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Unibuddy: An AI Based AR Indoor Navigation Solution

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Abstract: Many students confront the dilemma of travelling in enormous and bewildering new college campus. It becomes difficult for them to locate crucial offices, stationaries, and entry blocks in a new setting. In almost every area of the facility, a precise and reliable localization system is required to provide a mobile assistant that can help freshmen navigate campuses.

We propose a solution to this challenge in the form of a hybrid tracking system that works effectively and efficiently on mobile devices (agent) such as smartphones and tablets and is specifically intended for complicated interior areas (environments).

***Keywords*—AI, AR, Navigation, Indoor Navigation, Localization system, Web-based application**

I. Introduction

People frequently lack familiarity with campus layouts in large indoor venues, such as colleges with huge campus areas, making it challenging to reach a desired location on time. Hence, not being able to locate the necessary site at the appropriate moment becomes troublesome. A precise and dependable position of the user is needed in practically every area of the campus for a mobile assistant that can aid users while moving in indoor spaces. Our goal is to provide the proper overlay and location-based data displayed on agent, i.e. any mobile devices. The aim is to calculate precise location and display the path (considering both position and orientation of the agent in environment) in real-time. Global Positioning System (GPS) is a part of our lives as it is used in everyday situations when we need navigation assistance outdoors and gives the best results as well, but it does not work reliably indoors and fails to perform to that level. Modern indoor localization techniques that work effectively make use of so-called beacons, which are scattered throughout the building and emit a special identity. Bluetooth or other radio frequency (RF) technologies , can also be used but they only work for short distances and require a complex infrastructure. Hence is not feasible in the long run. Our project comprises of 3 major technologies: AI, Augmented Reality and GPS enabled navigation.

II. AI

The study of building intelligent computer systems that can exhibit human brain like thinking abilities is called Artificial Intelligence. Artificial Intelligence (or simply AI) has resulted in many breakthroughs and technical advancements not only in core research topics in computer science but also in other industries. Today we experience a developed and intricate system comprising out of AI research at its core in our daily live. Neural networks, evolutionary computing, machine learning, natural language processing, object-oriented programming, are advanced research topics branching out from the tree of AI. Artificial Intelligence (AI) is a rapidly growing field, with new innovations coming in every other day its growth is multiplying at every step. AI has the ability to bring a revolution in the way we live and work. AI refers to the development of computer systems that can mimic human intelligence. If we take examples from our surroundings visual perception is the automation of human vision, speech recognition algorithms aim to mimic human auditory senses, decision-making, and language translation work just like the complex human brain.

During the 1950s a thought emerged in the minds of the scientists and researchers. This thought fuelled them to explore the idea of AI. It is then that they began thinking of machines that could function like humans. Since then, AI has made significant progress. We see AI applications in our day-to-day lives, ranging from self-driving cars to virtual assistants like Siri and Alexa.

III. Agents and Environments

Artificial Intelligence (AI) agents are computer programs that are created to perform or carry out tasks that would normally require human intelligence. These agents can be programmed to learn from their environment and improve their performance over time. AI agents have become increasingly popular in last decade due to the advancements in technology and the need for automation in various industries.An AI agent's primary function is to perceive its environment, reason about it, and act accordingly to achieve its goals. An environment's function is to provide the data and stimuli on which the agent acts upon. An AI environments tends to be more complex due to their dynamic nature, ambiguous nature and uncertainty in real world problems. Both AI agents and environments are necessary for artificial intelligence systems' functioning, they differ significantly in terms of functionality and complexity. Understanding these differences can help developers create more effective AI systems that can adapt better to different environments.

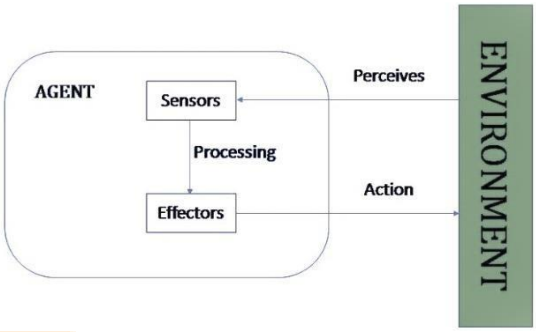

Fig.1.1:-Pictorial representation of relationship between environment and agent.

