AR INDOOR MAPPING AND NAVIGATION

Mrs. Snigdha Kesh[1],Shariq Majeed Khan[2], Sibam Kumar[3], Tamanna Sethia[4], Thanushree S[5]

[2345]Student, Department of Computer Science and Engineering , AMCEC, Bangalore-083, India
[1]Faculty, Department of Computer Science and Engineering , AMCEC, Bangalore-083, India

ABSTRACT

In the world of location-based services, indoor navigation has proven to be a difficult problem to solve. Due to a lack of GPS signals within, traditional methods like GPS-based navigation are useless. In this project, an augmented reality (AR)-based indoor mapping navigation system is proposed. The system is made to make it easier for people to move around interior spaces like malls, airports, hospitals, and other big structures.The suggested system makes advantage of augmented reality (AR) technology to give consumers a more immersive and intuitive navigating experience. The technology shows users directions, sites of interest, and other pertinent information on their mobile device's screen using an AR-capable camera and an indoor map that has already been constructed.Any object or location in the indoor environment can be pointed at by the user, and the system will instantly display any pertinent details and directions.The technology uses computer vision algorithms to identify indoor landmarks and items before superimposing augmented reality (AR) features to direct the user through the area.The suggested AR-based indoor mapping navigation system has the potential to completely transform interior navigation by giving users a more user-friendly and engaging experience. A number of experiments and user studies have been used to evaluate the system, and the findings indicate that it is a workable and efficient solution for indoor navigation.

Keyword: - *Indoor Navigation , Augmented Reality, Location Based Services, Computer Vision Algorithms and User Friendly Experiences, Indoor Mapping.*

1.INTRODUCTION

AR-based indoor navigation uses AR technology to display directions on a screen superimposed on top of actual environments as viewed through a smartphone or tablet's camera. By doing this, the user may effortlessly manoeuvre through intricate buildings without the need of a map or other guides.

The suggested system seamlessly overlays location information over the user's perspective to create augmented reality. It does this by automatically identifying a location from image sequences captured inside surroundings. We created a location model of an indoor space, which comprises of locations and paths between places, in order to recognise a location. Utilising prior knowledge of the indoor environment's layout, location is identified.

The concept of guiding a person through an inside environment is known as indoor navigation. Typically, users utilise a paper map or facility directory to locate an object and determine the best path to their intended location. Although GPS-based mapping has been around for a while and is known for being an accurate locating tool, it can only be used in outdoor contexts and not inside ones since walls and roofs scatter and attenuate the satellite signals that are used to identify a location.

To solve the issue, an interior navigation system that doesn't require wireless technology or hardware installation should be used. Additionally, it makes use of interactive augmented reality to enhance navigation, lessening cognitive load and involving the user in more enjoyable activities.

1.1 Objectives

- The purpose of AR in indoor mapping is to give people a simple and engaging means of navigating challenging indoor spaces. It can be challenging to read and comprehend traditional mapping techniques, such as paper maps or digital floor plans, particularly in large or complicated buildings. Virtual reality (AR) can offer a more natural and intuitive method to traverse indoor places by superimposing virtual guides or other visual clues over the user's perspective of their surroundings. This can be especially helpful in places like airports, hospitals, or retail centres where guests might not be familiar with the building's layout

- The precision and effectiveness of location monitoring are improved as a result of augmented reality in indoor mapping. GPS technology, which is frequently used for outdoor mapping, frequently lacks accuracy in enclosed spaces. AR can offer more precise position monitoring and customised guidance by combining sensors and image recognition technologies. This can be especially helpful in sizable indoor places like convention centres or sporting venues where patrons would need to find particular seats or locations.

- Enhancing the user's experience by offering more contextual information or interactive elements is the third goal of AR in indoor mapping. AR can offer consumers real-time information about nearby points of interest, such as shops, restaurants, or exhibits, by superimposing virtual information onto their perspective of their surroundings. Virtual tours and scavenger hunts are only two examples of interactive experiences that may be made with augmented reality. With AR, you can provide visitors a more immersive and interesting experience, which will enhance their likelihood of returning.

