System Requirement Specifications

Final Year Project

SmartGuide: A smart campus guide using BLE based indoor localization

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1 Overview of Project

Outdoor and indoor localization is an integral component of IoT (Internet of Things) in this era of mobile computing. Indoor localization can open new horizons for ubiquitous applications targeting university departments, government small institutes, software houses, airports, shopping malls, museums etc. Our project will find the location of a specific person by using appropriate machine learning approach using BLE based Android application. This location will be used to provide guided tour of the indoor building (Computer Science and Engineering Department at UET, Lahore) we will use to validate our work.

This project will guide persons who are not much familiar with visiting place. It has an android application that will predict the indoor location of a person at room level and also gives information of current room location and nearby rooms in the form of text, images, audio and videos. In our case visiting place will be CSE dept at UET LHR. For room prediction, RSSI fingerprints of BLE beacons will be captured for training of model. After finding the location of the person, guidelines of that certain room/area will be provided to the user on user end Android application. Indoor positioning has numerous applications. We can use indoor positioning of people to guide them inside shopping malls, airports or museums.

1.1 Background

Outdoor localization has been formalized by using satellite-based technologies i.e. GPS [2], BeiDou [5], GLONASS [5], and GALILEO [1]. It is hard for finding the indoor location by using conventional GPS technology because of no direct (Line of Sight) [4] in indoors, so we cannot use these technologies for indoor positioning. Up to date, the technologies used for indoor localization approach are: TOA (Time of Arrival), AOA (angle of arrival), TDOA (Time Difference of Arrival) but they have some limitations. TOA and TDOA require precise clock count and its synchronization and AOA-based systems require special antennas for their propagation. So, we are going to implement a system which employs suitable machine learning approach to find the location by using RSSI (Received Signal Strength Indicator) values which based on the technique of fingerprinting because there is less hinderance of other signals in using this technique.. This RSSI values will pass to the trained model (a model which is trained on a given set of input and output values by using appropriate machine learning algorithm) which gives the location of the user's mobile device. The indoor positioning system which we are using is communicating with hardware device so we require a technique which translates the signal into a location. There are three categories to transform this: proximity, geometric and scene analysis. Proximity methods create zones and assigns the users location when they enter that zone. Geometric method uses signal measurements from device locations and put them in geometrical equations to predict the location but scene analysis method measures the signal from different refence points by standing at one location and then predicts location by passing that fingerprint to trained model which is called fingerprinting technique [**?**].

1.2 Motivation

People/visitors who go to an unknown place find it difficult to traverse and wants to find places/people of interest easily. Such problems motivate us to provide ease and leverage facility to users so that they can see the information of a particular indoor environment on his mobile application automatically. BLE is available on nearly every smart device so no additional hardware required at user end. Hence by utilizing their indoor location determined using machine learning on BLE fingerprints, guided tours of smart campus to visitors can be provided and facilitating them. We are using latest technology of BLE beacons because they work on battery and consume less energy than Wi-Fi signals [6].

1.3 Scope

In this project, android application runs on a user's mobile device and and will capture BLE RSSI fingerprints. The fingerprints collected at the initial stage will be processed and used to train suitable machine learning model, after training of the ML based location prediction model, based on the room prediction relevant information of nearby rooms, facilities and personnel available will be prepared to be displayed to user at run time , the user will be guided to install our Android app on their phone, their mobile device will capture BLE fingerprint and the fingerprint will be sent to back end server where our trained model will predict their current location inside building in terms of room [3]. The relevant information will be delivered and shown on user mobile device providing guided tour. The placement of Bluetooth low energy beacons will be held in CSE dept at UET Lahore.

1.4 Problem Statement

Whenever a visitor goes to university campus or visits a new place, he does not know about the specifications of that area i.e. what happens in that specific room or what courses have been taught in a particular and its nearby labs. So, we are developing a system which assists them in determining the textual and pictorial information of a particular area and its nearby locations. For this purpose, we first find the indoor location of a user by using BLE beacons and RSSI values, and then provide information to him automatically on his Android application.

1.5 Possible Applications of work

The possible application of work for our project are as follows:

- Software house information (Development, QA, Frontier)
- Airport assisting system

- University Campus smart information system
- Government small Institutes
- Medical departments exploration in hospitals

2 Overall Description

2.1 Product Context

- It navigates the user location
- It also give the user's nearby location
- It provides information of the current location of user i.e. the room's pictures and in textual description it will tell about the office hours or if it is a lab then how many teachers are teaching in that lab and the schedule.
- User can see that if his nearby place is room or lab. It will provide the room number and pictures.
- Most of us don't use guide boards because it is time consuming. This app will navigate you to your required lab.

2.2 User Characteristic

User Characteristic	Values
Role	User
Age	Above 12
Gender	Male, Female
Education Level	College, Undergraduates and above
Culture Background	User must know how to deal with android applications and how to use them
Interest	Travel , Online socializing
Profession Level	Fair, good, very good
Computer Skills	Fair, good, very good, Excellent

Figure 13: User Characteristics

2.3 Constraints

- It only tells the indoor location of CSE department because we need BLE beacons for deployment which predict room location. Actually, BLE beacons are very expensive. That's why, it is implemented in specific area.
- User can only use this app for CSE department.
- This app cannot tell about the outdoor location.
- Only visitors and new student of CSE department use this app.s
- If we have more resources such as BLE beacons, we can enhance the scope of the project such as we can implement this in other departments and other locations.
- We are not providing information in video form.

2.4 Assumptions and Dependencies

- We can implement our project in different departments of UET.
- Even we can also implement this application in shopping malls, Offices and other universities.
- We can also provide information in video format in this app.
- We can introduce the concept of indoor localization for whole world.

3 Existing System

3.1 Comparison of Existing Systems

The smart campus guided tour based on indoor localization is not implemented yet, also there are little or even no research specifically focus on the smart campus guided tour based on indoor localization. There exist a research that presents a smart phone guidance application based on augmented reality in multiple areas and the attributes of application are the information about exact points of location, searching of exact area or indoor location and navigation, but it provides outdoor locations of large university campus using GPS, because it is not based on room level prediction and information about indoor locations. But there are a lot of researches that provide different methodologies for room level prediction. In recent years, indoor localization systems have great significant research activity and growing interest for their great expected social impact. In spite of the numerous research advances, no proper solutions have yet defined. There are multiple solutions present in research area for room level prediction [7]. Here are the comparisons of few of them:

System Type	Methodology	Weakness	Accuracy Achieved
Image based indoor localization	Convolution Neural Network(CNN)	-Time consuming effort required to built data set -Low accuracy	74.09%
By using Capacitive Sensors	Pressure sensing systems that detect presence	-Deployment of sensors in floor is expensive -Impractical	73.01%
By using Zigbee sensors	K- Nearest Neighbors(KNN)	-Expensive -Medium Scalability	76%
By using Wi-Fi	Deep Learning algorithms	-Consumes more power -Wi-Fi signals are not accessible to some areas	71%

Figure 1: Comparison of Existing Systems

3.2 Drawbacks of Existing Systems

There are many drawbacks in existing systems. In some systems, camera is required for indoor positioning which is obtrusive for some users. High cost and effort is required for the deployment of indoor localization infrastructure. Most of the existing systems have medium or low accuracy. In image based indoor localization, time consuming effort is required for built data sets. Wi-Fi fingerprinting is relatively better than other systems because of finding position by using already deployed infrastructure. But its main drawback is that it consumes more power. There are some spots where Wi-Fi access points would be difficult to power. There are some areas where Wi-Fi signals are not accessible. In our proposed system, we will find indoor location using BLE beacons. BLE beacons are small in size, light weight and cheaper then Wi-Fi. BLE consumes less power than Wi-Fi. BLE beacons flexible and easily deployed deployed than sensors used by existing systems. BLE RSS signals can have a higher sample rate than Wi-Fi RSS signals (0.25 Hz 2 Hz). Our proposed system will provide more accuracy than existing systems and also it is unobtrusive. So, our proposed system will overcome the shortcomings in existing systems. Furthermore, our system will not only predict location but also provide information of that location and nearby location in form of text, videos, audio and images which is missing in existing systems because they find indoor positioning for different purposes [8].

