Indoor Navigation System using Augmented Reality (AR)

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Abstract **– Location based services is an important aspect of living, as these not only provide time benefits but also saves a lot of energy. The major issue we face to provide such luxury is the cost to implement it. Sometimes it is crucial for an individual to know the correct path to its destination because everyone require a comrade that can guide you to your destination. There are various ways to achieve this luxury of indoor navigation but here we will focus on one of the cheapest and easiest way to find the path in an indoor environment that we have implemented. This paper will throw some light on the uncharted way to achieve the luxury of indoor navigation using Augmented Reality.**

*Index Terms***: Location based services, Cost to Implement, Indoor Navigation, Augmented Reality.**

I. INTRODUCTION

Location based services (LBS) uses user location and treat it as marker in the available graph of markers and then trace a path between two objects using some standard physics and live location tracking via global positioning system. The major purpose of such technology is to provide the best(shortest) path to the destination in an unknown environment. The most expensive thing in the above-mentioned luxury is the access to GPS system and manipulate it for indoor system. The navigation system is a handshake system between user and the provider where user requests for the path and the provider do the work to provide the path.

Navigation can be segregated into two categories i.e. outdoor navigation and indoor navigation. Outdoor is performed outside i.e. on roads while Indoor is performed inside a building or institute. The major cause of difference is the use of technology, for outdoor navigation we use satellite-based Global Positioning System while for indoor navigation we can't use the same technique because radio signals cannot penetrate the solid walls and find the accurate position. There are various ways to address the problem of indoor positioning using available tech. Some of the technologies that are used are – Bluetooth beacons, WIFI graph and many more. The thing is that it is important for a developer to address this problem as it is one of the major problems faced by people when they visit to a new indoor environment. Indoor Positioning System (IPS) is the technology of the time that needs to be evolved as we are making the world as a home and each one should know the right way to its destination inside the home.

Today in this evolving time centric world people are so much into themselves that they can't even waste a single second to ask and navigate in a huge Institute or Building. Rather than just roaming and asking they want something, something cool and self-efficient which can not only guide them but also provide a better navigation experience. Due to such large construction there are many consumers who visit the Institute or Mall or Super-Market for the first time and just can't find exactly what they are looking for and then many time customers/users leave unsatisfied this leads to reduce in the popularity and the mark that a user-friendly organization must leave.

Enormous development in navigating systems, 3d technologies and the leaning of world towards Augmented Reality and Virtual Reality has made the development of such Indoor navigation system possible, in many developed countries there are 3d navigable Super-Markets where you can navigate directly to the item you want to search. As a citizen of one of the most rapidly developing country why not we provide such Indoor navigation capabilities to our users and consumers to help them in saving their crucial time. Hence this is the prime time to hit the metal.

Our major objective in this research paper can be summarized as follows:

- We provide a new and innovative way to achieve navigation in indoor environment using Augmented Reality as the key to this lock.

- We will explain how Indoor navigation can be implemented using this technology with all the supportive data.

- To provide an assistant for indoor navigation.

- To improve the navigation system and modify it with VR and AR implementation.

- To help the users in finding the path to where they need to be in a building.

- To provide a third-person navigation in a building from a different geographical location.

II. Indoor Navigation System

An Indoor Navigation System is a technology that helps the user to navigate in an indoor environment by providing the path to reach the destination from the position entered by the user. This have various applications and uses like an emergency condition where user need to escape from an unknown institute in the case of fire or earthquake then this can help the user to find the path. Assistance for elderly people who needs to get the shortest path as the energy is the concerned rather than time. Medical emergencies are also another situation where this can be the ultimate time saver. Below we have explained some important but basic question that one thinks about when we think about Indoor Navigation System.

