EVOLUTION IN ELECTRICAL AND ELECTRONIC ENGINEERING
e-ISSN: 2756-8458

EEEE

Vol. 5 No. 1 (2024) 358-363
https://publisher.uthm.edu.my/periodicals/index.php/eeee

Augmented Reality Navigation Using Android

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DOI: https://doi.org/10.30880/eeee.2024.05.01.045

Article Info

Received: 13 January 2024
Accepted: 16 March 2024
Available online: 30 April 2024

Keywords

augmented reality, motion tracking, marker, Unity

Abstract

Augmented Reality (AR) navigation refers to the use of AR technology to track movement while moving in real-world environments. Traditional navigation methods often rely on maps or GPS-based instructions, which can be cumbersome and less intuitive. The AR navigation system aims to overcome these limitations by overlaying virtual directions and visual cues onto the real-world view captured by the device's camera. The development process involves designing user-friendly interfaces, integrating location services, implementing real-time object recognition algorithms, and utilizing Android's built-in mapping and navigation functionalities. The objectives of the work are to design mapping of QB block, to design AR real-time movement tracking, and to evaluate its accuracy, usability, and reliability by conducting user testing and collecting feedback. Unity was used to create 3D mapping of the QB block and scene setup to generate a minimap that does real-time tracking. It has a 70% accuracy rate after a few tests. In conclusion, the system is considered successful because it managed to accomplish all three objectives.

1. Introduction

Augmented reality is an overlay of digital information integrated into the user's environment in real-time. Its principle is to apply computer-generated virtual information such as text, images, 3D models, music, video, etc.., to the real world after simulation [1]. With the rapid development of powerful mobile devices and advanced software, AR technologies have become common knowledge to many consumers. The latest data on augmented reality demographics shows that awareness levels range from 70% to 75% among 16 to 44-year-olds [2].

AR can be used in many cases such as retail, entertainment and gaming, navigation, tools and measurement, architecture, military, and archaeology. In retail, AR can be used to provide additional product information and it can attract by sparking curiosity to customers [3]. Due to the limitations of a 2D navigation map, it could add cognitive load for users to construct the relationship between the 2D navigation map and the real environment [4]. Palinko surveyed drivers and concluded that most of the users found the augmented reality system, despite the needed improvements, is better than a current lot of navigation devices [5].

Marker-based AR requires a marker to be scanned to activate an augmentation. A marker is kind of similar to a QR code which contains some recognizable patterns that the camera can easily recognize and process as shown in Fig. 1. According to Daisuke [6], localization using AR markers has attracted attention as a solution for indoor localization.

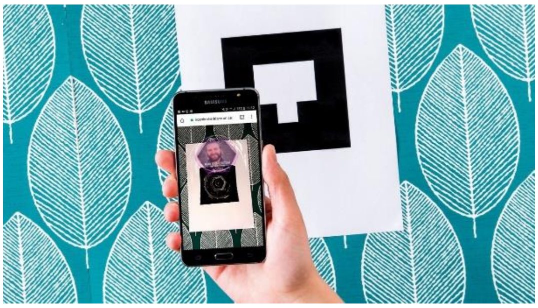


Fig. 1 *An example of Marker-based AR.*

The Global Positioning System (GPS) is the most developed and widely used Global Navigation Satellite System (GNSS) [7]. Currently, about 31 GPS satellites are orbiting the Earth at an altitude of around 17700 kilometres. It provides users with accurate information on positioning, velocity and time everywhere around the world. For GPS to work properly, a device needs to receive strong signals from at least three to four satellites and ideally seven to eight at a time to provide the most accurate location data [8]. GPS signals are blocked or reflected by dense walls of the building so it will not work correctly when a user is inside one.

ARCore applies an algorithm called Simultaneous Localization and Mapping (SLAM) to figure out where a phone is concerning the environment as it moves [9]. ARCore uses feature points—visually recognisable features found in the captured camera image—to calculate its location change. The pose (position and orientation) of the camera concerning the environment is estimated over time by combining the visual data with inertial measurements from the device's IMU as shown in Fig. 2.