4 Software Development Life Cycle Used

To implement a project, one must have to follow some software development life cycle to deliver his project completely according to user requirements in time. By following a certain SDLC, a project developer feels so comfortable as he have specific tasks and time to implement project timely which meets the user's point of view. In our project, there are lots of fluctuations time by time. So, we decided to follow AGILE model.

4.1 AGILE SDLC

Agile SDLC model is a combination of incremental and iterative process models deals with customer requirements satisfaction by rapid delivery of working product to the customer. This model breaks the whole project in small modules. Do proper testing after completion of each module. Then deliver this working module to the customer and important stakeholders to satisfy them. If that module doesn't meet their point of views properly or to which customer point of view as he didn't explained in the document, then it has to be iterated to fulfill their new recommendations. And the other perspective is that if the customer wants to add some functionality in that particular module then a developer has to follow an incremental technique to add specific functionalities. To complete each deliverable module of the project, developer has to follow these steps

- Planning
- Requirements Analysis
- Design
- Coding
- Unit Testing and
- Acceptance Testing

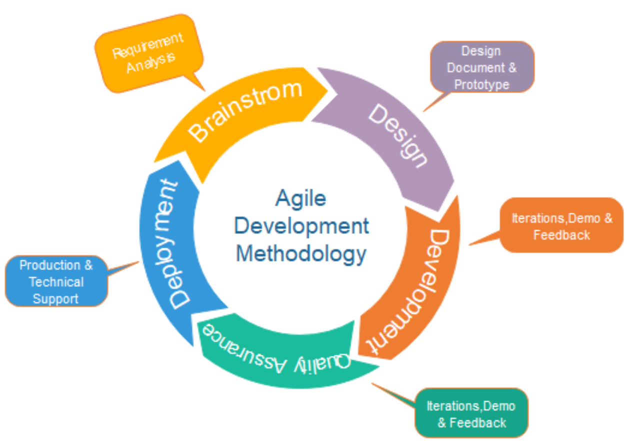


Figure 2: Agile Methodology

4.2 Justification for AGILE SDLC

These steps will justify that our project is based on agile methodology:

- All the requirement specifications and the scope of the project is strictly defined in our documentation but by the time, it may require some amendments, so they will change by ourselves.
- Planning of time, design, implementation and testing is done.
- Hardware and software parts of our project are specified into a work breakdown structure.
- All the Modules of our project are divided in small pieces of time according to estimated time.
- In model training module, we first use Weka and then following TensorFlow to meet the requirements; hence we followed an incremental and iterative model.
- Do unit and acceptance testing after completion of each module.
- Budget plan for our project is defined
- We Add functionality of delay in Data Capturing application which capture data after some seconds when a user change his indoor location.
- Add restart functionality to restart scanning of Bluetooth devices once it stops which leads to incremental change in data capturing application.
- Roles and responsibilities of team members vary according to the prescribed task and time limit.

5 Requirement Analysis

The most important section of system requirement specification document is requirement analysis. To start any project, anyone needs to know his system requirements. This section includes all the software, hardware functional requirements of our system, user interfaces, database diagram, use case diagram, use case tests and test cases. Basically, we will discuss all the specifications of our system.

5.1 Hardware Functional Requirements

- **Deployment of BLE beacons**

Deployment of BLE beacons on the ceiling is the requirement to capture fingerprints of BLE beacons with different mobile devices. At what angle and at what part of the ceiling these beacons should display, all we get it know before their deployment.

5.2 Software Functional Requirements

5.2.1 Data Capturing Application

- **Bluetooth scanning for nearby devices**

A scanning function is made in data capturing application to scan BLE beacon for nearby mobile devices. Devices who present/locate near a certain BLE beacon are being scanned.

- **Capture RSSI values for nearby beacons**

BLE beacons Bluetooth range exists in a certain region and this region contain different mobile devices far and near to BLE beacon depending upon their indoor location. So, this function will capture RSSI fingerprints for all mobile devices which being scanned in that certain region.

- **Add delay factor to capture FP's**

Once fingerprints of certain mobile device have been captured at a particular location and by determining the indoor location, we provide room information through our application to a user's mobile device. The user may change his indoor location after a while. To provide updated room information to the user we are making a delay function which captures user fingerprints after a certain time (seconds) and provide him updated information according to his room location.

- **Automatic restart Bluetooth scanning for nearby devices once it stops**

Automatic restart scanning function will scan for BLE beacon nearby mobile devices once scanning has been stops, because in this way our system will able to automatically find coming and going devices in a particular region and provide rooms information accordingly.

- **Generate .csv file for each BLE beacon**

After capturing the fingerprints of all devices with a single BLE beacon which lie in that certain region, this function will generate .csv file and RSSI values of all devices in that file.

5.2.2 SmartGuide: Android Application

The functional requirements of our system for User are as follows:

- **Load trained model in Android app**

There is need to load machine learning trained model in our Android application to predict the room location of a particular person.

- **Get the prediction of room from trained model**

When a trained model receives .csv file of a particular BLE beacon, it gives the particular roomID of that beacon to a mobile device which is receiving higher RSSI value from that BLE beacon.

- **Allow user to know his indoor location**

This function will enable users to see their indoor location i.e. in which room they are.

- **Fetch information of that particular room**

This function will send RoomID of a particular BLE beacon to the database from which room information in image, texts and audio format can be fetched.

- **Provide information of the room to the user**

After fetching the information of a particular room, this function becomes enable and displayed that information on user mobile screen.

- **Enable user to get information of nearby rooms**

This function allow users to see their nearby (left, right, front and back) rooms and textual and pictorial information about that rooms.

The functional requirements of our system for Admin are as follows:

- **Allow admin to SignUp for our application**

To use an Android application, in this case admin has to register on our application to add, update and delete records of certain data in our application.

- **Provide account activation functionality to the admin**

Admin can login on another device; he has no restriction to use our application on a certain device. He may be login or logged out.

- **Admin has all the records of data**

Admin has the ability to get all up-to-date records of data. Data can be of staff members, their visiting hours, room information, lab accessories and much more.

- **Store information to database in images, audios and text format of rooms and their nearby rooms**

This function will store information about rooms in images, audios and text format in the database. Also, the information about nearby rooms of a certain room will also be stored by the admin in the database manually.

- **Allow admin to edit or update the information about rooms**

When After sometime, the specifications and in formations about certain rooms and departments can be changed. So, this function will enable admin to update the information accordingly to provide up-to-date information to the user.

- **Admin has all those functionalities which a user has**

Admin can see the information of a room and nearby rooms in any format provided in our application like user.

5.3 Non Functional Requirements

- **Reliability**

Our project will be reliable .The user's information will be kept confidential and there will be no worry of losing the information.

- **Usability**

Our application will be usable for the users and easy to use.

- **Maintainability**

This system will have the capability to adapt changes and amendments done in the database by the admin as the information of rooms will be updated or edited.

- **Security**

Our Android application will work under potential risks. It will not be accessible by the malicious user or be crashed by external attacks.

- **Recoverability**

In case of crash, our system information will recoverable

- **Safety**

Optimize safety in the design, development, use and maintainability of the application.

- **Reusability**

Our system will provide reusability factor to the visitors of the department.

- **Performance**

To make a system which gives accurate and up-to-date information about rooms even a user change his indoor location after a while. This system will give results efficiently in small time.

5.4 Hardware Interfaces

BLE beacons are bluetooth low energy beacons. Simple bluetooth consumes more power than BLE beacons and move to long ranges. On the other hand, BLE consuming much less power because it transmits data over the small range.Bluetooth having version greater than 4.0 are BLE.BLE Beacon is a small device with a massively used for broadcasting of signals. It has unique ID. A beacon has three major components: a small ARM computer, a Bluetooth mode and battery to ignite the module of the circuitry. The CPU of the ARM computer has an antenna attached to it. It broadcasts electromagnetic waves with specific lengthand frequency. We develop Data Capturing Application that will interface with beacons in order to capture the signal strength of BLE beacons in the form of RSSI values. These RSSI values further used for the prediction of room.

