e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
( Peer-Reviewed, Open Access, Fully Refereed International Journal )
Volume:06/Issue:04/April-2024 Impact Factor- 7.868 www.irjmets.com

# AUGMENTED REALITY BASED NAVIGATION INTERFACE SYSTEM

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DOI : https://www.doi.org/10.56726/IRJMETS52199

## ABSTRACT

The Augmented Reality Based Navigation Interface System is a new age project that leverages AR technology to revolutionize the way we interact with navigation system, this innovative technology seamlessly helps in integrate real-world surrounding with virtual information and offer the user a immersive navigation experience. The AR navigation system employs computer or mobile vision, meta data, and sensors fusion to determine the accurate position and orientation of the user. By combining the technologies, system can offer the step direction and adapt changing condition and useful in indoor navigation. As we delve into the details of the project. We will explore the technologies used, the methodologies applied and working of the Navigation System. This innovation has the potential to reshape the way we navigation in complex indoor environments like college campus, shopping malls and many more and ultimately improve the quality of living.

**Keywords:** A* Algorithm, ARCore, Unity, Augmented Reality, Indoor Navigation System.

## I. INTRODUCTION

Today, many areas of our life are transitioning to online solutions. But despite this trend, there are still plenty of times when we need to move around in the physical space in order to take particular actions or achieve certain goals. In most cases, having an address, a unique name, or a set of coordinates makes this task fairly straightforward. It is further simplified by the various applications in the market that can help you reach your destination via step-by-step movement instructions, for example via GPS directions on your smart phone.

However, there remain some limitations to these types of solutions. In the case of relying on GPS services, it is well known that GPS sensors don't always provide accurate location information. GPS satellites don't transmit strong enough signals to reach indoor users. And signals that enter buildings through windows are often unreliable and can produce location errors up to hundreds of meters . This is why an entirely different technology solution is required in order to provide accurate directions to indoor locations. AR indoor navigation, or augmented reality indoor navigation, is a solution that provides turn-by-turn directions to locations or objects where GPS and other technologies cannot accurately work. Augmented reality (AR) is the technology that shows the real-world environment with digital information overlaid onto it.

AR allows adding any type of 3D models as objects into the real world. Users can then interact with them in real time, change object placements, scale, or rotate them. There are two significant parts to AR-based indoor navigation – one being the actual navigation and localization and the next being the AR directions such as arrows, markers, text and other symbols on the screen. AR-based indoor navigation incorporates AR-technology and provides directions on screen overlaid on top of real environments that are seen through the camera of a device like a smart phone or tablet.

This way, the user can easily navigate through complex buildings without using a map or other references. This makes the navigation process not only easier and more efficient, but also more convenient.

**Some benefits of using Augmented Reality:**

- Improving the quality of production processes.
- Reducing production and service costs in the field.
- Refining training and skills sharing.
- Improve industrial safety standards.

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- Optimising the product ASSEMBLY process.

**Frameworks:**

The ARKit (iOS) or ARCore (Android) frameworks can be used for visual recognition of various objects such as text, images, or other 2D or 3D shapes. These frameworks provide for the rotation or positioning of each object and give useful information about detected vertical and horizontal planes.

There are some restrictions on the use of ARCore indoor navigation, as it only works on supported devices. The device must have a high quality camera, motion sensors, and the design architecture to ensure it performs as expected. In addition, the device needs to have a powerful enough CPU that integrates with the hardware design to ensure good performance and effective real-time calculations.

Algorithms : A* algorithm is used to find the shortest path from source to the destination.

SLAM (simultaneous localization and mapping) is a method used for autonomous vehicles that lets you build a map and localize your vehicle in that map at the same time. SLAM algorithms allow the vehicle to map out unknown environments. Sensors like IMU: Inertial Motion Units (IMUs) are sensors that measure movement in multiple axes. Accelerometers measure a changing acceleration on the sensor. They can be used to measure the tilt of the sensor with respect of the Earth, or the force of a hit. They are common in mobile devices and automobiles.

