INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact Factor: 6.078
(Volume 10, Issue 2 - V10I2-1138)
Available online at: https://www.ijariit.com

Indoor navigation using augmented reality

Mahalakshmi Padam
vpadam2@gitam.in
Gitam Deemed to Be University, Rudraram, Telangana

Dr. Y. Md. Riyazuddin
rymd@gitam.edu
Gitam Deemed to Be University, Rudraram, Telangana

ABSTRACT

The majority of contemporary competitive commercial navigation programs rely on GPS-based navigation technology. However, it is the interior navigation performance is lower than that in an outdoor situation. Much of the research and development on indoor navigational systems entails the installation of additional equipment, which often comes with a substantial setup charge. A study and comparison were undertaken to identify the best indoor localization, pathfinding, and path navigation systems for an indoor navigation strategy. The goal of this project is to demonstrate a user-friendly and cost-effective indoor navigation system. The recommended solution combines augmented reality technology with the built-in sensors included in the majority of mobile devices to determine the user's location and give an immersive navigation experience. In this project, a smartphone app for indoor navigation was developed and tested. AR Core will use the predicted route to display AR guidance. Surveys were done to assess the methodology's effectiveness and gather input from participants. The method's architecture, an example, and applications are described.

Keywords: *Indoor Navigation, Indoor Localization, Erroneous Orientation, Heuristic, Image Recognition, Latency Reduction, Path Navigation, Augmented Reality,*

I. INTRODUCTION

GPS-based outdoor navigation solutions for cell phones have recently gained popularity due to their great precision. GPS signals cannot be received within intricate multi-story buildings, so outdoor navigation is essential. In comparison to exterior navigation, commercial inside navigation systems have made comparatively little progress.

This study proposes a real-time indoor navigation system that leverages augmented reality (AR) technology in conjunction with the built-in sensors of mobile devices to be both effective and economical. "The user's current position is determined using the magnetic field, Wi-Fi signals, and inertial sensor of mobile devices, and the route to the destination is calculated using the ACO algorithm to give navigation direction" [23]. This solution does not necessitate the installation of additional hardware. Augmented reality technology replaces the normal map, providing an immersive virtual navigating experience.

The usage of spatial information in the mobile environment has increased since smartphones with a Global Positioning System (GPS) receiver, a digital compass, and accelerometers became standard. To obtain continuous spatial information that covers the user's whole journey, most mobile AR applications now available that employ POI data only display location information as a point in their AR view, forcing the user to switch from an AR view to a standard 2-dimensional view. In this paper, we offer a scenario-based strategy for developing a mobile augmented reality system that utilizes geographical data, namely route information for pedestrian use.

II. LITERATURE SURVEY

An interior navigation system consists of three basic components: localization, pathfinding, and a path navigation system. While navigation seeks to build a path from the user's position to a specific destination, positioning seeks to determine the user's current position.

A. Indoor Positioning Techniques:

The most prevalent positioning methods, "including GPS, Wi-Fi-based positioning, BLE beacon-based positioning, magnetic field-based positioning, and vision-based positioning, are explained in order to decide which method is best."[23]

When walls and roofs obscure the direct line of sight between GPS devices and satellites, the signal may be degraded [1]. Furthermore, it is difficult to determine the floor level [2]. As a result, GPS signals, particularly in multilevel constructions, are insufficient to provide precise tracking information.

Because Wi-Fi is now extensively established inside buildings, using it for locating is extremely convenient and has a low hardware installation cost [3]. The approach is time-consuming since it collects Wi-Fi signals and uses a fingerprinting technique to relate them to a location. Building barriers may also cause multipath effects, reducing precision [4].

The BLE beacon consumes less electricity and is tiny, inexpensive, and easy to set up [5]. Aside from that, Bluetooth is a more cost-effective wireless communication method than others in terms of battery use [6]. The fingerprinting technique takes time, as does Wi-Fi-based positioning, and BLE positioning is more vulnerable to multipath effects than Wi-Fi-based location [5].

