DIRECTION TRACKING USING AUGMENTED REALITY

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Computer Science and Engineering

By

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SCHOOL OF COMPUTING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited with Grade "A" by NAAC | 12B Status by UGC | Approved by AICTE
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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **Saran T (Reg.No - 39110903) and Sanjay S (Reg.No - 39110892)** who carried out the Project Phase-2 entitled **"DIRECTION TRACKING USING AUGMENTED REALITY"** under my supervision from January 2023 to April 2023.

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DECLARATION

I, **Saran T (Reg.No- 39110903),** hereby declare that the Project Phase-2 Report entitled **"DIRECTION TRACKING USING AUGMENTED REALITY"** done by me under the guidance of **Dr. G. KALAIARASI M.E., Ph.D.,** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in **Computer Science and Engineering**.

DATE: 20.04.2023

PLACE: Chennai **SIGNATURE OF THE CANDIDATE**

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ABSTRACT

The advancement in technology has created new challenges using different techniques. Augmented Reality (AR) is the amalgamation of a true object viewed by a user which is augmented by the virtual scene generated by a computer with additional information. In AR, the system augments with the help of a mechanism to combine virtual and real-world but the user maintains a sense of presence in real- world. It is one of the emerging technologies that has attracted researchers in the field of enhancing information for education and training, product visualization, and virtual try in the field of marketing, finding a way for tourism and many more applications to a very great extent. A lot of factors influence an effective AR experience. A discussion is carried on about the important factors like Graphical rendering, Calibrating, Tracking that contributes to an effective AR experience depending on the AR application. This project highlights different tracking techniques that are already carried out and is classified as Sensor-based and Vision-based tracking. Sensor-based tracking can additionally be divided into other tracking suchas Optical, Magnetic, Acoustic, and Inertial. Vision-based tracking is further categorized into Marker-based and Markerless Tracking. The usage of the tracking technique depends on the AR application. Finally, the project deals with the implementation of Marker based application and its usage in detail.

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LIST OF ABRREVIATIONS

AR	Augmented Reality
VR	Virtual Reality
UWP	Universal Windows Platform
FFMPEG	Fast Forward Moving Picture Experts Group
Open GL	Open Graphics Library
GPS	Global Positioning System
LED	Light Emitting Diode
UI	User Interface
QR code	Quick Response code
PF	Proportional-fair
BLE	Bluetooth Low Energy
PDR	Pedestrian Dead Reckoning
GIS	Geographic information system

CHAPTER 1

INTRODUCTION

AR is a combined effect of a real object viewed by a user which is augmented by the virtual scene generated by a computer with additional information. AR augments real-world scenes through techniques to combine virtual and real worlds but the user maintains a sense of presence in the real-world.

Applications of AR are increasing rapidly in various fields to name a few are military, industry, and training, and education, tourism, healthcare, and marketing. The opportunities available for online education, especially in fields where there is a lot of importance for practical knowledge and are not suitable for non-classroom training are referred in (Chia-Wen Tsai, 2017). An increasing number of AR applications are developed based on hardware devices like smartphones in various fields like training, maintenance, assembling of products, manufacturing, and many more are discussed in (Eleonora Bottani and Giuseppe Vignali, 2019). AR creates an interactive environment between the virtual and real world where the objects of the real-world are captured by the camera and are enhanced by the computer-generated display, sound, text, and effects (Krevelen, D. W. F. V. and Poelman, R, 2010) .

Marker Based Tracking

The tracking method to be used depends on its AR applications. A detailed discussion about the usage of marker-based tracking is highlighted. Most of the AR tracking techniques needs costly devices. The marker-based tracking is based on themobile phone technology where the camera is the only source for tracking. A developer who wants to maintain the budget or to keep the application and setup as simple as possible can opt for Marker Based Tracking. Environments that are identical, with reflective surfaces or have repetitive features are difficult to bifurcate and in such circumstances, markerless tracking becomes very unpredictable. In such situations if markers are added to the environment tracking becomes possible much simpler and easier. Besides, a dynamic environment is even more difficult to track as the locations of the features vary. A tracking system can avoid some of theseproblems by attaching markers in this kind of environment; a markerbased system is often a better choice.

In environments where several moving objects are more tracking with sensor becomes difficult. The markerless tracking system also loses track in such situations and therefore only marker-based tracking system can be used. If an application needs any added information the marker can provide it. It is something missing in any other type of tracking. A marker-based system is highly efficient for the type of application where the emphasis is not yet on the tracking implementation but an easydemonstration of the application concept. Succeeding during implementation, a suitable tracking method can be used. If the environment already has some existing markers like images or some signs the markerbased system can take advantage of this. The application can be developed to improve and train the marker to detect them and use them to achieve a more robust tracking system. The processing power and memory required for Marker-based systems are less compared to any othertypes of tracking. In some types of applications, user interaction is simple to implement with markers. It can also be used to indicate the existence of virtual data for the user. For example a book with 3D images that has additional augmented content so that the user can experience the 3D visual with a camera phone.

CHAPTER 2

LITERATURE SURVEY

This problem statement has been extensively studied over the past 5 years by researchers and mapping companies in a bid to create a solution, and all their solutions vary from analyzing various patterns of creating maps.

1. The work of R. Silva, J. C. Oliveira, G. A. Giraldi presents an overview of basic aspects of Augmented Reality (AR) and the main concepts of this technology. It described the main fields in which AR is being applied those days and important AR devices. Some characteristics of Augmented Reality systems had been discussed and this paper provided an overview of them.

2. In Ausburn, Lynna J. Ausburn, Floyd B's research paper Virtual reality (VR) had demonstrated effectiveness as an instructional technology in many technical fields. However, VR research had generally lacked a sound theory base to provide explanatory or predictive strength. Further, research into the effectiveness of new desktop technologies that place VR within the reach of schools and teachers is currently embryonic. The study reported here is a pilot and is highly exploratory. It was the first step in developing a theory-based line of inquiry into desktop VR as an instructional technology with potential for Career and Technical Education. Grounded in several theory and research strands, this study compared the effects of presenting a complex scene via desktop VR and a set of still photographic images.

3. R. Azuma 's paper surveys the field of Augmented Reality, in which 3-D virtual objects were integrated into a 3-D real environment in real time. It described the medical, manufacturing, visualization, path planning, entertainment and military applications that had been explored. This paper also describes the characteristics of Augmented Reality systems, including a detailed discussion of the tradeoffs between optical and video blending approaches.

Registration and sensing errors were two of the biggest problems in building effective Augmented Reality systems, so this paper summarized current efforts to overcome these problems. Future directions and areas requiring further research were discussed.

4. Zhou, F., Duh, H. B.-L., and Billinghurst, M ‘s paper reviewed the ten year development of the work presented at the ISMAR conference and its predecessors with a particular focus on tracking, interaction and display research. It provided a roadmap for future augmented reality research which would be of great value to this relatively young field, and also for helping researchers decide which topics should be explored when they are beginning their own studies in the area.

5. In Krevelen, D. W. F. V. and Poelman, R (2010) paper describes the field of AR, including a brief definition and development history, the enabling technologies and their characteristics. It surveyed the state of the art byreviewing some recent applications of AR technology as well as some known limitations regarding human factors in the use of AR systems that developers woukd need to overcome.

6. Rolland, J. P., Baillot, Y., and Goon, A. A ‘s paper presented a top-down classification of tracking technologies aimed more specifically at head tracking, organized in accordance with their physical principles of operation. Six main principles were identified: time of flight (TOF), spatial scan, inertial sensing, mechanical linkages, phase-difference sensing, and direct-field sensing. It was briefly describing each physical principle and present implementations of that principle. Advantages and limitations of these implementations were discussed and summarized in tabular form.

7. A Survey of Augmented Reality Tracking Systems by H. Regenbrecht, G. Klinker, and T. Müller. This paper provided a comprehensive overview of the different tracking systems used in AR, including fiducial markers, natural feature tracking, and sensor-based tracking.

