OPUS

Campus Navigation System Based on Augmented Reality

Group Members

Omer Fayyaz (01-131172-045)

Muhammad Zorays-ul-Haq (01-131172-033)

Supervisor: Dr Kashif Sultan

A Final Year Project submitted to the Department of Software Engineering, Faculty of Engineering Sciences, Bahria University, Islamabad in the partial fulfillment for the award of degree in Bachelor of Software Engineering

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THESIS COMPLETION CERTIFICATE

Student Name: Omer Fayyaz Enrolment No: 01-131172-045

Student Name: Muhammad Zorays-ul-Haq Enrolment No: 01-131172-033

Program of Study: Bachelor of Software Engineering

Project Title: Opus

It is to certify that the above students' project has been completed to my satisfaction and to my belief, its standard is appropriate for submission for evaluation. I have also conducted plagiarism test of this thesis using HEC prescribed software and found similarity index at _____ that is within the permissible limit set by the HEC. I have also found the thesis in a format recognized by the department.

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Signature: _____ Date: _6th July 2021__

Name of the Student: _Omer Fayyaz___

Signature: _____ Date: _6th July 2021__

ABSTRACT

We frequently encounter difficulties when visiting a new building, whether it is a new office, a new university, a new hospital, or any other new indoor environment. It is a very common problem for people to have difficulty locating their destination in a new building. As a result, we are introducing a mobile application designed specifically for Bahria University students to assist them in navigating the Iqbal Block and business school (this limitation is due to insufficiency of floor plans). Our Augmented Reality-based application will guide the user to their desired location after they enter their destination. This application will also assist users in remembering important dates by using a reminder system. This app will also notify users of any important university announcements. The system can be further modified, and many new features can be added.

DEDICATION

To parents, teachers, friends and specially supervisor.

ACKNOWLEDGEMENT

We frequently encounter difficulties when visiting a new building, whether it is a new office, a new university, a new hospital, or any other new indoor environment. It is a very common problem for people to have difficulty locating their destination in a new building. As a result, we are introducing a mobile application designed specifically for Bahria University students to assist them in navigating the various localities like, faculty and admin offices, cafeterias, library, auditorium etc. Our Augmented Reality-based will guide the users to their desired locations once they enter the university. This application will further assist users in remembering important dates by using a reminder function. Students can set assignment, quizzes, and exam reminders They will be notified about any important university announcements.

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CHAPTER - 1

INTRODUCTION

1 Introduction

Our project Opus is a mobile based application which will help the students of Bahria University. It will help the new students finding their desired classrooms offices and labs using augmented reality AR other than this, students can get updates related to university events and will help and update them with university related tasks i.e., quiz assignments.

1.1 Purpose

This documentation will provide a thorough analysis of the methods, phases, and designs fundamental for this project Opus (campus navigation system based on augmented reality) in a clear and incisive manner. This document will allow for a complete understanding, of what is to be expected of the project to be presented. A clear understanding of the system and its functionality will allow for the accurate software system to be developed for the users of the software and will be used for the development of the future stages of the project. This document will provide the bases of the project.

1.2 Motivation

Student life is a very hectic life everyone expects us to do more than we can so to make this hectic life a little easier why do not we help them with their daily life tasks through assisting them around their institute i.e., reminding them about their classes navigating them to different offices etc.

1.3 Problem Statement

In a university building consisting of several classrooms, offices, and labs, it is difficult for new students or even some time existing students may fail to reach their destination smoothly. In the case of a class, new students often get late or mislead because they are unaware of the architecture of the building. This causes a problem particularly for new students.

Not just this, sometimes students often find difficult to remember the deadlines of assignments, time for quiz or in some cases time of a class which often leads to their academic loss.

1.4 Objectives

The Objective of this project Opus is to provide the campus guide to new enrolled student and help all the students with their daily university tasks such as:

- Navigation to desired class/office/labs
- Reminder for class/quiz/assignment
- Student will be able to get News related to campus.

1.5 Contributions

As the system is developed for the student so they can get benefits from the. The system will be available over the internet thus can be accessed easily. The system can be scalable for any of its user.

1.5.1 Existing System

1.5.1.1 Google maps augmented reality*:*

Google maps augmented reality is a huge beacon in the field of augmented reality and outdoor navigation and gave an effective level of attractiveness to the google maps application developed by google as it is the combination of street view and old navigation system. It allows users to see directions of the destination on their mobile screen with the help of graphics in real-time as 3d arrows or character displayed on mobile screen guides the user to find the destination. This application also allowed users to search nearby locations like restaurants, hotels, parks, gyms etc. Problems with this application are that the accuracy of GPS degrades from place to place and sometimes due to bad network connectivity or unavailability of internet and it is not available everywhere in the world like google maps.

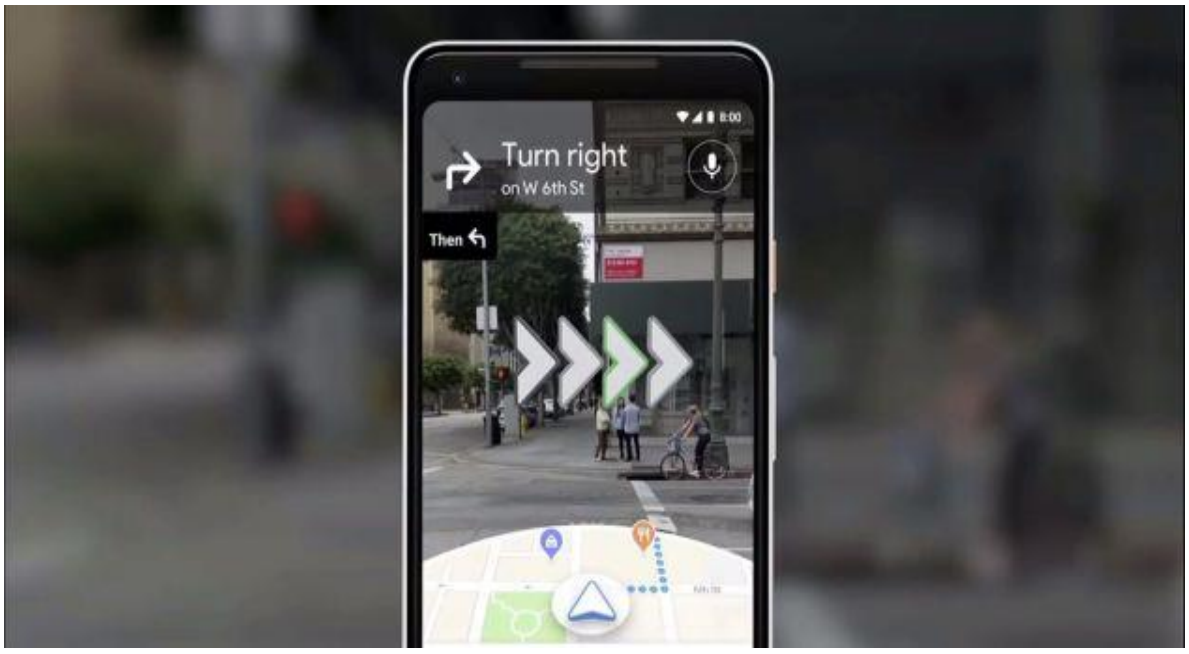

Figure 1.1 Google Maps

1.5.1.2 Gatwick airport app for passenger:

The Gatwick airport app for passenger is another outstanding augmented reality based indoor navigation system developed to facilitate the passengers as it helps them to navigate to their desired

location in the premises of the airport. Instead of GPS the technology used here is Bluetooth beacons for providing the accurate results to the users. Users need to connect his device with the Bluetooth network there.

Figure 1.2 Gatwick

1.5.1.2.1 AR based city:

Like Google maps augmented reality but on smaller scale AR city is also another augmented reality based amazing application developed for outdoor navigation powered by computer vision. This application helps users in some famous locations.

This application uses augmented reality and computer vision to help users to navigate in approximately 300 cities around the world. Also, at some selective locations the have enhanced the AR experience by introducing a new technology known as urban visual positioning, a huge breakthrough in the field of augmented reality, developed with the help of computer vision, provides greater accuracy then GPS (more than 2x). As user navigates the name of building, streets etc. appears on the screen of mobile.

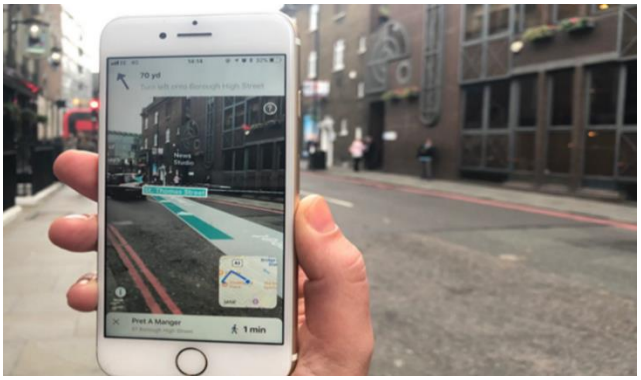

Figure 1.3 AR City

1.5.2 Proposed System

The proposed system uses visual positioning system (VPS) like google Street View data to clarify a user's position in AR-based Outdoor Navigation, using surrounding buildings as reference points.

The core features of the systems are:

- **Navigate to classrooms/offices.**
  Students can use navigation system of this app through their mobile camera. Our project uses AR for the navigation so when the user enters the destination Opus will guide them to their desired location through an arrow guide.

