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A Study on Augmented Reality Assisted Navigation App Using Machine Learning and Computer Vision

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Abstract—Indoor navigation has become as important as outdoor navigation. Navigating in big, unknown indoor environments with static 2D maps is a challenge, especially when time is a critical factor. Here we try to present a solution to this problem through an augmented reality based indoor navigation application to assist people in navigating indoor environments, which runs on mobile devices like smartphones or tablets. The excellent computing capabilities in today's high-end phones or smartphones in combination with their multiple sensors, such as Global Positioning System (GPS), motion sensors, camera, wireless receivers, will allow us to develop a system more advanced than any previous attempts for indoor navigation. The solution will utilize an indoor image based positioning system that takes advantage of smartphones augmented reality (AR) and inertial tracking. The system will have the capability of delivering continuous 3D positioning and orientation of the mobile device which makes it ideal for any navigational application.

Keywords-Augmented Reality (AR), Global Positioning System (GPS), Indoor Navigation, Technology

I. INTRODUCTION

Navigation as a field has always had a very important role in human life. In today's modern lifestyle we find individuals spending more time indoors. People often have to work in large offices, shop in giant complexes and attend classes [1] at large institutional campuses. Yet there is no comprehensive solution to help users locate themselves indoors, in a manner comparable to GPS positioning outdoors. Individuals inside malls, museums, airports, hospitals, institutions, stores, and office buildings always have a need to know what their current position is in relation to their surroundings. With this capability, individuals can determine what points of interest such as washrooms, ATMs, vending machines, and telephones are located nearest to them on a map. They can also determine what route they should take to reach their destination.

This will be useful in big indoor environments, where people are usually not familiar with the floor plan of the building and therefore find it difficult to get to a desired destination in time. For displaying location-based information and the correct overlay on the mobile screen the 3-Dimensional location (position and orientation) must be computed in real-time on a mobile device. This enables the system to support position-dependent augmented reality (AR) applications.

To precisely track the user for AR tasks only, computer vision methods (optical i.e., visual feature tracking) in combination with other localization methods (usually inertial tracking) can be used.

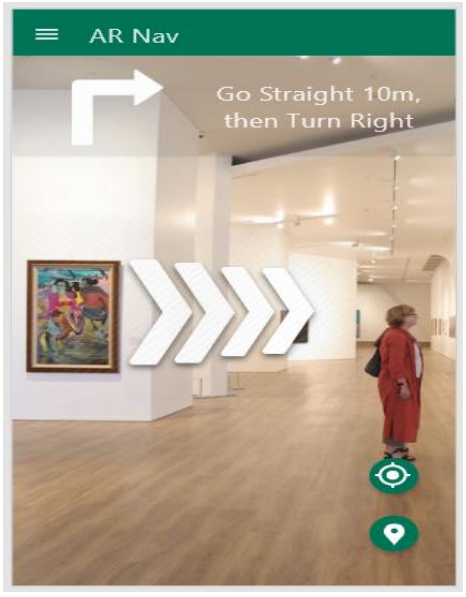

Figure 1. Prototype of proposed system interface

II. HISTORY OF AUGMENTED REALITY

Augmented Reality is a passably new term. The earliest evidence of occurrence dates back 1901. L. Frank Baum, in his novel, 'The Master Key', a fifteen year old encounters a demon who gives him many gifts, one of which was a "Character Marker". The gift was a pair of spectacles, when anyone wears them, everybody you meet will be marked on the forehead with a letter indicating his or her character. For example, 'G' stands for good, 'E' for evil, 'W' for wise, 'F' for foolish, and 'C' for cruel.

This device, named "Character marker" has been seen in review has an early prefigure of features related to those obtained in Augmented Reality devices. The official term was later coined in 1990 by Tom Caudell.

