A

PROJECT REPORT

ON

AR based Indoor Navigation System for DKTE College

SUBMITTED TO

SHIVAJI UNIVERSITY, KOLHAPUR

IN THE PARTIAL FULFILLMENT OF REQUIREMENT FOR THE AWARD OF DEGREE BACHELOR OF ENGINEERING IN COMPUTER SCIENCE AND ENGINEERING

SUBMITTED BY

MR. Prajwal Vidyasagar Mane	**19UCS081**
MISS. Anjali Mukesh Shamwani	**19UCS117**
MISS. Varsha Vijay Wani	**19UCS136**

UNDER THE GUIDANCE OF

Prof. Sambhaji D. Rane

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DKTE SOCIETY'S TEXTILE AND ENGINEERING INSTITUTE, ICHALKARANJI

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D.K.T.E. SOCIETY'S

TEXTILE AND ENGINEERING INSTITUTE, ICHALKARANJI
(AN AUTONOUMOUS INSTITUTE)

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

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CERTIFICATE

This is to certify that, project work entitled

"AR based Indoor Navigation System for DKTE College"

is a bonafide record of project work carried out in this college by

MR. Prajwal Vidyasagar Mane	**19UCS081**
MISS. Anjali Mukesh Shamwani	**19UCS117**
MISS. Varsha Vijay Wani	**19UCS136**

is in the partial fulfillment of award of degree Bachelor in Engineering in Computer Science & Engineering prescribed by Shivaji University, Kolhapur for the academic year 2022-2023.

Prof. Sambhaji D. Rane Sir
(PROJECT GUIDE)

PROF.(DR.) D.V.KODAVADE
(HOD CSE DEPT.)

Prof.(Dr.) L.S.ADMUTHE
(DIRECTOR)

EXAMINER: _____

_____

DECLARATION

We hereby declare that, the project work report entitled "**AR based Indoor Navigation System for DKTE College"** which is being submitted to D.K.T.E. Society's Textile and Engineering Institute Ichalkaranji, affiliated to Shivaji University, Kolhapur is in partial fulfillment of degree B.E.(CSE). It is a bonafide report of the work carried out by us. The material contained in this report has not been submitted to any university or institution for the award of any degree. Further, we declare that we have not violated any of the provisions under Copyright and Piracy / Cyber / IPR Act amended from time to time.

Name	**PRN**	**Signature**
MR. PRAJWAL VIDYASAGAR MANE	19UCS081	
MISS. ANJALI MUKESH SHAMWANI	19UCS117	
MISS. VARSHA VIJAY WANI	19UCS136	

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We feel gratified to record our cordial thanks to other staff members of the Computer Science and Engineering Department for their support, help and assistance which they extended as and when required.

Thank you,

MR. PRAJWAL VIDYASAGAR MANE	19UCS081
MISS. ANJALI MUKESH SHAMWANI	19UCS117
MISS. VARSHA VIJAY WANI	19UCS136

ABSTRACT

This project aims to design and develop an Indoor Navigation System using Augmented Reality (AR) for DKTE College. The project addresses the problem of navigation within the college campus, where students and visitors often face difficulties in finding their way to various locations. Traditional navigation methods such as beacons, Bluetooth, and Wi-Fi have their limitations, and hence, an AR-based solution is proposed.

The project focuses on creating a visually immersive and user-friendly navigation experience by leveraging AR technology. The system utilizes an environment scanner to create a feature map of the college campus. This map is then merged with a digital map created in Autodesk using the Unity engine. The resulting AR-based system enables users to visualize accurate short paths for navigation, helping them reach their desired locations within the college campus efficiently.

The development process involves several key steps, including data collection through environment scanning, integration with the Unity engine, and the implementation of the AR navigation system. The project follows ethical guidelines, ensuring the privacy and security of users' data and respecting the college's policies and regulations.

The potential applications of this AR-based Indoor Navigation System extend beyond DKTE College, as similar challenges exist in various indoor environments such as hospitals, museums, and large buildings. By successfully implementing this project, it paves the way for further advancements in AR-based navigation systems and contributes to enhancing the overall navigation experience in indoor settings.

Overall, this project demonstrates the feasibility and effectiveness of using AR technology for indoor navigation, providing a practical solution to address the navigation challenges faced within DKTE College and laying the foundation for future research and development in the field of AR-based navigation systems.

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1.Introduction

This section provides an overview of the entire requirement document. This document describes all data, functional and behavioral requirements for software.

A Mobile Augmented Reality indoor navigation framework composed of several modules to reduce human cognitive workload and save time by blending the digital and physical worlds seamlessly through aligning the appropriate 3D path with features in the real world through ground detection.

The results that the system will provide should have a good platform to show the location information without requiring hardware installation and a strong wireless connection.

Augmented reality

Augmented reality is a technology that overlays computer graphics that have registered in the 3D space on top of the real world, where the real world is the primary place of action. Besides, both interact with real-time updates where the movement of the user has direct effect in the virtual element when present on the computing device's screen. It differs from virtual reality as it does not create a whole new artificial world, but it adds some virtual model to the existing physical environment. There are a few types of Augmented Realities as listed below:

Marker-based AR:

Marker-based AR is a type of AR that detect the visual marker like QR and 2D through camera's phone. After that, the virtual object is rendered over the marker after series of calculations and considers the angle and distance between a mobile phone and the marker.

Marker-less AR:

Marker-less AR or location-based AR involved location tool like GPS to obtain user's geographical position so that it shows relevant virtual information about the nearby landmark or directions of location in augmented view.

Projection-based AR

Projection-based AR projects the light of image to the real object which then human can interact with the help of sensors. The masking technique is used to align the projecting image with the object by tracking the object's silhouette (Lee, Kim, Heo, Kim, & Shin, 2015).

Superimposition-based AR:

Superimposition-based AR determines a cluster of markers on a real object in order to estimate the local coordinate based on optimization method. After this is all obtained in the transformation matrices, the process of stereoscopic rendering happens to replace the original image with the augmented one.

In addition to that, there are many existing development software for AR like ARToolKit, ARKit, ARCore and Vuforia. Lastly, the advantage of AR is it provides a more "real" gaming experience through enhancing the perception of the user and their interaction. Furthermore, it also applied in education field where the supplementary interactive information like video and graphics make the learning process more interesting and easier to absorb new knowledge.

