International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 3, May-June-2020, ISSN (Online): 2395-566X

Interactive and Realistic 3D Assistance for Inside Environment

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Abstract – **Indoor assistance has gained popular among the globe in recent decades. Various technologies like Wi-Fi, Bluetooth, GPS, GSM, RFID and WLAN etc. has been used to provide direction assistance inside the indoor environment. However the prevailing techniques are often failed in their real time implementation to prove the accuracy and adaptability. During this paper, we proposed a low cost, simplified framework for indoor assistance and that we have developed the indoor assistance as a simplified Application Programming Interface (API) especially for iPhone. We used QR codes printed on the paper, and placed on the floors of the indoor corridor. These QR codes are scanned and detected by a smart phone's camera. The 3D animated toy is employed to guide the indoor user together with the audio output as voice guidance which may be used for the blind people. This smart indoor assistance System uses augmented reality (AR) in an incorporated iOS-based application. Furthermore, we utilized augmented reality to point out continuous routing information, and a compass to work out the direction towards the destined location.**

Keywords– **Wifi, GPS, RFID, WLAN, iPhone, augmented reality, iOS.**

I. INTRODUCTION

Augmented Reality (AR) is employed to superimpose computer generated graphics on the important view of the user to make the effect of mixture of virtual and reality. With complex building layouts and therefore the mobility of the population, the necessity for indoor positioning and navigation systems is continuously growing. Simple floors maps are hard to read for many people, and that they are expensive to remake when information on them changes. AR Kit is iOS platform for building augmented reality experiences [1]. Using different APIs, AR Kit enables your phone to sense its environment, understand the planet and interact with information. A number of the APIs are available across Android and iOS to enable shared AR experiences. AR Kit's motion tracking technology uses the phone's camera to spot interesting points, called features, and tracks how those points give time. With a mixture of the movement of those points and readings from the phone's inertial sensors, AR Kit determines both the position and orientation of the phone because it moves through space. SLAM technology (Simultaneous Localization on and Mapping) allows users to scan previously mapped real-world objects, like toys, sculptures, architectural models, product packaging, industrial machines and more to look at and interact with AR content in an exceedingly 360degree manner. The most working of the project is to display the AR model on the camera to display the directional information in 3D form.

Overall, the scope of the project involves research on augmented reality, audio API, and other additional techniques that may improve the program in computing the route in indoor environment.

II. LITERATURE REVIEW

1. ARToolKit

ARToolKit is an open source software library for developer to develop AR applications. ARToolKit was formerly developed by Dr. Hirokazu Kato and supported by Human Interface Technology Laboratory (HIT Lab) at the University of Washington, HIT Lab NZ at the University of Canterbury, New Zealand [2],

And AR tool works, Inc. Generally ARToolKit is employed to overlay a predesigned 3D object on the detected marker. The great a part of ARToolKit is that it's able to precisely real-time track the view point of the user by using computer vision techniques to calculate the camera position and orientation relative to the marker orientation so the virtual object that rendered on top of the marker appears always aligned with the marker. The rendering from ARToolKit provides smooth animation of 3D object. First a frame from the video stream is grabbed from the net cam. The image are going to be converted into binary image (black and white) supported the edge value which is that the technique of linearization and threshold [3]. Next the program will seek for square regions by using image labelling technique where those connected components and also the size which is sort of to accommodate a fiduciary marker are going to be extracted. After that, the outlines of the contours that may fit four line segments are going to be recognized as square regions. The corner will then be detected from the mentioned contour.

The square region may be in any orientations therefore it must be normalized to the initial orientation when the marker is trained. The pattern inside the normalized square region will then be compared with the pre-trained markers which are stored as binary data. If there's a match, the arrogance value, which is that the percentage of matching, are going to be computed. When there's a marker detected, the position and orientation of the marker relative to the camera are going to be computed. After the view point is computed, OpenGL API are going to be accustomed overlay the VRML model on the marker supported the computed view point (camera's coordinates). As a result, the virtual object will appear exactly aligned with the marker and also the same process is repeated for real time processing.

2. Analysis of ARToolKit accuracy

The performance of ARToolKit plays a very important role in determining the performance of the complete indoor positioning system because the 3D arrows and every one navigation guides are obsessed on the detection input from ARToolKit. The subsequence modules within the program are more stable than the detection module of ARToolKit.

