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A Comparative Study of Marker-Based and Marker-Less Indoor Navigation in Augmented Reality

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Abstract - *Navigation has been an important subject of research for many years. People have always been interested in developing devices, technologies, and applications that help them find their location and aid in navigating to destinations. We present this paper for comparison between Marker- Based and Marker-Less Augmented Reality for indoor navigation, discussing various points of comparison for their efficiency in Indoor environment. This paper provides the comparison to a reader so that he chooses the technique best suited for the indoor environment.*

***Key Words*: AR, GPS, Wi-Fi, Marker-less, Marker-based**

1. INTRODUCTION

Navigation requires knowledge of current position of the person. The availability of cheap, globally available technology providing current positioning using GPS has been a major driving force in the popularity of navigation applications. Ever since GPS became popular on a wide scale, it has always been expected that a similar efficient solution for indoor navigation will be available soon. But GPS poses number of problems if it is used indoors, due to its requirements for a clear line of sight with earth-orbiting satellites for accurate positioning. Current technology does not give any straightforward solution to a low-cost, global indoor navigation system which requires no installation or dedicated infrastructure, as indoor navigation systems often uses technologies based on ultrasonic or radio frequencies and infrared.

2. INDOOR NAVIGATION WITH AUGMENTED REALITY

2.1 Marker-Less Indoor Navigation

Various Positioning Techniques in Marker-Less Indoor Navigation are shown in Figure 1. Now, in the following section various techniques for indoor positioning will be introduced.

Technology	*Indoor*/Outdoor	Accuracy	Range	Cross-Platform	Power Supply
GPS		5- 20 m	Worldwide		
Wi-Fi		5-15 m	< 150 m		
Bluetooth		1-3 m	< 30 m		
VLC		< 50 cm	< 8 m		

Fig: 1 Types of Marker-Less Technology

2.1.1 Indoor Navigation Using GPS

Marker-less navigation employs GPS, compass, velocity meter or accelerometer present inside a device namely: - Smartphone, laptop, etc. to provide location information.

Availability of Smartphone and its ability to detect the location using GPS helped navigation in augmented reality come into existence.

Marker-less AR denotes the application that recognizes the things that are not directly provided to the application beforehand.

Marker-less AR solutions have included new hardware packages like Google Tango though we prefer a solution self-developed that produces same results without the need for specialized software.

GPS Marker-less Tracking is one of the best methods used for tracking in outdoor environment. It provides location positioning without the use of specialized markers.

Fig -2: GPS Marker-less Technology Example

The above Fig: 2 show the marker-less detection with the help of GPS, Accelerometer, Compass etc., though the marker-less augmented reality is very helpful in outdoor navigation but proves inefficient when working in indoor environment.

2.1.2 Indoor Navigation Using Wi-Fi

Wi-Fi is a good alternative to GPS within a building because of its non availability and due to the ease in installation of Wi-Fi positioning system (WPS) as Wi-Fi access points already present in many buildings. For example, existing cash register systems, public hotspots and access points of shops or exhibitors. The users don't have to connect with the Wi-Fi directly, only the Wi-Fi should be enabled for navigation.

Accuracy of a Wi-Fi enabled system depends on various factors such as:

- the number of available networks
- reflections in corridors
- Shielding through walls, ceilings and your own body etc.

The precision of Wi-Fi used for indoor positioning varies from 5to 15 m. Also the sensors present in Smartphone can be used to increase accuracy. A big advantage compared to GPS is that it is possible to determine the current floor level.

Wi-Fi could be used for navigation in complex buildings such as museums, malls, railway stations, airports Indoor navigation using Wi-Fi is useful when Wi-Fi has to replace GPS in buildings. For example in complex infrastructures such as shopping malls, exhibition halls, railway stations, airports, hospitals, museums, office and industry buildings.

An indoor navigation app improves visitor service and enables analyzing visitor flows.

2.1.3 Indoor Navigation Using Bluetooth

Bluetooth similar to Wi-Fi is also a good alternative to GPS for indoor navigation. Bluetooth can't receive signals but can send them. Bluetooth's are comparatively cheap and has life up to 2 years. Bluetooth has the advantage of compatibility with both IOS and Android.

In Indoor environment they have maximum range of 30 m but gives best results up to 1 m (which is less). Although it is more precise as compared to Wi-Fi, it requires additional hardware.

Bluetooth is used to create a bridge between online and offline world .Also, navigation in complex architecture buildings and detailed information about exhibitions in museums and trade fairs are possible using Bluetooth.

2.1.4 Indoor Navigation Using VLC (Visible Light Communication)

VLC is used for positioning mainly in indoor environment using the camera of Smartphone which can detect the light emitted by fluorescent lamps or LEDs. This enables indoor navigation (via app) and tracking (analysis of motion profiles via app).

