 3DMax, AutoCAD, Blender, SketchUp, Adobe Photoshop, Adobe Premiere, Sony Vegas Pro, Google Analytics and AdSense
Networking: Network and Computer System Administration, CCTV Technician/IT

WORK EXPERIENCE Programming Tutor Freelance, 2019-Present

- Provide one-on-one tutoring services in various programming languages and software applications

IT Software and Data Analyst Freelance, 2018-Present

- Develop custom software and data analysis tools for clients in various industries

Network and Computer System Administrator Cabreros Realty Corp, 2018-2022

- Maintained and secured network and computer systems for the organization

TECHNICAL EXPERIENCE Programming and Web Development Projects Freelance, 2018-Present

- Developed various websites, applications, and software tools for clients
- Utilized a variety of programming languages and frameworks, including Laravel, Django, and Xamarin

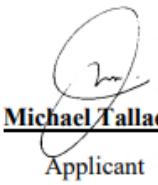
Multimedia Art Projects Freelance, 2018-Present

- Created various digital art projects for clients using Adobe Photoshop, Adobe Premiere, and Sony Vegas Pro

CERTIFICATIONS

- STI Dasmariñas TVL-ICT Com Prog NC III – Java & .NET Technology 2018
- Microsoft Certified: Azure Developer Associate, 2021
- Google Analytics Individual Qualification, 2020
- Google Project Management, 2023
- Google Project Planning: Putting It All Together, 2023

"I hereby certify that the above information is true and correct to the best of my knowledge"



Michael Tallada
Applicant

MICHAEL ANGELO ZAMORA

Adress: Blk 1 Lot 8 Goldenville 2 Sabang,
Dasmarinas Cavite
Contact Number: 09754804662
Email: zmrmchl@gmail.com

PERSONAL INFORMATION

AGE: 23
DATE OF BIRTH: JANUARY 17, 2000
PLACE OF BIRTH: MAKATI CITY
RELIGION: CHRISTIAN BORNAGAIN

EDUCATION

Bachelor Of Science in Information Technology (2019-present)

Cavite State University – Silang Campus

Senior Highschool (Technical-Vocational-Livelihood) (2017 – 2019)

Philippine Christian University - Emilio Aguinaldo Hwy, Dasmariñas

EXPERIENCE

On The Job Training (2018 – 2019)

CREOTEC Philippines INC. – Dasmariñas Center

SKILLS

- Computer Literate
- Patient
- Knowledgeable about Microsoft Office and Excel
- Time-management Skills
- Communication Skills
- Can work under Pressure
- Fast Learner