A. Why indoor navigation system?

There are many characteristics that make indoor navigation different from outdoor navigation. In comparison with outdoor environments, indoor environments are more complex as there are various objects (such as walls, equipment, and doors) that reflect signals and lead to multipath and delay problems. Also, due to existence of various objects, indoor environments typically rely on Non-Line-of-Sight (NLoS) propagation where signal cannot travel directly in straight path from an emitter to a receiver which causes inconsistent time delays at the receiver. Furthermore, the existence of objects and obstacles leads to high attenuation and signal scattering. Typically, indoor positioning applications require a higher precision and accuracy in comparison with outdoor positioning applications in order to deal with relatively small areas and existing obstacles. On the other hand, there are some characteristics of indoor environments that facilitate positioning. For example, small coverage area makes it relatively under control in terms of predetermined infrastructure, corridors, entries and exits, small temperature and humidity gradients, and slow air circulation. Also, indoor environment is less dynamic due to a slower moving speed within.

B. Performance Metrics for Indoor Navigation System.

There are various aspects which can decide the performance of indoor navigation system such as speed, accuracy, robustness, availability, cost, coverage area, scalability. Some places may require only some aspects to be covered depending upon the need.

III. LITERATURE SURVEY

Tango: Tango (formerly named Project Tango, while in testing) was an augmented reality computing platform, developed and authored by the Advanced Technology and Projects (ATAP), a skunkworks division of Google.

It uses computer vision to enable mobile devices, such as smartphones and tablets, to detect their position relative to the world around them without using GPS or other external signals. This allows application developers to create user experience that include indoor navigation, 3D mapping, physical space measurement, environmental recognition, augmented reality, and windows into a virtual world.

Tango is different from other emerging 3D-sensing computer vision products, in that it's designed to run on a standalone mobile phone or tablet and is chiefly concerned with determining the device's position and orientation within the environment.

The software works by integrating three types of functionality:

- Motion-tracking: using visual features of the environment, in combination with accelerometer and gyroscope data, to closely track the device's movements in space.

- Area learning: storing environment data in a map that can be re-used later, shared with other Tango devices, and enhanced with metadata such as notes, instructions, or points of interest.

- Depth perception: detecting distances, sizes, and surfaces in the environment.

Together, these generate data about the device in "six degrees of freedom" (3 axes of orientation plus 3 axes of position) and detailed three-dimensional information about the environment.

ArcGIS Indoors:

- ArcGIS Indoors is a complete system for indoor mapping used to create a connected workplace. It provides a common operating picture for executives, workplace services personnel, and other employees and visitors to understand, manage, and use their workplace environment. Through an extended version of ArcGIS Pro, native web and mobile applications, and an indoor information model, ArcGIS Indoors helps you create, customize, share, and apply workplace maps and location data so you can manage workplace operations and build an environment that is comfortable and engaging for your people.

- ArcGIS Indoors is designed to work with other parts of the ArcGIS platform, so you can extend the capability to natively leverage other aspects of ArcGIS, the world's leading mapping and spatial analytics platform.

  A. Live Survey
- Nirmala's Mart –
  Customer Problems –
  - Need to ask many times to find a product.
  - Can not find the correct position.
  - Confusing experience.
  - Customer Review –
  - Greatly positive and use the app.
  - Will reduce the load and make the experience better.
  - Employee Review –
  - This will lure the customers to buy the product due to its fresh feel.
  - Easy to use

- Big Bazar (Empress Mall) –
  Customer Problems –
  - Need to walk allot just to find the section then finding the product is another task.
  - Lot of walking and tedious to shop and time killer.
  - Customer Review –
  - Will be a great helping hand.
  - Aged people can go straight to the destination rather than roaming and getting irritated.
  - Will use the product.
  - Employee Review –
  - *Great idea.*
  - *This will grab the customer's attention.*

IV. IDEA GENERATION

As we have discussed earlier that the cost to use Global Positioning System, Bluetooth beacon, Zigbee, Wi-Fi graph and Tango are the costly method which require lot of input and most importantly a huge capital. That's the main reason why we removed the dependency to find the live location of the user instead of that we are working for a simple but effective way to navigate in indoor environment. This we have achieved by using a 3d model of an institute where we have created the indoor details using the floor map.