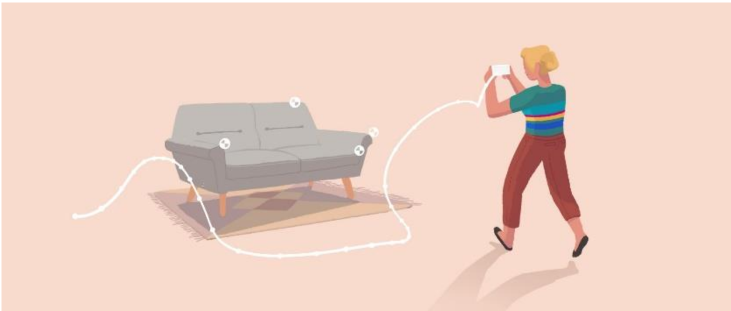


Fig. 2 *Recognisable features.*

Gaurav Bhokar [10] explained that AR navigation would work by acquiring the real-world view from the user’s perspective as shown in Fig. 3. Then location information like GPS together with other tracking data also acquired at the same time. Some virtual world information is generated based on real-world view and location information data. This new information is displayed to the user thereby creating an AR.

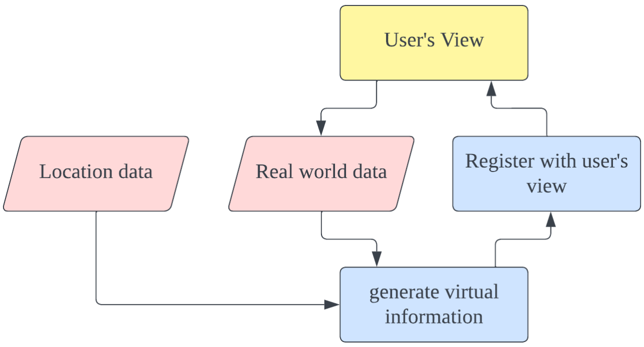
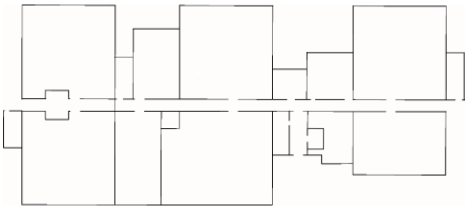


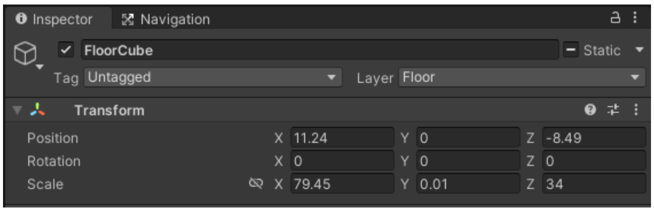
Fig. 3 *Simple System for AR Navigation.*

People get lost more easily within complex public buildings [11] such as university campuses, libraries, and hospitals. Many factors lead to difficulties in identifying directions, for example, indoor structures vary among buildings, and walls may hinder the view [12].