- **Bluetooth Low Energy Beacons**

Figure 3: BLE beacons

- **Interfacing with Beacons**

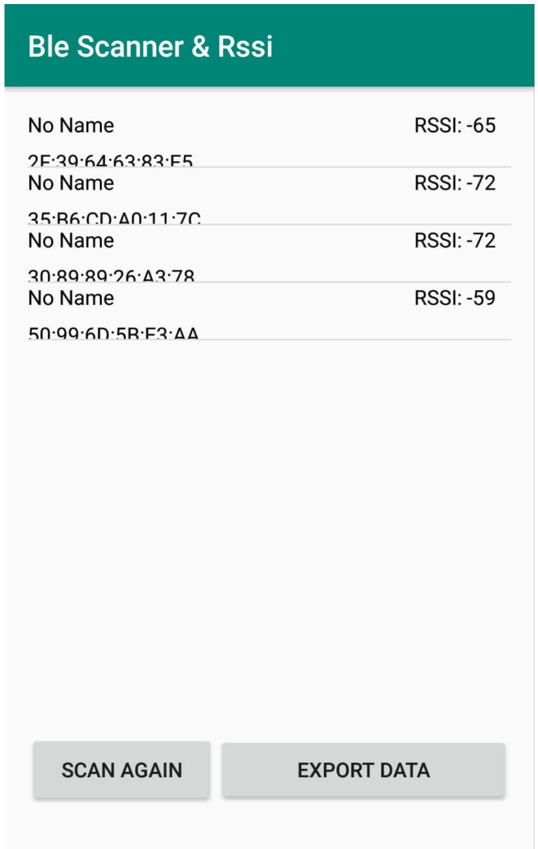


Figure 4: Data Capturing Application

5.5 Communication Interfaces

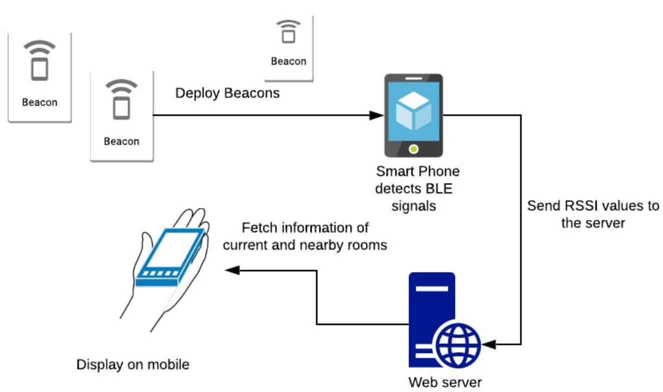


Figure 5: Communication Interface

5.6 User Interfaces

- **Splashig Screen**

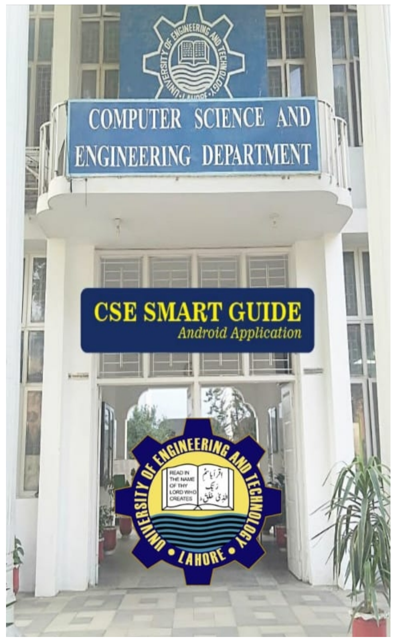


Figure 6: Splashing Screen

- **Screen 1**

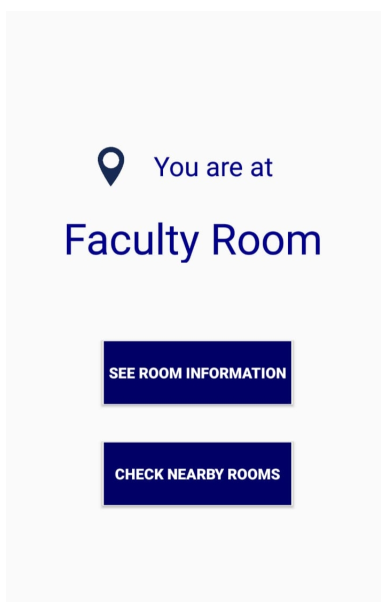


Figure 7:Prediction of Room

- **Screen 2**

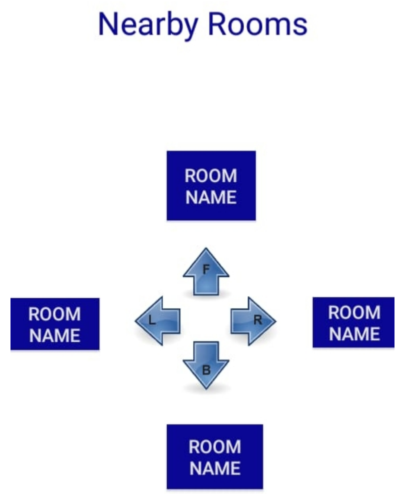


Figure 8: Nearby Rooms

- **Screen 3**

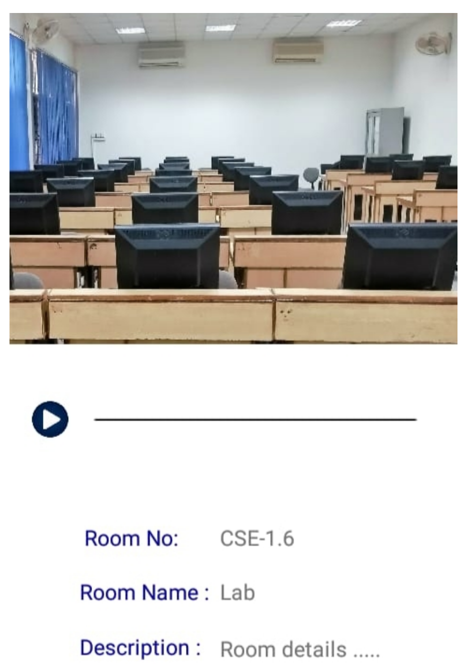


Figure 9: Room Information

- **Screen 4**

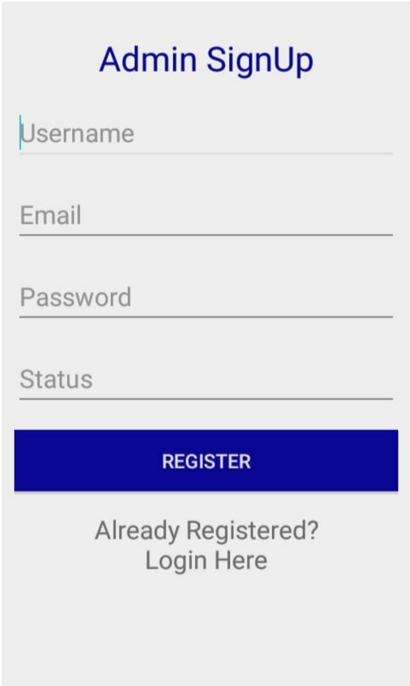


Figure 10: Admin SignUp

- **Screen 5**

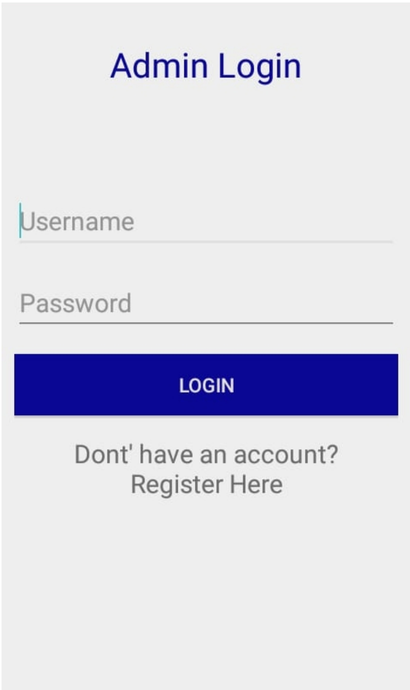


Figure 11: Admin LogIn

- **Screen 6**

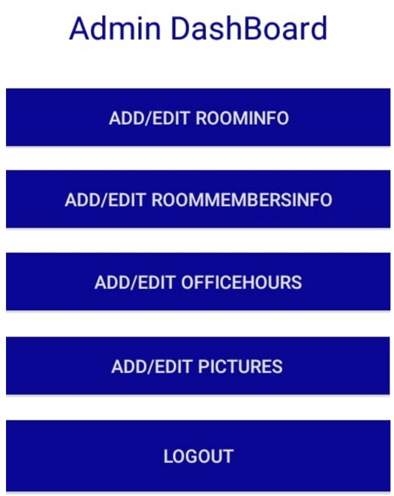


Figure 12: Admin Tasks

- **Screen 7**

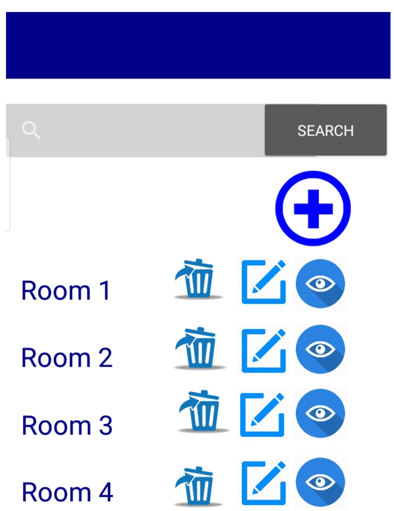


Figure 13: Room Index

- **Screen 8**

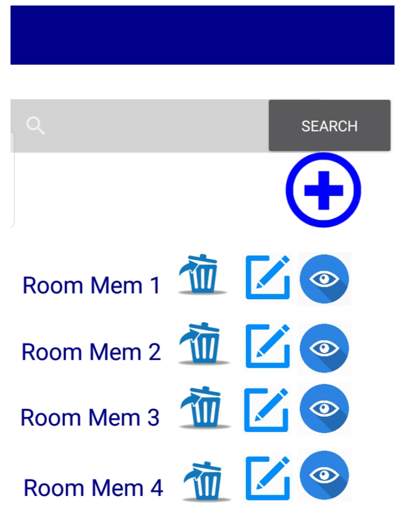


Figure 14:Room Members Index

- **Screen 9**

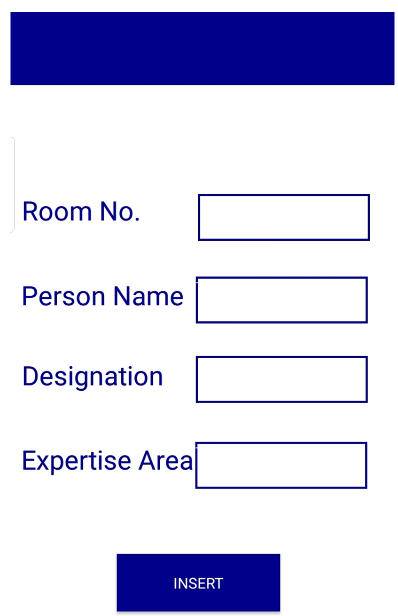


Figure 15: Addition and editing of room members information

- **Screen 10**

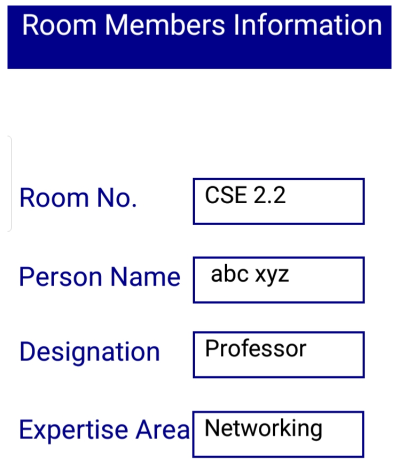


Figure 16: View room members information

All other interfaces for Admin of modifying office hours, pictures information are similar to above interfaces.

5.7 Use Case Diagram

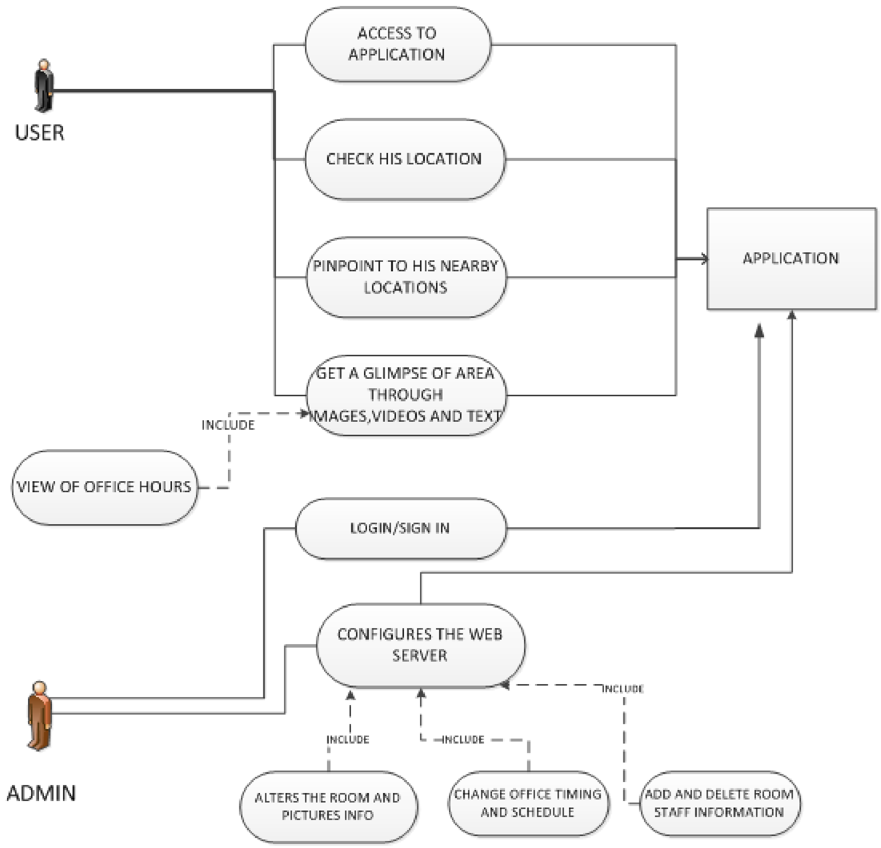


Figure 17: Use Case Diagram

5.8 Use Case Texts

Use Case Name	Access to the application
Actor	User
Description	User has to step into the application for the benefits of the app through his mobile phone.
Pre-conditions	1- The mobile must have Android OS. 2- The application must be downloaded on the phone.
Normal flow	1- The app will be downloaded through Google PlayStore. 2- User opens the app the front page appears showing "Welcome to CSE Department".
