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Indoor Navigation Using Augmented Reality

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ABSTRACT

This system advice directions to the destination in the user's camera screen. QR codes shall be installed at all possible destinations in the building assuming any destination can be the starting point of the user. Users must scan a QR code to select a destination. Google AR Core takes live feed from the user's camera and does simultaneous localization and mapping to update the user's location. Shortest path to the chosen destination is found using A * algorithm and the directions to the destination are shown in the user's camera screen using Augmented Reality. The application is developed in Unity from scratch using some essential plugins like Google ARCore. We aim at developing the front end in the simplest way possible so that the users can easily reach their destination by just opening the camera where the directions are shown as animations in their surroundings.

Keywords : Navigation, QR Code, A* Search Algorithm, NavMesh, Augmented Reality, SLAM.

I. INTRODUCTION

Indoor navigation deals with navigation within buildings. Because GPS reception is normally non-existent inside buildings, Wi-Fi or Bluetooth Beacons can be used for indoor navigation. But these have an accuracy of 5 – 15 meters and require costly hardware installation. It is easier to navigate indoors when you can see your surroundings. So, we intend to develop an Indoor Navigation Application using Augmented Reality.

II. METHODS AND MATERIAL

A. Requirements

It mainly requires the following:

1. Unity
2. Google AR Core
3. Blender

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.

Google AR Core is a plugin that brings AR functionalities to unity. To provide augmented reality, our devices need to understand it. ARCore provides a variety of tools for understanding objects in the real world. These tools include environmental understanding, which allows devices to detect horizontal and vertical surfaces and planes. They also include motion tracking, which lets phones understand and track their positions relative to the world. As AR Core continues to improve and expand, it will add more contextual and semantic understanding about people, places, and things.

Blender is a free and open-source 3D computer graphics software tool used for creating animated films, visual effects, art, 3D printed models, motion graphics, interactive 3D applications, virtual reality, and computer games. Unity natively imports Blender files. This works under the hood by using the Blender FBX exporter.

B. Processing the Application

By referring with the different papers of previous work, this is an Indoor Navigation Application using Augmented Reality without any limitations. The first step in developing this application is to build a 3D model of the building along with the interiors in which we want to deploy this application. We have used the Blender tool to develop the 3D model of the building. The system needs to understand the user's location and it must map it to the 3D model of the building. To achieve this we are going to install QR codes at all possible destinations in the building assuming any destination can be the starting point of the user.

Each QR code is pegged to the specific graph node but not every node contains QR code. Using QR codes, the navigation map identifies the user's location and places a 3D object on the smartphone's screen. 3D objects are presented by arrows which set the direction to the next point. Once the user scans any QR code, the system understands his/her current location and asks him to select the destination. After the user selects the destination, the user's camera is opened. Google AR Core does simultaneous localization and mapping by taking live feed from the user's camera which means the live feed of the camera is compared with the 3D model of the building to get the exact location of the user. The user's location is updated very seamlessly similar to GPS as the user moves across the building. Depending on the chosen path, AR (Augmented Reality) arrow points toward the next node along the path. Thus, the user knows exactly where it is needed to make right turns or left turns. As the system gets the user's location, it finds the shortest path to the chosen destination using A * shortest path finding algorithm. A * algorithm is much faster, efficient and reliable than Dijkstra's algorithm. After the system gets the path to the destination, it places a virtual 3D arrow object in the user's camera screen which will assist the user to go through the shortest path to reach the destination. The shortest path keeps on updating as the user's location is updated. So, the directions are updated even if the user moves in the wrong direction and there is no need for the user to scan QR codes along the path to destination.

III.Methodology

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

1. 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).

Simultaneous Localization and Mapping (SLAM) is the concept of constructing or updating a map of a simulated environment while simultaneously keeping track of an user's location within it in real time. We used this to keep track of the user's movement and replicate the same in the 3D model of the building and further use it to update the path to the destination.

2. Nav Mesh: In Unity, a NavMesh represents an area where the center of the user object can move. The object here can be a point, or a circle with size, the two are equivalent. In our application, the Nav Mesh is constructed based on the blueprint of the building and includes all the walls, doors and other objects that the user can't pass through. This allows us to estimate only the area where the user can walk through.

3. A* Algorithm: A* is an informed search algorithm, or a best-first search, meaning that it is formulated in terms of weighted graphs: starting from a specific starting node of a graph, it aims to find a path to the given goal node having the smallest cost (least distance travelled, shortest time, etc.). It does this by maintaining a tree of paths originating at the start node and extending those paths one edge at a time until its termination criterion is satisfied. A* is like Dijkstra's Algorithm in that it can be used to find a shortest path. A* is like Greedy Best-First-Search in that it can use a heuristic to guide itself. In the simple case, it is as fast as Greedy Best-First-Search. The secret to its success is that it combines the pieces of information that Dijkstra's Algorithm uses (favoring vertices that are close to the starting point) and information that Greedy Best-First-Search uses (favoring vertices that are close to the goal).