Gyroscopes: providing a measure angular rate. Accelerometers: providing a measure specific force/acceleration. Magnetometers (optional): measurement of the magnetic field surrounding the system..

## II. LITERATURE SURVEY

**Designing an Augmented Reality Based Navigation Interface for Large Indoor Spaces (Fanny Curtson), 2021 –**

This research paper investigates the development and iterative testing of an Augmented Reality (AR) navigation interface. It comprises three key design elements: the AR interface, overlay interface, and user-testing findings. The study unfolds in three rounds, with each round revealing user feedback and design improvements. Notably, users showed a preference for path B over path A, and occlusion challenges became evident. Design iterations aimed to declutter the interface, enhance map interactions, and improve the user's spatial awareness. The results demonstrate a positive evolution in System Usability Scores (SUS), suggesting improved user satisfaction. In conclusion, this research emphasizes the importance of iterative design in AR interfaces and highlights areas for future exploration.

**Augmented Reality Navigation (Munesh Kumar Sharma, Satya Chachaundiya, Vishal), 2020:**

This research delves into the integration of Augmented Reality (AR) into navigation systems to enhance user experiences. It underscores the significance of user-centric, nonintrusive solutions that align virtual information with the real world. The paper explores vital design considerations, including the use of display technologies like video displays, optical displays, and projective displays. It emphasizes the need for intuitive navigation interfaces that offer clear visual cues for both vehicular and pedestrian navigation.

The study provides insights into different scenarios for AR navigation, including vehicular navigation aimed at improving driver safety and reducing distraction, pedestrian navigation for urban environments, and indoor navigation. For indoor navigation, it explores the use of technology like iBeacon and Indoor-Atlas to address GPS signal limitations.

While highlighting the opportunities offered by AR navigation systems, the research acknowledges potential challenges, such as ensuring the user's real-world view is not obstructed and addressing privacy concerns associated with AR camera input. Overall, this paper sheds light on the transformative potential of AR in revolutionizing navigation systems.

**A Low cost Augmented Reality system for Wide Area Indoor Navigation (Vivek Dosaya , Shashwat Varshney ,Vijaya Kumar Parameshwarappa, Akshay Beniwal,Shraddha Tak),2020:**

The paper introduces a low-cost augmented reality (AR) system for indoor navigation, addressing challenges in large structures like malls and airports. It aims to assist visually impaired individuals and the general public. The system relies on AR technology to accurately determine a user's location without GPS or complex technologies.

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Virtual anchors are placed throughout indoor environments for persistent navigation, usable by registered app users.

The system also explores integration with the Aarogya Setu app for COVID-19 exposure tracking. It specifies hardware and software requirements, functional aspects, and discusses the system's architecture, development platforms (Unity and Azure Cloud), and anchor placement with spatial sounds. Usability tests demonstrated successful navigation, but limitations in poorly lit rooms and obstacle detection were noted. Future enhancements include gamification, obstacle detection, and improvements for stair-related routes. This system presents a promising solution for efficient and informed indoor navigation.

**Guiding People in Complex Indoor Environments Using Augmented Reality(Georg Gerstweiler),2018:**

The provided text outlines a research project focused on enhancing Augmented Reality (AR) navigation and tracking. The researchers introduce the Hy Mo Track Framework, which relies on an accurate 3D model of the environment, offering a hybrid tracking solution for reduced drift and improved AR indoor navigation.

The study highlights challenges in conventional AR path planning, such as static arrows and basic graph traversal algorithms not being sufficient for a credible user experience due to limited field of view (FOV) of AR glasses. The researchers propose a novel path planning algorithm tailored to AR, aiming to enhance the user's guiding experience.

The research methodology involves analyzing floor plans, creating a 3D model, implementing the tracking module (Hy Mo Track), and testing it in real world scenarios, including an airport setting. The results indicate successful 3D model generation for apartments, continuous tracking with Hy Mo Track at an airport, and a promising new FOV Path concept. User studies show that the FOV Path outperforms traditional straight paths in terms of performance and user satisfaction.