- **Set Reminders**
  User can set Reminders through this application for their quiz assignment and other daily life activities.

- **Get updates about university events.**
  User can also get updates about the event happening or will be happening in the university.

1.6 Report Organization

Chapter 1 discusses the introduction of our project.

Chapter 2 discusses the background study & literature review. We have also analyzed the existing work to further analyze the problem statement and Project solution. Project overview is also discussed in this chapter including project vision, scope, and functions.

Chapter 3 focuses on system requirements including functional and non-functional requirements. It also discusses project feasibility and model analysis.

Chapter 4 discusses system design requirements including design approach, constraints, system architecture, logical design, dynamic view, and component design. It also includes user interface design and system prototype.

Chapter 5 discusses the applicability of the project that involves system implementation strategy, technologies used and mythologies.

Chapter 6 consists of discussion related to the evaluation of the project including all sort of testing like component testing, unit testing, integrated testing, and system testing.

Chapter 7 concludes the thesis by summarizing different aspects of the work including contributions, and future work.

CHAPTER - 2

BACKGROUND AND LITERATURE REVIEW

2 BACKGROUND AND LITERATURE REVIEW

2.1 Project Background

We chose the field of augmented reality for our project, with the goal of assisting newcomers or visitors to campus. This will be a mobile-based application that will play a significant role in the world of technology. Several users will become acquainted with augmented reality because of this project. It is a start, so that locals understand what augmented reality is. This project can be expanded to navigate in hospitals where it is difficult to find wards and departmental buildings. Similarly, we can use the same system to park our car in a mega-parking lot. Most of the time, we forget where we parked our car. With this navigation we can easily access to the path where we had parked the car.

The main purpose of this work is to provide ease to student, visitor, or newcomer of the campus.

- To help the student, visitor, or newcomer to save their time.
- To provide the facility to everyone to direct them towards their location instead of asking someone. because sometimes someone may guide wrong.

We choose Unity as the development environment for this project because it is easy to use and many NavMesh advantages. There are three big components in this project.

- ARCore based localization.
- The navigation
- The AR views.

2.2 Literature Review

As like other projects, this sort of system already does exist. Some of them are:

- **AR based City**
- **AR based Hospital**
- **AR based Market**

2.2.1 AR based City

It is an AR based app that will guide you to famous locations and navigate you on a local track in many different cities.

The app uses augmented reality and computer vision at scale to help you navigate and explore 300 cities around the world. In select locations, we enhance the AR experience with

urban visual positioning, our industry-leading breakthrough in location-based AR that, thanks to computer vision, localizes users with greater accuracy than GPS. Never get lost again by following the 3D instructions. Not just this the names of the streets, cafe and buildings will also appear in front of you.

2.2.2 AR based Hospital

Just like AR city, there is an app for a hospital that shows the user where the child ward, female ward, male ward, doctor's rooms, emergency room, and all other areas of the hospital are. You can reach your desired destination by following the arrow design.

2.2.3 AR based Market

When a new person visits a new place, he may not know exactly where the places are located. As a result, he can use that AR-based market app that is tailored to a specific market. You can enjoy your groceries if you follow the commands.

2.3 Analysis from Literature Review

Our project is primarily concerned with university guidance. This application is being developed specifically for our newcomers and visitors. We created this app to help visitors and students navigate their destination and stay up to date on all upcoming events.

The projects presented in the literature review differ from our project in that their scope is focused on the city, hospital, and market. The main area in which we will be working in this project is navigation system using Augmented Reality and developing a mobile application. This application serves as a virtual guidance agent for visitors who are visiting the university for the purpose of admission or anything else.

This application will also be very useful to all students because it keeps track of upcoming events at the university and where they are being held.

2.4 Conclusion

In this chapter, we have covered the background and literature review of this thesis report. We have discussed the previously created apps like our project. We have also included the research papers that we have studied to get knowledge about the technologies that can be used for our project.

CHAPTER - 3

SYSTEM REQUIREMENTS

3 SYSTEM REQUIREMENTS

In this chapter, system requirements including functional and non-functional are mentioned. System requirements are an import aspect of the whole system. These requirements must be fulfilled at the end. If the system is implemented according to these requirements, it will be considered a complete successful project.

3.1 Functional Requirements

3.1.1 FR #1: Setting the Reminder

The system can set reminders for different daily life tasks.

Output:

The user will get a notification.

Error:

There will not be an error.

3.1.2 FR #2: Edit Reminder

The system allows the user to edit the previously set reminder.

Output:

The notification of the reminder will be shown at the updated time.

Error:

There will not be an error.

3.1.3 FR #3 Delete Reminder

The system will allow user to delete reminder that is already been set.

Output:

Selected reminder will be deleted.

Error:

There will not be an error.

3.1.4 FR #4 Navigation

The system will allow user to navigate through different buildings of campus. User will add his/her destination and the system will guide the user through guide arrows using Augmented Reality.

Output:

The user will reach their destination.

Error:

If the system is not accurate user might end up in some other class/office.

3.1.5 FR #5 Add News

The admin will be able to add a new news related to campus.

Output:

User will be able to see Campus News.

Error:

A human error (wrong spelling etc.) is possible.

3.1.6 FR #6 Delete News

The admin can delete the news that he/she previously uploaded.

Output:

The selected news will be deleted from the database.

Error:

If the internet is not working properly, it might not get deleted.

3.1.7 FR #7 View News

The User will be able to view the news uploaded by the admin through clicking on the news button.

Output:

The user will be able to view the news.

Error:

If the internet is not working properly, it might not work properly.

3.2 Use Cases

3.2.1 Reminder

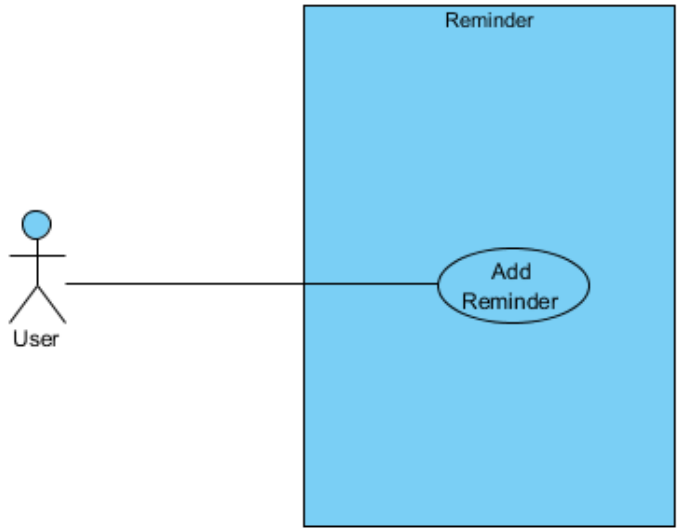

Figure 3.1 : Reminder

Use Case Description:

Use Case ID:	Op_01	
Use Case Name:	Reminder	
Actor(s):	Student	
Pre-Conditions:		
Priority:	High	
Basic Flow:	User can set reminders for quizzes assignment or classes through tapping on the set reminder button	
Actor Actions		**System Response**
1	User taps on Set Reminder button	**2** System will ask for quiz, assignment, or a class reminder
3	User will select the desired option	**4** System will ask for time and date
5	User will provide the system date and time	**6** System will give a reminder at the selected date and time

Table 1 : Use case Reminder

3.2.2 Edit Reminder

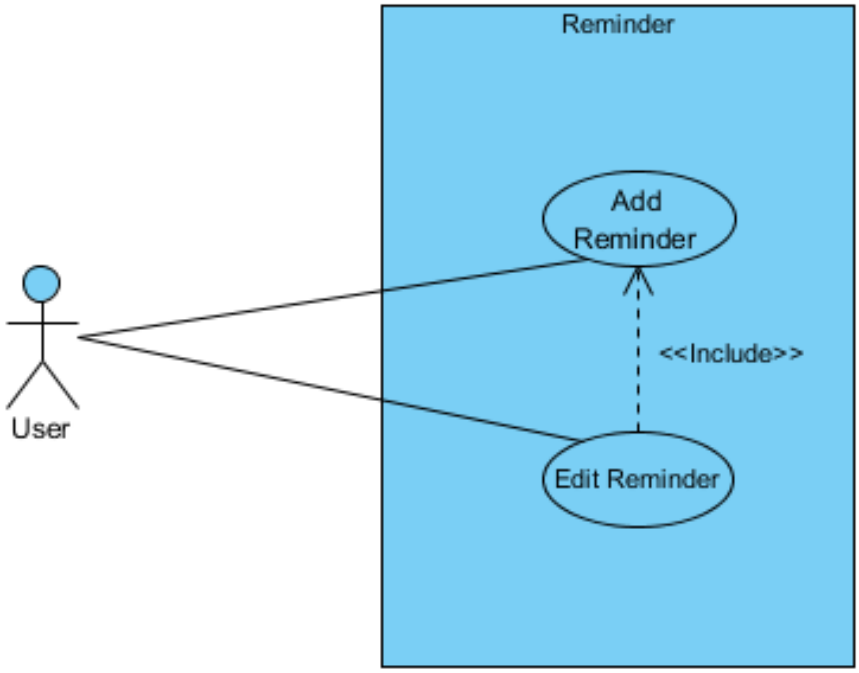

Figure 3.2 : Edit Reminder.