III. LITERATURE REVIEW

We have found a number of indoor navigation system in available from various resources whose documents we have selected and effectively evaluated. The author of [2] proposed a prototype for indoor navigation that uses interior features establish user's location and serves the user with navigational instructions. The author reviewed a sample of his workings by testing a prototype in a simulated physical shopping mall environment it was concluded that AR-based navigation can be convenient in indoor locations using the feature of position markers.

The author in [3] surveys the current state-of-the-art in Augmented Reality. This document provides a fully-fledged description of work performed in different application domains and demonstrates the existing issues experienced when building AR applications in consideration of technical constraints of the mobile device. The main and most focused challenge of AR i.e., it has to deal with vast amount of information in reality is very well briefed in this particular document. Moreover, the use of hardware devices as a solution to this limitation was also presented in this paper.

[4] describes the various important sectors in which Augmented Reality is grounding as real life applications. The fields briefed in this paper are Construction, DIY Car Repair, Learning to Cook and GPS turn-by-turn navigation. The author has concluded characterizing the innumerable ways by which Augmented Reality can transform our lifestyles in future. Moreover, technologies used to frame AR were also explained well.

IV. RELATED WORK

Currently used navigation solutions are mostly focused on outdoor navigation. They use a well-suited, precise resource in the form of Global Positioning System (GPS) for their purposes. However, the same cannot be said for indoor navigation system as they isn't yet a similar resource available and multiple concepts have been explored to work around that with little success.

Most commonly related work on indoor navigation is mostly focussed on using position markers [5] with small distances of each other. This is somewhat effective but cannot be considered completely reliable and also does not provide a seamless experience.

Based upon the existing solutions, a more improved system can be developed by integrating the newer advancements in technology.

V. METHODOLOGY

The system employs Augmented Reality (AR) to provide directions to the user. The [6] AR elements will be generated using surface detection which will be determined by Computer Vision and Machine Learning techniques. The user's location will be determined by multiple methods. The primary methods will be landmark-based markers and inertial tracking [7] using the device's motion sensors.

These techniques were selected as they require the least external markers to be installed and can work with any environment in its current state. The application will have a wireframe model of the building present in its database with all places of interests and pathways marked in it.

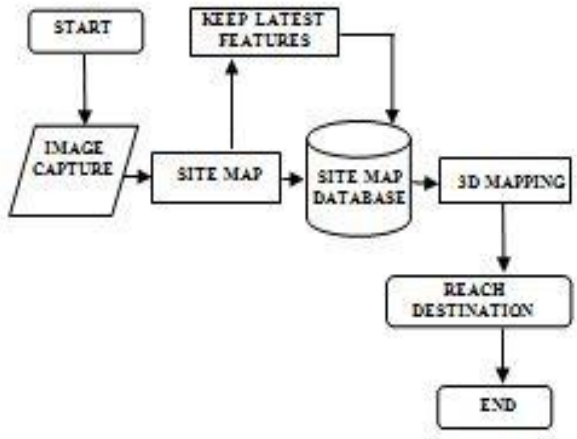

Figure 2. Proposed System

[8] To provide the design and development of a full mapping tracking and visualization pipeline for large indoor environments, following modules were needed to be designed and integrated –

a. Mapping
    i. [9] Capturing the environment using computer vision (CV) camera.

ii. Recreating the stored 3D map using camera setup of individual mobile device.

b. Tracking
   i. Handling of multiple visual tracking solutions simultaneously on a mobile device, but still keeping computational effort low.
   ii. Designing a heuristic routing algorithm to map the route according to track location.

c. User Interaction
   i. Interface to display marked locations and routes.
   ii. Development of AR navigational element.
   iii. Testing the navigation scenario under real world conditions.