Post-condition	Application will be opened and front page will show that this app will guide the user in CSE department.

Figure 18: Use Case 1

Use Case Name	Checking the location and explore nearby places
Actor	User
Description	User can find out where he is standing right now and what the neighboring locations are.
Pre-conditions	1- Bluetooth connectivity must be turned on. 2- Bluetooth must be connected to beacon. 3- User must be in department premises.
Normal flow	1- After main page, another page appears with two buttons. 2- User can check his current location by clicking first button showing "My current location" which gives the user its current location. 3- Next button shows "Nearby Rooms/Labs" by clicking that user get to know about the surrounding rooms and labs around him.
Post-condition	1- User will able to know his location at that moment. 2- He will also know the neighboring rooms and labs.

Figure 19: Use Case 2

Use Case Name	Pictures, schedule and office timings of rooms & labs.
Actor	User
Description	The information of current and neighboring rooms and labs through pictures and texts with the extension of office timing of the teacher's room can be seen
Pre-conditions	User must know the location where he is standing and the nearby labs and rooms.
Normal flow	1- When the user clicks current location button, next screen gives 3 buttons. • One gives the pictures of the room. • Second gives the schedule and name of lab attendant if it is lab. • Third gives the office timing if the room belongs to any teacher. 2- When the user clicks the nearby rooms button, then the next screen shows rooms or labs nearby him and when the user clicks any of the room button he will be provided with the images, schedule and office timings.
Post-condition	User will be given the information i.e. pictures, schedule, office timing of his current position and the nearby rooms and labs.