The performances of ARToolKit are often evaluated from its ability of detecting a marker and therefore the tracking accuracy upon the detection of marker. Confidence value that represents the matching percentage of the detected marker with the pertained marker is calculated by ARToolKit once it detects a marker. The accuracy of ARToolKit [4] to detect a marker is very obsessed on the lighting condition from where it detects the marker. If the lighting condition is analogous to the lighting condition where the marker is trained then the edge value is suitable for straightforward detection of the marker. Nevertheless, the edge value is adjustable to suit different lighting condition within the indoor environment. On the opposite hand, the tracking accuracy of the ARToolKit upon the detection is shown in Figure 1.

The experiment is administered with the conditions that a 55mmx55mm marker is being fixed at x- and z-directions while changing y-direction (20cm to 100cm) from the camera. The camera used may be a web cam with resolution 640 x 490 pixels and frame rate of 15 is employed because the configuration of this project [3]. The result shows that the systematic error of ARToolKit to continuously track a marker is low for the estimated distance from 20cm up to 70cm from the camera to the marker. This is often considered acceptable because the expected working range from the marker to the user is fixed within the mentioned range.

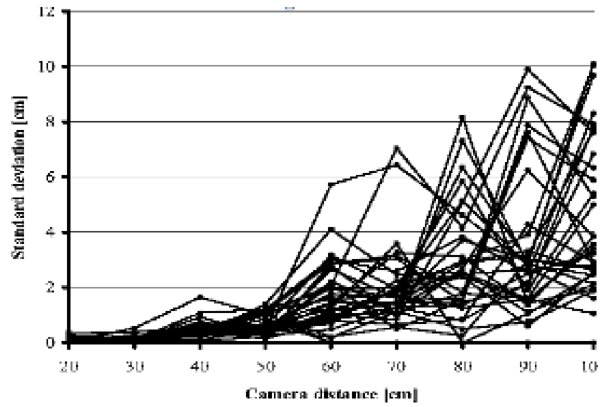

Fig .1.Plot of systematic error of ARToolKit at different camera distance.

III. MATERIALS

Requirements are the essential needs or constraints which are to develop a system. Requirements are broadly classified as User requirements and also the system requirements. These requirements are often collected while designing the system. The two major classifications of requirements are software and hardware requirements. The functional and non functional requirements of this mobile indoor assistance system are mentioned in the following.

1. Navigation:

The application should be ready to detect continuously the present position of the user inside the indoor environment.
Generating Route
The detected position of user inside the indoor and also the specified end destination by the user, the system generates route between the source and destination.

2. User preferences:

User is in a position to activate/deactivate the vibrating cane anytime during the usage of the system counting on the non-public preference of the user.

3. Supporting technologies:

This application requires that the implementation should be feasible using technologies that are accessible to the end users.

4. Time response:

This application must perform in a very proper time constraint that reflects average walking speed, motion and obstacles within the environment.

IV. METHOD

A compute set of hardware and software needed for this project includes a computing device (smart phone) with ARToolKit software installed on it. The overview of the work can be seen in Figure 2 that consists of several blocks of module, each dedicated with certain

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functionality to form an indoor positioning system. The marker detection in ARtoolkit will process the frame and recognize it if there is at least one trained marker. If there is any QR code detected, then the smart phone will only shows live image captured from camera. However if QR code is detected [5], the corresponding location ID will be input to the route planner module then the module will compute the route connecting the current location (based on current detected QR) and the desired destination (based on the location input by the user at the beginning of the program). Once the route is identified the information will be passed to rendering module from the ARtoolkit [6] to render the corresponding 3D animated image on the detected QR code. The audio module will output the voice guidance that corresponds to the route.

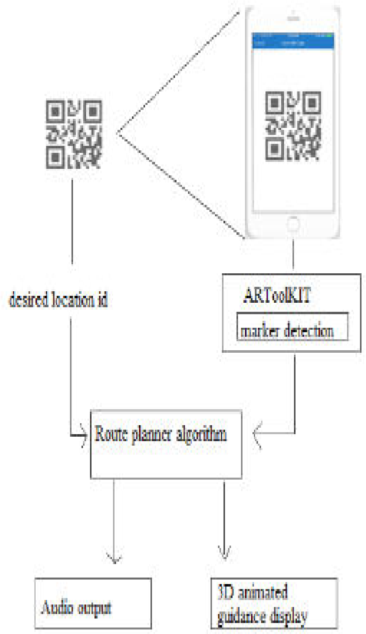

Fig.2. Overview of the work.

