AR WAY-FINDING APPLICATION FOR CAMPUSES

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***Abstract*- This research paper is about developing a mobile based application to navigate the path in 3D using Augmented Reality. Nowadays, almost everyone is using their smartphones in order to find the right path to the destination. However, existing systems are mostly restricted to outdoor navigation only and these applications cannot help us navigate indoors. We are going to build an Augmented Reality based application for navigation as well as pedestrian information. Our application is solely created to achieve ease while navigating in a campus - which can be termed as campus navigation. Augmented Reality (AR) being more user friendly and interactive, the various features like showing points of interest and labeling the main spots inside the campus, easily finding path to the desired destination by visual marker guidance, getting detailed information of the campus with location-based and vision-based AR technologies are being taken into consideration. The user will be able to navigate from any one point to another without any kind of map or external guidance.**

INTRODUCTION

In the current scenario, it is difficult for the people in a new area to find certain places, like schools, malls, colleges, etc. They tend to rely on Google Maps or Global Positioning System (GPS) systems [1]. However, it does not completely solve the problem as it cannot help us navigate indoors too. The existing applications like Google Maps etc. are mostly restricted to outdoor navigation only and such applications cannot help us navigate indoors. The sign boards do provide map of the complete indoor space in certain malls, institutes or at complex indoor spaces like the airports etc. but people still tend to get confused regarding the paths. Hence, the idea of making something interesting which will help people navigate indoors too. The idea is to build an Augmented Reality (AR) application for navigation as well as pedestrian information.

AR is a new rising research field in recent years. AR system integrates virtual information into the real world and enhances the users' visual experience and makes users more intuitive and more real understanding of the real world [3]. Examples of Augmented Reality experiences include Snapchat filters and the game Pokémon Go. According to the identification and information acquisition, mobile AR technology is classified into location-based AR and vision- based AR. Location based AR firsts positions an area GPS in the device, or using current location information achieved by network, and then obtains the virtual information corresponding to the current position objective[4]. Other than location-based AR, vision-based AR must first obtain the images by the camera; then matches the captured images with a given template; and the last registers the corresponding virtual information on the images [5].Thus, AR can be very interactive, unique and user-friendly. The users will just not navigate with its help, but also they will be able to know about certain areas in that public place in detail.

Currently, the application idea is focused and limited to a certain college campus. Wherein campus, the exact position and detail of every school can be obtained by using the augmented reality technology leading to campus internal navigation. Hence, this paper investigates mobile location-based and vision-based AR technologies and implements the campus navigation system by using these technologies.

LITERATURE REVIEW

A. Existing navigation system

QIN Yong-xu el. at (2013), proposed Mobile location-based and vision based AR technologies are used in implementation of the campus navigation system. The system provides the related information for each building, e.g. teacher, research and teaching information of a faculty. It also provides navigation for one point to other. The artificial markers are pasted on each building of school like library, classroom and after scanning of these markers data is provided in form of text, images and videos. The virtual model is also created after scanning. The system is developed by AutoNaviMAP API, OpenGL API and AndAR API, and tested on an android mobile phone. AutoNaviMAP API provides the system GPS support, OpenGL API provides the system display support and AndAR API provides the system identification support [6].

Umar Rehman and Shi Cao(2017), proposed a paper on electronic gadgets study. For example, cell phones or a head-mounted gadget. Specifically, Google Glass is inspected as a wearable head-mounted gadget in examination with handheld route that helps including a cell phone and a paper map. The specialized evaluation built up the attainability and unwavering quality of the framework. The human components study assessed human-machine framework execution measures including apparent precision, route time, emotional solace, abstract outstanding burden, and course memory maintenance. The outcomes demonstrated that the wearable gadget was seen to be increasingly exact, yet other execution and outstanding burden results showed that the wearable gadget was not fundamentally unique in relation to the handheld cell phone. Complex open structures like air terminals utilize different frameworks to direct individuals to a specific goal. Such approaches are generally executed by demonstrating a story plan, having managing signs or shading coded lines on the floor [7].

Georg Gerstwelier(2017), proposed an idea which is based on a visual hybrid tracking approach for smart phones and tested in a real world airport scenario. The tracking and the guiding part of a reliable indoor navigation requests a 3D model of the environment [8]. Sebastian Kasprzak, Andreas Komnios, Peter Barriie(2013) in the proposed paper state that AR can be used in other public places like malls. the malls.

User interface is provided to enter the source and destination. The user needs to scan the starting point and the directions to the destination are provided in text format, if the user wants he/she can scan the logos in mid-way to reach the destination or can continue with the provided instructions. The system uses Vuforia SDK for logo recognition [9].