Natural resources, such as magnetic field signals, mean that no additional infrastructure is needed. Furthermore, it will be unaffected by barriers such as walls or ceilings [7]. However, the precision may be influenced by the hard-iron and soft-iron effects generated by metal components [8]. Fingerprinting takes a long time.

Vision-based location can be divided into two subcategories: marker-less tracking and visible marker-based tracking [9]. Marker-less vision recognition does not require any additional infrastructure because it relies on natural environmental elements such as corners and textures to deliver positioning information [10]. However, because the system must continuously scan and compare the world with a large-scale database, considerable computational and memory resources are required [23] [11]. When utilized in a dynamic context with constant change, this approach is similarly unreliable [7].

Any image-based identifier, such as a QR code, is considered a visible marker [12]. The marker will be placed in a specific region to offer location information when read. The markings around the structure must be installed in a more expensive manner. In addition, the user must continue to locate and scan the marker in order to update their location. Both vision-based positioning systems can track objects with reasonable accuracy in confined spaces, making them excellent for interior positioning [13]. However, light and temperature will affect both [7]. For example, neither approach will work during a blackout.

As previously indicated, GPS signals are insufficient to give accurate indoor positioning. Building barriers can disrupt Wi-Fi and BLE beacon transmissions, whereas light sources can disrupt vision-based positioning. A technological fusion positioning system, which incorporates multiple technologies to complement one another, would thus be the best solution. According to [14], the fusion approach, which mixes Wi-Fi and magnetic field signals, has a median accuracy of 1.20 metres, which is higher than utilizing solely Wi-Fi.

Furthermore, the approach proposed in [15]"[23] that combines Wi-Fi and magnetic fields can consistently achieve a precision of 0.836 metres in the experimental scenario. Furthermore, because most buildings already have Wi-Fi and magnetic fields are a natural resource, additional infrastructure costs may be kept to a minimum. Table 1 compares the various indoor placement methodologies.

Positioning Technology	Indoor Positioning Accuracy Range
GPS	>40m
Wi-Fi	30 – 40m
BLE Beacon	10 – 20m
Magnetic Field	2 – 6m
Visible Marker	Unreliable
Marker less Vision Recognition	Unreliable
Fusion (Wi-Fi + Magnetic Field)	1.2m

Table 1: Comparisons of indoor positioning

B. Path Navigation Techniques:

"Dijkstra's algorithm, the A* algorithm, and the ACO algorithm are three popular pathfinding algorithms [18]. Dijkstra's algorithm is an established approach for determining the shortest path between two nodes, however the A* algorithm is a variant that combines the benefits of uniform-cost search and pure heuristic search to identify the best path [19]. However, the Ant Colony Optimization (ACO) algorithm mimics how ants would migrate over a graph. The ACO algorithm chooses the path in the same way that ants do, by following the trail with more pheromones [16][23].

"The A* algorithm is more effective than Dijkstra's algorithm, argues [18]. However, as shown by the test results in [16], the ACO algorithm is more accurate and takes less time to explore a route than the A* method. In an interior context, the A* algorithm will have a much greater calculation cost than the ACO approach.[23] When compared to the ACO algorithm, the path examined with the A* technique is occasionally somewhat shorter, but it takes eight times as long. The ACO algorithm is thus good for pathfinding in indoor situations, according to [16].

C. Route Guidance Techniques:

Indoor navigation is commonly given via digital maps. However, research has shown that computer images fall short in their ability to precisely depict the real surroundings, making it difficult for users to compare the map to the real world. Users must contrast the actual landmark and direction with those on the map,"[23], adding to the confusion [20].

AR has evolved to provide more immersive support in order to improve the user experience. AR is a technology that overlays virtual images onto the camera's view of the real world. In contrast to digital maps, which depict the world from a third-person perspective, augmented reality (AR) presents a first-person image of the desired location, allowing users to interact with the device more accurately [21]. It has also been established that AR can accelerate human navigation processes and lessen the effort required for recognition [22].

III. PROPOSED METHODOLOGY

This system makes use of visual simultaneous localization and mapping (SLAM) technology to map an indoor region in real time. Following that, users can browse the map and receive navigation instructions to their location using an AR-capable smartphone.