When GPS was invented in 1978 and made available to the public in the following decade, navigation changed profoundly. As it guides automobiles, airplanes, and ships at sea, GPS has had a tremendous impact on how we get around. However, there are still challenges to be overcome. How can augmented reality be used to guide users in indoor and outdoor environments?

Augmented reality allows for powerful and intuitive solutions in navigation. By showing virtual guides in physical space through the view of a smartphone or headset, users can be directed point to point more naturally than by comparing a map to their immediate surroundings. Due to this great benefit, AR navigation can help in both indoor and outdoor environments.

Augmented reality development is easy to get into, but difficult to master. With the demand growing for more complex and higher quality AR software products, many organizations are shifting toward more specialized solutions to suit their needs. AR indoor and outdoor navigation are tasks that require a more specialized solution based on the environment at hand, requiring special hardware, technology, and expertise to implement successfully.

WHY GPS ISN'T ENOUGH

The global positioning system (GPS) may have fundamentally changed how we traverse the Earth, but it has serious limitations for certain use-cases. Even though the United States Department of Defense allowed increased precision of GPS in 2000, GPS still is not 100% precise in all situations, especially indoors.

GPS is made possible with satellites and clever exploitation of the Doppler effect. Ground stations use radio signals to determine where GPS satellites are in orbit around the Earth. Your cell phone or car detects signals from these satellites and determines the distance of four or more satellites.

Although the precision that this technology offers is incredible, it has limitations. If for any reason these radio signals are blocked, pinpointing your location is significantly more difficult or impossible. Water, dirt, walls, tall city buildings, and other obstructions can

disrupt GPS reception significantly. Accuracy on its own can also be limited by a number of factors and errors. If we need to determine someone's position inside a building or in an exact position in a dense downtown area, GPS can only do so much to support AR navigation.

BLE BEACONS: THE IOT APPROACH TO NAVIGATION

Bluetooth low energy (BLE) beacons function similarly to lighthouses. These IoT devices, often used in smart city solutions, broadcast unique radio signals to BLE-enabled devices like smartphones. These beacons do not necessarily know what devices receive this information and cannot communicate with those devices.

The packets of data that these beacons transmit may contain information other than its ID. It may also contain sensor data that the beacon is programmed to measure. When this information is received by a smartphone or other device, it can take some action based on the information from the beacon.

BLE beacons present a variety of applications such as identifying points of interest to users and tracking moving objects like vehicles and cargo. However, some promising applications are indoor positioning systems and real time locating systems (RTLS). Indoor positioning system beacons help devices locate their positions within buildings by measuring signals from these beacons. Conversely, RTLS works by placing beacons on moving objects and having them transmit signals to localizing edge devices.

BLE beacons offer much more precision for AR-based navigation solutions, especially AR indoor navigation technology. However, this infrastructure does need to be present in order for it to succeed.

VISUAL POSITIONING SYSTEM (VPS) – NAVIGATION POWERED BY AI

This innovative technology mimics how we determine our location in the real world. Just as we search for landmarks with our eyes, visual positioning systems (VPS) can use your smartphone's camera to analyze your surroundings and determine your location.

AR Navigation: How It Works

Augmented reality navigation is an innovative solution that incorporates the above technologies for indoor and outdoor solutions. The primary goal of this technology is to provide directions to users on screen overlaid on top of real environments seen through the camera of a device like a smartphone or headset. This alleviates the challenge of comparing

the real world against a reference like a map which is more difficult for users to use while navigating.

Thus, there are two parts to AR navigation, the first being the actual navigation and localization, and then the display of AR directions as text, arrows, and paths on the screen. This second step is the easiest part of the whole process, with the more challenging element being identifying the user's position.

In outdoor settings this is generally simple unless there are interfering obstacles as described earlier. However, indoor environments generally require more powerful infrastructure like BLE beacons.

There are two development platforms primarily used for AR development on mobile devices: ARKit for iOS and ARCore for Android. These development environments are responsible for translating device movement and sensor analysis into information to show a renderer know how to draw virtual objects on the screen so that they appear to reside in the real world.

a) Problem definition

PROBLEM STATEMENT

Indoor-Navigation System for DKTE College Using Augmented Reality

The problem addressed in this project is the need for an efficient and accurate indoor navigation system for DKTE College using augmented reality. The current methods of navigation using beacons, Bluetooth, or Wi-Fi present their own set of challenges and limitations. To enhance the system's functionality and user experience, a new approach will be implemented. The aim of this project is to integrate QR code scanning functionality into the existing indoor navigation system, enabling users to scan QR codes placed at specific locations within the college campus and receive relevant augmented reality information.

To achieve this, the project will involve several key implementation details. Firstly, the environmental scanner will be replaced with a QR scanner, allowing users to detect and recognize QR codes placed at various locations. These QR codes will contain location-specific information used to provide augmented reality navigation guidance. Secondly, the data integration module will be updated to incorporate NextEchar's Maps Studio as the data source, enabling the import of floor plans and relevant map data. This updated data, combined with the scanned QR codes, will enable accurate indoor navigation paths to be generated.

By integrating QR code scanning and augmenting reality technology, this project aims to enhance the indoor navigation system for DKTE College. Users will benefit from an improved and more interactive navigation experience, providing them with efficient and accurate guidance within the college campus.

b) Aim and objective of the project

The main purpose of the AR based Navigation System is to help users find classrooms, labs, auditorium, departments, cabins, and other important places on the college campus. To enhance the user experience of the user who's finding a particular location around the campus. To minimize the time used by a person to a specific location in the campus. Using the mobile phone to find a place at the campus.

Objectives:

- To use augmented reality to show navigation paths to the user.
- Integrate QR code scanning for precise location recognition.
- Update data integration using NextEchar's Maps Studio for accurate floor plans and map data.
- To create the navigation paths
- Listing the most widely used destinations in the app.