Use Case Description:

Use Case ID:	Op_02	
Use Case Name:	Edit_Reminder	
Actor(s):	Student	
Pre-Conditions:	There should be a reminder that was set before	
Priority:	Medium	
Basic Flow:	User can edit the reminders that was set before	
Actor Actions		**System Response**
1	User taps on My Reminder button	**2** System will show all the reminders
3	User will select the desired reminder	**4** System will show different options related to that reminder
5	User will select the edit option	**6** System will allow the user to edit the reminder

Table 2 : Use case Edit Reminder.

3.2.3 Delete Reminder

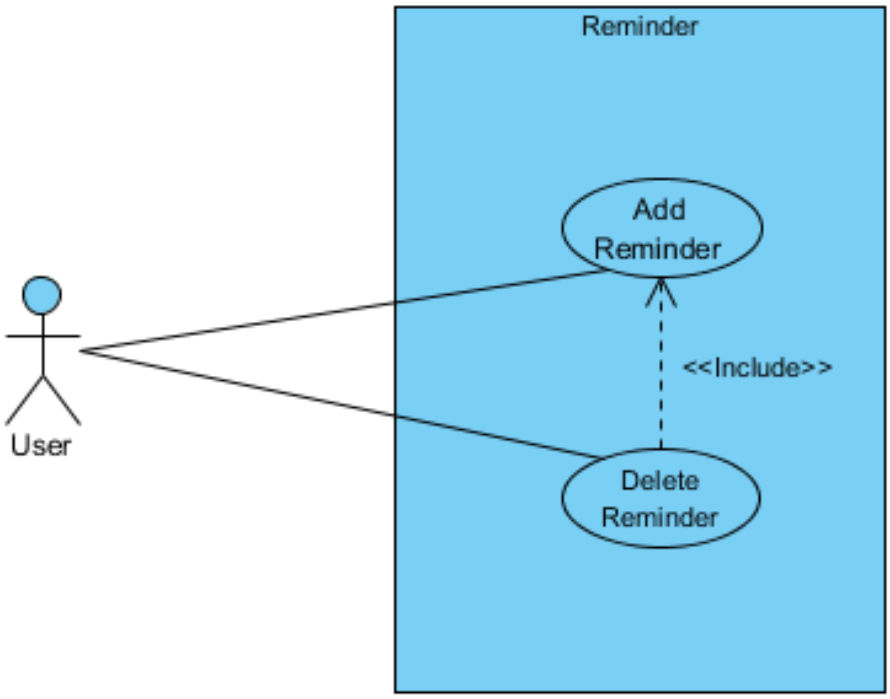

Figure 3.3 : Delete Reminder.

Use Case Description:

Use Case ID:	Op_03	
Use Case Name:	Delete_Reminder	
Actor(s):	Student	
Pre-Conditions:	There should be a reminder that was set before	
Priority:	Medium	
Basic Flow:	User can delete reminders that was set before.	
Actor Actions		**System Response**
1	User taps on My Reminder button	**2** System will show all the reminders
3	User will select the desired reminder	**4** System will show different options related to that reminder
5	User will select the delete option	**6** System will delete the selected reminder.

Table 3 : Use case Delete Reminder.

3.2.4 Navigation

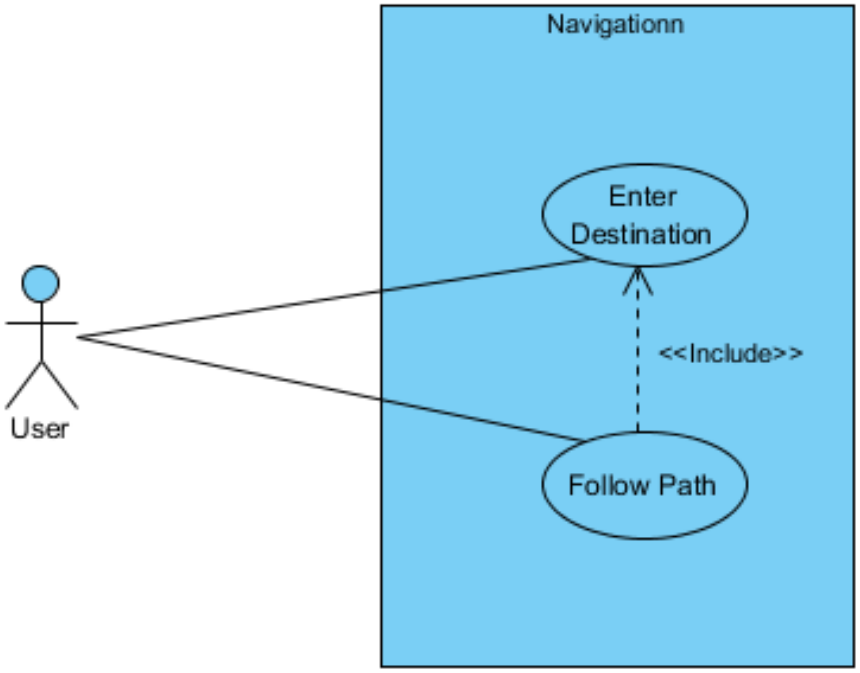

Figure 3.4 : Navigation

Use Case Description:

Use Case ID:	04	
Use Case Name:	Navigation	
Actor(s):	Student	
Pre-Conditions:		
Priority:	High	
Basic Flow:	User can use the app to navigate to various classes, offices, café etc.	
Actor Actions		**System Response**
1	Users click on “Navigate”	**2** System will allow the user to enter destination
3	User will enter the destination	**4** System will ask user to press the localization button
5	User will press on localize button	**6** System will guide the user by giving direction through camera using AR

Table 4 : Use case Navigation

3.2.5 Add Announcement

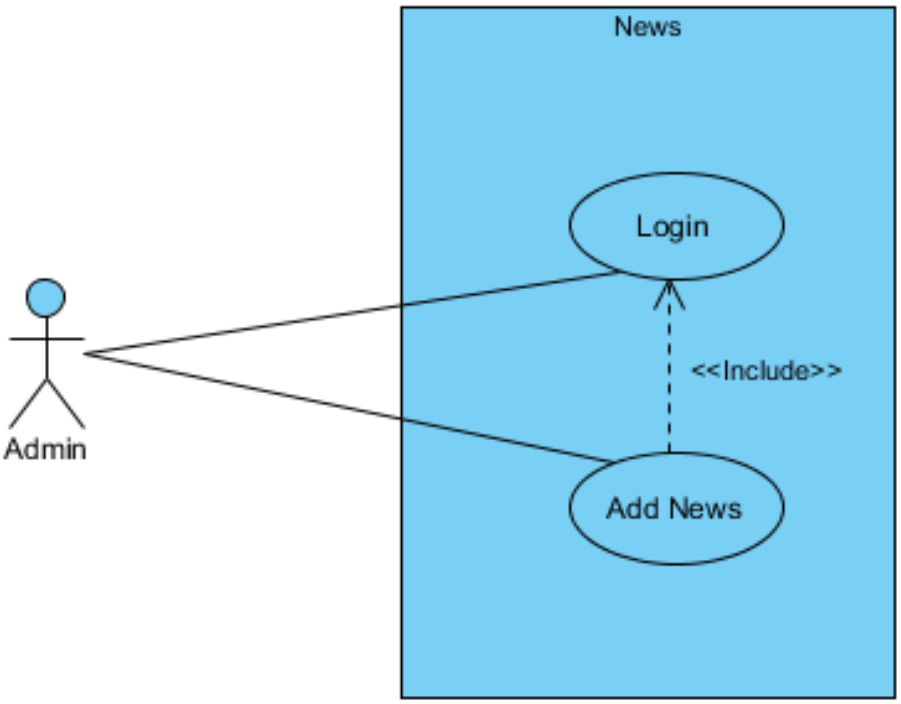

Figure 3.5 Publish News.

Use Case Description:

Use Case ID:	Op_05	
Use Case Name:	Publish_News	
Actor(s):	Admin	
Pre-Conditions:	Admin should have password for the firebase database	
Priority:	High	
Basic Flow:	Admin will update the campus related news	
Actor Actions		**System Response**
1	Admin will login on firebase	**2** System will allow the admin to add News/Announcement

Table 5 : Use case Publish News.

3.2.6 Delete Announcement

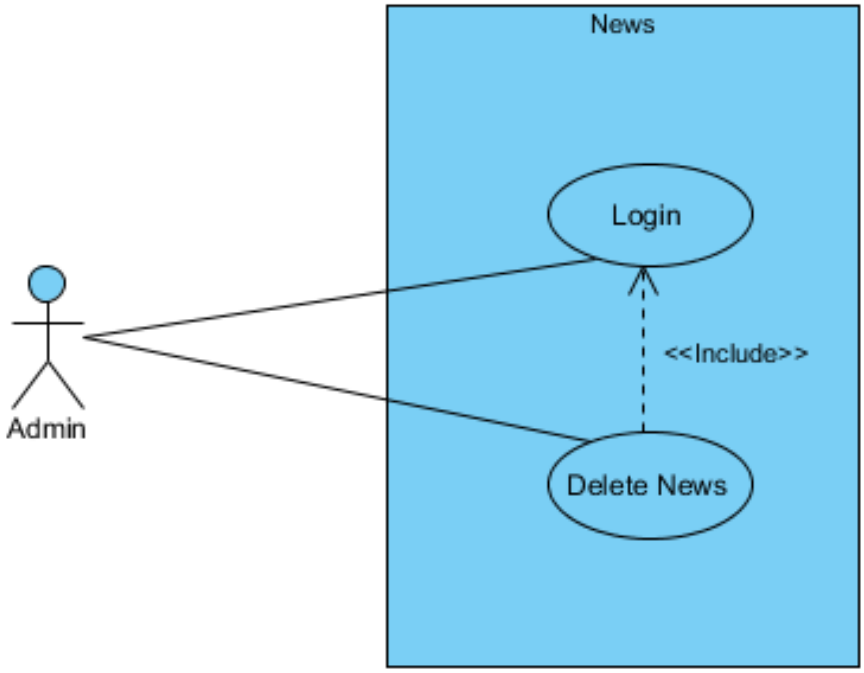

Figure 3.6 : Delete News.