In conclusion, this research project seeks to overcome the limitations of existing AR navigation methods by developing innovative solutions that consider the unique characteristics of AR devices and user needs. Publication and further studies with different AR devices are on the horizon.

**Comparison with existing Systems:**

| Features \ Papers | Designing an Augmented Reality Based Navigation Interface for Large Indoor Spaces | A Low cost Augmented Reality system for Wide Area Indoor Navigation | Guiding People in Complex Indoor Environments Using Augmented Reality | Augmented Reality based Navigation Interface System |
|---|---|---|---|---|
| Path Optimization and User Preference | ✓ | × | × | ✓ |
| Field of View (FOV) Enhancement | × | × | ✓ | ✓ |
| Unique Path Planning Algorithm for AR | × | × | ✓ | ✓ |
| Addressing Privacy Concerns with AR Camera Input | ✓ | × | × | ✓ |
| Solutions for Visually Impaired Individuals | × | ✓ | × | ✓ |

## III. REQUIREMENT ANALYSIS

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

1. Google ARcore

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2. Unity:

3. AR Foundation

4. Adobe Illustrator

**Google Arcore:**

ARCore is Google's platform for building augmented reality experiences. Google ARCore includes different APIs that are used to sense the environment using just a smartphone's RGB camera and understand the world and interact with it. Google ARCore considers key capabilities like Motion Tracking, Environmental Understanding, Depth Understanding, Light Estimation and User Interaction to provide a feature called Simultaneous Localization and Mapping (SLAM).

**Unity:**

Unity provides a workspace that combines artist friendly tools with a component-driven design that makes game development pretty darn intuitive. Both 2D and 3D development is possible in Unity, with 2D physics handled by the popular Box2D engine. Unity uses a component-based approach to game dev revolving around prefabs. With prefabs, game designers can build objects and environments more efficiently and scale faster.

**AR Foundation:**

AR Foundation is a software framework developed by Unity Technologies that simplifies the creation of augmented reality (AR) applications. It is designed for use with the Unity game engine and provides a unified interface for building AR experiences that can run on various platforms, including iOS and Android devices.

Key features of AR Foundation include support for motion tracking, plane detection, hit testing, light estimation, and interactions with the real world. It simplifies the implementation of features such as object tracking, image recognition, and face tracking. Additionally, AR Foundation integrates well with Unity's existing tools and workflows, making it accessible to a wide range of developers, from beginners to experienced professionals.

**Adobe Illustrator:**

Adobe Illustrator plays a crucial role in creating augmented reality (AR) navigation interfaces by enabling the design and development of visually engaging, user-friendly AR elements. Designers use Illustrator to craft intricate 2D graphics, icons, and UI components that seamlessly blend the virtual with the real world. Its vector-based tools ensure high-quality scalability, vital for AR's dynamic environment. These designs serve as overlays on AR applications, enhancing users' spatial awareness and providing them with intuitive, interactive guidance. Adobe Illustrator's versatility empowers AR developers to build immersive, informative navigation experiences, revolutionizing how people interact with their surroundings through cutting-edge technology.