The basic idea has been taken from games where the main character can locate his place using min map and can find the distance and the smallest path to its distance. The question

arises that can't we use this technique to implement in real world using some same tools.
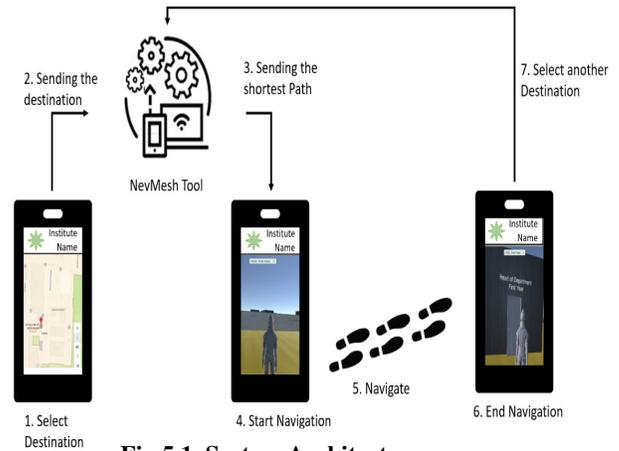

Fig 5.1. System Architecture

V. DESIGN and IMPLEMENTATION

The major focus of the project is to provide accurate indoor navigation even in low network area. For this we are using algorithms to find the shortest distance and baked the path according to the structure to avoid any type of collision. Unity provide a tool NavMesh from which we can provide the shortest path and make the movement accordingly. To test this, we have deployed the program on a Pie based Android device where we have done the Third person navigation. As the User selects the location the NavMesh will guide the user to the destination via the shortest path and if user want to go to another location then he/she can add another location.

A. Flow of the system

At the start of the app the user needs to decide the starting point that is the location from where user want to begin navigation and once the start point is decided the user can decide the end point that is the destination of the navigation. Once these inputs are provided the NevMesh tool will automatically find the shortest path between the points and the navigation can be started. The user can then follow the first-person view and can walk as the camera moves I the same indoor surrounding and once reached to the destination the user can end the Navigation or can select another destination.
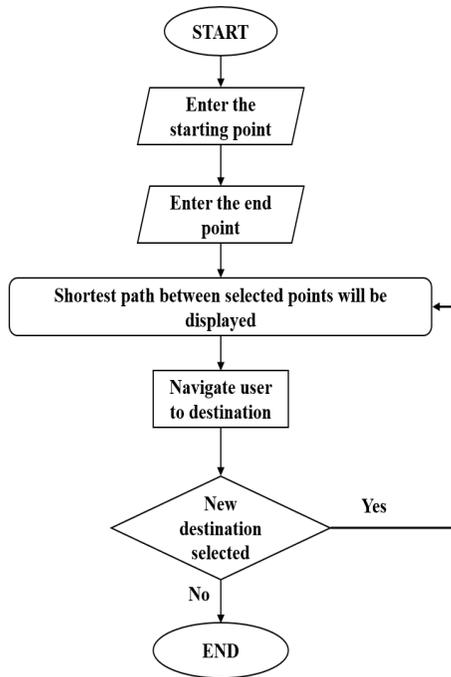
Fig 5.1.1 Flow Chart

B. Implementation

Our proposed system will be consisting of two modules:

1. Interior Modelling:

Any interior model consists of several isolated objects such as rooms, doors, walls, pillars and many more. To design these models, we are using Unity 3d. Unity 3d provides various 3d models which can be used as it is and some of the models are needed to be developed by own due to cost issues. We also need to provide accurate structure to those models and place them accurately according to the structure of the building. We have created the Ground floor model of our college SBJITMR with more than 8 rooms and have applied textures to each one of them. These textures need to be created and are useful to provide the feel of actual aura. This enables the user to get the exact feel that he/she is travelling in the same building. We have provided a marker to every room so that our camera/3d model can move towards the marker following the shortest path provided by the NavMesh. Every room is having a door and the name on it so that user can confirm that he/she have reached the right location.