8. Marker-less tracking for augmented reality: a review by D. Wagner and D. Schmalstieg. This paper discussed the challenges of marker-less tracking for AR and provides an overview of the different approaches, such as image- based tracking and sensor-based tracking.

9. Real-time camera tracking for augmented reality applications by G. Klein and D. Murray. This paper presented a real-time camera tracking system for AR that uses natural features in the scene, such as corners and edges.

10. Visual tracking for augmented reality by G. D. Hager and K. Toyama. This paper provideed a survey of visual tracking techniques for AR, including template matching, feature-based tracking, and optical flow-based tracking.

11. AR based Directional Tracking System for Industrial Environment by Dhanraj C. and K. L. Sudha. This paper presented an AR-based directional tracking system for an industrial environment that used a camera and image processing techniques to track the direction of objects. The system was capable of tracking objects in real-time and displaying the direction on an AR display.

12. Real-time AR-based Directional Tracking of Moving Objects by Hyeonseok Lee, Yongho Kim, and Sang Hyun Park. This paper proposed a real-time AR-based directional tracking system that can track moving objects in real-time using AR markers and a camera. The system used a Kalman filter to estimate the position and direction of the objects and displayed the information on an AR display.

13. AR-based Directional Tracking for Indoor Navigation by Hanjun Kim and Hyeonseok Lee. This paper proposed an AR-based directional tracking system for indoor navigation that could track the direction of the user using an AR marker and a camera. The system used a particle filter to estimate theuser's direction and display the information on an AR display.

14. Directional Tracking of Autonomous Mobile Robots Using AR by Rajesh Kannan Megalingam and R. Aravindan. This paper proposed an AR-based directional tracking system for autonomous mobile robots that can track the direction of the robots using an AR marker and a camera.

    The system used an extended Kalman filter to estimate the robot's position and direction and displayed the information on an AR display.

15. AR-based Directional Tracking of Medical Instruments in Laparoscopic Surgery by Jun-Won Choi, Ho-Young Song, and Byung-Ju Yi.

    This paper proposed an AR-based directional tracking system for medical instruments in laparoscopic surgery that could track the direction of the instruments using an AR marker and a camera. The system used an adaptive filter to estimate the instrument's direction and displayed the information on an AR display.

2.1 INFERENCES FROM LITERATURE SURVEY

Author	Year of Publications	Description	Pros	Cons
Azuma R	1997	It described the path planning, entertainment and also in the military applications that had been explored.	Creation of map for the first time in AR	Practically not implemented
Rolland, J. P	2000	It compared the two technological approach that were carried out in augmented reality for the purpose of 3-D medical visualization.	Used multiple techniques of tracking in AR	Less Accuracy
R. Silva, J. C. Oliveira	2003	It describes the main fields in which AR is applied nowadays and important AR devices. Some characteristics of AR systems are discussed.	Correction of visualization errors	High maintenance of components
Zhou, F.	2008	It reviewed the ten-year development of the work presented at the ISMAR conference and its predecessors with a particular focus on tracking, interactionand display research.	Implemented the tracking	More limitation of using AR
D.W.F. van Krevelen	2010	It surveyed the state of the art by reviewing some of the latest applications of the AR technology as well as some known limitations regarding the human factors in the use of AR systems	Concentrated on user friendly techniques	Used only one method

2.2 Open problems in Existing System

There are several problems that exist in existing outdoor AR navigation systems. Here are some common issues:

Poor Accuracy: One of the most common problems in outdoor AR navigation systems is poor accuracy. GPS and compass sensors can be affected by environmental factors such as buildings, trees, and weather conditions, resulting in inaccurate location tracking and orientation.

Limited Field of View: AR displays typically have a limited field of view, which can make it difficult to navigate through outdoor environments that require a wider perspective.

Limited Interaction: Current AR navigation systems often have limited interaction capabilities, such as touch or voice commands, which can make it difficult to use the system while on the move.

Limited Battery Life: AR navigation systems can drain the battery of mobile devices quickly, making it difficult to use the system for extended periods of time.

Limited Content: Existing AR navigation systems often have limited content, such as digital markers and overlays, which can make it difficult to navigate through complex outdoor environments or find specific points of interest.

Limited Accessibility: AR navigation systems may not be accessible to individuals with disabilities, such as visual impairments, who may have difficulty using the system.

Limited Integration: AR navigation systems may not be fully integrated with other location-based services, such as transportation or restaurant apps, which can limit the usefulness of the system.

Addressing these problems will require significant improvements in the accuracy and functionality of AR navigation systems, as well as a more comprehensive approach to integrating these systems with other location-based services.

CHAPTER 3
REQUIREMENT ANALYSIS

3.1 Feasibility Studies/Risk Analysis Of The Project

Another big problem with implementing AR solutions is the technological gap between AR devices. It is one thing to design an app for a fully-fledged AR gear, and it is a completely different thing to do it for a smartphone. The latter case got many limitations that make the whole experience not really user-friendly and somewhat redundant to the activity it augments.

Considering that the majority of the target audience will not likely purchase AR gear due to its impractical and high prices - smartphones remain a preferred function and since they have certain augmented reality app design limitations - it neuters the whole point of implementing AR solution to the mix.

Risk analysis is an important aspect of developing AR outdoor navigation systems to ensure the safety of users. AR outdoor navigation systems can present several risks to users, including hazards in the physical environment, distraction, and disorientation. Therefore, risk analysis is essential to identify potential risks and take appropriate measures to mitigate them.

Here are some steps involved in performing risk analysis for AR outdoor navigation:

Identify Potential Risks: The first step in risk analysis is to identify potential risks that could impact the safety of users. This could include hazards such as uneven terrain, obstacles, or busy roads, as well as issues related to the AR system, such as errors in the GPS or compass data, or incorrect digital overlays.

Assess Risks: Once potential risks have been identified, the next step is to assess their likelihood and severity. This involves considering factors such as the frequency of occurrence and potential consequences. For example, hazards such as uneven terrain or busy roads could have a high likelihood of occurrence and severe consequences if not properly addressed.

Develop Mitigation Strategies: Based on the assessment of risks, the next step is to develop mitigation strategies to reduce or eliminate the identified risks. This could include physical modifications to the environment, such as placing signs or barriers to mark hazards, or modifying AR system to reduce distractions or improve accuracy.

Implement Mitigation Strategies: Once mitigation strategies have been developed, they should be implemented as part of the AR outdoor navigation system. This may involve making changes to the environment or modifying the AR system to incorporate the mitigation strategies.

Monitor and Evaluate: The final step in risk analysis is to monitor and evaluate the effectiveness of the implemented mitigation strategies. This involves monitoring the system for potential risks and assessing the impact of the mitigation strategies on reducing or eliminating those risks. Regular evaluation can help to identify any new risks and ensure that the mitigation strategies remain effective.

What's the solution to this problem? It is a question of time when the price for AR gear will drop to a mass consumer acceptable level. The thing is - Augmented Reality Technology is in its early stages, and it is too soon to expect that its gear will be available for a regular Joe from the get-go.

3.2 SOFTWARE REQUIREMENTS SPECIFICATION DOCUMENT

3.2.1 Software Requirements

Vuforia - Developers can easily add advanced computer vision functionality to Android, iOS, and UWP apps, to create AR experiences that realistically interact with objects and the environment.

Unity - Unity's AR Foundation is a cross-platform framework that allows to write augmented reality experiences.

ARway Kit - ARwayKit is fast, scalable, highly customizable, web-based, real-time, and tightly integrated with a cloud mapping

FFMPEG - FFmpeg is a widely-used cross-platform multimedia framework which can process almost all common and many uncommon media formats.

OpenGL - OpenGL is a cross-language, cross-platform application programming interface for rendering 2D and 3D vector graphics.

3.2.2 Performance Requirements

- The application should be able to provide the real-time updates with minimal delay of time being.
- The application should have a high degree of accuracy in the location tracking the orientation of the objects.
- The application should be able to operate even in the low-light and dark conditions.