## IV. SYSTEM ARCHITECTURE

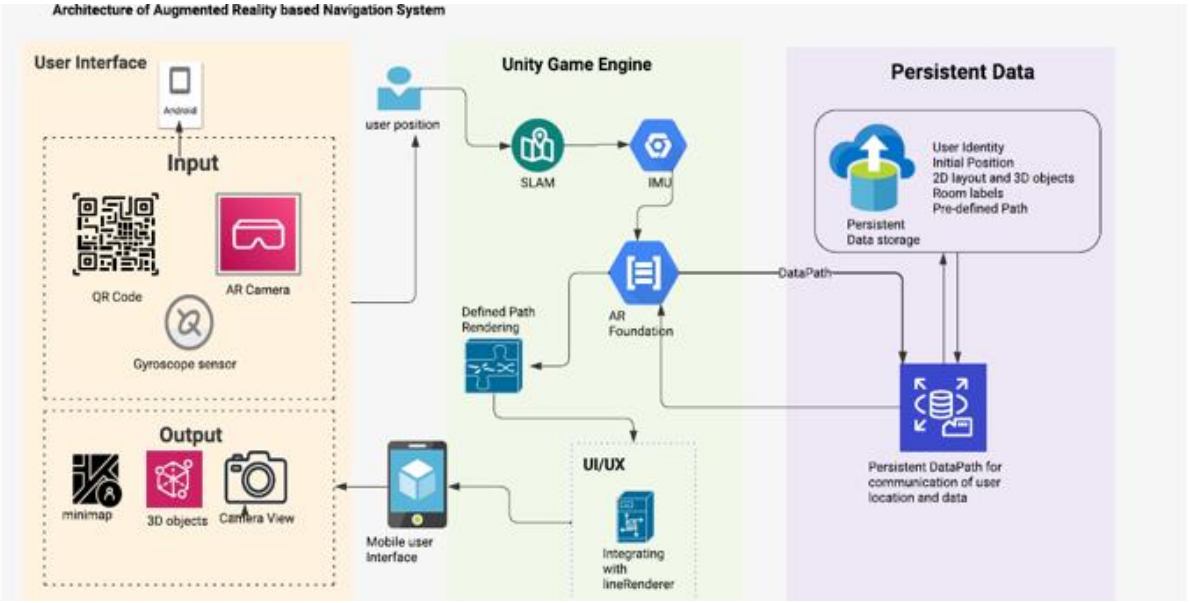


**Fig:** (a) System Architecture of ARBNIS

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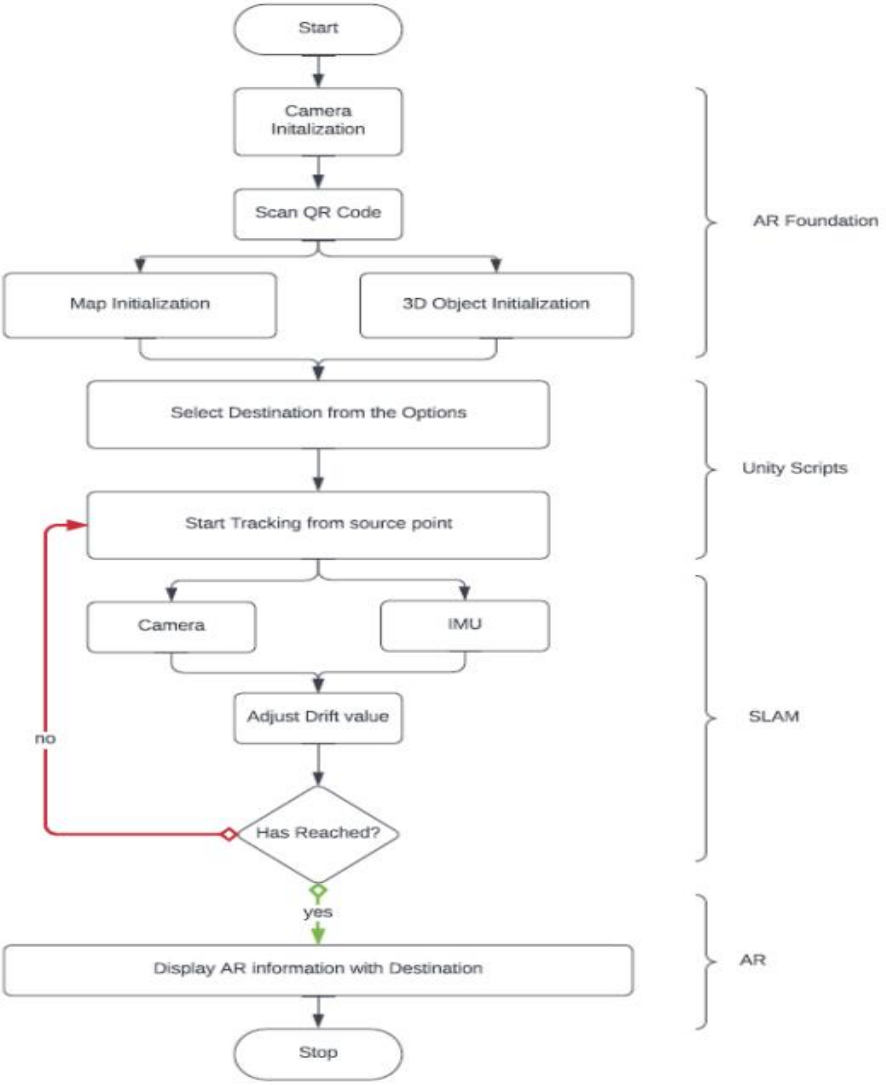
System Architecture for Augmented Reality Based Navigation System i.e fig (a) is divided into 3 modules i.e. User Interface , Unity Game Engine and persistent Data System .