Use Case Description:

Use Case ID:	Op_06	
Use Case Name:	Delete Announcement	
Actor(s):	Admin	
Pre-Conditions:	Log in to firebase	
Priority:	Normal	
Basic Flow:	Admin will be able to delete the updated news if there is any modification required.	
Actor Actions		**System Response**
1	Admin will select the news which needs to be edited	**2** System will show different options related to the news
3	Admin will select the delete option	**4** System will ask for the confirmation
5	Admin will click on the ok button	**6** System will delete the selected news.

Table 6 : Use case Delete News.

3.2.7 View Announcement

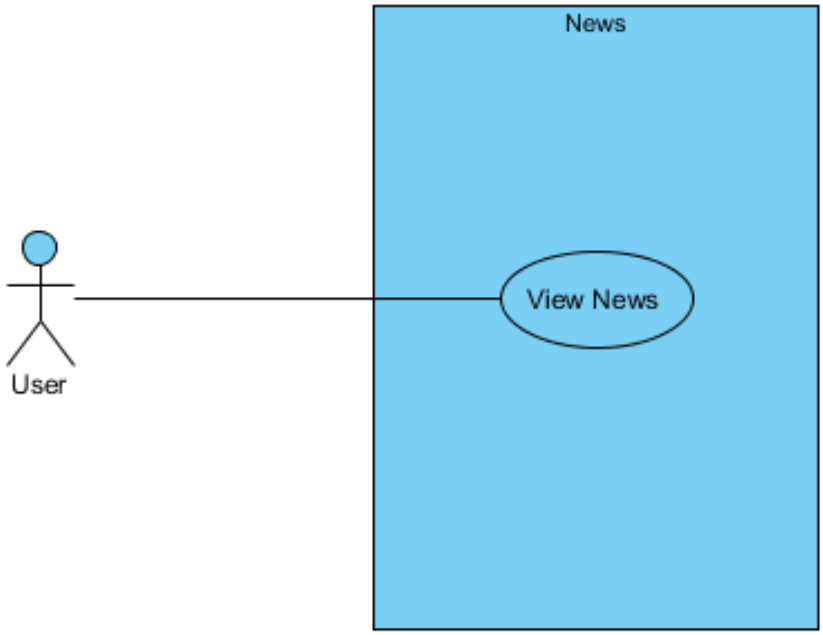

Figure 3.7 : View News

Use Case Description:

Use Case ID:	Op_07	
Use Case Name:	View Announcement	
Actor(s):	Student	
Pre-Conditions:		
Priority:	Low	
Basic Flow:	User can view different campus related news.	
Actor Actions		**System Response**
1	User taps on News button	**2** System will show all the news sorted according to time

Table 7 : Use case View News

3.3 Non-Functional Requirements

3.3.1 Usability

A user-friendly interface is provided by the application to the users. The users can easily reach their destination without anu hurdles.

3.3.2 Dependability

Minimum amount of time will be taken to solve the errors generated by the system.

3.3.3 Performance

The application will be able to provide the path by checking different routes from start to end point using A* Algorithm. The system usage range could also be increased.

3.3.4 Supportability

The application will support Android phones or devices operating Android that supports augmented reality functionality with AR core and have Android 10.

3.4 Database Requirement

For Real Time Data, Firebase database is used for this project.

3.5 Project Feasibility

The feasibility of any project is determined by the problem addressed or the benefits it provides. This application assists students and teachers in navigating to classrooms if they are unfamiliar with the location, as well as remembering the time of a quiz, assignment, or class, among other things. We divide feasibility into the following categories:

3.5.1 Technical Feasibility

This application is developed by using android studio and unity. Application is developed under the operable environment of Bahria University. The system is designed to cope with real life problems of newcomer students or teachers as they are not familiar with the architecture of classrooms or offices.

3.5.2 Operational Feasibility

The system was created in response to the current region's conditions and can be easily applied in this setting. The system is functional in the current environment and can withstand all the conditions and stresses of this region. The system can be moved to any other environment and easily configured for that environment. The system is highly scalable and can be configured in any way.

3.5.3 Legal and Ethical Feasibility

After installation, this application will prompt users to grant permissions for using mobile and accessing current location, addressing all legal and ethical concerns. It will not store any of the user's personal information, and the blueprints of the university will remain private.

3.6 Conclusion

In this chapter, we have covered the requirements of our project. We have covered both functional and non-functional requirements of our project. We have discussed the interface requirements including hardware, software, and database requirements. We have also discussed the project feasibility by considering the technical, operational, and legal feasibility.

CHAPTER - 4

SYSTEM DESIGN

4 SYSTEM DESIGN

4.1 Interface Design

4.1.1 Low Fidelity Prototype

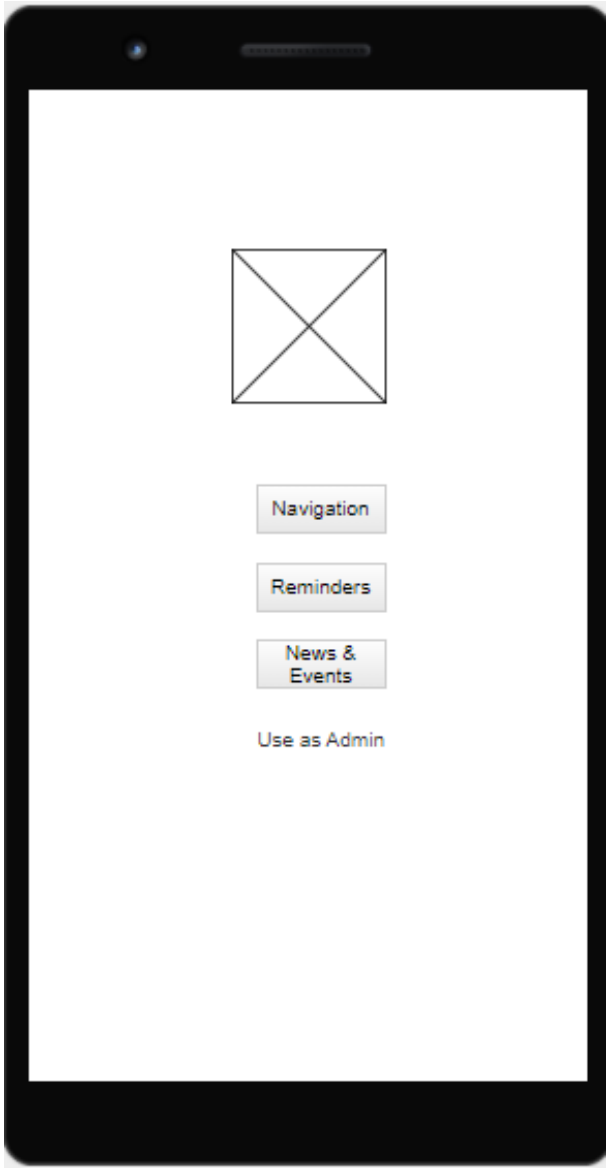

Figure 4.1 : Prototype 1

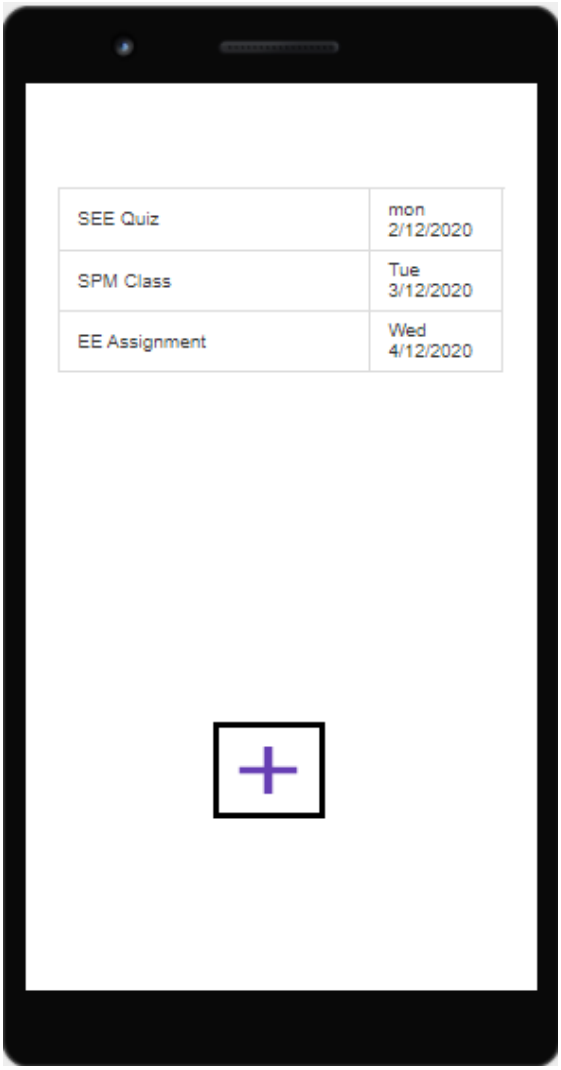

Figure 4.2 : Prototype 2

Figure 4.3 : Prototype 3

4.1.2 High Fidelity Prototype

Figure 4.4 : High Fidelity Prototype 1 (Splash Screen)