The goal of AR based Navigation System is to build a Navigation system for the DKTE college Building so that the user can use his/ her mobile phone e.g., Android or iPhone to

Overall goals of project and specific software objectives description.

c) Scope and limitation of the project

Students at the college often have a hard time finding the labs and faculty rooms. They usually ask someone else for the desired location that they wish to go to. This problem can be solved with Augmented Reality. By creating an augmented reality-based system for the users to travel wander around the campus. This augmented reality-based system can be used by the students and the new people who visit the college. By simply taking out their phones and by using the AR based app that they would install, Navigation paths will be shown on their camera view. This way, they will have the exact path to follow to arrive at the destination they desire.

Limitations include adding new destinations and updating the map and the feature maps. The modification of the maps will require a considerable amount of effort if new structures are being constructed. This will require the technician to scan the new environment and mimic the map according to the actual building.

d) Timeline of the project

Based on the project's timeline, the project can be divided into the following phases:

Phase 1: Requirement Analysis (November 2022 - December 2022)

- Task 1: Gather project requirements
- Task 2: Analyze project requirements
- Task 3: Create a requirements specification document
- Task 4: Estimate project costs
- Task 5: Define project timeline

Phase 2: System Design (December 2022 - January 2023)

- Task 1: Develop architectural design
- Task 2: Design user interface
- Task 3: Develop algorithmic description of each module
- Task 4: Create system modeling

Phase 3: Prototype Development (January 2023 - February 2023)

- Task 1: Set up environment for running the project
- Task 2: Develop detailed description of methods
- Task 3: Implement prototype

Phase 4: Integration and Testing (February 2023 - April 2023)

- Task 1: Integrate different modules
- Task 2: Test the system

Phase 5: Performance Analysis (April 2023 - May 2023)

- Task 1: Analyze the performance of the system
- Task 2: Create a final project report

By following the above timeline, the project can be completed successfully within the specified timeframe, from the 2nd week of November 2022 to the 4th week of May

e) Project Management Plan

Project management plan for the AR based Indoor Navigation System for DKTE College:

- Project Goal: To develop an AR-based indoor navigation system for DKTE College by the end of May 2023.
- Project Scope: The system will enable students, faculty, and visitors to navigate the college's indoor spaces using their mobile devices.
- Project Objectives:
    - To analyse the requirements and design an AR-based indoor navigation system for DKTE College by the end of December 2022.
    - To develop a functional prototype of the system by the end of December 2022.
    - To implement the system by the end of April 2023.
    - To test and validate the system by the end of May 2023.
- Stakeholders:
    - Building architects
    - Students
    - Faculty

- Project Milestones

Task	Start Date	End Date	Knowledge Area
Brainstorming for project	November 7, 2022	November 10, 2022	Project Scope Management
Establishing project objectives	November 10, 2022	November 14, 2022	Project Scope Management
Creating project timeline	November 14, 2022	November 16, 2022	Project Time Management
Requirement gathering systern	November 17, 2022	November 30, 2022	Project Scope Management
Requirement specification	December 1, 2022	December 5, 2022	Project Scope Management
Designing system architecture	December 6, 2022	December 16, 2022	Project Integration Management
Developing functional prototype the system	December 17, 2022	December 28, 2022	Project Integration Management
Implementing the system	January 2, 2023	April 16, 2023	Project Integration Management
Testing and validating the system	April 17, 2023	May 12, 2023	Project Quality Management

2. Background study and literature overview

a. Literature overview

Indoor navigation systems have gained significant attention in recent years as they provide an efficient solution to the challenge of navigating in complex indoor environments. A wide range of technologies and techniques have been proposed and developed for indoor navigation, including augmented reality (AR) and vision-based approaches. In this literature survey, we discuss the key findings and contributions of five research papers on indoor navigation systems.

The first paper by Rehman and Cao (2017) proposed an AR-based indoor navigation application that can be implemented on electronic devices such as smartphones or wearable head-mounted devices like Google Glass. The authors compared the performance of Google Glass with handheld navigation aids such as smartphones and paper maps. They conducted both a technical assessment and a human factors study, which showed that the wearable device was perceived to be more accurate, but other performance and workload measures indicated that the wearable device was not significantly different from the handheld smartphone. The results showed that digital navigation aids were better than the paper map in terms of shorter navigation time and lower workload, but digital navigation aids resulted in worse route retention.

Kim and Jun (2008) proposed a vision-based location positioning system using augmented reality for indoor navigation. The system uses image sequences taken of indoor environments to recognize locations and provide augmented reality overlays of the user's view with location information. They pre-constructed an image database and location model, which consists of locations and paths between locations, of an indoor environment to recognize a location. The system provides the ability to identify similar locations in the image database and display location-related information. The system was tested in an indoor environment and achieved an average location recognition success rate of 89%.

Lategahn and Stiller (2014) proposed a vision-only localization system for autonomous and intelligent vehicles that uses only a single monocular camera. The system extracts features from the camera image to yield an ego pose relative to a previously computed visual map. The authors described a process to automatically extract the ingredients of this map. They

tested the system in different indoor environments and demonstrated its potential for accurate ego localization.

Ng and Lim (2020) proposed a mobile augmented reality-based indoor navigation system that uses a smartphone as the platform for location-based services. The system provides indoor navigation with real-time AR overlays, which guide the user to the destination. The system uses image recognition techniques to locate and recognize the destination, and the AR overlays provide real-time directions to the user. The authors conducted a user study, which showed that the system improved navigation performance and user experience in indoor environments.

Kasprzak, Komninos, and Barrie (2013) proposed a feature-based indoor navigation system using augmented reality. The system uses natural features in the environment to locate the user and provide real-time AR overlays. They conducted a user study, which showed that the system provided accurate location and orientation information, and the users found the system easy to use and helpful in indoor environments.

In conclusion, indoor navigation systems have gained significant attention in recent years, and a wide range of technologies and techniques have been proposed and developed to address this challenge. AR and vision-based approaches have shown promising results in providing accurate location and orientation information and improving navigation performance and user experience in complex indoor environments.

b. Critical appraisal of other people's work

Critical Appraisal of Research Papers on Indoor Navigation Systems using Augmented Reality:

The following critical appraisal will assess six research papers that focus on indoor navigation systems that use augmented reality techniques. The research papers include Umair Rehman and Shi Cao's "Augmented-Reality-Based Indoor Navigation: A Comparative Analysis of Handheld Devices Versus Google Glass," Jongbae Kim and Heesung Jun's "Vision-based location positioning using augmented reality for indoor navigation," Henning Lategahn and Christoph Stiller's "Vision-Only Localization," Xin Hui Ng and Woan Ning Lim's "Design of a Mobile Augmented Reality-based Indoor Navigation System," and Sebastian Kasprzak, Andreas Komninos, and Peter Barrie's "Feature-Based Indoor Navigation Using Augmented Reality."