Muhammad Fadzly bin Abdul Malek el. at (2017), presented an idea which shows the development of an interactive indoor localization system that uses live input video capture and can identify location markers to indicate its current location. In addition, augmented reality is also used to superimpose augmented reality objects above the location markers to indicate the direction to be taken by the user, which assists the user in navigating to the chosen destination. The developed system was implemented on a Raspberry Pi, an embedded computing platform, with a USB camera and display glasses for the live video capture and display devices respectively [10].

Christoph Bichlmeir, Ben Ockert, proposed that AR has been utilized in the therapeutic field too reports on the methodologies and middle of the road aftereffects of the ARAV- Augmented Reality aided Vertebroplasty venture that has been started to make an AR framework dependent on a stereo video transparent head-mounted presentation that is for all time accessible in the working room (OR) [11]. Likewise Mark Billinghurst el. at (2014), proposed gesture interaction with AR which examines motions. Connection is utilizing AR. It shows a customer server design for nothing hand signal cooperation. Utilizing this framework, an assortment of motion-based communication strategies are executed, for example, having the option to utilize squeezing motions to get and move virtual substance in three measurements [12].Jesperi Rantanen(2018), proposed an indoor route framework that can be made without AR is talked about in the paper, where movement setting acknowledgment to upgrade the aftereffect of a foundation free indoor route calculation is utilized. Target applications are troublesome route situations, for example, people on a call, salvage, and strategic applications. The route calculation utilizes the inertial route and visual route combination. Irregular Forest classifier calculation is instructed with preparing information from the Inertial Measurement Unit and visual route information to arrange between strolling, running and climbing. This data is utilized both in person on foot route to do stationary identification with versatile limit and in molecule channel combination to bar visual information from during climbing [13].

B. Existing mobile-based application review

To choose the suitable application, we need to compare the features of our application with the existing applications. We found out some key features in common and the apps were graded according to the availability of these features.

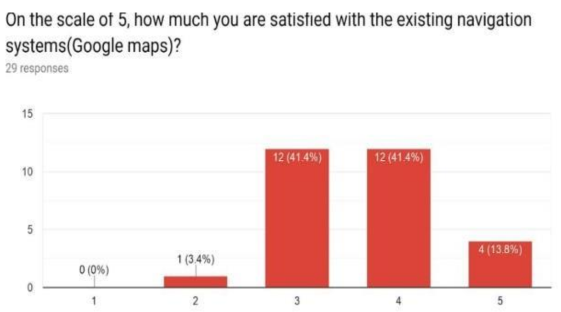
The existing wayfinding applications and their features are depicted in figure below wherein the tick indicates that the corresponding feature exists in the application

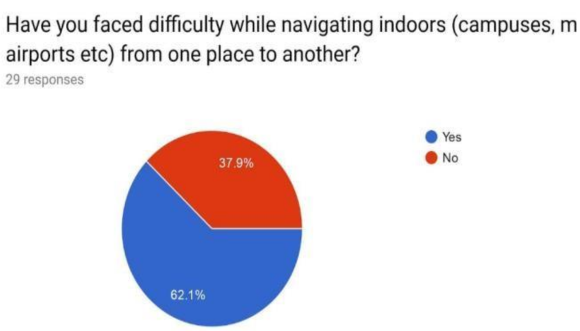
	ARway	Google Maps	Local Scope	Maze Map	Find Car	Waze
Augmented Reality	✓	✓	✓		✓	
Points of Interest		✓	✓	✓		✓
Mapping	✓			✓		✓
Positioning	✓	✓		✓	✓	✓
Way-Finding	✓	✓	✓	✓	✓	✓
Indoor Navigation	✓			✓		
Location Sharing	✓	✓	✓		✓	
Cab Booking		✓				
Traffic Monitoring		✓				✓
Adding Stops		✓				
Labels		✓	✓	✓		✓
Customization	✓			✓		✓
Offline Maps		✓			✓	
Multi Language Support		✓	✓			

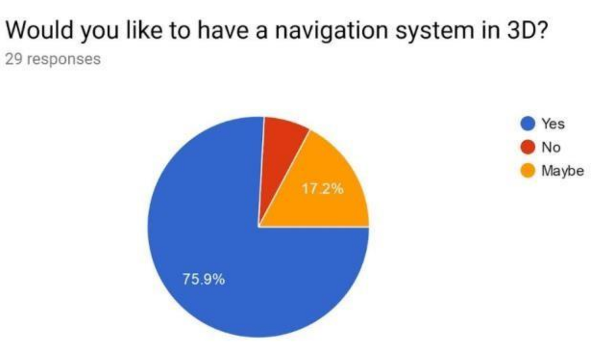
Fig.1.Existing applications and their features.