3.2.3 Non-Functional Requirements

- The application should have a user-friendly interface that is easy to navigate.
- The application should be responsive and provide real-time updates.
- The application should be able to operate in low-light conditions.
- The application should be compatible with a wide range of mobile devices.
- The application should have a high degree of accuracy in location tracking and orientation.

CHAPTER 4

DESCRIPTION OF PROPOSED SYSTEM

Accuracy of AR applications or realistic results is depending on tracking method which is the process of locating a user in an environment. It takes account of the position and orientation of the AR user. Generally, tracking the head is the most important part as the user uses a mobile screen by which the augmented images of the real world are displayed. Due to tracking accuracy of the AR system is improved and prevents problems such as visual capture and does not allow visual sensors to gain a priority over other sensors. For example, insufficient registration accuracy can cause the userto reach wrong portion of the real environment because the augmentation has been displayed on another portion. The eyes of the users get used to the error in the virtual environment and after some time they start to accept these errors as correct which isnot desirable.

Direction tracking using AR in outdoor environments typically involves integrating various technologies and sensors, such as GPS, compass, and camera, to provide users with real-time navigation instructions and digital overlays. Here's a general overview of the steps involved in direction tracking using AR in outdoor environments:
Collecting Data: The first step in outdoor direction tracking is to collect data about the environment. This includes GPS coordinates, landmarks, and other relevant information about the outdoor space. This data can be collected using specialized mapping software or by manually creating digital markers.

Integrating Sensors: Once the data has been collected, it is necessary to integrate various sensors, such as GPS, compass, and camera, to provide real-time location tracking and navigation instructions to users. These sensors help to determine the user's location, orientation, and movement, allowing the AR system to provide accurate and relevant information.

Creating Digital Markers: Digital markers are used to provide users with navigation instructions and other relevant information about the outdoor environment. These markers can be created using AR authoring tools or customized to suit the specific

needs of the application. They can be placed at key locations along the user's route, such as landmarks or decision points, to help guide them through the outdoor space.
Displaying AR Overlays: AR overlays are superimposed onto the real-world view using the camera and display of the user's device. These overlays can include navigation instructions, digital markers, and other relevant information, such as restaurant reviews or historical facts. The AR system continuously updates the overlays based on the user's location and orientation, providing them with real-time information about their surrounding objects.

User Interaction: Finally, the user interacts with the AR system by following the navigation instructions and digital markers displayed on their device. The system can also provide feedback to the user, such as alerts or notifications, based on their location and movements.

Sensor-based tracking systems are analogous to open loop systems whose output is perceived to have error. Vision-based tracking techniques can use image processing methods to calculate the camera pose relative to real world objects and so are analogous to closed loop systems which correct errors dynamically.

The main difficulty of real time 3D tracking lies in the complexity of the scene and the motion of target objects, including the degrees of freedom of individual objects and their representation. Vision-based tracking aims to associate target locations in consecutive video frames, especially when the objects are moving fast relative to the frame rate. In some cases, this can be mitigated when markers such as LEDs are allowed placed in the environment, especially in small-scale applications.

4.1 SELECTED METHODOLOGY OR PROCESS MODEL

Indoor environments are usually more predictable whereas the outdoor environments are limitless in terms of location and orientation. As contrasting to indoors, there is less chance for preparing the environment to track the user while working outdoors. Moreover, already specified artificial landmarks cannot be used and natural landmarks need to be found.

Although world tracking can produce realistic AR experiences with accuracy and precision, it relies on details of the device's physical environment that are not always consistent and can be difficult to measure in real time without a degree of error. To build high-quality AR experiences, be aware of these caveats and tips.

Design AR experiences for predictable lighting conditions. World tracking involves image analysis, which requires a clear image. Tracking quality is reduced when the camera can't see details, such as when the camera is pointed at a blank wall or the scene is too dark.

Use tracking quality information to provide user feedback. World tracking correlates image analysis with device motion. ARKit develops a better understanding of the scene if the device is moving, even if the device moves only subtly. Excessive motion—too far, too fast, or shaking too vigorously—results in a blurred image or too much distance for tracking features between video frames, reducing tracking quality. The ARCamera class provides tracking state reason information, which one can use to develop UI that tells a user how to resolve low-quality tracking situations.

Allow time for plane detection to produce clear results, and disable plane detection when needed results are available. Plane detection results vary over time—when a plane is first detected, its position and extent may be inaccurate. As the planeremains in the scene over time, ARKit refines its estimate of position and extent.When a large flat surface is in the scene, ARKit may continue changing the plane anchor's position, extent, and transform after when already used the plane to place content.

4.2 ARCHITECTURE / OVERALL DESIGN OF PROPOSED SYSTEM

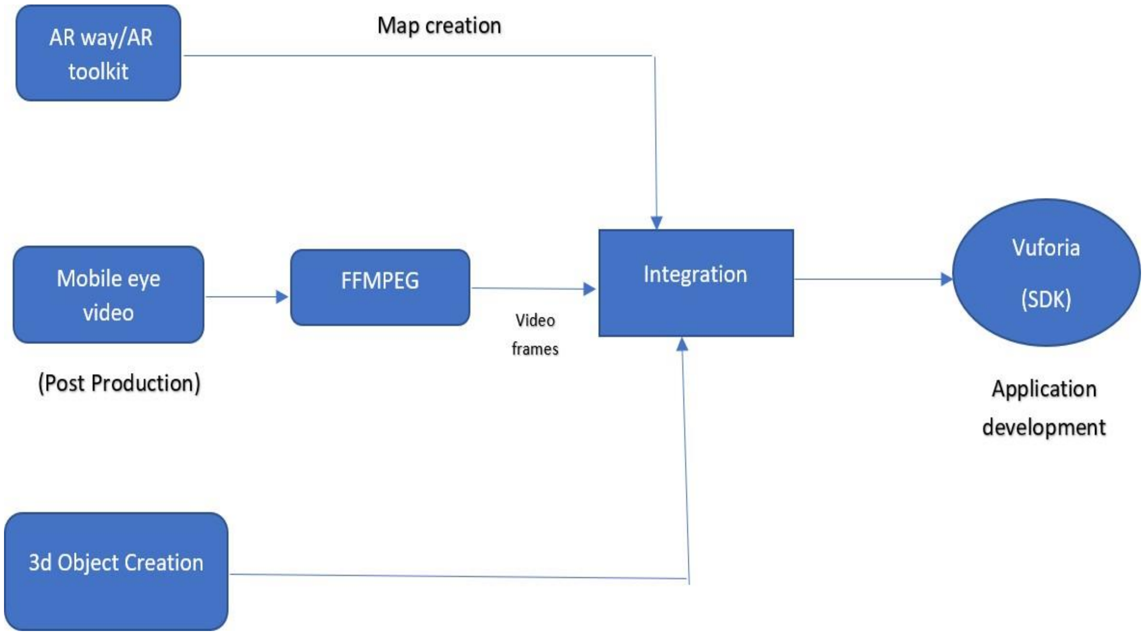

Fig 4.1: System Architecture for Direction Tracking using AR

In the above Fig 4.1, AR way Kit is fast, scalable, highly customizable, web-based cloud mapping and localization infrastructure that makes it the easiest way to build, deploy, and manage spatial apps on any platform. This kit helps to build the root map for the environment.

Then Post production is done though smartphone and the video have been split into video frames using FFMPEG cross platform. Virtual objects are designed using Unity/OpenGL ,then everything is merged in the Integration phase.

Vuforia Engine is the most widely used platform for AR development with support for the majority of phones, tablets, and eyewear.

4.3 DESCRIPTION OF SOFTWARE FOR IMPLEMENTATION AND TESTING PLAN OF THE PROPOSED MODEL/SYSTEM

4.3.1. Vuforia

Vuforia Engine is the most widely used platform for AR development , with support for the majority of phones, tablets, and eyewear.

Developers can easily add advanced computer vision functionality to Android, iOS, and UWP apps, to create AR experiences that realistically interact with objects and the environment.