Figure 4.5 : High Fidelity Prototype 2 (main menu)

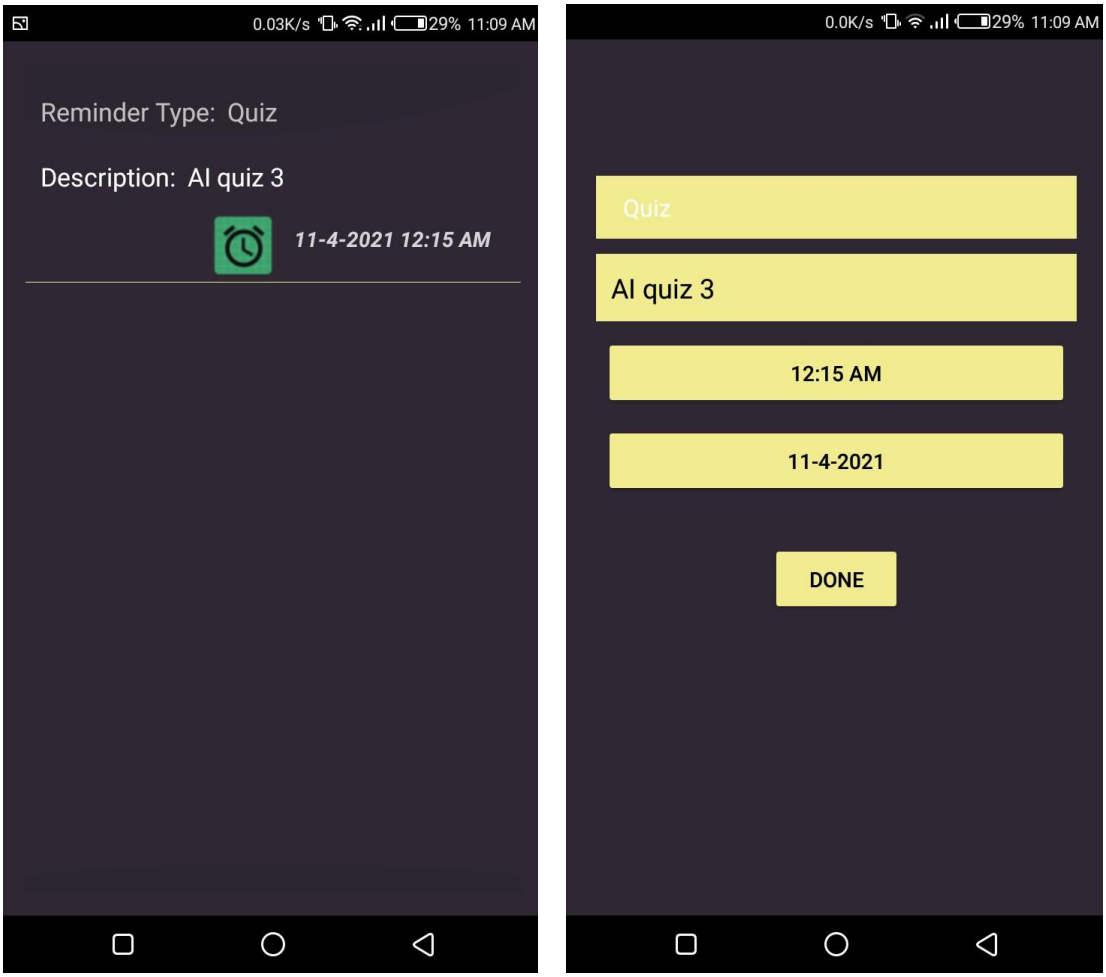

Figure 4.6 : High Fidelity Prototype 3 (Reminders)

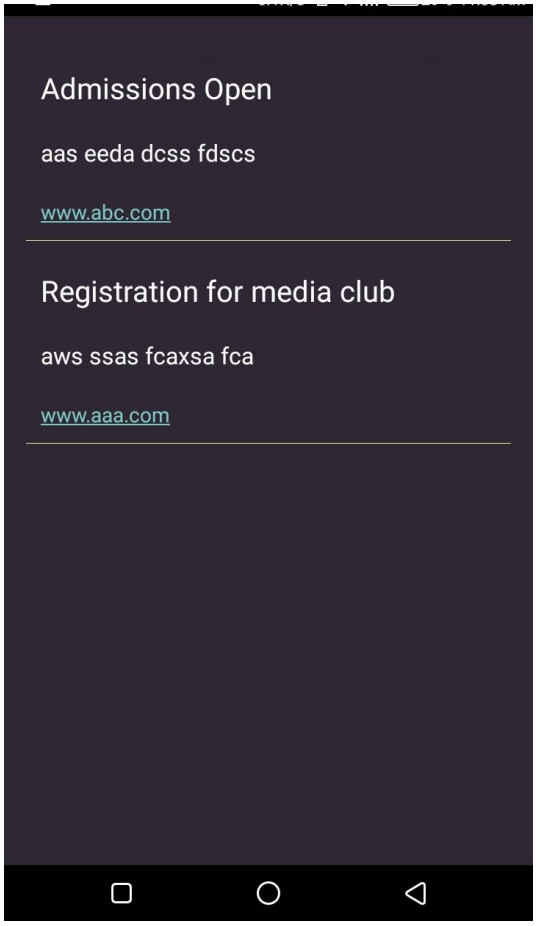

Figure 4.7 : High Fidelity Prototype 4 (Announcements)