Figure 20: Use Case 3

Use Case Name	Room/Lab staff information
Actor	User
Description	In this use case, User can have the knowledge of the working staff or the teacher's name in the room or lab
Pre-conditions	1- User should have the information of his current position by having the pictures, schedule and office timing of that room or lab. 2- He should have the pictures, schedule and office timing about the nearby rooms and labs.
Normal flow	1- When user is checking current location, another button is given which says "Staff Information" and by clicking that the user will know the teacher's name, his skills and which subjects he teaches. 2- When the user clicks nearby rooms/labs it will also give the staff information button and by clicking that user will know the teacher's skill and if it is lab then he will know which teachers are using this lab and for what subjects.
Post-condition	User will know the skills of teacher of specific room and what he teaches as well as he will know which teachers are teaching in specific lab.

Figure 21: Use Case 4

Use Case Name	Login/Sign in
Actor	Admin
Description	Admin have to make himself registered as an admin
Pre-conditions	Admin must have his login ID
Normal flow	1- Admin opens webserver. 2- Enter his login ID and password. 3- Click to "login as an admin"
Post-condition	Users have the access to webserver and he can alter the information in the webserver.

Figure 22: Use Case 5

Use Case Name	Alteration in rooms and labs information
Actor	Admin
Description	Admin can change the required information w.r.t changing environment i.e. change of any teacher, change of any lab etc.
Pre-conditions	Admin must have the authority to access the webserver of the application.
Normal flow	4- Admin access to the server where he can change picture or the text of specific room/lab. 5- Admin can also change the office timing of teacher's room and schedule of the labs.
Post-condition	Up to date information will be given to the user.

Figure 23: Use Case 6

Use Case Name	Amendments in room staff information
Actor	Admin
Description	If the teacher changes his lab, the admin has the authority to change his lab information and if lab attendant is changed then admin can modify it.
Pre-conditions	1- Admin has access to web server. 2- He should have up to date information.
Normal flow	1- Admin opens the server and checks for the specific teacher or staff. 2- Update/delete/insert the information.
Post-condition	Up to date information of the room staff will be provided.

Figure 24: Use Case 7

5.9 Test Cases

Feature Name	Test Case ID	Summary	Execution Steps	Expected Results
Bluetooth scanning and connecting with device	1	Validate that Bluetooth is connecting to the beacon.	1- Turn Bluetooth connectivity on 2- Scan Bluetooth 3- Connect to the beacon	You are connected to beacon 'X'
Automatic Bluetooth scan	2	Validate that Bluetooth is scanning automatically.	When the person moves Bluetooth scans itself.	You are connected to another beacon 'Y'
Predictions of rooms	3	Validate the predictions of room	1- Get the information of rooms 2- Train that model through tenserflow 3- Predict using weka	Your accuracy is '123%"
Send Room ID to Android App	4	Validate that data capturing app is	After predictions of room the room ID is send to	Room ID 2 is sent to Android app

		sending room ID to android app	android app	
User know his indoor location	5	Validate that user will know his location	1- Turn Bluetooth connectivity on 2- Connect to beacon 3- Open the application 4- Click on "your current location"	You are at this place
User is getting nearby locations information	6	Validate that user will know the information of his nearby rooms	1- Turn Bluetooth connectivity on 2- Connect to beacon 3- Open the application 4- Click on "Nearby Locations"	Your nearby rooms are a- Room 'X' b- Lab 'Y'
Login/Sign In by admin	7	Validate that Admin is getting access to webserver	1- Open the webserver 2- In the required area type admin login ID and password	1- Message appears "You are logged in as an admin". 2- Webserver will be opened for admin
Admin change the information	8	Validate that when admin amend anything it will appear	1- Open the webserver 2- Login to the webserver 3- Update/Modify the database	Room No 'X' information is updated Or 'xyz' is shifted to room no '123'

6 Planning

6.1 Milestones

Milestone No.	Milestone	Completion Date
001	Project Kick-Off	20 Sep 2019
002	Research Work and Complete Analysis	01 Nov 2019
003	Complete Planning and Design	20 Nov 2019
004	Complete Backend Coding	15 Jan 2020
005	Complete Testing	01 Feb 2020
006	Complete Implementation and Deployment	15 Feb 2020
007	Project Closure	01 Mar 2020

Figure 25: Milestones

6.2 Work Breakdown Structure

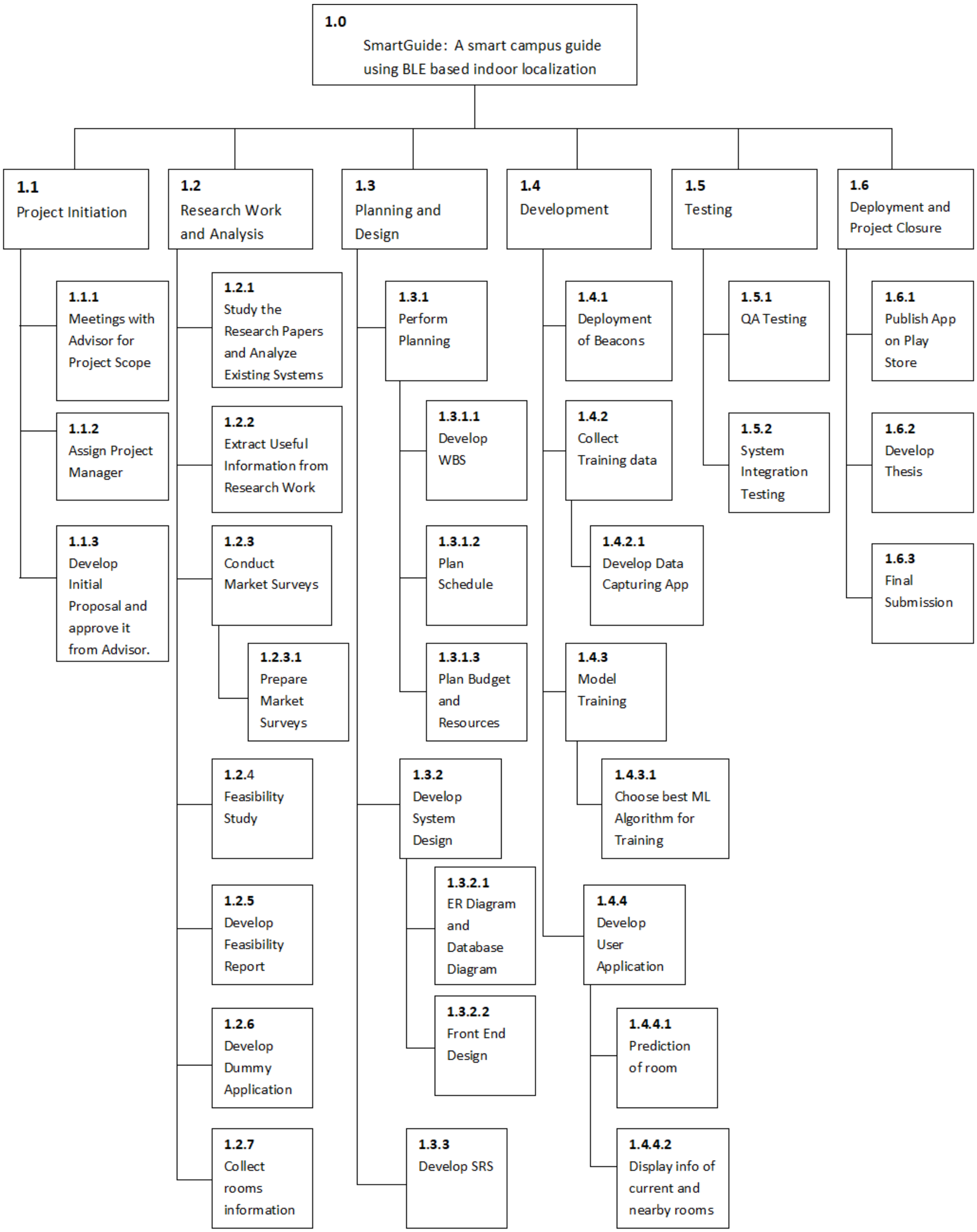


Figure 26: Work Breakdown Structure

6.3 Network Dependency Diagram

Activities	WBS ID	Predecessor	Duration (days)
A	1.1.1		10
B	1.2.1	A	12
C	1.2.3	A	10
D	1.2.7	A	03
E	1.2.4	B, C	04
F	1.3.1	E	10
G	1.3.2.1	E, D	08
H	1.4.2	F, G	20
I	1.4.3	H	12
J	1.3.2.2	G	08
K	1.4.4	I, J	20
L	1.5	K	15
M	1.6.2	L	10
N	1.6.1	L	07