Tracking information on the position and orientation of the device in the real world is provided by the Device Pose Observer. It is computed from camera frames of the environment and from sensor measurements. Use the Device Pose Observer in the application for tracking the device in relation to the real world. Device Tracking uses Vuforia Fusion to detect and utilize the platform’s native tracker or it will use Vuforia’s sensor-fusion technology.

While observing a target, users will likely find a position where tracking is limited or even lost. To accommodate for the different states the success of tracking a target can be in, different tracking statuses are reported to the state. Retrieve the status pose and status info from the state and improve the AR experience by, for example, notifying users to return to a better viewing position when the tracking quality is degraded. See Status Poses and Status Info for detailed information.

Also, there may be situations where the AR tracking is interrupted by for instance a call during the experience and the application is paused. To resume the experience, the application can relocalize itself if the duration and the movementbetween pause and resume was not too excessive.

Fig 4.2. Sample image target in Vuforia

4.3.2. Unity

Unity's AR Foundation is a cross-platform framework that allows to write augmented reality experiences once, then build for either Android or iOS devices without making any additional changes. The framework is available via Unity's AR Foundation package.

Unity is a powerful game engine that can be used for a wide range of applications, including direction tracking. Unity's features, such as real-time 3D graphics, physics simulation, and scripting capabilities, make it an excellent tool for developing direction tracking applications.

One of the ways Unity can be used for direction tracking is through the development of virtual reality (VR) applications. By using Unity to create a VR environment, users can move around in a virtual space and have their movements tracked in real-time. This allows for immersive experiences that can simulate real-world scenarios, such as training simulations for emergency responders or military personnel.

Another way Unity can be useful for direction tracking is through the development of augmented reality (AR) applications. AR applications can use Unity to overlay digital information on top of the real world, allowing users to navigate and receive directions in real-time. For example, an AR application could use Unity to display arrows and directions overlaid onto a live video feed from a user's smartphone camera.

Unity can also be used to develop more traditional direction tracking applications, such as GPS navigation apps. By integrating with GPS data, Unity can provide real-time location tracking and navigation instructions to us.

For rendering the features from the tileset, a MapAtWorldScale is used witha RangeAroundTransformTileProvider. A MapAtWorldScale is chosen because the map is needed to render at the real-world scale to support the augmented reality experience. RangeAroundTransformTileProvider uses the AR camera's root transformto load tiles around it. The rendered tiles contain the vector data information that we added to the dataset.

For rendering the campus buildings, a POI Modifier is used for instantiating 3D prefabs of Department names.

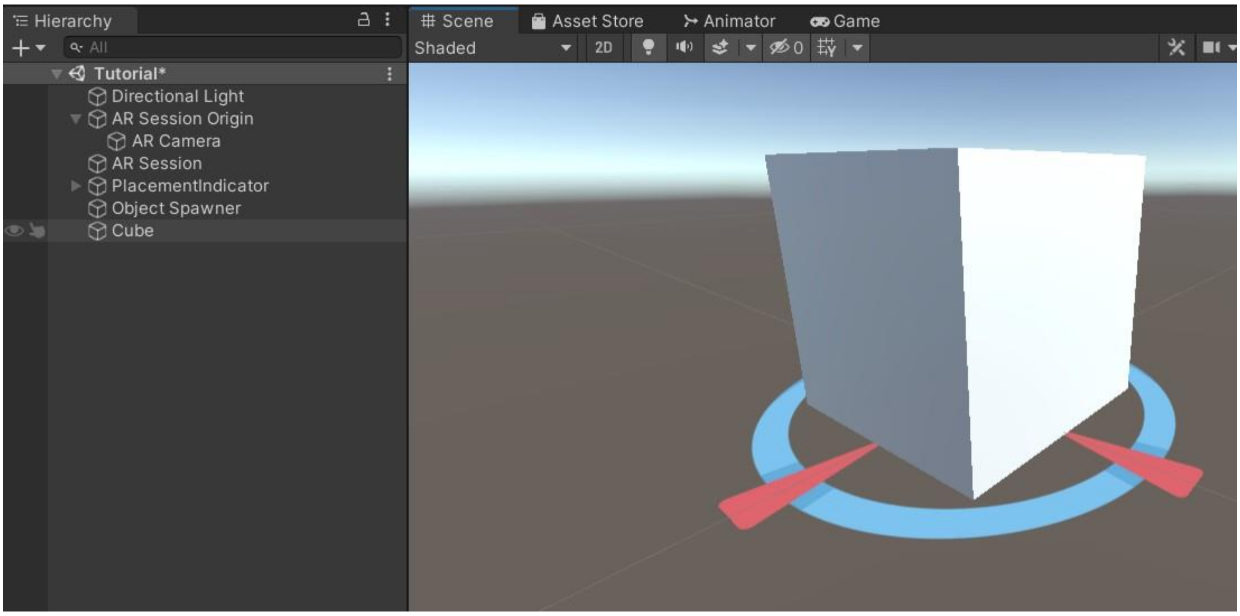

Fig 4.3. 3D object creation using Unity

4.3.3. ARway Kit

ARwayKit is fast, scalable, highly customizable, web-based, real-time, and tightly integrated with a cloud mapping and localization infrastructure that makes it the easiest way to build, deploy, and manage spatial apps on any platform.
ARwayKit comes with lots of sample codes to get started easily for use-cases such as Localization, Navigation, Games, MultiPlayer, multimaps. It comes with an

integrated Web Studio so the developers can create and manage their Location AR content and maps in Realtime from the Web.

The Arway Toolkit is an AR development platform that provides a range of tools and features for creating AR applications. One of the key features of the Arway Toolkit is its ability to enable direction tracking in AR applications.

Using the Arway Toolkit, developers can create AR applications that can track the user's position and orientation in real-time, allowing for the creation of AR experiences that provide accurate direction tracking. This is accomplished throughthe use of AR markers and computer vision technology, which allows the AR application to recognize and track the user's position and orientation relative to theAR markers.

The Arway Toolkit also provides a range of other features that can be useful for direction tracking applications. For example, it includes support for audio and visual cues that can be used to provide directions to users. It also includes support for indoor mapping and navigation, which can be useful in environments where GPS is not available or accurate.

Arway is an AR navigation platform that provides a toolkit for developers to create AR-based navigation and wayfinding solutions. Arway's toolkit is useful for direction tracking as it allows developers to create AR navigation experiences that can be used for indoor navigation, outdoor navigation, and more.

Here are some ways in which Arway's toolkit can be useful for direction tracking:

Indoor Navigation:

Arway's toolkit allows developers to create AR navigation experiences that can help people navigate through indoor spaces such as shopping malls, airports, hospitals, and more. By using AR technology, users can easily find their way through complex indoor environments with the help of digital navigation markers overlaid onto their real-world view.

Outdoor Navigation:

Arway's toolkit can also be used for outdoor navigation, helping users find their way around cities or towns. By using GPS data and AR markers, Arway can create immersive navigation experiences that help users get to their destination more efficiently.

Wayfinding:

Arway's toolkit is useful for creating wayfinding solutions that can help people find their way around unfamiliar environments. For example, Arway can be used to create AR-based wayfinding solutions for large events such as music festivals or conferences, helping attendees find their way to different stages, booths, or sessions.Customization: Arway's toolkit allows developers to customize the look and feel of the AR navigation experience. This customization can include the design of the digital navigation markers, the style of the user interface, and more, making it easier for developers to create unique and engaging navigation experiences.

4.3.4. QR Code

QR codes can be used as markers in AR-based direction tracking solutions. By using AR technology and QR codes, it is possible to create immersive navigation experiences that can help users find their way around complex environments.

Here's how QR codes can be used as markers in AR-based direction tracking solutions:

1. QR Code Generation: First, QR codes need to be generated for the specific locations where navigation markers are required. This can be done using various free or paid online QR code generators.
2. Scanning QR Codes: Users can scan the QR codes using their mobile devices or AR-enabled devices, which will trigger the AR navigation experience. The QR codes can be placed at strategic locations throughout the environment to guide users towards their destination.
3. AR Navigation Experience: Once the QR codes are scanned, the AR navigation experience begins, and users can see digital navigation markers overlaid onto their real-world view. These markers can provide directional arrows, distance measurements, and other information to guide users towards their destination.
4. Customization: The appearance of the digital navigation markers and other UI elements can be customized using AR development tools such as Unity or Arway, allowing for a unique and engaging navigation experience.