IV. Augmented Reality

Navigational problems can now be solved effectively and simply with augmented reality. Users can be guided from point to point more organically by viewing virtual guidance in real space through the perspective of a smartphone or headset rather than by comparing a map to their immediate surroundings. This significant advantage allows for the implementation of AR navigation in indoor as well as outdoor settings. The development of augmented reality is simple to learn but challenging to master. Many businesses are turning to more specialised solutions as the market for more sophisticated and high-quality AR software products grows.

Depending on the surrounding environment, AR indoor and outdoor navigation tasks call for a more specialised solution that requires specialised gear, technology, and knowledge to successfully deploy. Navigational problems can now be solved effectively and simply with augmented reality. Users can be guided from point to point more organically by viewing virtual guidance in real space through the perspective of a smartphone or headset rather than by comparing a map to their immediate surroundings. This significant advantage allows for the use of AR navigation in both indoor and outdoor settings. The development of augmented reality is simple to learn but challenging to master. Many businesses are turning to more specialised solutions as the market for more sophisticated and high-quality AR software products grows. Depending on the surrounding environment, AR indoor and outdoor navigation tasks call for a more specialised solution that requires specialised gear, technology, and knowledge to successfully deploy.

V. GPS Vs AR enabled navigation

Our travel habits have changed as a result of the global positioning system (GPS). Even though the US Department of Defence permitted increased GPS accuracy in 2000, it is still not always accurate, especially indoors. The Doppler effect and satellites were used to create GPS. Ground stations collect radio signals that are used to locate GPS satellites as they orbit the Earth. These satellites send out signals, which our cell phone or car picks up and uses to calculate the separation of four or more satellites. Although this technology aims to offer incredible precision, it has some drawbacks. Extraction of the precise location becomes substantially more difficult, or in certain situations, nearly impossible, if these radio signals are ever blocked owing to flaws in the system. GPS reception can be severely hindered by water, mud, walls, big city buildings, and other barriers. Since indoor GPS navigation is currently neither scalable nor effective, indoor AR navigation.

VI. RELATED WORK

In their study titled, Indoor navigation using augmented reality Prashant Verma, Kushal Agrawal, and Sarasvathi V. have suggested developing an indoor navigation application that uses augmented reality to help people navigate at complex architectures in addition to developing a cloud platform (Content Management System) from which the administrator of a particular building can be able to modify and manage the navigation path. The Unity3d framework was used to create the AR- based mobile app. Smartphones have the ability to run the programme. It has been demonstrated that an augmented reality-based application's interfaces and user experiences are superior to those of conventional 2D maps or paper maps that are displayed outside of buildings to aid in navigation. Technical evaluations of the research's design were carried out in a hospital building.

Through the Indoor Navigation Using Vision-Based Location Positioning and Augmented Reality, An augmented reality technique-based vision-based location-positioning system for interior navigation has been proposed by JongBae Kim and HeeSung Jun. The suggested system uses indoor image sequences to automatically identify locations, and it achieves augmented reality by seamlessly superimposing location data over the user's field of view.

When employing augmented reality for feature- based indoor navigation A prototype for indoor navigation utilising augmented reality has been shown by Sebastian Kasprzak, Andreas Komninos, and Peter Barrie. It makes use of interior features to pinpoint the user's location and deliver directions. They put the prototype to the test in a model of a real shopping mall and discovered that interior environments, particularly those with targets spread out over multiple floors, can benefit from the usability benefits of AR-based navigation. Finally, we suggest more research be done on employing augmented reality to give internal navigation instructions.

In Indoor Navigation Performance Analysis by Pierre-Yves Gilliéron, Daniela Büchel and Ivan Spassov advise the development and use of algorithms to permit a user with a pedestrian navigation system to access map databases. The first phase consists in creating a 3D topological model that is specifically designed for the localization procedure. The link/node view of a network has a significant advantage in supporting navigation because a path through a network can be simply expressed as a series of choices at nodes. Link/node structures serve as the foundation for the shortest path algorithm (Dijkstra) and other conventional methods for finding the best routes through networks. The second step is to design map- matching processes.