Figure 27: Network Dependency Diagram Table

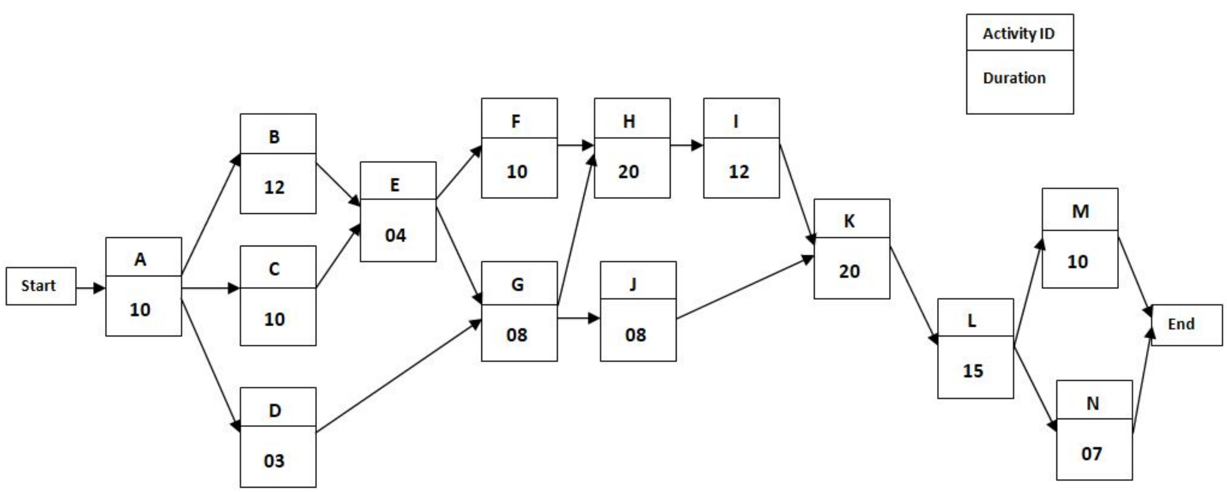
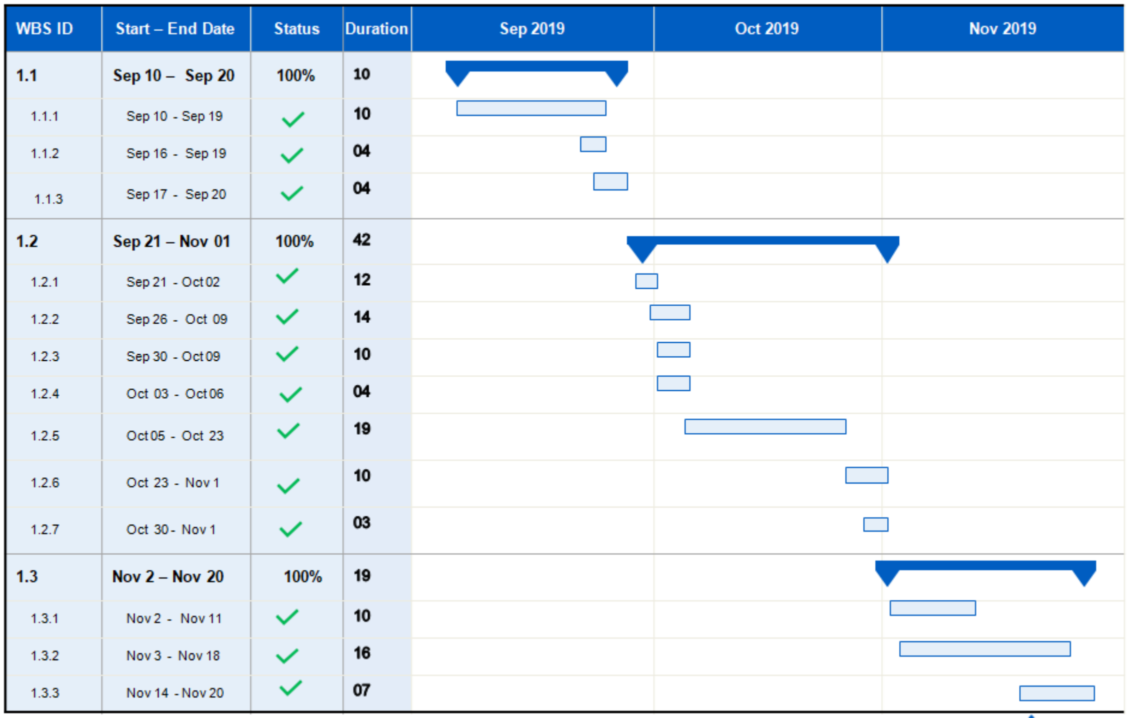


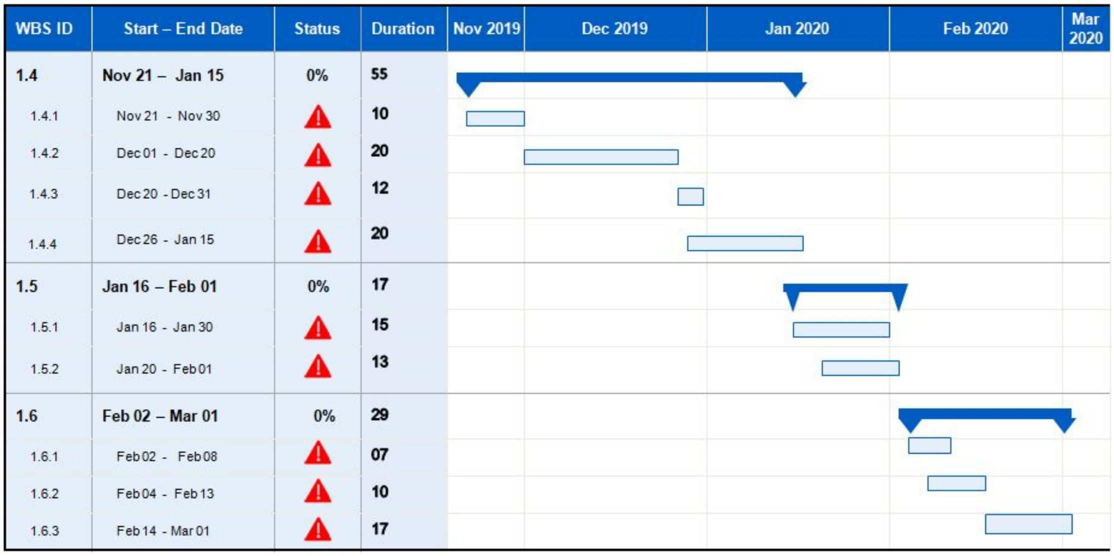
Figure 28: Network Dependency Diagram

6.4 Gantt Chart



WBS ID	Start – End Date	Status	Duration	Sep 2019	Oct 2019	Nov 2019
1.1	**Sep 10 – Sep 20**	**100%**	**10**			
1.1.1	Sep 10 - Sep 19	✓	10			
1.1.2	Sep 16 - Sep 19	✓	04			
1.1.3	Sep 17 - Sep 20	✓	04			
1.2	**Sep 21 – Nov 01**	**100%**	**42**			
1.2.1	Sep 21 - Oct 02	✓	12			
1.2.2	Sep 26 - Oct 09	✓	14			
1.2.3	Sep 30 - Oct 09	✓	10			
1.2.4	Oct 03 - Oct 06	✓	04			
1.2.5	Oct 05 - Oct 23	✓	19			
1.2.6	Oct 23 - Nov 1	✓	10			
1.2.7	Oct 30 - Nov 1	✓	03			
1.3	**Nov 2 – Nov 20**	**100%**	**19**			
1.3.1	Nov 2 - Nov 11	✓	10			
1.3.2	Nov 3 - Nov 18	✓	16			
1.3.3	Nov 14 - Nov 20	✓	07			