A. User review / Contextual Inquiry

The need of users in context of navigation using augmented reality through Google Forms is depicted through graphs below. In which users' knowledge about AR was checked, the user is analyzed on different aspects such as navigation systems they are using currently, have they faced any difficulty while indoor navigation, are they satisfied with current navigation systems, are they ready to use application based on AR and many more.







After conducting a full-fledged customer survey, we could empathize the customer situation and their needs. The response regarding using a 3D navigation system was quite positive. Most of the people were unaware of Augmented Reality, so the introduction of this technology seemed challenging. Although, the response was satisfactory and the requirements were understood. To help people navigate in a better way using a 3D based technology is what we concluded from the user survey.

METHODOLOGY

A. Interactive Campus

The main aim of our system is to be as easy as possible, at the same time, informative to the user. The end users should be able to understand the campus completely with the navigation process. For this to happen, we have made custom markers for various points of interest (POIs) for the campus. Users will be able to understand which place is meant to be visited. Along with that, the campus will be visually appealing to the users with the checkpoints and signposts, which are going to guide the user from time to time. Finally, we have also introduced events banners which will advertise or promote the recent events that will be taking place in the college. The users will see a promo video of the event on the event posters or banners.

B. Working

GeoFencing is a boundary or region of interest in the geographical region. Geo-fencing is used for many applications and it provides many benefits to many users. One of the major applications for Geo- fencing is security, when anyone enters or leaves a particular area, an alert or text messages has been sent to the user’s device [13].

Geofencing combines awareness of current user's location with awareness of the user's proximity. Geofencing combines awareness of current user's location with awareness of the user's proximity to locations which can be specified using latitude and longitude radius is adjusted to the proximity proximity for the location.Hence to define a geofence,i.e. creating a circular area, or fence, around the location of interest , the radius, longitude, latitude are required[14].

A. Geo-fence on Android

On Android, there are different ways to deal with geofences. One can use Google’s GeofencingApi. This API is component of Google’s Location Apis which has GeofencingRequest, GeofenceApi, Geofence, and GeofencingEvents.. The GeofencingApi class is the entry point for all interactions with Google's geofencing API. The GeofencingApi can be used to add geofence by calling addGeofence() method and remove the geofences by calling removeGeofences() method.

Now to check whether a person is within geofence range we can make use of different algorithms such as Ray-casting, Winding Number and Circular Geofencing using Haversine Formula.

B. Point In Geofence Framework and Algorithm:

The following Fig. 1 shows basic procedure of accessing whether the point of interest is within the geofence range or not.

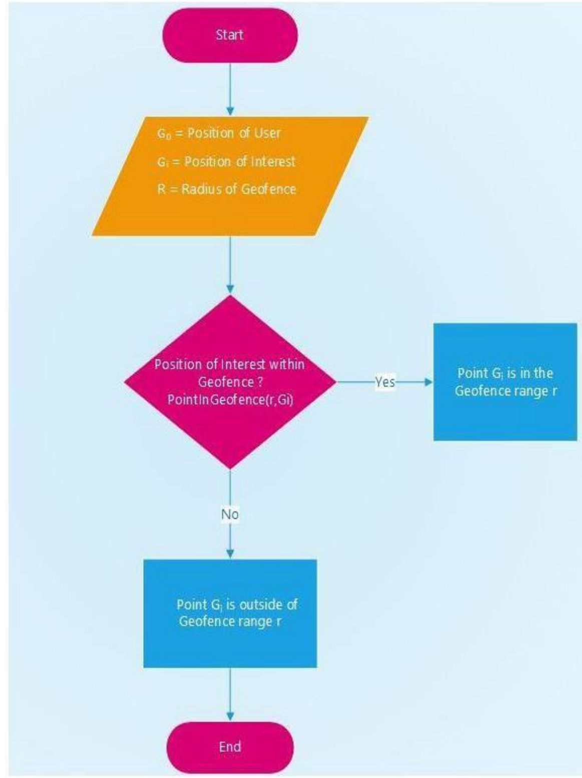


Fig. 1 Point in Geofence flowchart.

The algorithm based on the flowchart is as

Input: **r** is the radius of the geofence. **g** =[g_o,g_i]
g_i is the position of the interest, go is the position of user.