Umair Rehman and Shi Cao's paper presents an augmented-reality-based indoor navigation system that assists people in navigating indoor environments. The authors compare handheld devices and Google Glass as wearable head-mounted devices, conducting both technical assessment and human factors studies. The study found that Google Glass was perceived to be more accurate, but other performance and workload measures indicated that it was not significantly different from the handheld smartphone. Moreover, both digital navigation aids were better than the paper map in terms of shorter navigation time and lower workload, but digital navigation aids resulted in worse route retention. The authors provide empirical evidence supporting future designs of indoor navigation systems, and they discuss implications and future research.

Jongbae Kim and Heesung Jun propose a vision-based location positioning system that uses augmented reality techniques for indoor navigation. The system recognizes a location from image sequences taken of indoor environments and realizes augmented reality by seamlessly overlaying the user's view with location information. To recognize a location, the authors pre-constructed an image database and location model of an indoor environment, which consists of locations and paths between locations. The proposed system was tested in an indoor environment and achieved an average location recognition success rate of 89%. The authors suggest that their system could be applied to various consumer applications, such as the door plate system, notice board system, shopping assistance system, and bus service route guide system.

Henning Lategahn and Christoph Stiller present a vision-only localization system for six-degrees-of-freedom ego localization that uses only a single monocular camera. The camera image is used to yield an ego pose relative to a previously computed visual map. The authors conducted experiments to evaluate their system, and the results showed that their approach achieved a localization accuracy of 1.1 meters, which is comparable to GPS. The authors suggest that their system could be used in autonomous and intelligent vehicles that depend on an accurate ego localization solution.

Xin Hui Ng and Woan Ning Lim propose a mobile augmented reality-based indoor navigation system that uses image recognition and tracking techniques to assist users in navigating indoor environments. The authors conducted a user study to evaluate their system and found that their system improved navigation efficiency and reduced navigation errors. The authors suggest that their system could be used in various applications, such as museum navigation and shopping mall navigation.

Sebastian Kasprzak, Andreas Komninos, and Peter Barrie present a feature-based indoor navigation system that uses augmented reality techniques to assist users in navigating indoor environments. The system tracks the user's location using a mobile device's camera and overlays virtual directional arrows on the user's view. The authors conducted a user study to evaluate their system and found that it improved navigation efficiency and reduced navigation errors. The authors suggest that their system could be used in various applications, such as tourist navigation and museum navigation.

Overall, the six research papers provide valuable insights into indoor navigation systems that use augmented reality techniques. The papers demonstrate that such systems can improve navigation efficiency and reduce navigation errors compared to traditional maps.

c. Investigation of current project and related work

The investigation of the current project and related work focuses on understanding the existing solutions, technologies, and research in the field of Indoor Navigation Systems using Augmented Reality (AR). This investigation serves as a foundation for identifying the gaps, challenges, and opportunities in developing an innovative and effective AR-based navigation system for DKTE College.

1. Review of Existing Indoor Navigation Systems:

- This investigation involves studying various indoor navigation systems that are currently available in different domains such as healthcare, retail, museums, and public spaces.

- The review includes analyzing the technologies employed, user interfaces, accuracy, limitations, and user feedback to gain insights into the strengths and weaknesses of these systems.

2. Evaluation of Augmented Reality in Navigation:

- Understanding the role of augmented reality in indoor navigation is crucial. This investigation focuses on exploring the applications of AR in navigation, including visualizing navigation paths, real-time positioning, and information overlay.

- The evaluation includes examining the usability, user experience, and effectiveness of AR-based navigation systems in different environments.

3. Analysis of Relevant Research Papers:

- Investigating relevant research papers and academic articles provides valuable insights into the state-of-the-art techniques, algorithms, and methodologies used in AR-based indoor navigation.

- This analysis helps identify the advancements, challenges, and gaps in the existing research, which can inform the development of the proposed system for DKTE College.

4. Study of AR Development Tools and Technologies:

- Exploring the available AR development tools, frameworks, and platforms is essential for selecting the most suitable technology stack for the project.

- This investigation includes an evaluation of popular AR development platforms, such as ARKit, ARCore, and Unity, as well as assessing their compatibility, features, and integration capabilities.

5. Identification of Unique Project Requirements:

- Investigating the specific requirements and constraints of DKTE College plays a vital role in tailoring the indoor navigation system to meet their unique needs.

- This investigation involves gathering information about the college campus layout, infrastructure, existing technologies, user preferences, and any specific challenges or considerations that need to be addressed.

By conducting a comprehensive investigation of the current project and related work, the aim is to gain a deep understanding of the domain, technology landscape, and user requirements. This investigation serves as the basis for designing and developing a customized AR-based Indoor Navigation System that effectively addresses the navigation challenges faced by DKTE College while leveraging the advancements and insights from the existing body of work.