The navigation system in Unity allows us to create objects that can intelligently move around the game world, using nav meshes. It uses A* Algorithm built-in with its path finding.

A* Search algorithm is one of the best and popular techniques used in path-finding and graph traversals. In simple terms the algorithm can be expressed as:

$$F = G + H$$

Where, F is the parameter which is the sum of the other parameters G and H and is the least cost from one node to the next node. This parameter is responsible for helping us find the most optimal path from our source to destination.

G is the cost of moving from one node to the other node. This parameter changes for every node as we move up to find the most optimal path.

H is the heuristic/estimated path between the current code to the destination node. This cost is not actual but is, in reality, a guess cost that we use to find which could be the most optimal path between our source and destination.

Abbreviations:

AR – Augmented Reality
QR – Quick Response
GPS – Global Positioning System
RGB – Red Green Blue
SLAM – Simultaneous Localization and Mapping

IV.Working

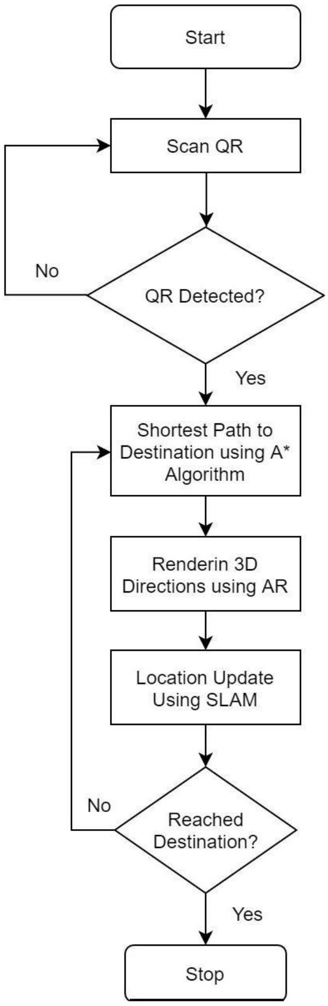

Figure 1: Flowchart of the system

V. Results

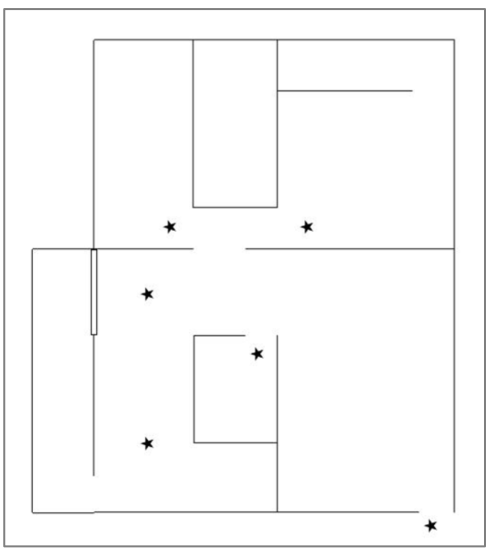

Figure 2: Floor plan for building the 3D model.

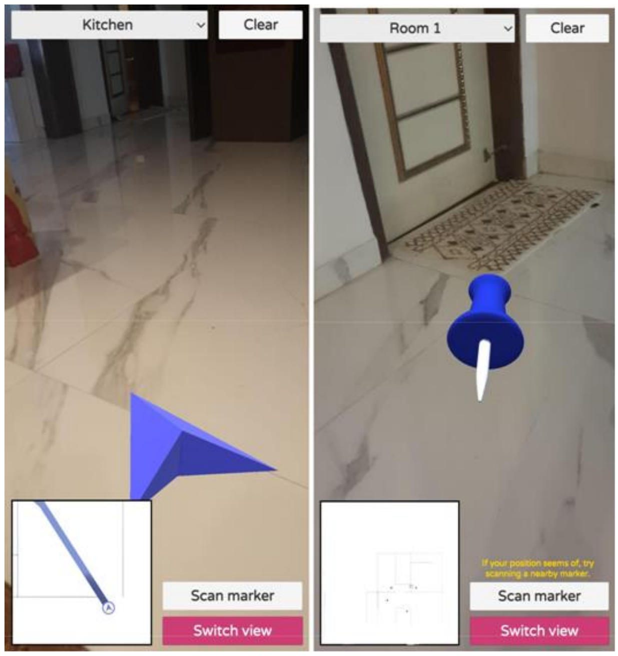

Figure 3 : Result Screenshots of the AR view displaying the route to destination, and a marker showing the destination reached.

VI. CONCLUSION AND FUTURE SCOPE

This application can be installed in any Android/iOS smartphone. The five major steps to achieve this are:

1. Developing the 3D map using the building floor plan.
2. QR-code based positioning of the user.
3. Google ARCore based simultaneous localization and mapping.
4. Finding shortest path to chosen destination using NavMesh (A * algorithm).
5. Navigation in the AR view.

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