4.2 Entity-Relational Diagrams (ERD)

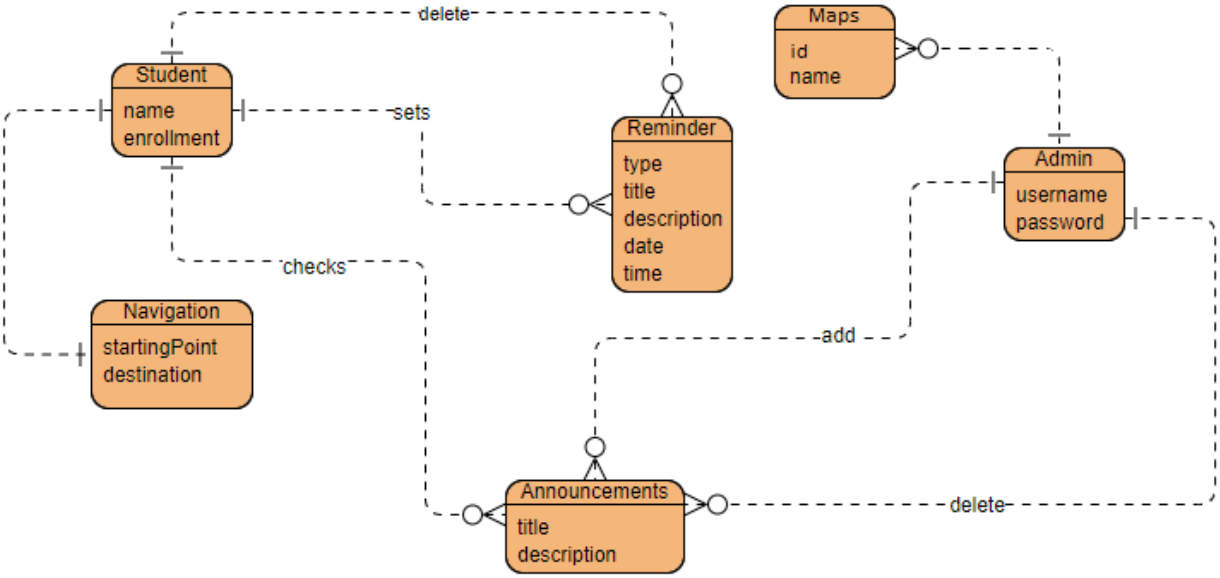

Figure 4.8 : ERD

4.3 Sequence Diagram

4.3.1 Set Reminder

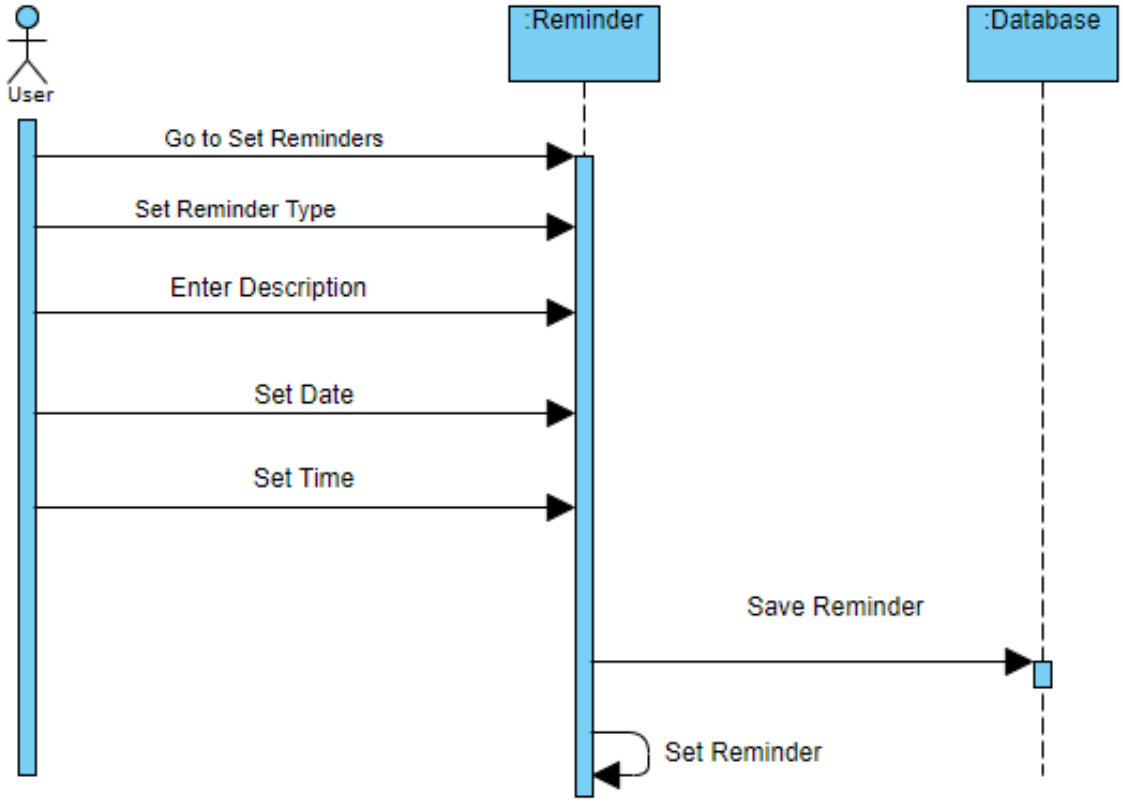

Figure 4.9 : Sequence Diagram (set reminder).

4.3.2 Edit Reminder

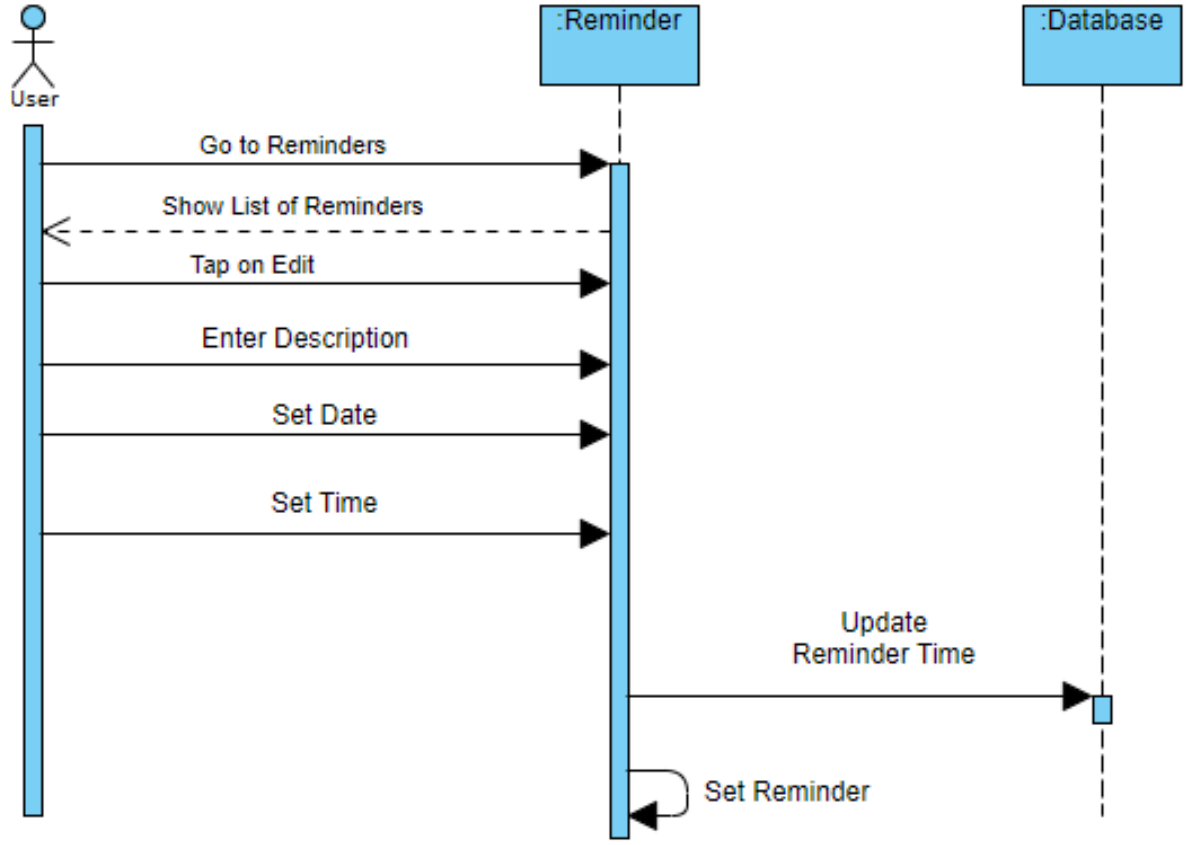

Figure 4.10 : Sequence Diagram (Edit Reminder)

4.3.3 Delete Reminder

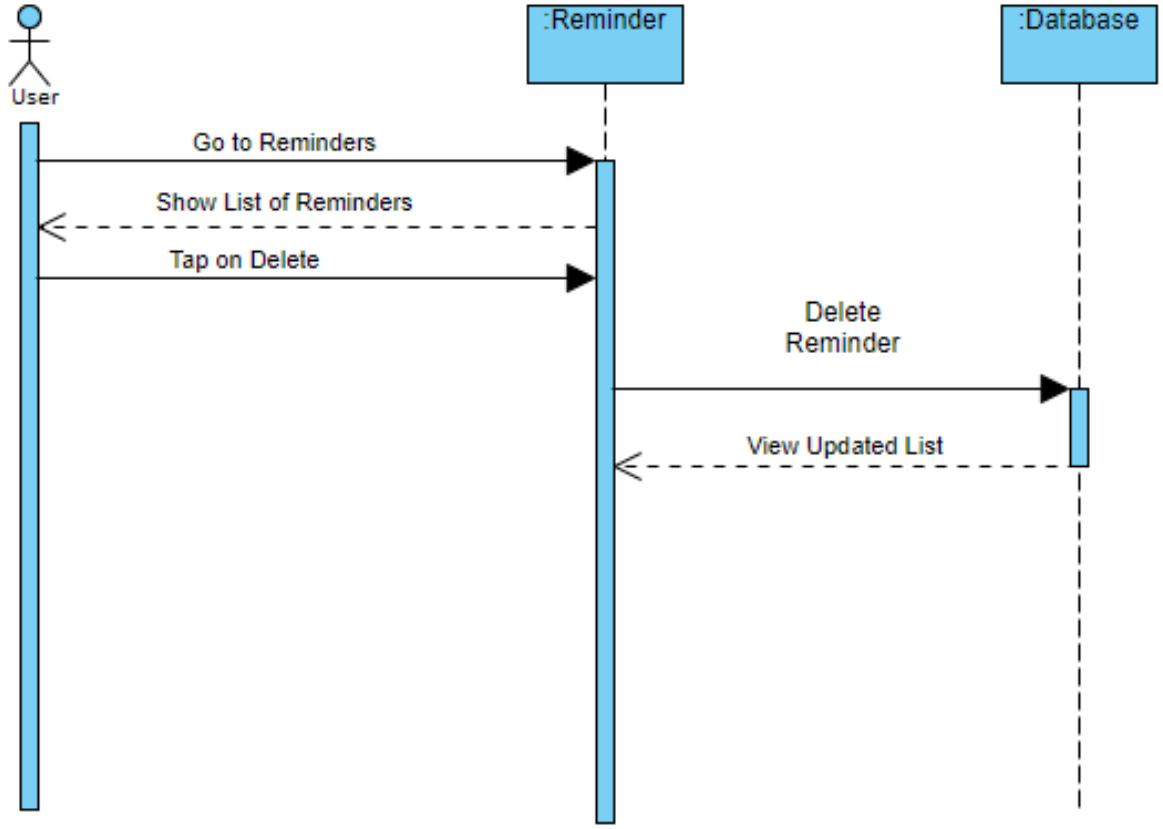

Figure 4.11 : Sequence Diagram (Delete Reminder)