The following are common components of a Visual SLAM system:

Visual sensors: Cameras and other types of visual sensors collect visual data about their environment.

Feature extraction: The feature extraction component extracts differentiating features from the visual input, such as corners, edges, or blobs

Feature Tracking: To detect the camera's motion, this component monitors the obtained features across multiple data frames.

Navigation: This section creates an environment map by combining the tracked features and predicted camera postures.

Users of Unity may create 2D and 3D games and experiences, and the engine supports drag-and-drop as well as a major scripting API in C# by utilizing Mono for both the Unity editor and the games itself. Previously, C# was the major language utilized in this game engine. Unity3D is a powerful cross-platform 3D engine with an easy-to-use programming environment. Everyone who wants to easily create 3D games and applications for mobile, desktop, the web, and consoles should focus on Unity because it is simple enough for beginners yet powerful enough for experts.

IV. SYSTEM DESIGN

The system's architectural layout and user interface are presented in this part.

A. Architectural Design

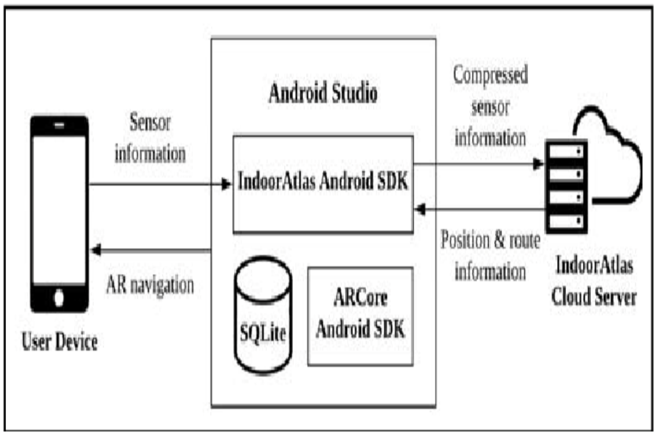

Fig 1. System Architecture

The AR indoor navigation smartphone software was made solely by integrating the AR foundation Android SDK and AR Core Android SDK, as well as using Unity 3D.

Basic Project Setup:

To begin, disable Autographic API and enable Open GLES3 in the Graphic API section of the Android settings. Then enable Dynamic Batching. In addition, Android 7.0 Nougat (API Level 24) is preferred as the minimum API level.

Configure IL2CPP in Scripting balanced, select '.NET framework' in API compatibility level, and enable ARM64 in Target architectures.

In the built-in settings, we must now select the Android platform. Install AR core via XR plug-in management, followed by AR foundation from the Unity Registry package manager.

B. User Interface Design

The user interface and navigation path of the mobile AR indoor navigation application are depicted in Figure 2. The user can choose their location by browsing the venue's categories and subcategories. Following the user's selection, the path will be calculated, and an AR navigation screen will appear, displaying an AR Navigation Path to the desired location.

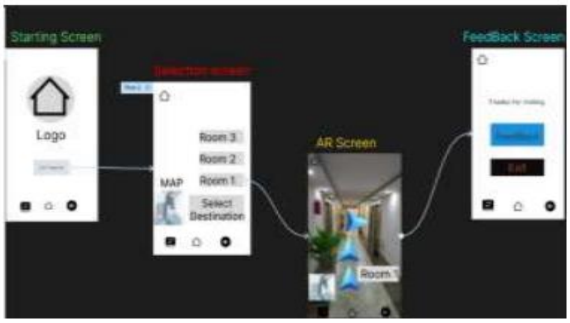

Fig. 2. User Interface and Navigation Path

V. IMPLEMENTATION

A building was assembled as a site for experimental detailing and floor designs while a method for navigating the campus was being created.

A. Platform

The AR indoor navigation system was implemented as a mobile application using Unity 3D, and as a result, the program is compatible with the Android operating system. The path was displayed to the user as AR images via the AR Core SDK and AR Foundation. Because only the venue information must be saved by the program.

B. Activities

At the start of the implementation, a mobile application with a venues menu and a searching function was built using the prototype design. The database was also used to store information about venue, such as its name and category.