1.2 Scope and Applicability

Our system's goal is to make it easy for users to go between different locations without stopping to ask for directions. Additionally, it piques users' curiosity, particularly those who are new to the university or are just stopping by. An inventive approach that uses the aforementioned technologies for both indoor and outdoor navigation is augmented reality. This technology's main objective is to show consumers directions on a screen that is superimposed over actual environments as seen through the camera of a device like a smartphone or headset. The difficulty of comparing the real environment to a reference, such as a map, which is more challenging for people to utilise while navigating, is reduced as a result.This makes it easier for users to navigate by eliminating the problem of comparing the real world to a reference, such as a map. As a result, AR navigation consists of two steps: first, the actual navigation and localization, and second, the display of AR directions on the screen as text, arrows, and routes. The method' hardest stage is actually the second one; determining the user's position is the more difficult step. On the most crucial gadget, the smartphone, it assists in fusing entertainment elements with real-world exhibits. Create a special experience for the visitors as a result.

For efficient navigation, AR makes path logistics and visual orienting easier.Applications for augmented reality (AR) can highlight and superimpose directions and instruction points for easy reading on what your camera views. In an emergency, you can also use AR to find your way. Our system's application is to make it easy for users to get around the institution without having to ask anyone for directions. Additionally, it piques users' curiosity, particularly those who are new to the university or are just stopping by.

2. LITERATURE SURVEY

The survey of previously published scholarly materials, such as books, journals, articles, and theses, that are connected to a certain topic or question is known as a literature survey or literature review. It involves looking up relevant literature on your selected topic or issue and evaluating it. It provides the most recent information available on the issue or topic you are writing about. In relation to the project, a literature review was done to better understand the concept, to develop ideas, to comprehend the approaches now in use, and to discover the limitations of those methodologies.

System for indoor navigation Systems known as interior navigation systems offer the best route between a starting point and a desired destination inside of a building. A positioning device that can process the anchor information to determine its own location and an anchor with its own specific location information are the two primary components of indoor navigation systems (Yang & Shao, 2015).
Although there are numerous potential indoor navigation services available on the market, the most appropriate one in terms of accuracy, responsiveness, and cost-effectiveness is still up for debate. Standard placement methods worldwide positioning system The most effective and well-known outdoor locating system is GPS. Through the use

of satellites, it can pinpoint a person's position on Earth's surface in terms of longitude, latitude, and altitude (Olevall & Fuchs, 2017).

The radio signal from satellites is blocked by construction materials like roofs and walls, which contributes to the poor accuracy of determining an indoor position (Jekabsons, Kairish, &Zuravlyov, 2011).

WiFi-Based System: WiFi positioning is achieved through WiFi access points (APs), which provide a signal that enables mobile devices to detect their precise location at any given time (Zandbergen, 2009). [1]. Hu (2013) talked about the use of Wi-Fi based indoor positioning systems in smartphones and made the point that wireless networks are a viable option for interior positioning because they are inexpensive to set up and don't require specialised hardware.The WiFi signals experience time-correlated fading as a result of interference from other devices and moving objects, and the coverage is limited (Zandbergen, 2009).

Bluetooth-Based System: It has been determined that Bluetooth beacons are the most precise locating technology available. By placing hardware beacons around the facility, each of which contains a unique location dataset, it serves as location awareness. Then, using Bluetooth Low Energy technology, the beacon's message is sent as a signal to connect with the mobile device (Pokale et al., 2017) [2]. The precision and effectiveness of beacons transmitted are directly linked to the battery power consumption, despite claims that it just uses less battery power to broadcast advertising signals. Additionally, per Olevall & Fuchs (2017).