4.3.5 A* algorithm

The A* algorithm is a popular search algorithm that finds the shortest path between two nodes in a graph. In direction tracking, A* algorithm can be used to find the shortest path from a starting node to a goal node while taking into account the direction of movement. To implement A* algorithm in direction tracking, a heuristic function is used that estimates the distance from the current node to the goal node, taking into account the direction of movement. For example, if the objects are moving towards the east, a heuristic function is used that gives higher weight to nodes in the east than in other directions.

Additionally, an obstacle avoidance system is used based on artificial intelligence (AI) to avoid obstacles in the path. This can be achieved by using sensors and algorithms to detect obstacles and find alternative paths. To implement AI-based obstacle avoidance, a combination of computer vision and machine learning algorithms are used. Computer vision algorithms can be used to detect obstacles in the path, while machine learning algorithms can be used to learn from past experiences and improve the obstacle avoidance system over time.

Overall, the A* algorithm with direction tracking and AI-based obstacle avoidance can be a powerful tool for finding the shortest path while navigating through obstacles. This can have applications in various fields, such as robotics, autonomous vehicles, and game development.

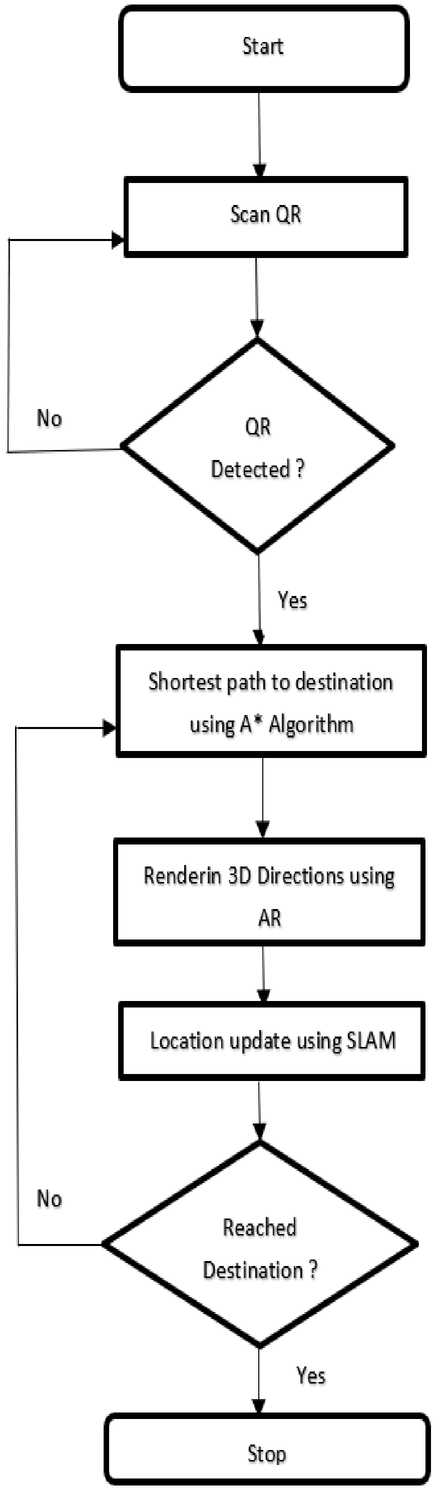

Fig 4.4. Flowchart of the Working System

CHAPTER 5

RESULTS AND DISCUSSION

Result

The project was operated on an android system mobile phone of Samsung SM- G9500. The AR visualization system was implemented based on OpenES as single- threaded programs.

To evaluate the performance of the proposed outdoor positioning method, the participants were asked to walk along four routes with the smartphone in the hand. Some markers were set with known coordinates along the routes to collect theground truth data. When participants walk over a marker, push the button was used to record the time. The ground truth between the markers is obtained by interpolating the step count.

Then the positioning error was calculated based on the Euclidean distance between the estimated position and the ground truth, and also gave the the Cumulative Distribution Function (CDF) of positioning result.

Discussion

It is discussed about the approach carried as compared with two state-of-the-art AR systems: (Xu et al., 2020; Khan et al., 2019). Xu et al. (2020) proposed an AR system for indoor/outdoor navigation. The AR positioning signals are corrected continuously by the ground-truth 3D indoor/outdoor walkability network in a 3D model. However, it is necessity for their tool to implement approaches through is a manual 3D drawing of indoor walkable space. Khan et al. (2019) presented an AR system based on the correspondences between images.

However, failure becomes more likely due to frequent changes in indoor environment and because reliable reference points are unavailable. Moreover, the AR application (Xu et al., 2020) only offer the position spot onto the AR view, and the AR system (Khan et al., 2019) only labels the facility's name along the pathway. These two methods can only provide local spatial in-formation in fixed location for users. Compare with them, our AR and outdoor map fusion technique links rich outdoor spatial information to real world scenes. Figure 14 presents a high-quality AR

system that integrates rich spatial information with the real world tightly and rationally. It is not only technical but also aesthetical for conveying spatial information.

CHAPTER 6

CONCLUSION

6.1 Conclusion

In this paper, a method for fusing AR view and indoor map in changing environments is designed during AR visualization that also considers the changes of the AR view when the pose of the mobile phone shifts. An innovative outdoor positioning approach is also presented that fuses BLE and PDR to enhance the accuracy of AR camera tracking. The experiments in an office building of Sathyabama University demonstrate that dynamic AR visualization techniques can display rich spatial information in real time on mobile phones, while preserving a high accuracy in the AR-GIS fusion. The AR content includes current position, outdoor map and spatial information, which change as the real scene changes. The layout of spatial information is rendered reasonable in AR view. This AR visualization will be clear and easy to understand, which effectively optimizes and enriches the spatial information in the visualization of indoor environment.

Any Android smartphone can be configured to run this programme. The five main steps to take are as follows:

1) Using the blue print of the campus, create the 3D map.
2) User placement based on QR codes.
3) Simultaneous localization and mapping using Google ARCore.
4) NavMesh's (A * algorithm's) quickest route to a specified location is determined.
5) Using the AR view's navigation.

6.2 Future Work

Though the AR-GIS system is shown outdoor map onto the AR view, it can't adapt to the change of the scene size. Thus, in future work, the system will try to process outdoor map data and improve the visualization technique method to realize the adaptive AR visualization. Besides, the current application only labels the name of outdoor scene, which can be further advanced with more details about the spatial information. Furthermore, the smoothing algorithm can be applied to enhance the accuracy of the device's position.

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APPENDIX

A) SOURCE CODE

Target

```
using System;
using UnityEngine;

public class Target {
public string Name;
public GameObject PositionObject;
}
```

Set Navigation

```
using System.Collections.Generic;
using TMPro;
using UnityEngine;
using UnityEngine.AI;

public class SetNavigationTarget: MonoBehaviour {
[SerializeField]
private TMP_Dropdown
[SerializeField]
private List<Target> navigation TargetObjects new List<Target>();

private NavMeshPath path;// current calculated path
private LineRenderer line;//linerenderer display path
private Vector3 target position = Vector3.zero;

private lineToggle false;

private void Start() {
path = new NavMeshPath();
line = transform.GetComponent<LineRenderer>();
line.enabled lineToggle;
}
```

```
private void Update (){
if (lineToggle && targetPosition!= Vector3.zero){
NavMesh.CalculatePath(transform.position, targetPosition,
NavMesh.AllAreas, path);
line.positionCount = path.corners.Length;
line.SetPositions(path.corners);
}
}

public void SetCurrentNavigationTarget(int selectedValue) {
targetPosition = Vector3.zero;
string selectedText =
navigationTargetDropDown.options[selectedValue].text;
Target currentTarget = navigationTargetObjects.Find(x =>
x.Name.Equals(selectedText));
if (currentTarget != null) {
targetPosition = currentTarget.PositionObject.transform.position;
}
}
public void ToogleVisibility(){
lineToggle =! lineToggle;
line.enabled = lineToggle;
}
}
```