Building locations and venues were then incorporated as assets to Unity 3D, allowing indoor placement using the AR Foundation SDK. Areas of interest, such as labs, staff rooms, and classrooms, were placed to the top of the floor plan after it was uploaded, as shown in Fig. 3. The application will be able to specify the locations of all campus venues by including points of interest.

Fig. 3. Integrating Areas of Interest

Then, as seen in Fig. 4, The path from one point to another was determined using the floor plan and the wayfinding system with nodes and edges.

Fig. 4. Adding Wayfinding System

Device Camera was used to perform fingerprinting after the floor plan and wayfinding information had been uploaded, as seen in Fig. 5. To receive location data and get to the right destination, the finger printing process requires physically moving around the selected venue after calculating the device's sensors.

Fig. 5. Fingerprinting

After importing the floor plan into your Unity project. The entire path of the plan should be baked with "Nav Mesh". Nav Mesh makes it easier to find your route to your desired destination.

"When a venue is selected as the destination in the mobile application, the user's location will be detected to determine the path to the venue. After the route has been correctly computed, the Navigation Path will be presented on top of the camera view, guiding the user through the navigation.

Fig.6. AR navigation process

In order to guide the user to the destination, the Navigation Path will move and turn in accordance with the path. The Navigation Path can be rotated and moved to the next node along the route by computing the difference between the device's current direction and the heading of the next node. Once you get at your location, you are free to explore."[23]

VI. RESULTS AND DISCUSSION

To download and install the mobile app, scan the QR code. After that, the user will be taken to the app's home page, as illustrated in Figure 6, where they must grant the app the necessary rights. The user can now continue to use the AR view and select their desired destination. Following that, the user must click the navigation button to commence the navigation, as illustrated in Figure 6. The AR Navigation Path guides the user to their intended destination. This process repeats itself at each location. Finally, we have included an additional feature that allows users to submit feedback on their AR experiences, allowing us to improve future versions of the application even more.

VII. CONCLUSION AND FUTURE SCOPE

Finally, the indoor navigation app provides clients with an immersive navigation experience through the use of augmented reality (AR) technology and mobile device sensors. It was able to determine the user's location and direct them to their intended location by superimposing AR navigation instructions on the camera view.

This prototype can be expanded to allow multi-floor navigation in the future, however it is only intended for navigation on the same floor level. Because the program currently supports multi-floor positioning and wayfinding, multi-floor navigation could be achieved simply by altering the AR Navigation path.

Moreover, because the goal of this research is to offer an easy and affordable indoor AR navigation service, the suggested solution might be used in a wide range of locations outside university campuses, such as malls, airports, and hospitals.

VIII. ACKNOWLEDGEMENT

I am thankful for data science professors of GITAM Deemed University, Hyderabad for their patience and valuable support lasted throughout the work.

IX. REFERENCES

[1] Indoor localization using Global positioning system reconsidered, by M. B. Kjaergaard, H. Blunck, T. Godsk, T. Toftkjr, D. L. Christensen, and K. Grnbk, in Persistent 2010, 2010, pp. 38–56.

[2] GPS Solutions, vol. 16, no. 4, pp. 449-462, 2012. D. Macias-Valadez, R. Santerre, S. Larochelle, and R. Landry. "Enhancing vertically Global positioning accuracy with such a GPS-over-fiber architecture and significant comparative delaying calibration."

[3] Wi-Fi fingerprint-based indoor positioning: Current developments and comparisons, IEEE

Communications Surveys and Tutorials, vol. 18, no. 1, pp. 466-490, 2016. S. He and S. H. G. Chan.

[4] "WiFi-based indoor positioning," IEEE Communications Magazine, vol. 53, no. 3, 2015, pp. 150–157. C. Yang and H. R. Shao.

[5] Indoor locating system based on Bluetooth position identification and categorization technique, Y. C. Pu and P. C. You, Applied Mathematical Modelling, 2018.

[6] Bluetooth Indoor Location Based on RSSI and Kalman Filter, C. Zhou, J. Yuan, H. Liu, and J. Qiu, Wireless Personal Communications, vol. 96, no. 3, pp. 4115-4130, 2017.