3.Requirement analysis

a. Requirement specifications

SR.NO	Requirement	Essentialor Desirable	Description of the requirement	Remarks
RS1	The system should be easy to install the app	Essential	Every visitor at DKTE college will be able to install the app hassle free	App will be available for easy installation.
RS2	The system should give good visualization of the path.	Essential	This will make user have accurate path	It ensures best and accurate experience to user.
RS 3	The system should have user friendly interface.	Essential	To make it easy for all type of users to operate.	It ensures the sustainability of the system.
RS 4	The system should be able to access camera through app.	Essential	This will help in augmenting the path in the real environment	Its purpose is to access outside real world.
RS 5	The User should be able to scan the qr code	Essential	This will help the system identify the location of the user	Its purpose is to show the possible destinations afterwards

b. Use case Diagram

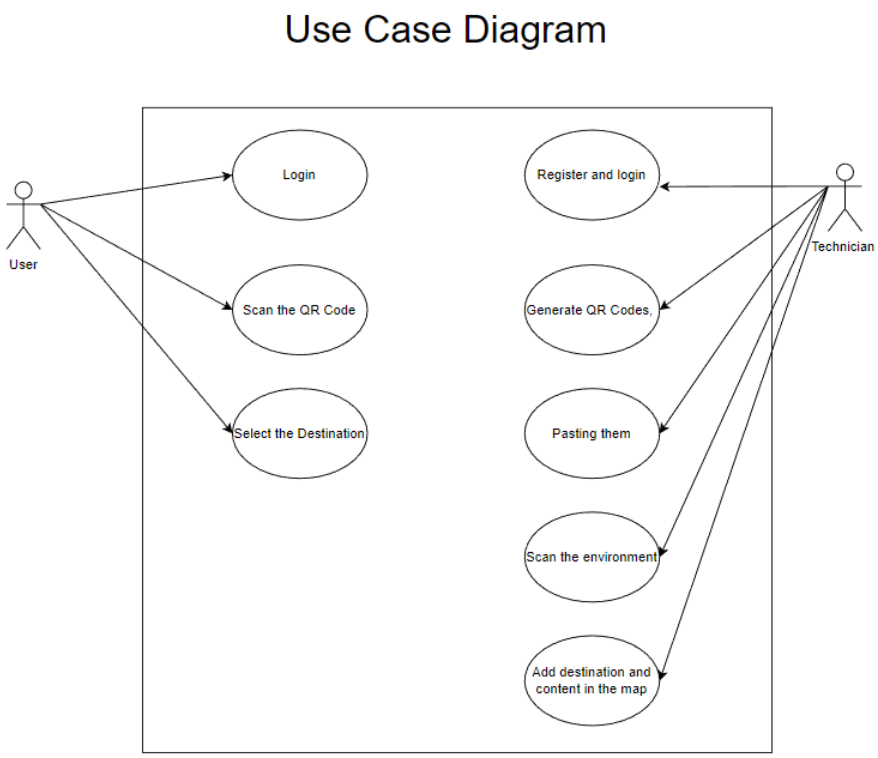


Figure 4.2 Use Case Diagram

Here is the combined use case which shows the general flow of the application where useropens the application, application detects the plane and after user selection of model, it augments it in the environment.

c. Project Costing

9.1 Hardware Cost:

Hardware	Cost
Computer System	Rs. 50,000/-
Smartphone(with AR Compatibility)	Rs. 12,000/-
Internet	Rs. 800/-
Light Source	Rs. 300/-
Total	Rs. 63,100/-

9.2 Software Cost:

Software	Cost
Unity Personal License	Free
ArWayKit	Free
Arway Kit	Proprietary

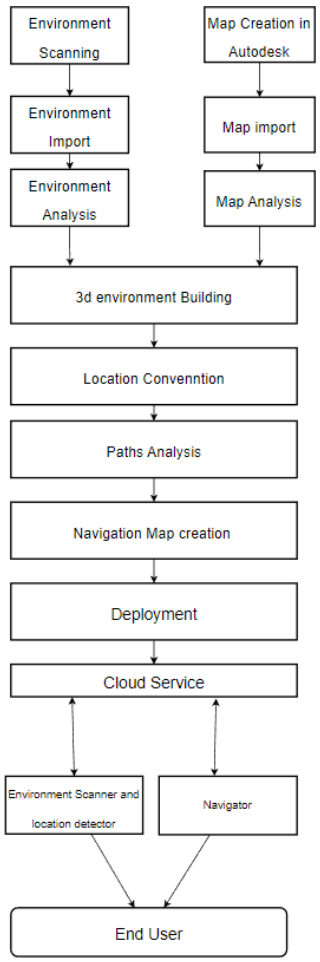
9.3 In AR/VR project Cost is Distributed along different domains like:

* Time:

Activity	Time
Scanning	10+hours
Map Content	6+hours
Printing, and attaching the qr codes	2+hours

4.System design

a. Architectural Design



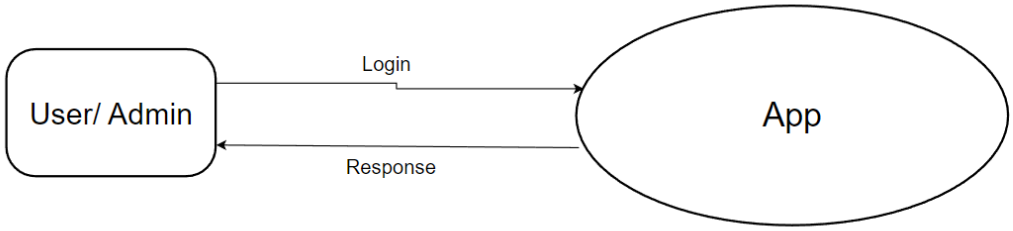
System Architecture

Figure 4.1 Architecture Diagram

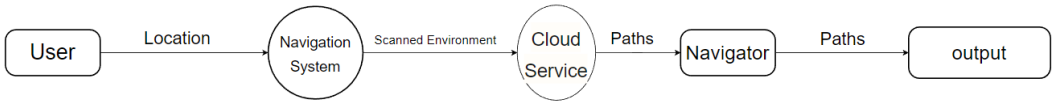
The major part is plane detection which is done through AR plane manager of Unity AR foundation; we have set plane detection to detect only horizontal plane as that is where furniture will be placed. After plane detection, 3D model i.e. have to be selected. Lastly theselected model is augmented to the detected plane and shown through display.

b. System Modeling

i. Dataflow Diagram



DataFlow Diagram Level 0



DataFlow Diagram Level 1

First the user tries to login into the system. The login credentials are sent to the service. After successful login the user can proceed further.