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2.1 Drawbacks of existing system

i. While active measurement systems like lidar are finding greater use in indoor measurement systems, the use of image/vision based acquisition systems will continue because of their higher resolution. A major problem in vision based systems is feature measurement and detection under variable lighting conditions, which is a characteristic of indoor environments.

ii. Many measurement systems are designed for environments that contain as few visual obstructions as possible.Indoor environments are often busy and cluttered. Measurement under these conditions is difficult, particularly for vision based systems. Under these conditions a measurement system has to be able to achieve two goals,
(1) detect and remove obstacles automatically
(2) measure the features of interest (e.g., walls)

iii. It’s known that acquisition systems that are able to combine the strengths of different sensor systems are able to deliver more reliable results. The development/improvement of new sensors and the combination of these sensors is an on-going research.

2.2 Augmented Reality

According to Silva, Oliveira, and Giraldi (2003) [4], augmented reality is a technique that places computer graphics that have been registered in 3D space on top of the real environment, which serves as the main setting for action. Additionally, both interact with real-time updates in which the user's movement directly affects the virtual element as it appears on the screen of the computer device. It varies from virtual reality in that it augments the current physical environment with certain virtual models rather than creating a whole new artificial one (Chavan, 2014).There are a few types of Augmented Realities as listed below:

- **Marker-based AR:** This sort of AR uses the phone camera to identify visual markers like QR and 2D. After several calculations that take into account the angle and distance between a mobile phone and the marker, the virtual object is then rendered over the marker.

- **Marker-less AR or location-based AR:**It uses a location tool, such as a GPS, to determine the user's location and then displays pertinent virtual information like local landmarks or instructions to a destination in augmented view (Chanphearith, Santoso, & Suyoto, 2016).

- **Projection-based augmented reality (AR):**It casts light onto a real object, which people may subsequently interact with via sensors. By tracing the object's silhouette, the masking approach is utilised to align the projection picture with the object (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 the optimization method (Argotti, Davis, Outters, & Rolland, 2002). 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 softwares 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 is also applied in the education field where the supplementary interactive information like video and graphics make the learning process more interesting and easier to absorb new knowledge.

3. IMPLEMENTATION

We used Unity as the primary development environment, the ARCore plugin, and the Startdust SDK to implement AR indoor mapping. To complete the implementation, our team followed a step-by-step procedure that is detailed below.

Unity Setup: We created a new project in Unity and imported the ARCore plugin from the Unity Asset Store. This provided us with a set of tools to work with AR, such as the AR camera, anchors, and raycasts. We then imported the Stardust SDK package, which contained the necessary tools to recognize indoor locations and paths. The SDK included an editor tool to create and manage the database of indoor environments, as well as some sample scenes and scripts to get started.

Database Creation: Using the Stardust SDK editor tool, a database of indoor places and paths was created as the first stage in developing the AR indoor mapping system. Using a 360-degree camera, we took panoramic 360-degree photos of indoor settings, which we then submitted to the editor tool. The paths between the places were then specified in a map of the interior space that was made by connecting the photos. To aid users in navigating the inside space, labels and other indicators were also added. We exported the finished database as a file and then imported it into the Unity project.

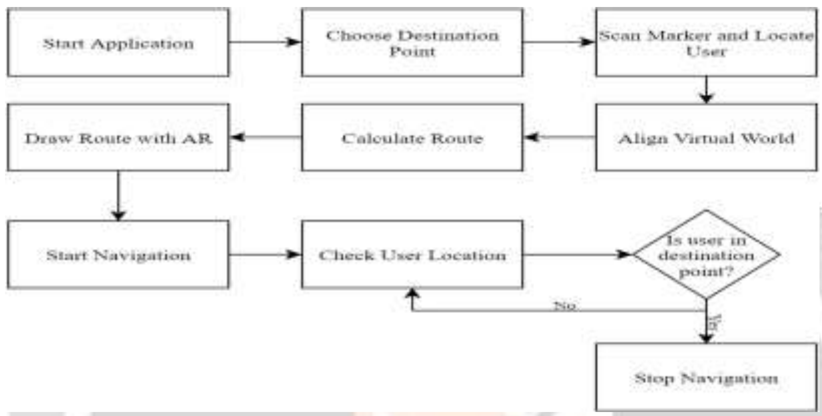
AR Integration: After creating the indoor environment database, we used the ARCore plugin to make it possible to track a user's position and orientation in the real world using a camera. In order to track the user's movements, we placed an AR camera in the scene. In order to manage user input, such as tapping the screen to choose a location or swiping to alter the orientation, we have implemented a few unique scripts. The user's location within the interior environment was determined using the Stardust SDK, and the pertinent location data was then shown in augmented reality. This was accomplished by superimposing the AR information on top of the real environment using a combination of raycasts, anchors, and UI elements.