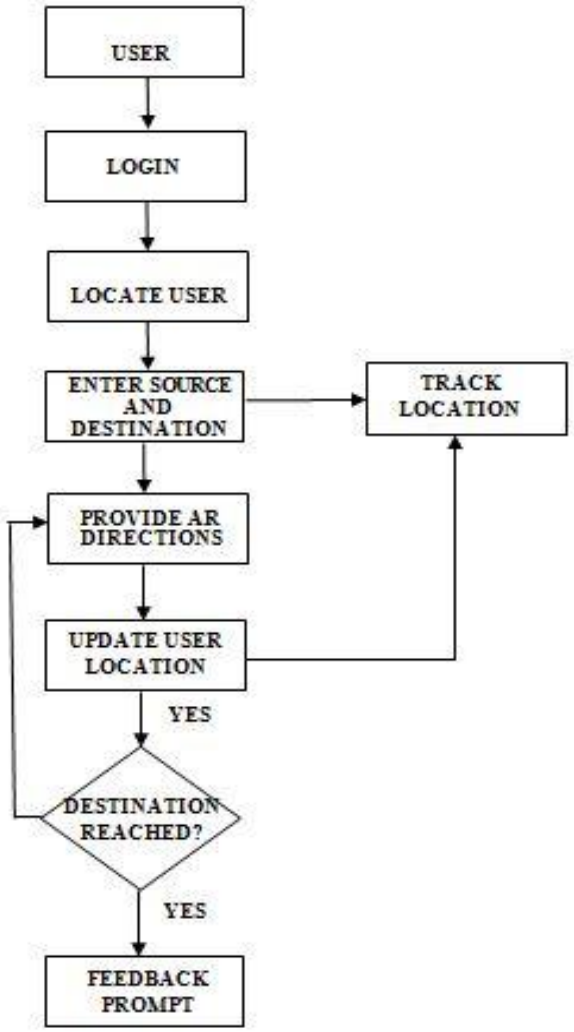

Figure 3. System Flow

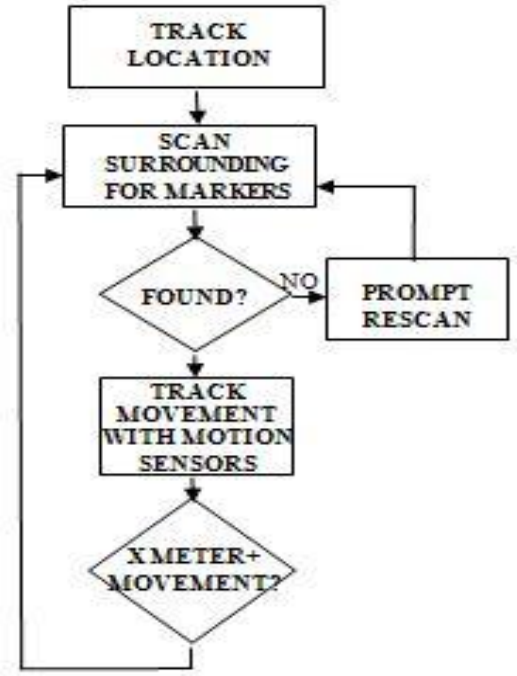

Figure 4. Location Tracking

VI. Results and Discussion

By analyzing previous efforts in the field of indoor navigation, we have observed that a major issue with them was lack of consistency and user engagement. Our solution aims to overcome these drawbacks by implementing technologies like [10] Augmented Reality (AR) which were underdeveloped previously.

VII. Conclusion and Future Scope

At present, Augmented Reality is just in its initial phase. And its future scope in mobile application is a never ending process. In the future, Augmented Reality is expected to be at a much greater boom than now. Our study of research paper which brief us about the previous systems developed for the purpose of indoor navigation has lead us to believe that there is no complete solution present for the problem statement and that our proposed system could be a promising approach to this.

For future iterations of our solution, we will keep integrating newer features that maybe introduced in Augmented Reality (AR) technologies as well as other relevant technologies. Augmented Reality is a view of the physical, real world environment that is augmented by synthetic, computer generated elements. It is emerging technology and very helpful in visual learning.

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