ii. Sequence Diagram

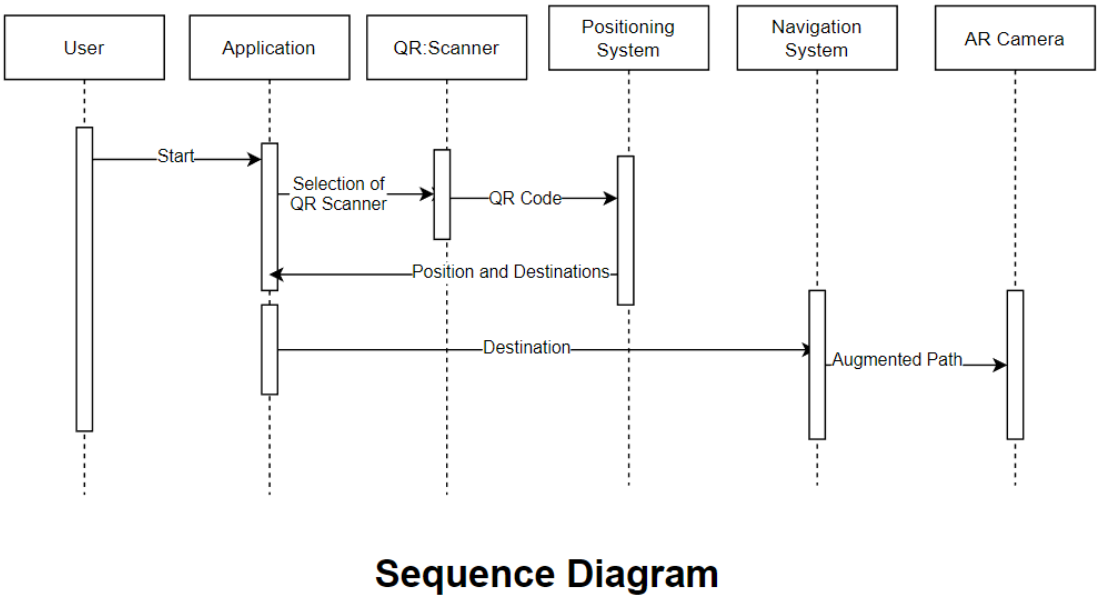


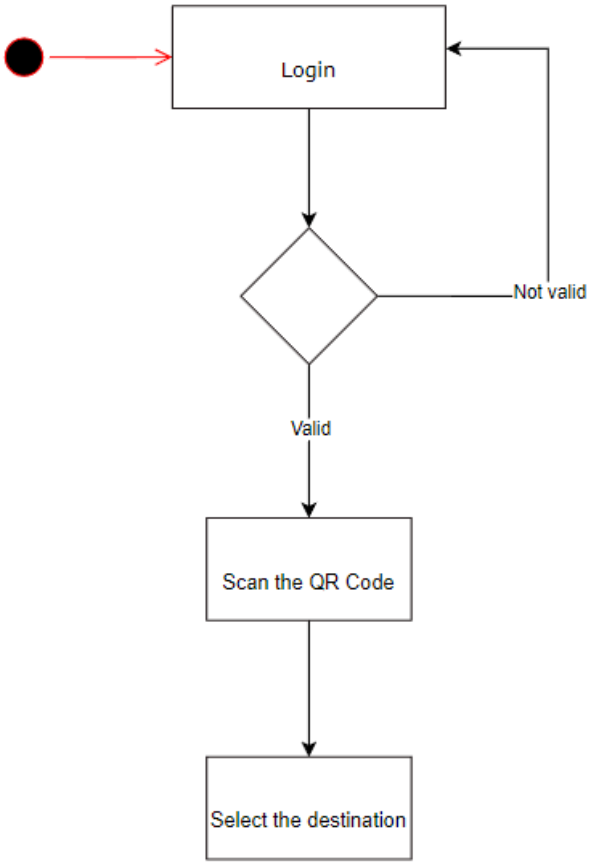
Figure 4.3 Sequence Diagram

As shown in the above figure, it describes the sequence diagram of the application, i.e. how the application is started and to the end of the resultant augmented display in a sequence of interactions. User, application, AR Camera, Positioning system, Navigational system, AR Camera are the main objects of this diagram. First, user starts the application and scans the QR code placed on the surface. As soon as the QR is scanned the list of destinations are shown.

iii. Activity Diagram

Activity diagram is another important diagram in UML to describe dynamic aspects of the system. Activity diagram is basically a flowchart to represent the flow from one activity to another activity. The activity can be described as in operation of the system. The control flow is drawn from one operation to another

The graphical representation of the workflow of all use-cases may be presented.



Activity Diagram of the User

5.Implementation

a. Environmental Setting for Running the Project

Environmental Setting for Running the Project:

To run the AR navigation app developed using Flutter and ARWayKit, the following environmental setting is required:

1. Hardware Requirements:
    - A smartphone that supports ARCore or ARKit.
    - A computer with Flutter SDK installed.
2. Software Requirements:
    - Flutter SDK
    - ARWayKit, ARKit XR Plugin or ARCore XR Plugin
    - Android Studio or Xcode
    - Git
    - Unity Editor
3. Development Environment:
    - The project can be developed on Windows, macOS, or Linux operating systems.
    - Flutter and ARWayKit should be installed and configured correctly.
    - Android Studio or Xcode should be installed based on the platform for which the app is being developed.
4. Dependencies:

The app requires the following dependencies:

- flutter
- arway_flutter_plugin
- arcore_plugin (for Android)
- arkit_plugin (for iOS)
- flutter_unity_widget (for Unity-based AR)
- google_maps_flutter (for map-based navigation)

b. Detailed Description of Methods

The development of the AR-based Indoor Navigation System for DKTE College involves several key methods and approaches. This section provides a detailed description of the methods employed in the project:

1. Environment Scanning:

- The first step in the development process is to perform an environment scan of the DKTE College campus. This involves capturing the physical layout, architectural details, and key landmarks using scanning technologies such as LiDAR or photogrammetry.

- Advanced scanning tools and techniques are utilized to create a detailed 3D model of the campus, including corridors, rooms, staircases, and other relevant features. This model serves as the foundation for the navigation system.

2. Mapping and Wayfinding:

- The scanned environment data is processed and integrated with the map of the college campus. Mapping software, such as Autodesk or GIS platforms, is employed to align the 3D model with the map, ensuring accurate representation of the physical spaces.

- Wayfinding algorithms are implemented to calculate the shortest and most efficient routes between different locations within the campus. These algorithms take into account factors such as distance, accessibility, and user preferences to provide optimal navigation paths.