User Interface is used to fetch the Qr Code encrypted text with the help of ZXing libraries ,It will give us the user position and orientation with respect to 3D model . The Unity Game Engine consists of SLAM which is Simultaneous Localization And Mapping and IMU which is Inertial Measurement Unit. They help in dynamic orientation of the mobile device with 3D model measurements. Unity Engine Contains important package i.e. ARFoundation which helps in AR view of the locality.

Persistent Data System saves and gives the real time data like GameObjects , Line Renderer etc it is called by the ARFoundation with help of DataPath , the predefined path is rendered with help of LineRenderer and Scripts. It is integrated with the Indicator GameObject. The Application Canvas will give the output as the Renderer 3D lines and Destination 3D GameObjects in the 3D model. GUI will consist of a minimap view and different destination options.

## V. PROCESS DESIGN AND SYSTEM BLOCK DIAGRAM




The Design of the navigation interface system is divided into three parts AR Foundation, Unity Scripts, and SLAM. These three parts are the important sections of the design of navigation system.

**Abbreviation:**

SLAM – Simultaneous Localization and mapping

AR – Augmented Reality

IMU – Inertial Measurement Unit

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QR Code – Quick Response Code

## VI. MATHEMATICAL MODEL

A navigation mesh (navmesh) is a data structure used for pathfinding.

Represent the navmesh as a graph where nodes are polygons and edges represent connections between adjacent polygons.For navigation within the generated navmesh, you can use algorithms like A* (A-star) to find the shortest path between two points.The A* algorithm heuristic function is commonly defined as:

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

where:

f(n) is the total cost of the path through node n,

g(n) is the cost of the path from the start node to node n, h(n) is a heuristic that estimates the cost of the cheapest path from n to the goal.