V. DISCUSSION

The mobile assistance system consists of scene kit, AR Kit, Camera and routing database. Figure 3 shows the system architecture of this work. Once the camera scans the QRcode, it will check with the run time database. The AR Kit will capture the real world environment continuously and load the character. Then, from the routing database which contains the directional information of the destined location, direction is fetched and order transformation on the direction (R, L, and S) will be done. After that, model (character) transformation will be applied to the scene kit. Finally, walking toy (character) will walk behind the user in the camera for the purpose of directing the user to the destination location.

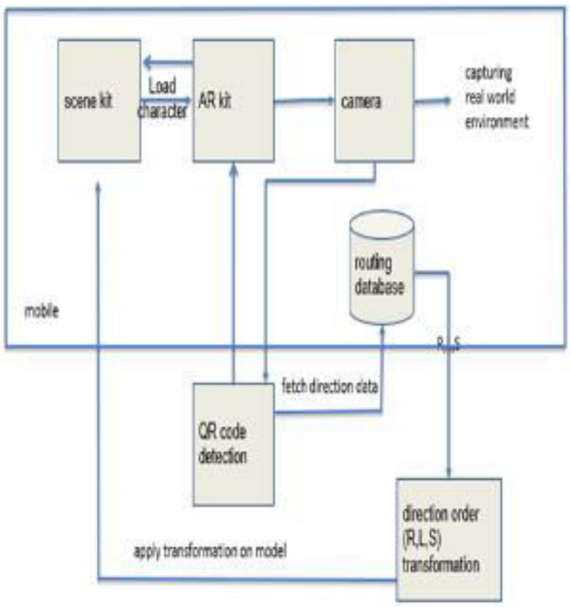

Fig .3. system architecture of the work.

1. QR code scanning and detection

This module involves creation of QR code inside the runtime database of application. Once the application gets opened, the camera gets started automatically and scans the QR code. Once the scanned QR code is valid, then the next module AR integration will get invoked.

2. AR kit integration

First a connected camera is being detected for camera setup. The parameters of the camera are loaded from the camera parameter file that is obtained from camera calibration process. Capturing the real world environment using phone camera and then AR framework will be integrated. Here scene kit is also involved to place the 3D model on the boarding point. The AR kit continuously captures the every motion of the camera. Once the route is identified the information will be passed to rendering module from the ARtoolkit to render the corresponding 3D animated image on the detected QR code. The audio module will output the voice guidance that corresponds to the route.

3. Routing database creation

Creation of the routing database and storing the routing are measured. This database will contain the routing measurements along with the direction information to the destination location. The directional information is left, right and straight. Once after the scanning process, the route to the destined location is accessed by the application.

4. Model integration and positioning

Integration of the 3D model and also the movement of the 3D model are carried out in this module. It integrates the walking toy (3D) into the scene kit according to the routing order transformation. It will display the routing 3D walking toy along with the voice guidance as an output. The result of this module is that the 3D model will guide the user to the destined location.

5. Route planner algorithm

This module will receive the destination input by the user at the beginning of the program. The location will be converted into the location ID for ease of processing. When the user moves to the new location the camera will continue to capture a new frame. Once a QR at that particular location is detected, the route planner module [7] will compute the link between the current location and the destination. The route planner is based on simple pre-calculated paths. In order to automate the routing planning, future work may incorporate algorithms such as Dijisktra’s shortest path or Bellman-Ford.

VI. RESULT AND FINDINGS

For performance evaluation, the project had been tested at the ground floor in the main block of Adhiparasakthi engineering college campus. The QR codes are pasted on floor of the corridor. The project has been tested from the ground floor reception to the computer science department laboratory in the first floor of the campus. The route planner module would look for the route from lookup table based on the detected location ID and the destination location input from the user.