2. Navigation:

The most important part of the app is navigation on the shortest path. In the model we have provided the user with a dropdown menu where he/she can select a

destination and as soon as they click on submit, the NavMesh tool will find the shortest path to the destination and will guide the user to the location. The tool will take care of all the paths and will only guide on the shortest path. This will save the time of user and increase the efficiency of the product.[6]

The navigation system allows you to create characters that can intelligently move around the game world, using navigation meshes that are created automatically from your Scene geometry. Dynamic obstacles allow you to alter the navigation of the characters at runtime, while off-mesh links let you build specific actions like opening doors or jumping down from a ledge. This section describes Unity's navigation and pathfinding systems in detail. Navigation requires the use of a simplified geometrical plane, often called a navmesh. The navmesh enables characters to plot a path around the various complex items in a scene. In this video we will look at how to create a navmesh (often called "baking") using Unity's Navigation view.
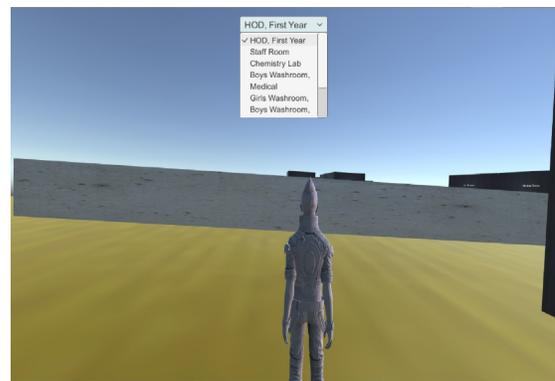

Fig 5.2.1 Dropdown Menu

Fig 5.2.2 Destination Reached

VI. ADVANTAGES AND APPLICATIONS

- *ADVANTAGES*

1. It is the fastest and low-cost way to develop an indoor navigation system.
2. No hardware dependencies.
3. This product will be a cross platform product so that we can use it any type of device be it MacOS be it Windows or Android or Symbian.
4. Keeping in mind the time importance this will increase the number of customers not only in number but also in satisfaction level.
5. The major advantage is one of its kind in the country.
6. As their no fully software dependent navigation system in our country there is always some kind of hardware dependencies, but this is fully hardware independent.
7. The major attraction is the mode of usage is in the form of game which will increase the curiosity and customers will enjoy while reaching to their desired location.
8. It will be present in highly compressed manner so the cost i.e. the size of the product will be very less.

- *APPLICATIONS*

1. This can be the best advertisement product for any Hotel or College institute as customers can use this and traverse the place without even getting there.
2. This will be very helpful in the time of emergencies as we can see the actual place of components and can navigate.
3. This will be very helpful in big super-markets where customer need to buy a thing and search for it all day.
4. This can be the time saving thing for every customer.

VII. CONCLUSION

This implementation paper will be a guiding light for the budding mind who wants to innovate the field of indoor navigation. It also helps them with the basic flow and architecture that they can use if they want to implement this using Augmented Reality, this will not only result in a great initiative but also a revolutionized idea as each user can create different models of different institutes and they can further integrate them all to create a robust mapping system with all the indoor details. This will result is low cost but effective way to achieve indoor navigation which can easily available for all the user around the globe. The proposed system can be modified with many marker and marker less techniques to gain better results. This implementation helps us to investigate a new way to achieve indoor navigation without any hardware limitations.

The application is one of its kind and is AR implementation of various buildings. We have applied engineering knowledge to analyze societal problem of people for indoor navigation whenever they want to traverse in a huge institute. We have analyzed the present solution and technologies to design a latest and user-friendly product. We have used modern tool Unity and ARCore to implement the project. During this project we have applied professional ethics & understood the importance of teamwork and communication while presenting project in various seminars for project, which lead to attain ourselves in lifelong learning.

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