A Hybrid Indoor a Navigation System by Andreas Butz, J'org Baus, Antonio Kruger, and Marco Lohse describes a hybrid building navigation system with permanent information booths and a mobile communication infrastructure feeding small portable devices. The graphical presentations used by the booths and mobile devices, which are derived from a single source and used for the same goal of wayfinding, employ a number of methodologies in order to convey potentially diverse subsets of the pertinent information.

VII. Methodology

This paper suggests that we use cutting-edge technologies to attain flawless indoor navigation. The proposal works in two phases:

A. Using AR to establish a virtual navigation environment.
B. Including all the important and most visited structures in our college on a web based app**.**
C. Integrating both the platforms to establish a well connected Web based, AR fuelled navigation system.

A solution that uses the aforementioned technologies for both indoor and outdoor navigation is augmented reality. This technology's main objective is to show users directions on a screen that is superimposed over actual environments as seen through the camera of a device like a smartphone or headset. This makes it easier for consumers to navigate by removing the need to compare the real world to a reference, such as a map.

As a result, AR navigation consists of two steps: the actual navigation and localization, followed by the displaying custom AR directions as avatars on the screen. Identifying the user's position is the more difficult stage in the procedure, making this second step the simpler one overall. Unless there are interference obstacles, as previously described, this is typically straightforward in outdoor settings. Here, the phone serves as an agent, using the camera (Actuator) to gather data about the surroundings.

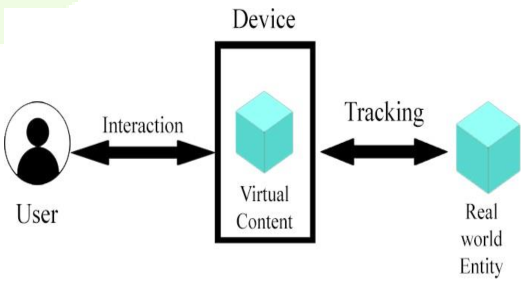

Fig. 1.2:- Pictorial representation of Augmented Reality architecture.

The two most often used platforms for developing indoor navigation products are ARCore for Android and ARKit for iOS. In order to demonstrate to a renderer how to create virtual things on the screen so that they look to exist in the actual world, these development environments are in charge of translating device movement and sensor analysis into information.

AR.js-based augmented reality on the web: The lightweight AR.js framework for web-based augmented reality features image tracking, location-based augmented reality, and marker tracking. A definition of Web AR (Augmented Reality on the Web) The technology behind augmented reality allows for the overlay of content on the physical world. It can be offered for a variety of gadget types, including handheld ones (like cell phones), headsets, desktop displays, and others. The 'reality' for handheld devices (or more generally for video see-through devices) is taken from one or more cameras and then displayed on the device display with some form of content added on top of it. There are four primary parts to the AR.js architecture:

Webcam/Mobile Camera: This component captures the video stream from the user's camera and sends it to the AR.js library for processing.

- **AR.js Library:** The AR.js library is the core of the system, responsible for detecting and tracking the position and orientation of the agent (user's mobile camera) in real-time. It uses computer vision techniques such as marker tracking and natural feature tracking to achieve this.

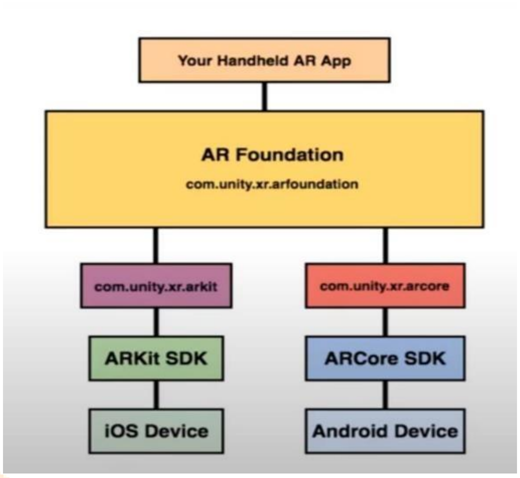

Fig. 1.3:- AR development platforms.

- **Three.js Library:** Three.js is a well-known JavaScript library that is used to build 3D graphics for the web and is utilised by AR.js. The user's camera is used to capture the real-world view, and Three.js is utilised to render the virtual items on top of it.