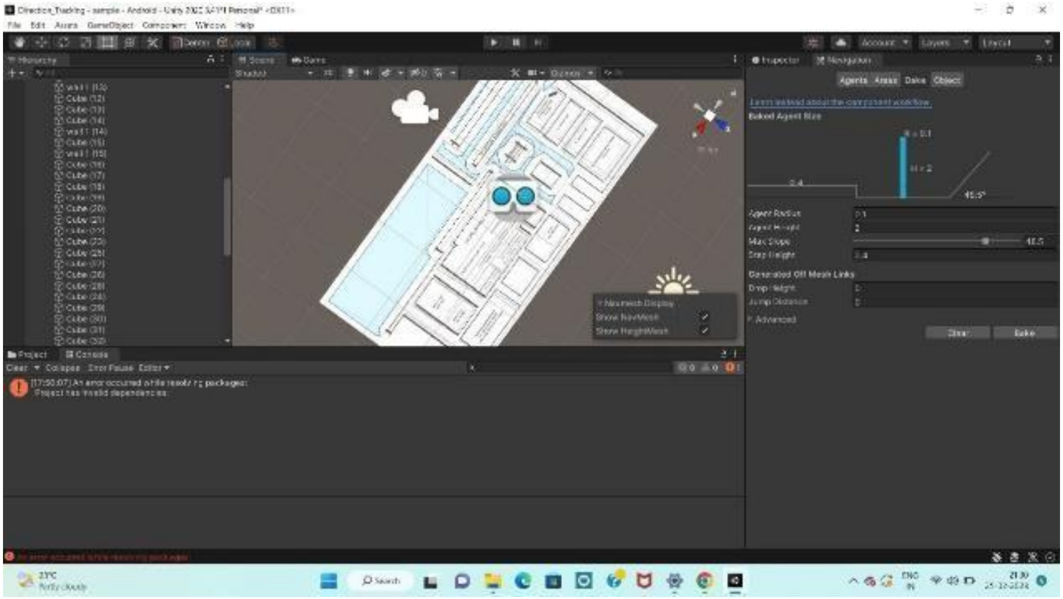
QR Code

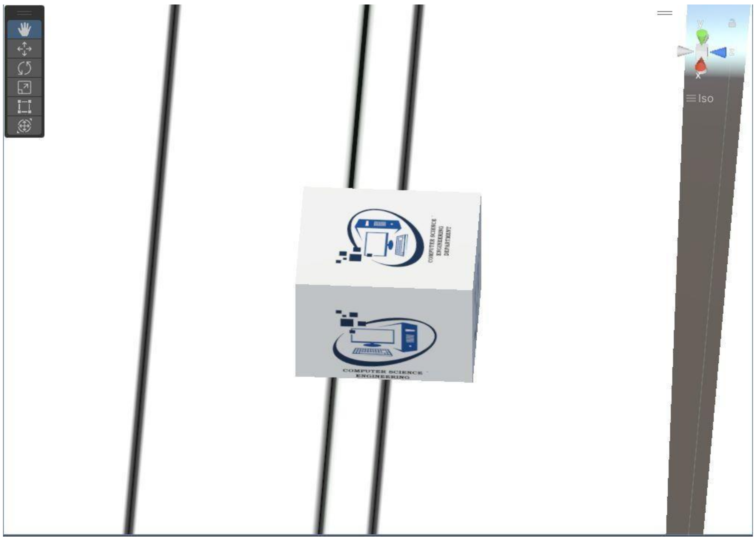
```
using System.Collections.Generic;
using Unity.Collections;
using UnityEngine;
using UnityEngine.XR.ARFoundation;
using UnityEngine.XR.ARSubsystems;
using ZXing;

public class QrCodeRecenter: MonoBehaviour {

[Serializefield]
```

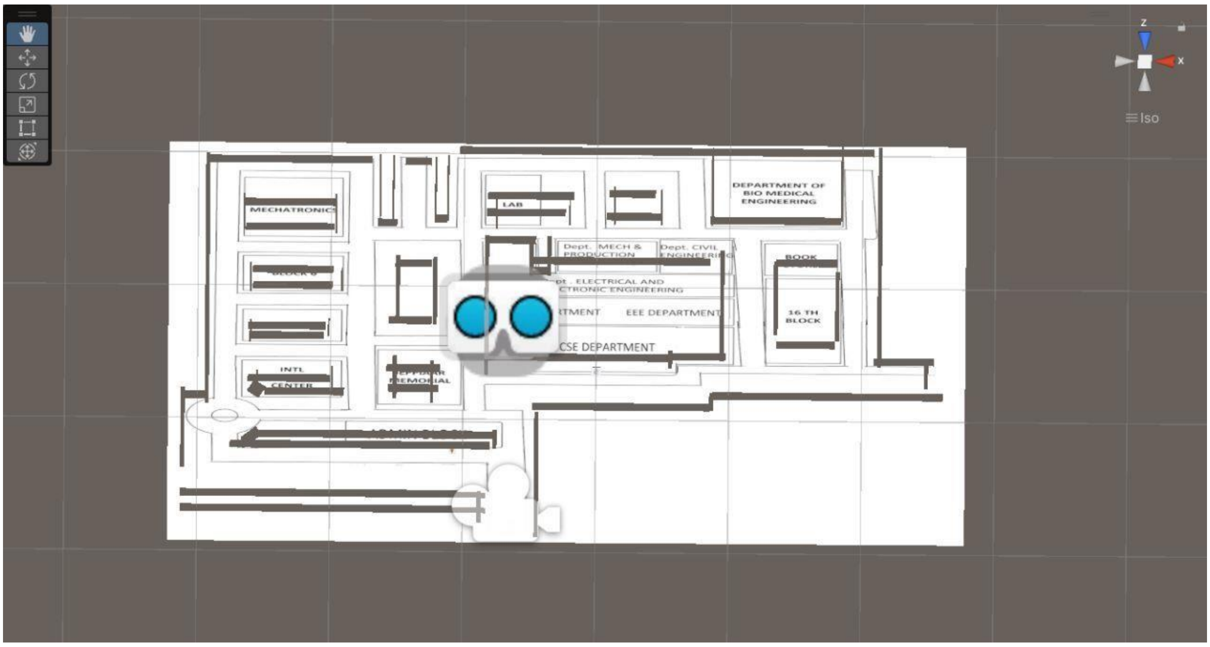
```
private ARSession session ;
[Serializefield]
private ARSessionOrigin sessionOrigin;
[SerializeField]
private ARCameraManager cameraManager;
[SerializeField]
private List<Target> navigationTargetObject = new List<Target>();

private Texture2D cameraImageTexture;
private BarcodeReader reader = new BarcodeReader();

private void Update(){
if (Input.GetKeyDown(KeyCode. Space)){
SetOrCodeRecenterTarget ("LivingRoom");
}
}

private void OnEnable() {
cameraManager.frameReceived += OnCameraFrameReceived;
}

private void OnDisable() {
cameraManager.frameReceived -= OnCameraFrameReceived;
}

private void OnCameraFrameReceived(ARCameraFrameEventArgs
eventArgs) {

if (!cameraManager.TryAcquireLatestCpuImage(out XRCpuImage image))
{
return;
}

var conversionParams = new XRCpuImage.ConversionParams {
inputRect = new RectInt(0, 0, image.width, image.height),
outputDimensions = new Vector2Int(image.width / 2, image.height /2),
```

```
outputFormat = TextureFormat.RGBA32,
transformation = XRCpuImage.Transformation.MirrorY
};
int size image.GetConvertedDataSize(conversionParams);
var buffer new NativeArray<byte>(size, Allocator.Temp);
image.Convert(conversionParams, buffer);
image.Dispose();
cameraImageTexture = new Texture2D(
conversionParams.outputDimensions.x,
conversionParams.outputDimensions.y,
conversionParams.outputFormat,
false);
cameraImageTexture.LoadRawTextureData(buffer);
cameraImageTexture.Apply();

buffer.Dispose();
var result reader.Decode(cameraImageTexture.GetPixels32(),
cameraimageTexture.width, cameraImageTexture.height);
if (result != null) {
SetOrCodeRecenterTarget(result.Text);
}
}

private void SetQrCodeRecenterTarget(string targetText) {
Target currentTarget = navigationTargetObjects.Find(x =>
x.Name.ToLower().Equals(targetText.ToLower())) ;
if (currentTarget != null){
session.Reset();
sessionOrigin.transform.position = currentTarget.
PositionObject.transform.position;
sessionOrigin.transform.rotation =
currentTarget.PositionObject.transform.rotation;
}
}
}
```