Enhancements to the User Experience: We added directional arrows, distance measurements, and voice-guided instructions to the AR display to improve the user experience. In order to provide users the ability to personalize their navigation experience, we also integrated a few interactive components like buttons and menus. Users might switch between 2D and 3D modes, select a different color palette, or alter the spoken language, for instance. By scaling down the panoramic photographs and using a lower quality for the AR display, we were also able to improve the performance of the AR display.

Testing and Optimisation: Lastly, we tested the implementation using the ARCore developer mode on a variety of Android devices. By lowering the size of the panoramic photos and employing a lower quality for the AR display, we were able to increase speed and cut latency. In order to collect feedback on the user experience and make any necessary modifications, we also tested the system with actual users.

Overall, it was a challenging but effective process to develop AR indoor mapping utilizing Unity, ARCore, and the Stardust SDK. Using cutting-edge AR technology, our team was able to develop a practical and user-friendly interior navigation system. The technology can be used in a variety of situations, such as navigating a big structure, locating a certain spot inside a gallery or museum, or perusing a virtual showroom.

4. INTERFACE DESIGN



Start app: The interface features a visually appealing start screen with a logo and a brief description of the app, creating an inviting first impression for users to engage with the system.

- **Choose destination:**A fluid and user-friendly destination selection process is provided for users through intuitive search functionality, categorised browsing, or a list of predefined possibilities.
- **Locate user:**The software makes use of the camera and augmented reality features of the device to precisely find and orient the user within the mapped region, ensuring accurate location for a dependable navigation experience.
- **Align virtual world:** By offering visual signals and instructions, the interface helps users align the virtual world with the physical surroundings while preserving a constant user perspective. This enables seamless integration of AR content.
- **Calculate route:** Based on the user's chosen location and the map of the surrounding area, the software intelligently determines the best route, taking into account things like distance, barriers, and favourite paths.
- **Draw route with AR:**To assist users in following the calculated route, the interface superimposes augmented reality (AR) visualisations, such as arrows or highlighted paths, onto the real-world view. This gives users simple and straightforward navigational instructions.
- **Start navigation:** With just a tap, users may start the navigation process, activate the AR guidance, and set out on their way to the desired location.
- **Check user location:**Throughout the navigation process, the software continuously detects the user's location and refreshes the user interface in real-time to give accurate progress updates and guarantee users stay on the proper path
- **Stop:**Users have the option to pause AR guiding at any time, which gives them the freedom to explore or otherwise engage with the environment without active navigation.

5. RESULT

We discovered that one of the main problems with earlier attempts in the field of indoor navigation was a lack of consistency and user involvement. By utilising previously unexplored technologies like Augmented Reality (AR), our method tries to get beyond these limitations.

6. CONCLUSION

An important step towards improving indoor navigation experiences has been the creation of an AR-based internal navigation system. Users have access to a novel and immersive approach to explore and navigate inside places thanks to the system's extensive mapping capabilities, ultra-accurate relocation functions, and seamless navigation features. The technology transforms how people interact with their surroundings by combining real-world environments with virtual content and utilising the strength of the ARCore and ARKit frameworks.

7. REFERENCES

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