In VLC, each lamp compiles its unique id into the light emitted which when detected by camera of a Smartphone can be used to find the position of the lamp in a map using its ID, thus able to find the location of the user.

VLC is a new technology as is expected to be best used in places such as supermarkets, shopping malls, DIY stores, airports, railway stations etc. A Smartphone can determine its position using VLC technology.

Advantages of VLC involves easy availability of lamps, high range up to 8m, cross platform technology which is battery independent and energy efficient if amps used are LEDs

VLC holds some disadvantages too like not suitable for outdoor navigation, special app or hardware required for tracking, low flexibility, etc.

Now, Lets Discuss Marker-Based Indoor Navigation.

2.2 Marker-Based Indoor navigation

When it comes to indoor positioning with high accuracy and low cost, there is no other method most viable than Augmented Reality (AR) Markers in indoor navigation, which has made this type of navigation highly desirable in Large-scale applications.

Taking in consideration the maintenance and implementation cost, marker-less approach is clearly erroneous, whereas in actual navigation, we use localized "markers" with the purpose of offering instructions or feature as a landmark to humans while navigating.

User can find his/her path to the destination in two ways:

2.2.1 Marker based AR system

Marker Based Tracking is primarily used by scanning a square marker consists of a black square with a white border with a predefined size. We use camera to scan these optical based images and hence using the relative position, gives out the desired result.

Fig-3: QR Code Based Augmented Reality

2.2.2 Natural Feature Tracking

Natural Feature-Based Tracing is defined as image-based tracking mechanism where we detect the predefined features of an object such as corner, edges, blobs, etc hence making it easy to use than specially designed ID Markers.

The images to be tracked are basically of two types: - High Featured Image and Low Featured Image.

High Featured image is easily trackable as a lot of feature points are present in those images, as shown in Fig: 4.

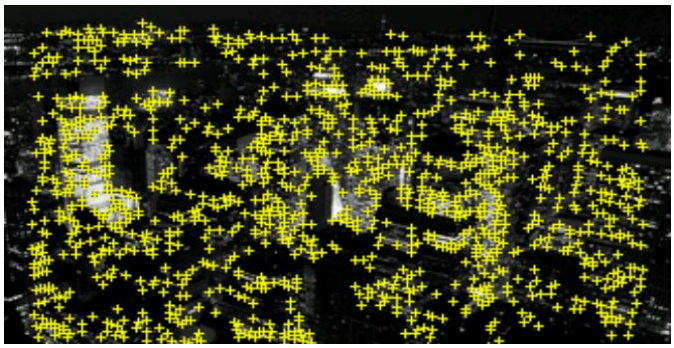

Fig-4: Image with High Feature points for tracking.

Whereas Low featured image includes very less Feature points thus, tracking of those images is hard and inefficient (shown in Fig: 5).

Fig-5: Image with Low Feature points for tracking.

The main requirement of marker-based indoor navigation application is the use of sensors and cameras.

2.2.3 Types Of Markers

Markers come with varied features and functionalities. They are sometimes troublesome to detect when scanned under oblique angles and less illuminated environment. Hence, markers with thick borders and well-defined features are preferred, as markers are the most crucial aspect of Augmented Reality Applications, and hence should not be ambivalent.

Template markers are black and white markers having simple image with a black border. The detection system recognizes the markers by estimating their segmented images with marker templates.

2D barcode markers hold black and white data cells as well as a border with other objects. Computer vision system observes the marker by samples the pixels via calculated center of each cell, and computes the final cell value.

Imperceptible markers are not discerned by the humans. The visual patterns offered by these markers cannot be perceived by the naked eye. Although, if the device operates on different wavelengths than visual light, one can use image markers, infrared markers and miniature markers, which will entirely be based on different radiations produced by the markers.

We can choose any of the appropriate markers for the application we are developing. For example if we are developing application related to long distance detection of markers, template markers can do clear justice to design. For data-based applications data markers can be rightly used.

3. CONCLUSIONS

In this paper, basically two Augmented Reality Techniques were discussed which could be used in Indoor Navigation i.e. marker-based and marker-less, both of which equally contributes and work well in different scenarios.

In cases where perfect accuracy and precision is required in Indoor Navigation, marker based (QR codes and Natural Feature Detection) could be the cheapest and easiest positioning method for an indoor navigation system and so it can be efficiently implemented in areas like shopping centers , university campuses, hospital.

Marker-less technique uses GPS, Wi-Fi, Bluetooth and VLC for Positioning of Object in the Real World. So Marker-less is one of the best methods for tracking currently which performs various types of outdoor tracking like active tracking , hybrid tracking etc., and recognition ,type of support in real environment without using special markers but every technology has its limitations so the marker less applications is a challenge, if area is small as it provides less precision.

So, there is a strong untapped potential in augmented reality in context of indoor navigation and can be tuned to work with any indoor space such as malls, hospitals, museums, airports etc.

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