4.3.4 Navigation

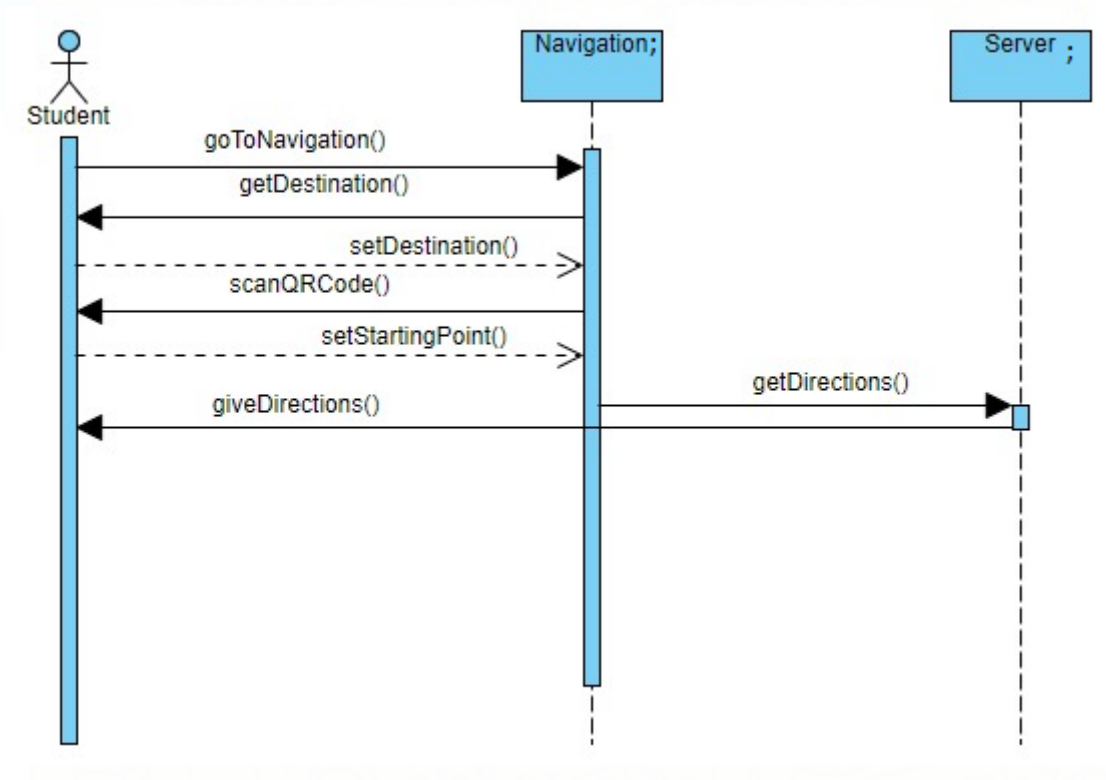

Figure 4.12 : Sequence Diagram (Real Time Controlling)

4.3.5 View Updates

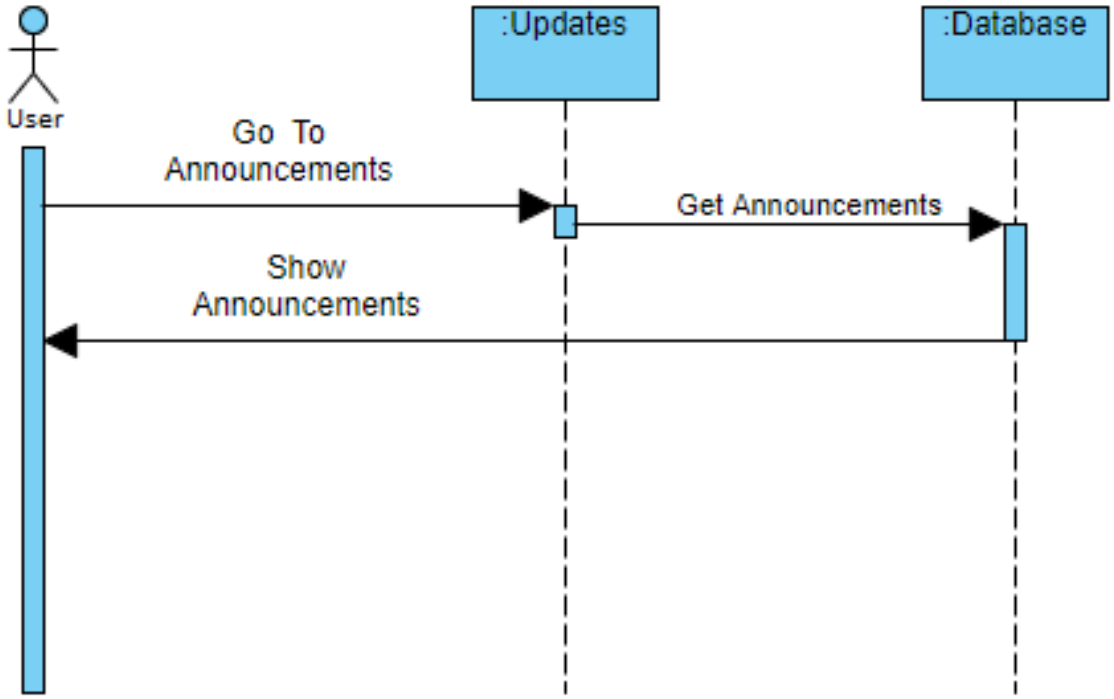

Figure 4.13 : Sequence Diagram (Schedule Controlling)

4.3.6 Add News/Announcement

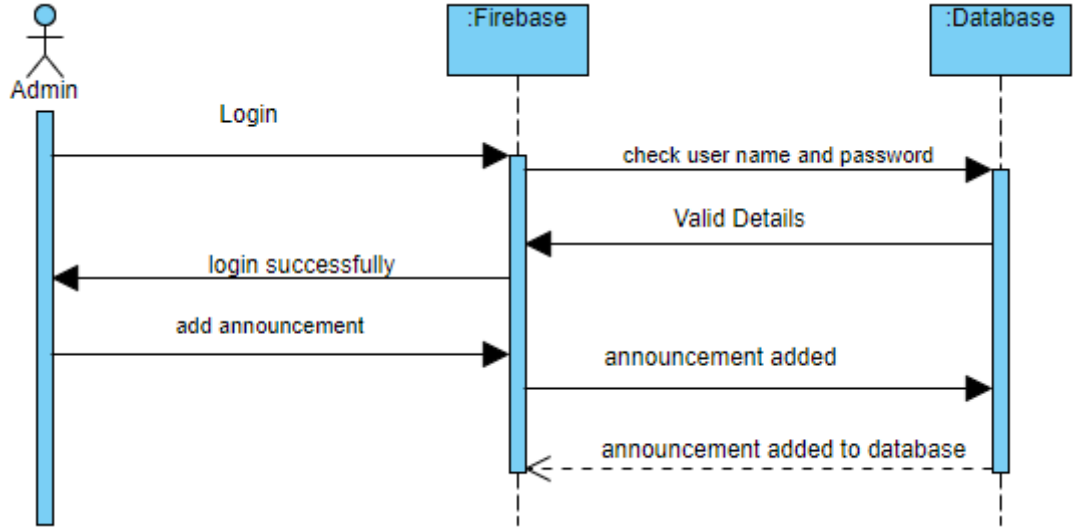

Figure 4.14 : Sequence Diagram (Add News/Announcement)

4.3.7 Delete News/Announcement

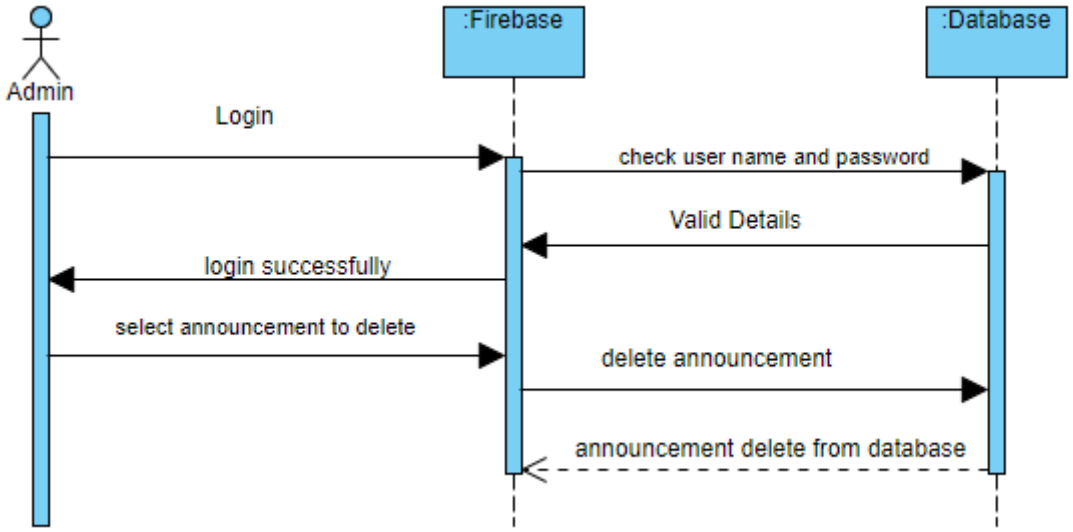

Figure 4.15 : Sequence Diagram (Delete News/Announcement)