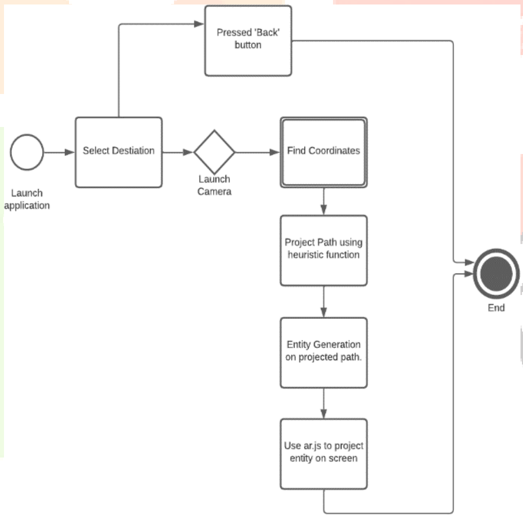

Fig. 1.4:- Flowchart for proposed Solution

- **AR Content:** This component consists of the virtual objects that are overlaid on top of the real-time physical world view. These elements can be 3D models, images, videos, or any other type of content that can be rendered using Three.js.

In the fig-1.4 we can see the approach outlines how to create the AR navigator. The process can be elaborated as:

Find(locate) the Coordinates of the Agent:- The first step in our indoor navigation system is to use GPS (Global Positioning System) to find the current location coordinates of the agent. Here the algorithm is utilising the capabilities of GPS to accurately determine the latitude and longitude of the user's current location.

Projecting Path Using Heuristic Function: After the coordinates have been determined, the next step is to project the path using a heuristic function. A heuristic function is a problem-solving approach that uses trial and error to determine the best solution. The user's current location and their destination can both be found using the heuristic function in this situation. A projection of the user's path is then created and displayed on a map on the agent device using The obtained coordinates.

Entity Generation on Projected Path Using AR.js+GPS Locator: The next step is to generate entities on the projected path using AR.js and GPS locator. Next we generate entities on the projected path using AR.js and GPS locator. A free JavaScript package called AR.js is used to build augmented reality (AR) experiences for the web. Entities are created as virtual objects and are customizable. Entities can be anything ranging from 3D models to images and can be placed along the projected path using the GPS coordinates.

Using AR.js to Project Entities Through Camera on Screen: In this step we use AR.js framework to project the generated entities on the user's screen. AR.js uses computer vision techniques to achieve optimal results. This combination results in an overlay of virtual objects onto the real world video captures. This results in the fusion of our AI generated entities and real world. To further simplify the procedure described above, we may alternatively state that the AR.js framework first projects the virtual entities onto the real- world environment as it is being taken by the user's device's camera.

Updating the Path According to the Current Location of the Agent: Next we generate entities on the projected path using AR.js and GPS locator. An open-source JavaScript package called AR.js is used to build augmented reality (AR) online experiences. Entities can be customised and are made as virtual objects. Entities can be anything ranging from 3D models to images and can be placed along the projected path using the GPS coordinates.

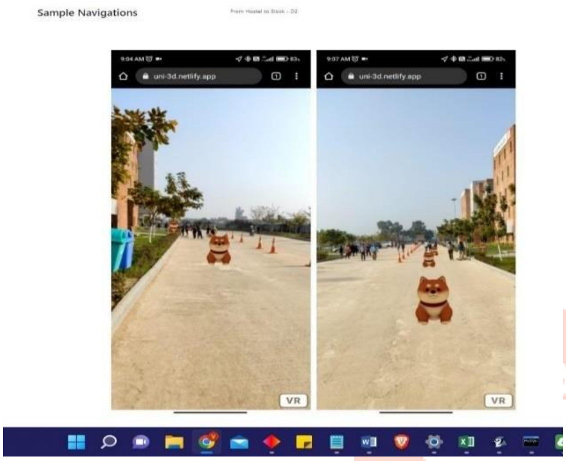

Fig.1.5.: Showing real-time result of application. AR navigation with animated dog(avatar) element showing target route

VIII. Conclusion

The proposed architecture combines indoor positioning systems, AI, and AR technology to provide an accurate indoor navigation experience. The AR view offers an immersive and engaging interface for navigating through the building, while the model leverages real- time data using ar.js to forecast the user's future location and the optimum route.

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