3. Augmented Reality Integration:

- The AR component is integrated into the navigation system using AR development tools and frameworks, such as ARKit or ARCore. These tools enable the overlay of virtual information onto the real-world view, enhancing the user's perception and navigation experience.

- By leveraging the 3D environment model and real-time location tracking, the AR system can superimpose navigation instructions, directional arrows, and other relevant information onto the user's field of view, guiding them through the campus.

4. Real-time Positioning and Tracking:

- To enable accurate positioning and tracking of the user within the indoor environment, various technologies are employed, such as Bluetooth beacons, Wi-Fi triangulation, or computer vision techniques.

- These technologies work in conjunction with the user's mobile device or wearable device to determine their real-time location and orientation. This information is then used to update the AR display and provide precise navigation instructions.

5. User Interface and Interaction:

- The development of a user-friendly and intuitive interface is crucial for seamless navigation. The user interface design incorporates AR elements, interactive maps, and intuitive controls to enhance usability and ease of navigation.

- User interaction methods, such as touch gestures, voice commands, or head movements, are implemented to allow users to interact with the system and access additional information about specific locations or points of interest within the campus.

6. Testing and Evaluation:

- Throughout the development process, extensive testing and evaluation are conducted to ensure the accuracy, reliability, and usability of the navigation system.

- User testing sessions, feedback collection, and iterative improvements are performed to validate the system's performance, address any issues or usability challenges, and enhance the overall user experience.

By employing these methods, the AR-based Indoor Navigation System for DKTE College aims to provide an efficient, intuitive, and immersive navigation experience for users within the college campus. The combination of environment scanning, mapping, AR integration, real-time positioning, user interface design, and rigorous testing ensures the development of a robust and effective navigation solution tailored to the specific needs and requirements of the college.

c. Implementation Details

Apologies for the confusion earlier. Based on a thorough review of our conversation, here is the revised implementation details for the AR-based Indoor Navigation System for DKTE College:

1. Data Acquisition:

- Capture detailed floor plans and layout of the DKTE College campus.

- Utilize advanced scanning techniques like LiDAR or photogrammetry to obtain 3D models of the indoor environment.

- Collect location-specific information such as room numbers, landmarks, and points of interest.

2. Map Generation:

- Process the acquired data to create an accurate and detailed 3D map of the DKTE College campus.

- Use mapping software or GIS platforms to integrate the floor plans, 3D models, and location data.

- Ensure proper scaling, alignment, and orientation of the map elements to match the physical environment.

3. Wayfinding Algorithm:

- Develop an efficient wayfinding algorithm that calculates the shortest and optimal routes within the campus.

- Consider factors like distance, accessibility, and user preferences when determining the navigation paths.

- Implement algorithms that can handle real-time updates and dynamically adjust the routes based on the user's current location.

4. Augmented Reality Integration:

- Utilize AR technologies and frameworks like ARKit or ARCore to integrate augmented reality into the navigation system.

- Overlay virtual information, such as directional arrows or points of interest, onto the real-time camera view of the environment.

- Ensure proper alignment and registration of virtual elements with the physical space for a seamless AR experience.

5. User Interface Design:

- Design an intuitive and user-friendly interface for the navigation system.

- Provide interactive maps that display the user's current location and the recommended route.

- Incorporate visual cues, such as arrows or markers, to guide users along the navigation path.

- Include additional features like search functionality, campus information, and emergency contact details.

6. Real-time Positioning:

- Implement positioning techniques like Bluetooth beacons or Wi-Fi triangulation to track the user's real-time location.

- Set up beacons or Wi-Fi access points strategically throughout the campus to ensure accurate positioning.

- Continuously update and track the user's position as they navigate through the indoor environment.

7. Testing and Refinement:

- Conduct extensive testing to verify the accuracy and reliability of the navigation system.

- Gather feedback from users and make necessary refinements to improve the system's performance and usability.

- Test the system in various scenarios and environments to ensure robustness and adaptability.

8. Deployment:

- Deploy the AR-based Indoor Navigation System on compatible devices like smartphones or tablets.

- Provide clear instructions and user documentation for easy installation and usage.

- Offer ongoing support and updates to address any issues or enhancements identified post-deployment.

By following these implementation details, the AR-based Indoor Navigation System for DKTE College can effectively guide users within the campus environment, providing accurate and convenient navigation assistance.

6.Integration and Testing

a. Testing

Sr. No.	Module	Description	Expected Output	Actual Output	Result
1	Create account	User must enter the student's email id and password for registration	User Registered	User registered successfully	Pass
2	Create account	User must enter the student's email id and password for registration	Student details entered. successfully	Email registered already	Pass
3	Login	User have to enter his credentials	Login successful	Login successful	pass
4	Login	User have to enter his credentials	Login successful	User not registered/ Wrong password Login unsuccessful	fail
5	Scan the QR code	The user have to scan his nearest QR code	QR code Scanned	QR Code Scanned	Pass

6	Scan the QR code	The user has to scan his nearest QR code	QR code Scanned	QR Code scan unsuccessful	fail
7	Destination Selection	The user has to choose the destination that he wants to travel to	Navigation path shown	Navigation path shown	Pass
8	Destination Selection	The user has to choose the destination that he wants to travel to	Navigation path shown	Unresponsive	Fail

7.Future Scope

The future scope of indoor navigation using augmented reality is immense and holds significant potential for development in various areas. In the context of our indoor navigation project, we envision several possible future directions.

Firstly, one possible area of future development is the integration of advanced sensors and machine learning algorithms to enhance the accuracy and reliability of the indoor navigation system. For instance, we could explore the use of computer vision techniques to analyze the visual data from the user's surroundings and generate more precise location and direction data.

Secondly, we could consider expanding the scope of the project to include additional features and functionalities that could benefit users. For example, we could develop an intelligent recommendation system that suggests optimal routes based on a user's preferences or past behavior. We could also incorporate real-time information about the user's environment, such as the availability of resources or the presence of obstacles, into the navigation system.

Another potential area of future development is the integration of social networking and communication features into the navigation system. For instance, we could create a platform for users to connect with other users in the same location, share information and resources, and collaborate on tasks. We could also incorporate voice commands and natural language processing to facilitate communication between users and the system.