Output: true if **r** does not violate **g**, otherwise

false 1: if pointInGeofence(g_i , r)then
2: return true
3: end if
4: for all $g_{o(i)}$ in g_o do
5: if pointInGeofence(r, $g_{o(i)}$**)** then
6: return false
7: end if
8: end for
9: return true

The above algorithm consists of the input parameters r and g. r = (x, y) is the current position to check for geofence violation.The geofence is specified by g = [gi , go] where gi is the keep-in geofence boundary polygon and Go = {go1 , ..., g0n } is the set of keep-out boundaries. goj is the jth of n keep-out geofence boundary polygons.

The PointInGeofence() function can be implemented by any of the algorithm like Ray Casting , Winding Number , TWC and Circular Geofencing using Haversine formula.

<u>1.Ray casting Algorithm</u>

The Ray Casting algorithm determines whether or not the position of interest, Gi, is inside a given polygon p, by projecting an infinite ray from Gi. If the infinite ray intersects an odd number of polygon edges, then r is contained in p, otherwise, r is outside of p. As the Ray Casting algorithm iterates over all edges of p and does not have an initialization step, if the geofence boundaries change from one time step to the next, code execution and results of the Ray Casting algorithm are not impacted.

<u>Algorithm:</u>

Input: p is a simple polygon
G_i is the position of interest buf is a buffer distance.

Output: true if p contains **G_i**, otherwise

false 1: count = 0
2: s is an infinite ray in the +y direction, originating at **G_i**
3: for all edges e in p do
4: if **G_{i_x}** is within buf of ex then 5: $e_{x,buf}$ = ex -2 * buf
6: else
7: e_{buf} = e
8: end if
9: if **G_i** is within buf of e or e_{buf} then
10: return false

Lines 9 -11 of above Algorithm state that if the position of interest, **G_i**, is within the buffer distance, buf , of the edge currently being considered, then **G_i** is considered outside polygon p.

<u>2. Circular Geofencing Using Haversine Formula:</u>

In the below algorithm, geofence of radius 'r' is created around the point G_o The distance between G_o and G_i is calculated using Haversine formula.The Haversine **formula** determines the great-circle distance between two points on a sphere given their longitudes and latitudes

Algorithm:

Input:

Gi the position of the interest. Gi = [lati, longi] Go is the current position of the user. Go [lato, longo] r is the radius of the geofence.

Output: True if the G_i is within Geofence range of G_o

checkWithInGeofenceRange ()
{
1: Distance = 0
2: Distance = getDistanceFrom Location (G_o , G_i) ; 3: If (d < r)
4: Return true
5: Else
6: Return false
7: End if
}
Get DistanceFromLoaction (G_o , G_i)
{
8: radius =6371;
//radius of earth 9:

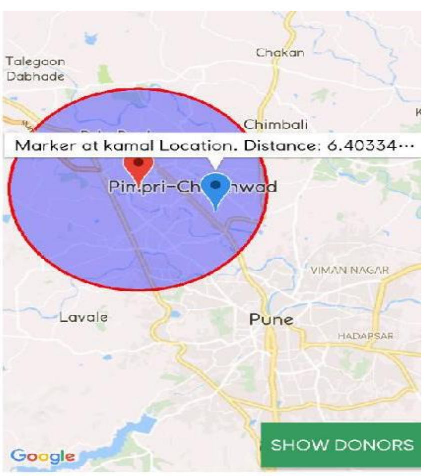
```
dlat = deg2rad ( lati ,
-lato );
10: dlong = deg2rad ( longi, -longo );
11: a = Math.sin ( dlat / 2 ) * Math. sin(
dlat/2 )
      + Math. cos ( deg2rad( lato) )
      * Math. cos ( deg2rad( lati) )
      * Math. sin ( dlong/2 ) *Math. sin (
        dlong/2 );

12:  c=  2  *  Math.atan2  (
        math.sqrt  (  a  )  ,
        Math.sqrt ( 1-a ) );
13:  D= R* c;
14:  Return d;
  }
```

So, after calculating the distance, if the distance is greater than radius then the point of interest Gi will be discarded and

if the distance is less than radius then the point of interest G_i is highlighted with marker within geofence.

The Fig 2. shows the geofence generated around G_o (shown by red marker) and G_i which is inside Geofence of G_o is shown with Blue marker.



CONCLUSION

The proposed system will satisfy the need of Indoor Navigation for MITAOE campus. It will be helpful for the new visitors like new students, parents, faculties to get familiar with the campus, also it will remove the need of guides that need to be allocated to students while “First Year Program Orientation”. The approach used while building the system for MITAOE campus can be used as reference for building the Indoor Navigation System for other public places.

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