## VII. RESULT

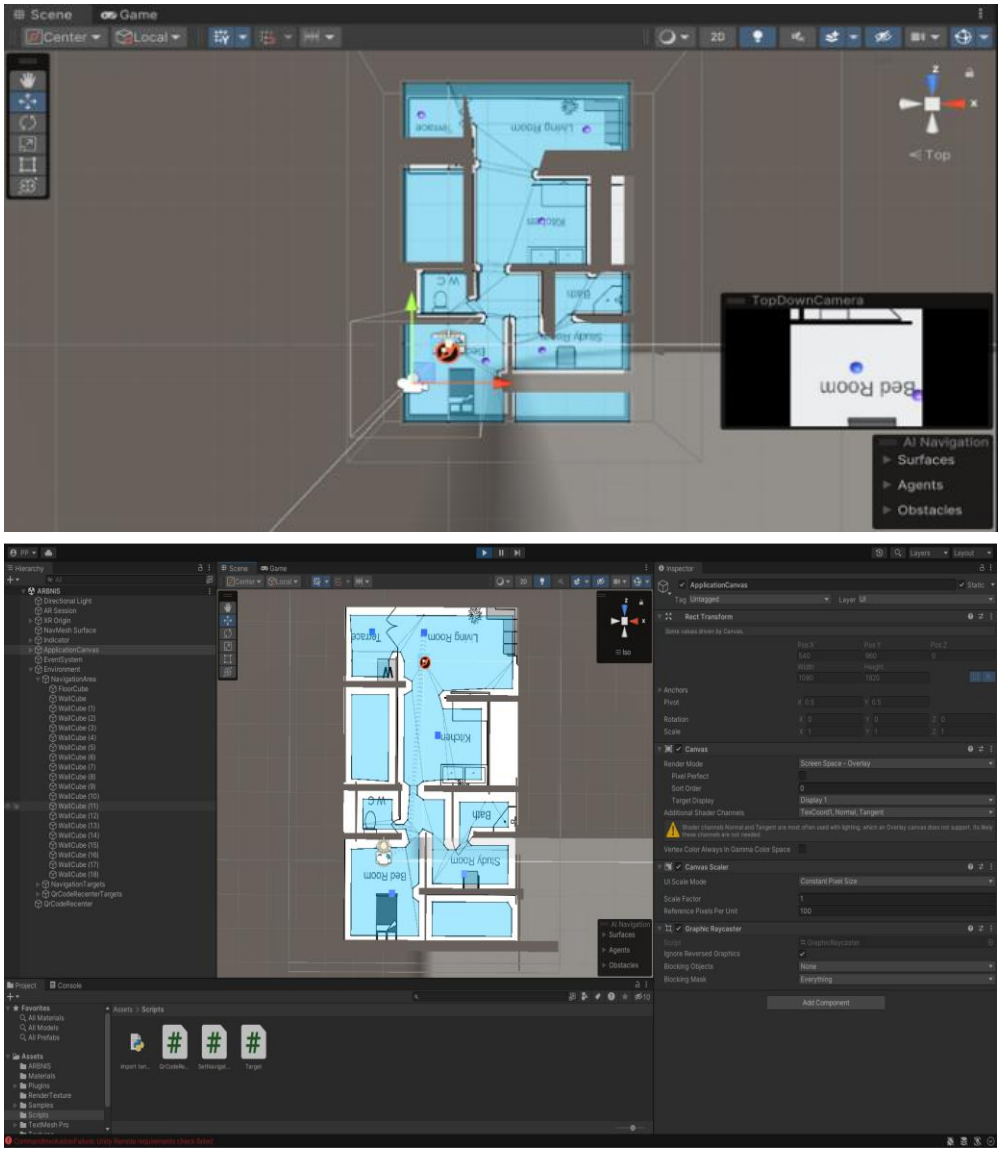


**Fig:** (b) Implementation and navmesh

The Result of the implementation is shown in the figure (b)., with the help of 2D blueprint we created a 3D model of the layout and with the help of AI navigation we able to develop a navmesh i.e the movable area by the user and navmesh helps us to navigate through the lines which are developed by the A* algorithm. The Destination can be viewed as GameObject created as 3D object .

## VIII. CONCLUSION

In conclusion, the campus navigation system is a valuable tool that enhances the overall experience for students, faculty, and visitors. It simplifies navigation, saves time, and promotes efficiency. With features like real-time updates, accessibility information, and user-friendly interfaces, it not only addresses the immediate navigation needs but also contributes to the inclusivity and sustainability of the campus environment. Implementing such a system can lead to improved satisfaction and a sense of belonging within the campus community.

The navigation system presented in this project represents a significant advancement in simplifying and improving the way individuals navigate their environments. Through rigorous research and development, we have achieved accurate and user-friendly navigation capabilities that have the potential to transform various industries, from transportation to tourism. The user feedback and testing have demonstrated its effectiveness in providing reliable directions and enhancing overall user experiences. However, it is essential to acknowledge that there are challenges, such as GPS signal limitations in urban canyons and the need for ongoing updates to keep maps current.

## IX. FUTURE WORK

One of the scenarios we can prepare a complete campus navigation system with detailed layout and blueprints. With implementation of Authentication and Authorization we can limit the login and share location with peers , Authentication also provide the service to grant the account permission to admin and provide security and verify that a user is who they say they are. Navigation System with Augmented Reality is a modern technology with more innovations and features , it can scale to greater extent.

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