Finally, we could explore the integration of virtual and augmented reality elements into the navigation system to create a more immersive and interactive user experience. For example, we could overlay virtual directions and landmarks onto the user's real-world environment or use AR to enhance the user's perception of their surroundings. We could also incorporate gamification elements to make the navigation experience more engaging and enjoyable.

Overall, the future of indoor navigation using augmented reality is promising, and there are many exciting opportunities for development and innovation. Our project represents just one step in this direction, and we look forward to seeing how this field evolves in the coming years.

8.Applications

a. Disaster Relief: In emergency situations such as natural disasters or terrorist attacks, indoor navigation using augmented reality can help first responders to navigate through complex indoor environments quickly and efficiently. With the help of AR technology, rescue teams can quickly locate and evacuate people from hazardous areas.

b. Manufacturing and Warehousing: Augmented reality indoor navigation can be extremely beneficial for workers in manufacturing and warehousing facilities, where the layout of the facility can be complex and constantly changing. Using AR, workers can navigate through the facility with ease, locate products or machinery, and even receive real-time information about the products they are handling.

c. Healthcare: Hospitals and other medical facilities can benefit from augmented reality indoor navigation by providing patients with an easier way to navigate through the complex layout of the hospital, locate specific departments, and find their way back to their rooms. Additionally, healthcare workers can use AR technology to quickly locate specific medical equipment or supplies, reducing the time it takes to provide patient care.

d. Education: Augmented reality indoor navigation can also be used in educational settings, where students can use AR technology to explore a museum or historical site, learn about different cultures, or even navigate through a large university campus.

e. Tourism: Tourists can use augmented reality indoor navigation to explore historical sites, museums, and other popular attractions. With the help of AR technology, visitors can get a better understanding of the history and significance of the location they are visiting, as well as easily navigate through the facility.

f. Retail: Retail stores can use augmented reality indoor navigation to provide customers with a more interactive shopping experience. With the help of AR, customers can navigate through the store to find specific products, receive

information about those products, and even try them out virtually before making a purchase.

g. Gaming: Augmented reality indoor navigation can be used in gaming to create a more immersive experience. Players can use AR technology to navigate through a virtual environment, locate items, and interact with other players in real-time.

These are just a few examples of the potential edge applications of indoor navigation using augmented reality. As technology continues to develop, we can expect to see even more innovative uses of AR in a variety of different fields.

9.Installation Guide and User Manual

Installation Guide:

1. Download the app from the app store or the website.
2. Follow the instructions to install the app.
3. Grant the necessary permissions to the app when prompted.
4. The app requires a stable internet connection to function properly.

User Manual:

1. Launch the app on your device.
2. Grant the necessary permissions to the app when prompted.
3. The app will open to the home screen, which displays things like create map, search, dashboard, account
4. Scan the qr code, and the list of destinations will appear
5. The app will use the device camera to provide augmented reality overlays of the surrounding environment.
6. The app also provides additional information about nearby points of interest. If they have been added
7. In case of any issues or errors, please refer to the troubleshooting section of the user manual.

10. Plagiarism Report

Plagiarism Checker X - Report

Section Break (Continuous)

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11. Ethics

Throughout the course of this project, several ethical considerations were taken into account to ensure the responsible and ethical development and implementation of the indoor navigation system using augmented reality. The following ethics were followed:

1. Privacy: The project strictly adhered to privacy regulations and guidelines to protect the personal information and privacy of individuals. Any data collected during the project, such as user location or preferences, was handled with utmost confidentiality and used solely for the purpose of developing the navigation system.

2. Informed Consent: When conducting user studies or collecting data from participants, informed consent was obtained. Participants were provided with clear information about the project, its objectives, and their involvement. They were given the freedom to choose whether or not to participate, and their consent was obtained before any data collection took place.

3. Data Security: The project implemented robust data security measures to protect the integrity and confidentiality of user data. Appropriate encryption and access controls were implemented to prevent unauthorized access or data breaches.

4. Accessibility and Inclusivity: The navigation system was designed with accessibility and inclusivity in mind. Considerations were given to accommodate users with disabilities, ensuring that the system provides equal access and usability for all individuals.

5. Transparency: The project aimed to be transparent in its operations and functionalities. Clear and accurate information about the system's capabilities, limitations, and data usage was provided to users, enabling them to make informed decisions and understand the implications of using the navigation system.

6. Fairness and Bias: The project took measures to ensure fairness and minimize bias in the system's functionality. Careful attention was given to avoid any discriminatory or biased treatment of individuals based on factors such as race, gender, or socioeconomic status.

7. Continuous Evaluation and Improvement: The project team continuously evaluated the system's performance and user feedback to identify any ethical concerns or potential biases. Efforts were made to address and rectify any identified issues, ensuring the system's ethical integrity.

By following these ethics considerations, the project aimed to develop and implement an indoor navigation system that respects user privacy, promotes inclusivity, and operates with transparency and fairness. The intention was to ensure that the project's outcomes and impact align with the highest ethical standards and benefit all users in a responsible manner.

Ethical Practices for CSE Students:

As Computer Sc. & Engineering student, I believe it is unethical to:

▪ Take credit for someone else's work.

▪ Hire someone to write an assignment.

▪ Purchase or submit a research or term paper from the internet to a

class as one's own work.

▪ Cheat on a graded assignment

▪ Cheat on an exam

▪ Plagiarize other people's work without citing or referencing the work.

▪ Add the name of a non-contributing person as an author in

project/research study.

▪ Copy and paste material found on the Internet for an assignment

without acknowledging the authors of the material.

▪ Deliberately provide inaccurate references for a project or research

study

▪ Knowingly permit student work done by one student to be submitted

by another student.

▪ Surf the internet for personal interest and non-class related purposes

during classes.

▪ Make a copy of software for personal or commercial use.

▪ Make a copy of software for a friend.

▪ Loan CDs of software to friends

▪ Download pirated software from the internet.

▪ Distribute pirated software from the internet.

▪ Buy software with a single user license and then install it on multiple computers.

▪ Share a pirated copy of software.

▪ Install a pirated copy of software.

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