[7] A survey of indoor positioning systems for wireless personal networks is presented by Y. Gu, A. Lo, and I. Niemegeers in IEEE Communications Surveys and Tutorials, vol. 11, no. 1, 2009, pp. 13–32.

[8] Location Fingerprint Extraction for Magnetic Field Magnitude Based Indoor Locating by W. Shao and colleagues, Journal of Sensors, vol. 2016, 2016.

[9] G. Kim and E. M. Petriu, "Fiducial marker indoor localization with Artificial Neural Network," IEEE/ASME International Conference on Advanced Intelligent Mechatronics, AIM, 2010, pp. 961–966.

[10] Real-time optical marker less tracking for augmented reality applications, I. Igo Barandiaran, C. Paloc, and M. Gra.

[11] "To Know Where We Are: Vision-Based Positioning in Outdoor Settings," by K.-W. Chen et al.

[12] A marker-based cyber-physical augmented reality indoor navigation system for smart campuses was developed by J. R. Jiang and H. Subakti. Proceedings from the 2016 HPCC/Smart City/DSS conferences, which included the 18th IEEE International Conference on High Performance Computing and Communications, the 14th IEEE International Conference on Smart Cities, and the second IEEE International Conference on Data Science and Systems, were published in 2017. Pages 1373–1379.

[13] Using inexpensive inertial sensors and marker-based video tracking, B. Hartmann, N. Link, and G. F. Trommer developed indoor 3D location estimation. Position Location and

Navigation Symposium, held by IEEE PLANS in 2010, pp. 319–326.

[14] Congreso Argentino de Ciencias de la Informatica y Desarrollos de Investigacion, CACIDI 2018, J. P. risales Campeon, S. Lopez, S. R. De Jesus Melean, H. Moldovan, D. R. Parisi, and P. I. Fierens, "Fusion of magnetic and Wi-Fi fingerprints for indoor locating," 2018.

[15] A Study of Wi-Fi-Aided Magnetic Matching Indoor Positioning Algorithm, in E. Wang, M. Wang, Z. Meng, and X. Xu, "Journal of Computer and Communications, Vol. 05, No. 03, pp. 91-101, 2017.

[16] "Multi-floor Indoor Navigation using Geomagnetic Field Positioning and Ant Colony Optimization Algorithm," 2016; K. Liu, G. Motta, T. Ma, and T. Guo.

[17] K. Liu, G. Motta, and T. Ma, "XYZ indoor navigation with augmented reality: A research in progress," Proceedings - 2016 IEEE International Conference on Services Computing, SCC 2016, pp. 299–306, 2016.

[18] "Path Planning for the Mobile Robot: A Review," Symmetry, vol. 10, no. 10, p. 450, Oct. 2018, by H. Zhang, W. Lin, and A. Chen.

[19] Pathfinding algorithms for people with visual impairments in IoT-based smart buildings: Comparison, P. T. Mahida, S. Shahrestani, and H. Cheung.

[20] [Path guiding by an automotive navigation system dependent on augmented reality] K. Akaho, T. Nakagawa, Y. Yamaguchi, K. Kawai, H. Kato, and S. Nishida, Electrical Engineering in Japan (English translation of Co. Gakkai Ronbunshi), vol. 180, no. 2, pp. 43-54, 2012.

[21] G. A. Lee, A. Dunser, A. Nassani, and M. Billinghurst, "AntarcticAR: An outdoor augmented reality experience of a virtual tour of Antarctica," 2013 IEEE International Conference on Mixed and Augmented Reality - Arts, Media, and Humanities, ISMAR-AMH 2013, no. Cci, pp. 29–38, 2013.

[22] Developing an augmented reality-enabled navigation system by researching user requirements and experience in complicated environments, M. J. Kim, X. Wang, S. Han, and Y. Wang,

[23] Ng, Xin Hui * and Lim, Woan Ning * (2020) Design of a mobile augmented reality-based indoor navigation system. In: 4th International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT), October 2020, Istanbul, Turkey.