B) OUTPUT SCREENSHOTS




Iso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MECHATRONICS
LAB
DEPARTMENT OF BIO MEDICAL ENGINEERING
Dept. MECH & PRODUCTION
EEE DEPARTMENT
CSE DEPARTMENT
16 TH BLOCK
INTL CENTER

C) RESEARCH PAPER

Direction Tracking using Augmented Reality

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Abstract
Universities are enormous, complex structures that employ a variety of technologies to direct visitors to specific locations. Such strategies are typically put into practice by displaying a floor plan, having directional signage, or using colored lines on the floor. Using augmented reality guiding visuals, it is feasible to personally direct individuals with equipment that enables 6DOF tracking in outdoor contexts. The suggested study focuses on three issues that are the primary causes of the lack of such a system in practical settings. First, a tracking system called HyMoTrack is given. It was tested ina real-world airport setting and is based on a visual hybrid tracking technique for smart phones. A 3D representation of the area is needed for tracking and directing in a trustworthy outdoor navigation system. the surroundings. Because of this, a 3D model generating technique was put into place that uses a vectorized 2D floor plan to generate a 3D mesh automatically. A unique AR route idea is proposed for directing people using AR devices, and the human component of an AR guiding systemis finally studied. This FOVPath is intended to respond not only to the user and target's positions, but also to the device's field of view (FOV) capabilities and view direction. This guarantees thatthe user will always receive accurate information within the available FOV. Technical assessments and user studies have been carried out and will be carried out to evaluate the idea.

Keywords: *augmented reality; navigation; outdoor tracking; Path Planning; Path 3D Model Generation; Visualization; CAD.*

I. INTRODUCTION

Augmented reality (AR) is the process wherein a user's perspective of a real object is mixed with a computer-generated virtual scene that contains extra data. Through methods to merge the real and virtual worlds, augmented reality (AR) enhances real-life situations while preserving the user's feeling of presence in the actual world.

Applications of AR are expanding quickly in many industries, including the military, business, training, education, tourism, healthcare, and marketing, to mention a few. The prospects for online education, particularly in disciplines where practical knowledge is highly valued and is not appropriate for non-classroom teaching, are mentioned in (Chia-Wen Tsai, 2017). A growing number of AR applications are being created in a variety of sectors using technology like smartphones. According to Krevelen, D. W. F. V. and Poelman (2010), augmented reality (AR) creates an interactive environment where the real and virtual worlds interact. The real world objects are collected by the camera and supplemented by computer-generated displays, sound, text, and effects.

Marker based Tracking

Its AR applications determine the tracking technique to be employed. The application of marker-based tracking is thoroughly discussed.Most AR tracking methods require pricey equipment. Based on mobile phone technology, marker-based tracking relies solely on the camera tocollect data. Marker-based tracking is an option for developers that want to stick to their budget or keep the application and configuration as straightforward as feasible. Markerless tracking is extremely unpredictable in situations where the environment is same, has shiny surfaces, or has repeated characteristics. If markers are given to the surroundings in such circumstances, tracking is made considerably simpler and easier. Additionally, tracking in a dynamic environment is very harder. because the features' positions are different. By attaching markers in this type of setting, a tracking system can avoid some of these issues; a marker-based system is frequently a superior option. Sensor tracking gets challenging in situations with plenty of moving objects. Only marker-based tracking systems may be employed in these circumstances since markerless tracking systems also become unreliable. The marker can offer any additional information that is required by an application. It is acomponent that all other tracking methods lack.

II. RELATED WORKS

The programmes that are now in use, the issues that are related to them, and the issues with the current navigation applications will all be covered in this chapter.

Arizona Mobile :

The University of Arizona's first official app and one-touch experience for all things, including a navigation system, is called Arizona Mobile [8]. With features like event calendars and video tours, Arizona Mobile not only makes life easier for current students but also allows former and present students from all over the world to stay current. These tools give every user the impression that they are on campus no matter where they are.

Review and Comparison:

This mobile application has a few distinctive characteristics. One recent addiction is the users'need for social engagement. Students could use this programme to stay current on headlines and college news. Nevertheless, due to a lack of information and utility in the more recent Android mobile versions, the map does not function properly with

them. Would advise including University Access within the app as opposed to sending users to a browser to access the mobile website.

III. LITERATURE SURVEY

In an effort to find a solution, researchers and mapping corporations have investigated this problem statement in great detail over the past five years. All of their answers stem from the analysis of different map-making patterns.

1) The work of R. Silva, J. C. Oliveira, and G. A. Giraldi provides a summary of the fundamentals of Augmented Reality (AR) and its key ideas. It outlines significant AR devices as well as the primary industries that use AR now. This study will cover several augmented reality system characteristics and give a general overview of them.
2) According to the research report by Ausburn, Lynna J. Ausburn, and Ausburn, Floyd B., virtual reality (VR) has proven to be a successful educational technique in several technical domains. VR research has, however, typically lacked a strong theoretical foundation to offer explanatory or predictive power. Additionally, research on the efficacy of new desktoptechnologies that make VR accessible to schools and teachers is still in its infancy. This study, which is a pilot, is quite exploratory. It represents a first step in the development of a theoretical line of investigation into desktop VR as a teaching tool with potential for Career and Technical Education. This study evaluated the outcomes of presenting a complex picture via desktop VR with a collection of still photographic photos. It was grounded in numerous theoretical and research streams.

3) In the article by R. Azuma, the field of augmented reality is examined. This technology allows for the real-time integration of 3-D virtual items into a 3-D physical world. It details the investigated uses in the fields of medicine, manufacturing, visualisation, path planning, entertainment, and the military. The properties of augmented realitysystems are discussed in length in this study, along with the advantages and disadvantages of optical and video mixing techniques. This paper highlights current efforts to address registration and sensing mistakes, two of the major issues in

designing efficient augmented reality systems. We talk about potential future directions and areas that need more study.

4) With a focus on tracking, interaction, and display research, Zhou, F., Duh, H. B.-L., and Billinghurst's paper examines the ten-year evolution of the work presented at the ISMAR conference and its predecessors. This relatively new discipline will benefit greatly from the roadmap it gives for future augmented reality research. It can also be used to guide researchers indeciding what areas to focus on when they start their own studies in the field.

5) The field of augmented reality is discussed in Krevelen, D. W. F. V. and Poelman's (2010) paper along with a brief definition, a timeline of its development, as well as the supporting technologies' features. It reviews the state of the art by going through several current AR applications as well as certain acknowledged drawbacks with relation to the use of AR systems for human factors that developers will need to get around.

6) In their study, Rolland, J. P., Baillot, Y., and Goon, A. A. provide a top-down classification of head tracking devices arranged in accordance with their physical operating principles. Time of flight (TOF), spatial scan, inertial sensing, mechanical linkages, phase-difference sensing, and direct-field sensing were found to be the six key principles. Each physical concept is briefly explained, along with the current applications of that principle. The benefits and drawbacks of these implementationsare discussed and compiled in a table.

IV. METHODS AND MATERIAL

A. Requirements

It mainly requires the following:

1. Unity
2. Google AR Core
3. Blender
4. Vuforia

Game production is remarkably simple thanks to Unity's workspace, which mixes component-driven design with artist-friendly tools. Unity allows for both 2D and 3D development, with the well-known Box2D engine handling 2D physics. Prefabs are the central element of Unity's component-based approach to game development. Prefabs allow game designers to build environments and objects more quickly and efficiently.