4.4 Class Diagram

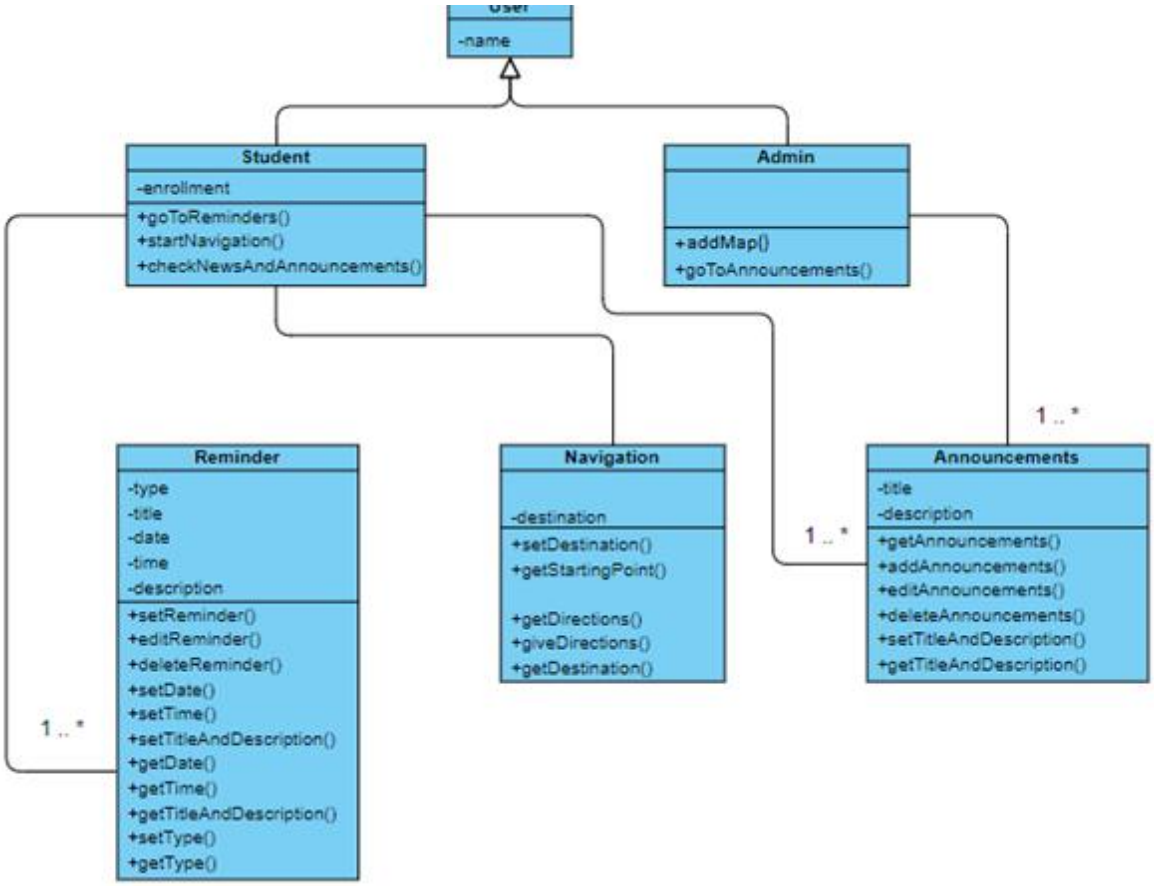

Figure 4.16 : Class Diagram

4.5 Conclusion

In this chapter, we have discussed the System design related constraints and system architecture. We have covered the logical design of our system by including Class and ER diagram. We have also covered the dynamic view of our project by including state, sequence, and activity diagrams.

CHAPTER - 5

SYSTEM IMPLEMENTATION

5 SYSTEM IMPLEMENTATION

5.1 Strategy

The strategy used in the development of this application is lengthy, but it is summarized here. The effort was split into three parts because the application is a combination of an alarm clock, notification system and a navigation system.

For alarm clock and notification system we use android studio for implementation of alarm clock for giving reminder and firebase real time database for giving announcements to users posted by admin.

For navigation system first we made floor plans of the university and then we used ARway Kit which is an SDK used to manage point cloud maps AR content of maps.

5.2 Tools Used

Following are the tools and technologies used in this project are:

Unity 3D
Unity is a platform developed by Unity Technologies to develop cross platform 2d and 3d games.

Visual Studio
Visual Studio is an IDE by Microsoft used to write and edit scripts for the application which is developed by unity.

Android Studio:
Android Studio is an IDE used to develop android applications and some of the components of OPUS are developed by using this IDE.

Azure spatial Anchors:
Microsoft Azure Spatial Anchors is cloud service and a platform that enables developers to create mixed reality applications. It provides anchors which is a digital content placed in a physical location where it can be seen by other devices on same location relative to environment by using augmented reality-based applications.

ARway Kit
ARway Kit offers a full-stack solution integrated with Mapping and Localization it provides a Web Studio where developers can manage point clouds maps (Map layer) and AR content maps (Application layer) easily in Real-time.

Firebase:
Firebase is cloud based no sql database that we are using to store our data regarding the announcements.

5.3 Algorithms

There are lots of algorithms that can be used in construction of this project, but we used A* algorithm.

A* Algorithm:

A* algorithm is the extension of breadth first search algorithm and it used to find the shortest path between two points. Most applications that involve navigation use this algorithm.

Working:

A* Algorithm uses the following function to find shortest path:

$$f(n) = g(n) + h(n)$$

where, n is the last node on the path, g(n) is the cost of the path from start node to the ‘n node and h(n) is a heuristic function that estimates lowest cost path from node ‘n’ to the destination node.

5.4 Methodologies

The system was created utilizing an iterative software development cycle paradigm. The main goal during development was to build the project in chunks and test those chunks repeatedly to achieve high performance.

5.5 System Architecture

The architecture is built on the Model-View-Presenter design pattern. It divides the software into three parts: the user interface (UI) (view), the business logic (model), and presenter components that allow communication between the view and the model. The ease of implementation within Unity and the developer's experience with the pattern were two of the decision forces that led to the selection of this pattern.

5.5.1 Data Layer

This is the database access layer, also known as the Database Operation layer. This layer is used to process data. Because this layer is entirely based on database operations, it could be considered a data manipulating layer. This layer makes use of data manipulation language, and in our case, we used Firebase Realtime Database, a cloud-hosted NoSQL database that allows you to store and sync data between your users in real time for announcements. We

also used azure spatial anchors for navigation, which is a managed cloud service and developer platform that enables multi-user, spatially aware mixed reality experiences on iOS, and Android devices.

5.5.2 Processing Layer

This layer is used for data retrieval and data insertion. This layer is known as the middle layer because it connects the presentation layer and the Data Manipulating layer. This layer has access to both architecture's layers. This layer connects the two previous layers. This is where business logic codes are written.

5.5.3 Presentation Layer

The final layer is also known as the front end. This layer, which is the most important, communicates directly with the user. This layer obtains information from a database. This layer also handles data flow from the user end to the database. This layer is also known as the interaction layer, which is why it takes so long to design. The only way to communicate with this layer is through the data layer.

5.6 Conclusion

In this chapter, we have discussed the thorough implementation of our project. We have discussed the programming languages used for the development as well as the algorithm used, and the databases used. We have discussed the methodology that is used for the development of our project.

CHAPTER - 6

SYSTEM TESTING

6 SYSTEM TESTING

6.1 Test Strategy

Testing is an important part of the system or software completion process because it controls quality and ensures quality engineering. To test the quality of software, various strategies can be used. Testing is required prior to system deployment, and it ensures that the system is bug-free and simple to use. It also gains credibility. While building, we performed unit testing on each component, followed by component or module testing. After system integration, we implemented a full testing mechanism by declaring some test cases, which we then applied to our system and generated a report.

6.2 Unit Testing

The software is built in units, or by combining small chunks into one large unit. The small chunks or codes were tested during the construction process. These small tests on these chunks are referred to as unit testing, in which one unit of the project is observed and tested. Unit testing is critical for avoiding logical and business logic errors.

Separate tests are performed on the hardware and software units. The hardware units are thoroughly tested, and the embed code is stress and load tested. Multiple routines were tested, and the best one was chosen.

6.3 Integration Testing

Several components are joined together to complete the project during system integration. The testing that occurs when these components are combined is referred to as an integration test.

Hardware integration takes a long time during the development process, and the same is true for the testing phase.

6.4 System Testing

The entire system was developed in this step, and the testing now leads to the system's overall testing. The system is tested using test suits that contain test cases that are more commonly pre-defined. The report for each test case is saved.

6.5 Test Suits

Following are the test suits that are applied on the system for its testing.

Software Test Suits

- Scanning Environment
- Localization
- Navigation

6.5.1 Test Case for Scan Environment.

Test Case ID: TO-01	
Test Case Name: Scan Environment	
Pre-Conditions: User must open the mapping application	
Typical Course of Action	
Action	**System Response**
• Open the mapping application. • Move slowly to capture maximum number of points. • Look around and cover area twice. • Keep your phone vertically straights.	• App ask user to enter his/her login details. • Improves the quality of cloud points. • Improves mapping results. • Help to make mapping process more accurate.
Result	Pass

Table 8 : Scan Environment

6.5.2 Test Case for Localization.

Test Case ID: TO -02	
Test Case Name: Localization	
Pre-Conditions: User must select his destination.	
Typical Course of Action	
Action	**System Response**
• Select any destination point. • Lost tracking.	• App show him/her the navigation arrows towards destination. • Repeatedly checks in the cloud database to get current position of user.
Result	Pass

Table 9 : Localization

6.5.3 Test Case for Navigation.

Test Case ID: TO -03	
Test Case Name: Navigation	
Pre-Conditions: User must select his destination.	
Typical Course of Action	
Action	**System Response**
• Select any destination point. • Follow the navigation arrows.	• App show him/her the navigation arrows towards destination. • Guide him/her towards his/her destination.
Result	Pass

Table 10 : Navigation

6.5.4 Test Case for Reminder

Test Case ID: TO -04	
Test Case Name: Reminder	
Pre-Conditions: User must click on Reminder Button.	
Typical Course of Action	
Action	**System Response**
• Click on Reminder button. • User will enter the date and time.	• App will ask user to enter date and time. • App will give the notification at the selected date and time.
Result	Pass

Table 11 : Reminder

CHAPTER - 7

CONCLUSION

7 Conclusion

This document addresses all the technical and non-technical constraints. The Opus is a virtual assistant for Bahria University students that will assist them in navigating the university and remembering important events.

This is an open-source system that can be used for navigation not only by students but also by visitors. This document explains the entire development cycle to the best of its ability. It contains all the design specifications needed to develop the system. This document serves as a technical document for developers and researchers, and it will assist lay audiences in learning about the system in detail and understanding the system's fine details specifications.

The system is extensible and has room for improvement. The system is designed in such a way that it can be scaled to any level at any time.

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