Figure 29: Gantt Chart



WBS ID	Start – End Date	Status	Duration	Nov 2019	Dec 2019	Jan 2020	Feb 2020	Mar 2020
1.4	**Nov 21 – Jan 15**	**0%**	**55**					
1.4.1	Nov 21 - Nov 30	⚠	10					
1.4.2	Dec 01 - Dec 20	⚠	20					
1.4.3	Dec 20 - Dec 31	⚠	12					
1.4.4	Dec 26 - Jan 15	⚠	20					
1.5	**Jan 16 – Feb 01**	**0%**	**17**					
1.5.1	Jan 16 - Jan 30	⚠	15					
1.5.2	Jan 20 - Feb 01	⚠	13					
1.6	**Feb 02 – Mar 01**	**0%**	**29**					
1.6.1	Feb 02 - Feb 08	⚠	07					
1.6.2	Feb 04 - Feb 13	⚠	10					
1.6.3	Feb 14 - Mar 01	⚠	17					

Figure 30: Gannt Chart

7 Design

7.1 Data Flow Diagram

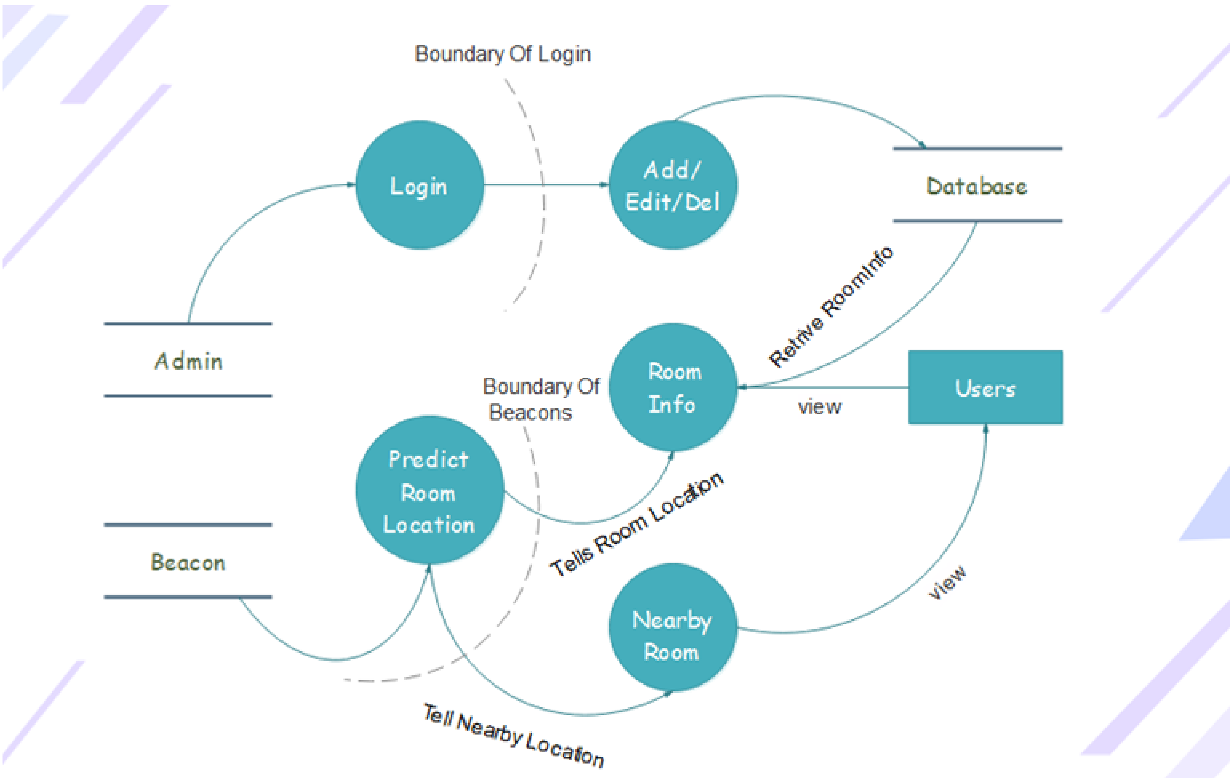


Figure 31: Data Flow Diagram

7.2 Activity Diagram

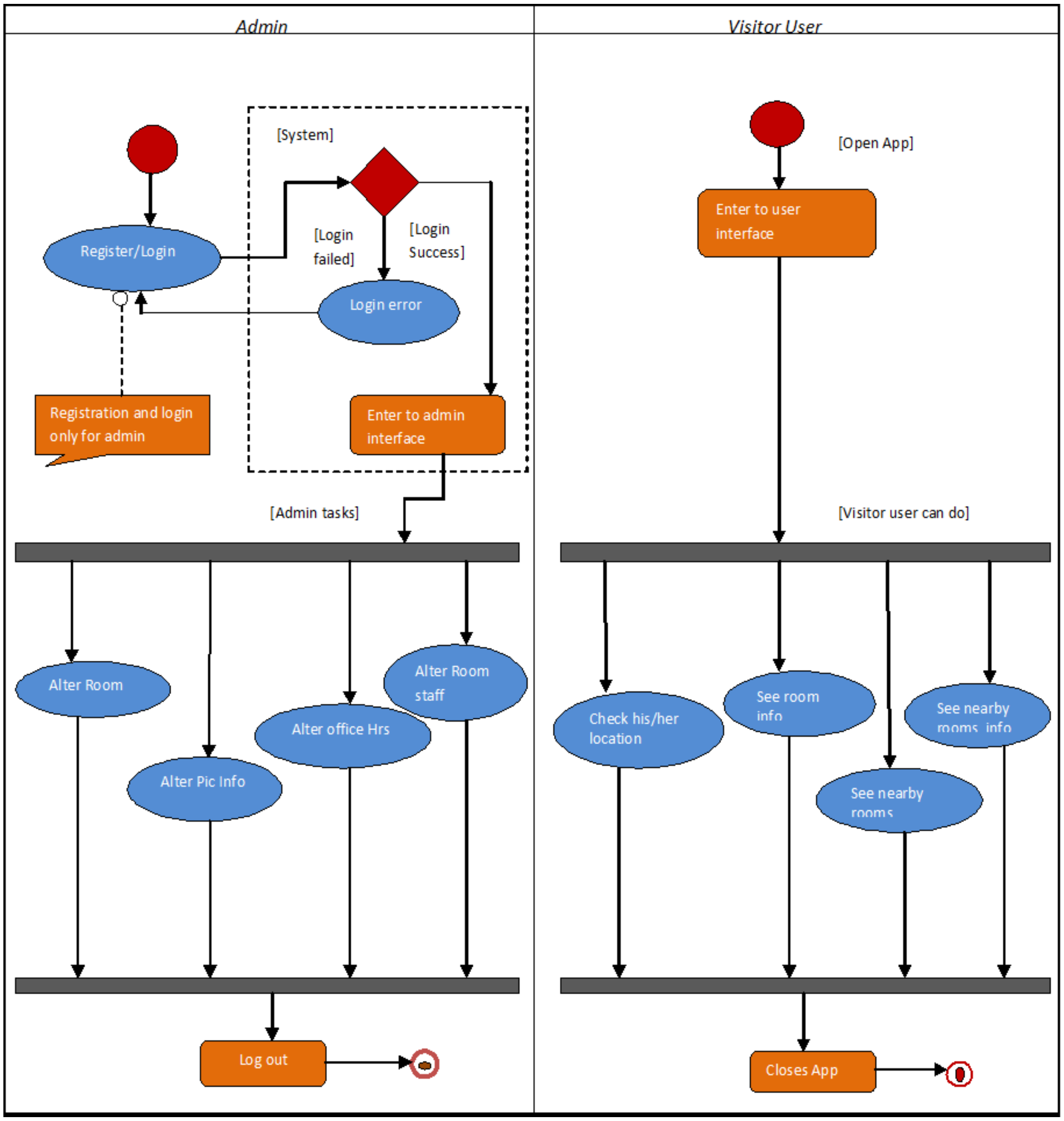


Figure 32: Activity Diagram

7.3 Data Modeling

7.3.1 ER Diagram

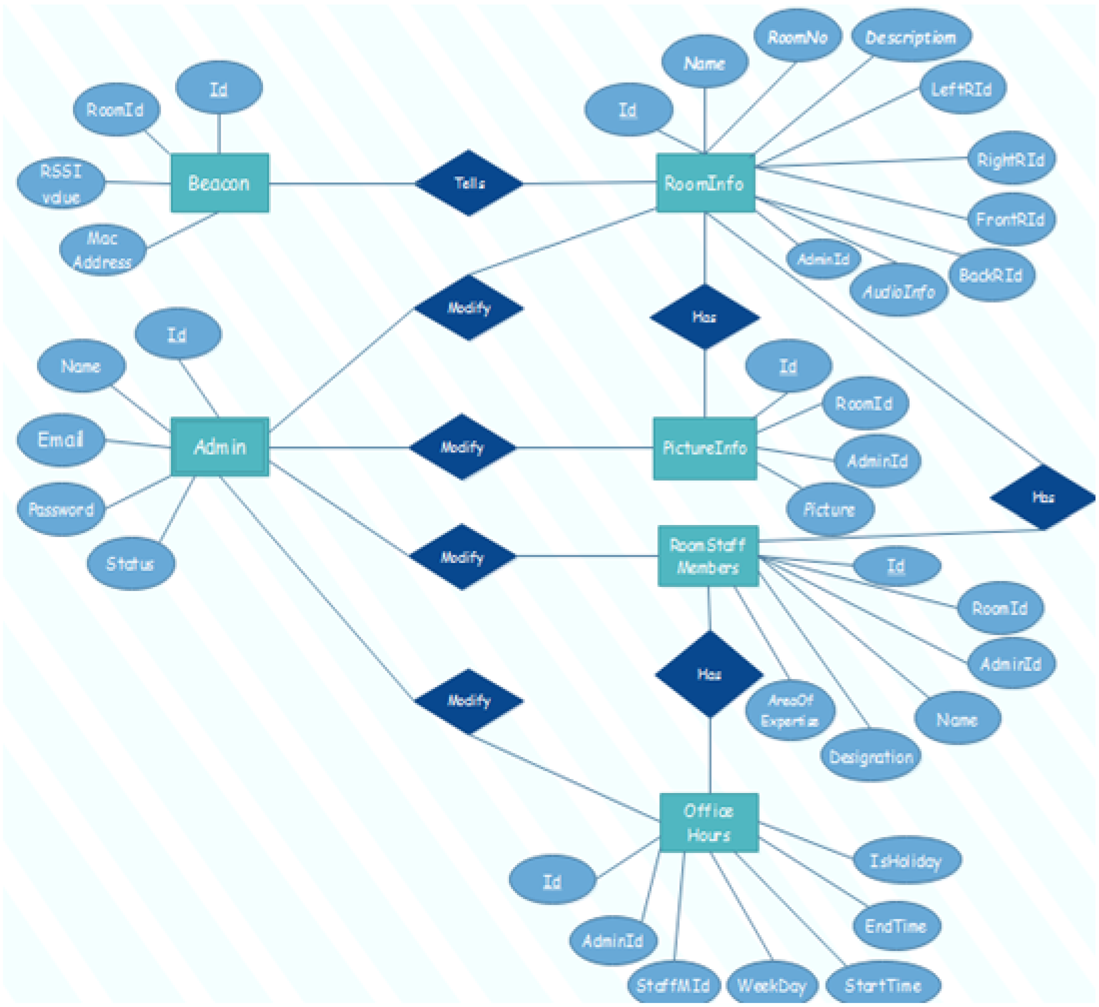


Figure 33: ER Diagram

7.3.2 Database Diagram

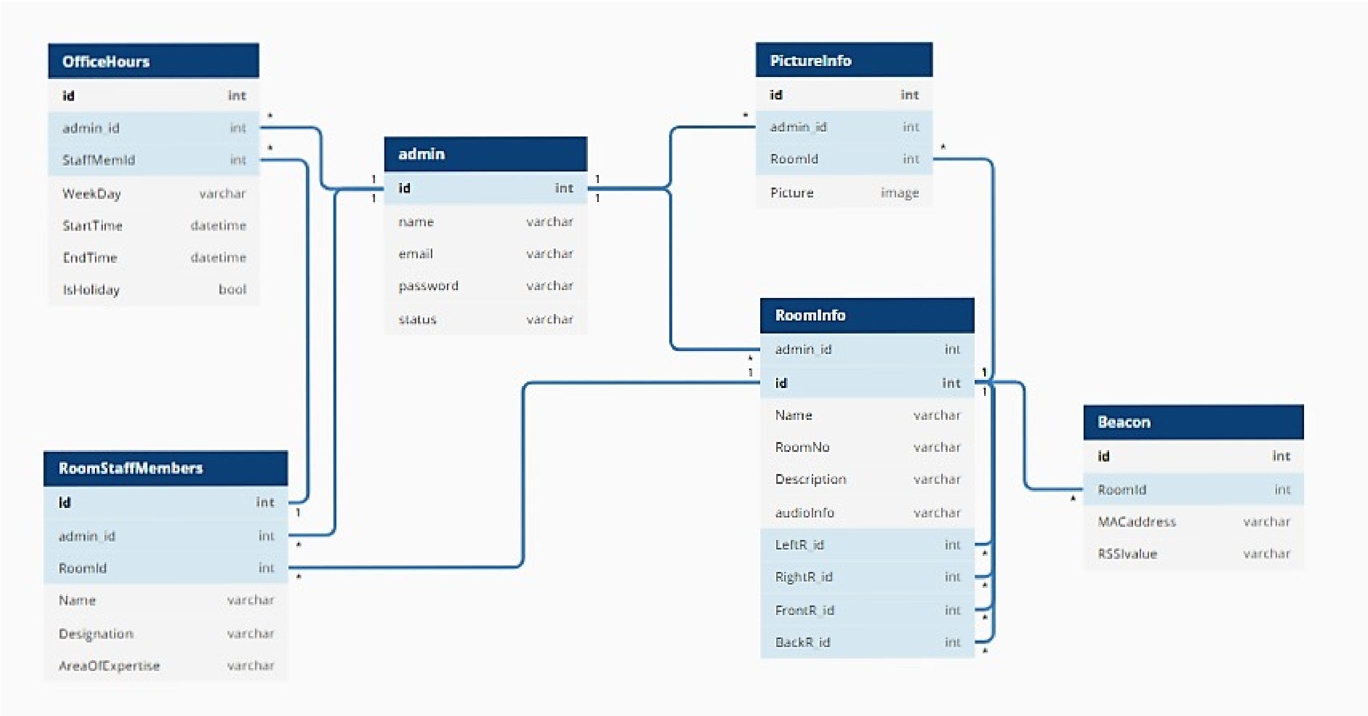


Figure 34: Database Diagram

7.4 Class Diagram

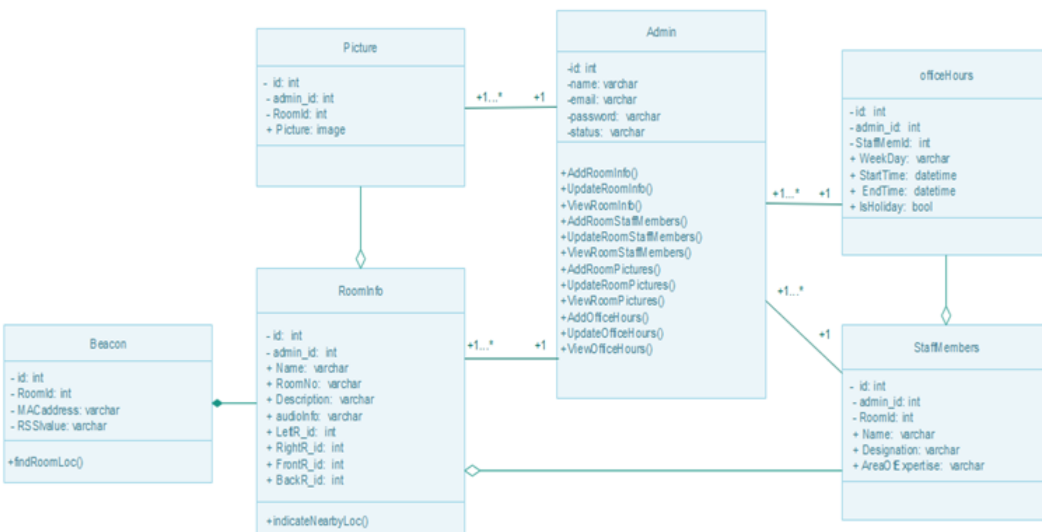


Figure 35:Class Diagram

8 References

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