A plugin called Google AR Core adds AR features to Unity. Our devices must comprehend augmented reality in order to give it. ARCore offers a number of methods for comprehending actual world items. The ability to recognise horizontal and vertical surfaces and planes is one of these tools, which also includes environmental knowledge. Also, they have motion tracking, which enables phones to comprehend and track their positions in relation to the outside environment. More contextual and semantic knowledge about people, places, and objects will be added as AR Core develops and grows.

A 3D computer graphics tool called Blender is available for free and is used to make animated movies, visual effects, artwork, 3D printed models, motion graphics, interactive 3D apps, virtual reality, and video games. Blender files are natively imported by Unity. The Blender FBX.

B. Processing the Application

This is a limitless outdoor navigation application employing augmented reality, as referenced by the various articles of prior research. The creation of a 3D model of the building and its interiors, where we intend to use this application, is the first step in its development. The 3D model of the building was created using the Blender tool. The system must be able to recognise the user's position and map it to the building's 3D model. To do this, we will place QR codes at every conceivable location within the structure, presuming that any location may serve as the user's initial destination. Each QR code is associated with a particular network node, however not all nodes have QR codes. The navigation map locates the user's location and displays a 3D item on the smartphone's screen using QR codes. Arrows that point in the direction of the next point are used to depict 3D objects. When a user scans a QR code, the system recognises his current location and prompts him to choose a destination. The user's camera opens once the user has chosen the location.The live feed from the user's camera is used by Google AR Core to perform simultaneous localization and mapping, which means that the livefeed from the camera is compared with the 3D model of the building to determine the user's precise location. As the user wanders around the building, the user's location is updated very fluidly, much like GPS. The AR (Augmented Reality) arrow may point in any direction depending on the path you choose. As a result, the user is perfectly aware of where to make right or left turns. The system uses the A * shortest path finding method to determine the shortest route from the user's current position to the destination of choice. The * method outperforms Dijkstra's algorithm in terms of speed, effectiveness, and dependability. After the system determines the route to the destination, it displays a virtual 3D arrow object on the user's camera screen to guide them along the shortest route to get there. As the user's position changes, the shortest path is continuously updated. There is no need for the user to scan QR codes along the way to their destination because the directions are updated even if they walkin the wrong direction.

V. METHODOLOGY

The main methodology which leads this application to work involves the following,

Google ARCore:
Google's platform for creating augmented reality experiences is called ARCore. With simply the RGB camera on a smartphone, Google ARCore's many APIs may be used to sense the environment, comprehend it, and interact with it. Simultaneous Localization and Mapping is a function offered by Google ARCore that takes into account important skills like Motion Tracking, Environmental Understanding, Depth Understanding, Light Estimation, and User Interaction (SLAM).

Nav Mesh:
A Nav Mesh in Unity represents a region where the user object's centre can shift. Here, the object might be either a point or a big circle; all options areequally valid. The Nav Mesh in our programme is made up of all the walls, doors, and other obstructions that the user cannot travel through and is built based on the building's blueprint. This enables us to estimate only the space that a user can traverse.
A* Algorithm:

A* is a best-first search algorithm that is informed, meaning it is written in terms of weighted graphs. It starts at a particular starting node in the graph and seeks to find the shortest path to the specified goal node (least distance travelled, shortest time, etc.). It accomplishes this by keeping track of a tree of paths leading from the start node and extending each path's edge separately until its termination requirement is met. A* can be used to determine theshortest path, similar to Dijkstra's algorithm. A* is similar to Greedy Best-First-Search in that it has theability to utilise a heuristic to direct itself. It is just as quick as Greedy Best-First-Search in the simple situation.The key to its success is that it combines the information that Greedy Best-First-Search and Dijkstra's Algorithm employ, prioritising vertices that are close to the starting point (favoring vertices that are close to the goal).
One of the best and most widely used methods for path-finding and graph traversals is the A* Search algorithm. The algorithm can be described simply as:

$$F = G + H$$

Where F is the parameter that has the lowest cost from one node to the next node and is equal to the sum of the other parameters G and H. We can find the best route from our source to our destination with the aid of this parameter.
G represents the expense of switching from onenode to another. In order to identify the best path, we move up each node's value of this parameter.
H represents the heuristic-estimated route from the current code to the target node. This cost is a guess that we use to determine which route could be the most efficient one to take between our source.
Abbreviations:
AR – Augmented Reality
QR – Quick Response
GPS – Global Positioning System
RGB – Red Green Blue
SLAM – Simultaneous Localization and Mapping

VI. WORKING

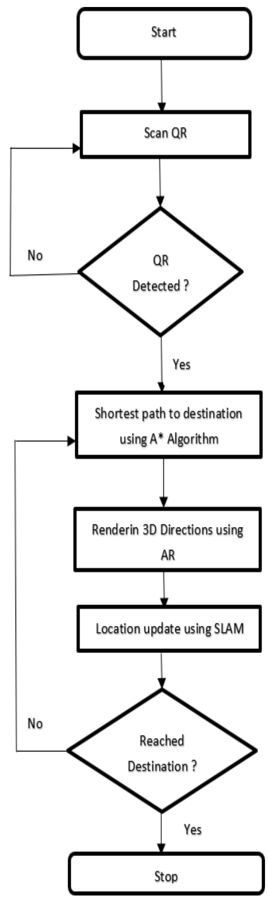

Fig 1. Flowchart of the Working System

Map

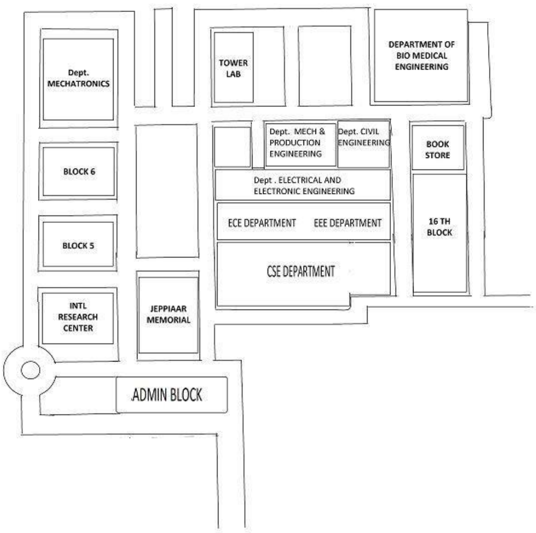

Fig 2. Blueprint of the University campus

VII. RESULTS

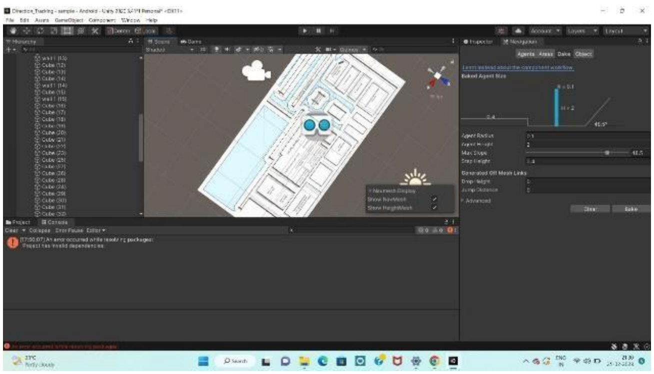

Fig 3.1 Screenshot of map and 3D object creation in Unity

Fig 3.2 Result Screenshot of AR view displaying the route to destination and a marker showing the destination block.

VIII. CONCLUSION AND FUTURE SCOPE

Any Android smartphone can be configured to run this programme. The five main steps to take are as follows:

6) Using the blue print of the campus, create the 3D map.
7) User placement based on QR codes
8) simultaneous localization and mapping using Google ARCore.
9) NavMesh's (A * algorithm's) quickest routeto a specified location is determined.
10) Using the AR view's navigation

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