Figure 4 shows the QR code for the computer science department laboratory placed on the ground floor corridor. The user is equipped with a smart phone and camera in the phone captures the live video of the condition in APEC campus when the user walks. The program is started when a user inputs a destination (Basement) at the initialization phase. Figure 5 shows the program recognizing the QR code and integrating the ARkit framework by including the 3D animated toy on the detected QR. The route planner module computes the route from the ground floor checkpoint to the first floor destination. Figure 5 shows the real time guidance for the destined location using ARToolKit framework using iPhone together with the audio output.

Fig .4.QR code in the corridor.

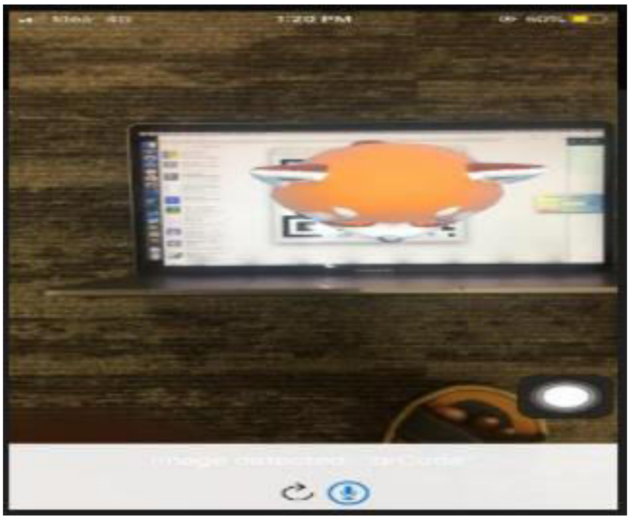

Fig .5. top view of 3D model placed on QR code.

Fig .6.Real time guidance to the destination.

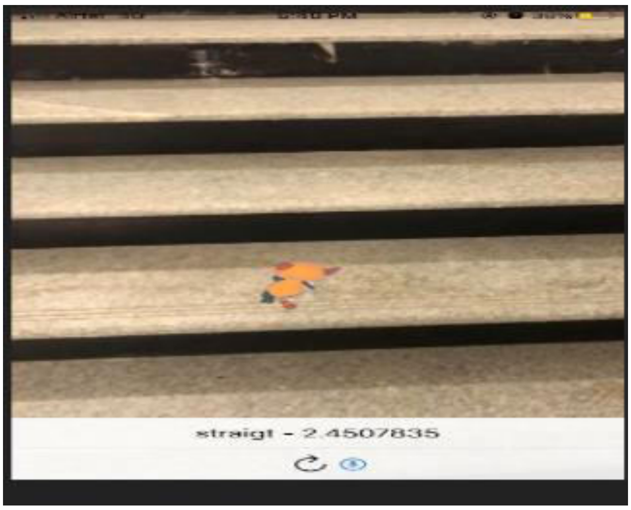

Fig .7. snapshot for 3D model walking on the stairs.

VII. RECOMMENDATIONS

The smart indoor mobile assistance system based on augmented reality aims to deepen a user's perception in perceiving the information conveyed from the database and to ease the user in identifying the route that leads to the destination. The proposed system has been tested in APEC campus, and it has shown its flexibility in working as indoor assistance to navigate five locations. However, there is still room for improvement in terms of the system's flexibility in handling more complicated indoor layout before it can be applied as an alternative to the current indoor navigation solutions. With the limitations and difficulties faced and innovation of newly occurred ideas while implementing this software solution, several future improvements were identified in order to have a better software system in the future. As a future work, we are planning to use Bluetooth beacon devices in important points on the walking path to verify and correct the user's location. Thus, user's location will not only depend on stored data but also the data retrieved from beacon devices. As a result, we will collect more precise data and the routing process will be more efficient. In addition to this application can also be implemented using android platform since most of the people are using android based smart phone.

VIII. CONCLUSION

This proposed system is a novel approach towards assisting a user in indoor navigation and localization. The proposed solution consists of an automated system that can efficiently identify and generate paths inside a large building. Its deployment costs are very low, as compared to solutions provided by other researchers. QR codes are printed on plain paper and pasted on the corridor. These QR codes are detected with a smart phone camera with the help of an application. Audio/textual information is associated with all the installed application. The guidance module lets the users to reach a destination over the shortest path in a single or multi-story building. Testing the system with real users and evaluating the data proved that the overall navigation system is an efficient, accurate, and an easy-to-use solution.

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