2. Methodology

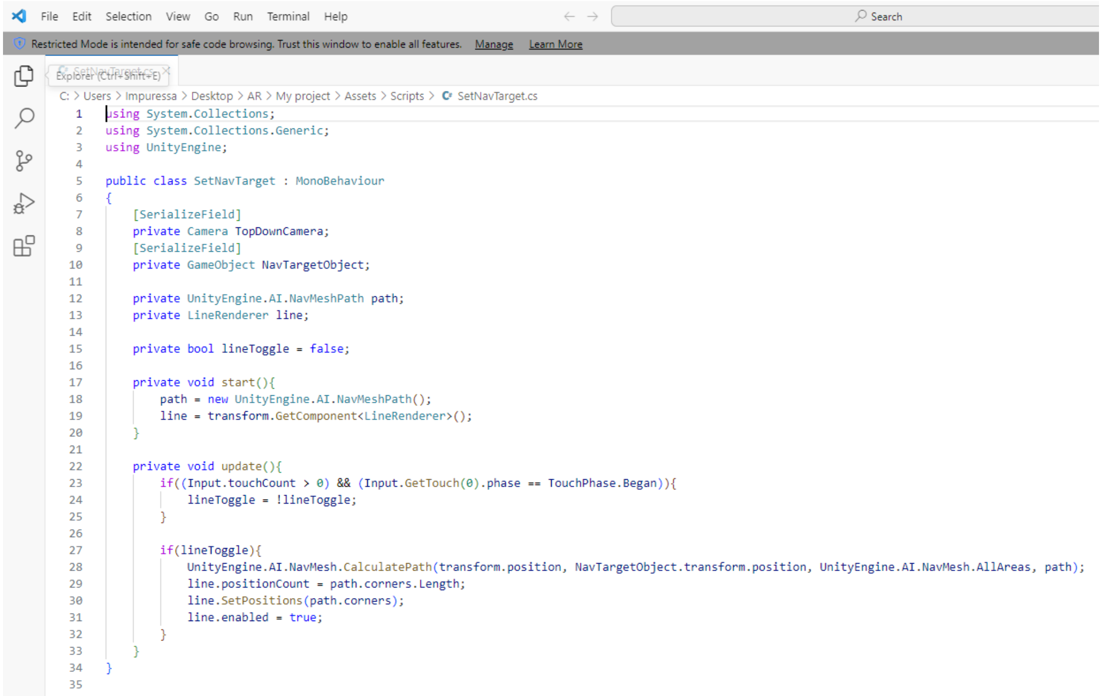
For the system to achieve success, first need to do some 3D design based on a rough sketch of the QB block plan in unity while making sure it was 1:1 with the real world as shown in Fig 4. A script named SetNavTarget is created to act as a unity component so TopDownCamera can act as minimap and IndicatorSphere which acts as use can be added. Fig. 5 and Fig. 6 show the setting of Unity.





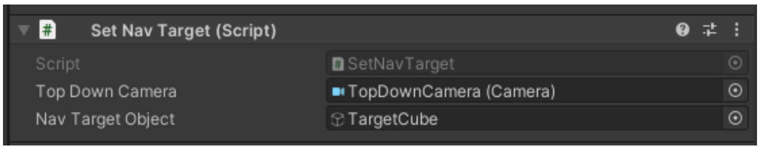
(a) (b)

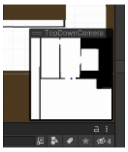
Fig. 4 *(a) rough sketch ground floor of QB block, (b) 1:1 scale.*




```csharp
using System.Collections;
using System.Collections.Generic;
using UnityEngine;

public class SetNavTarget : MonoBehaviour
{
    [SerializeField]
    private Camera TopDownCamera;
    [SerializeField]
    private GameObject NavTargetObject;

    private UnityEngine.AI.NavMeshPath path;
    private LineRenderer line;

    private bool lineToggle = false;

    private void start(){
        path = new UnityEngine.AI.NavMeshPath();
        line = transform.GetComponent<LineRenderer>();
    }

    private void update(){
        if((Input.touchCount > 0) && (Input.GetTouch(0).phase == TouchPhase.Began)){
            lineToggle = !lineToggle;
        }

        if(lineToggle){
            UnityEngine.AI.NavMesh.CalculatePath(transform.position, NavTargetObject.transform.position, UnityEngine.AI.NavMesh.AllAreas, path);
            line.positionCount = path.corners.Length;
            line.SetPositions(path.corners);
            line.enabled = true;
        }
    }
}
```

Fig. 5 *SetNavTarget script coded in C# language.*





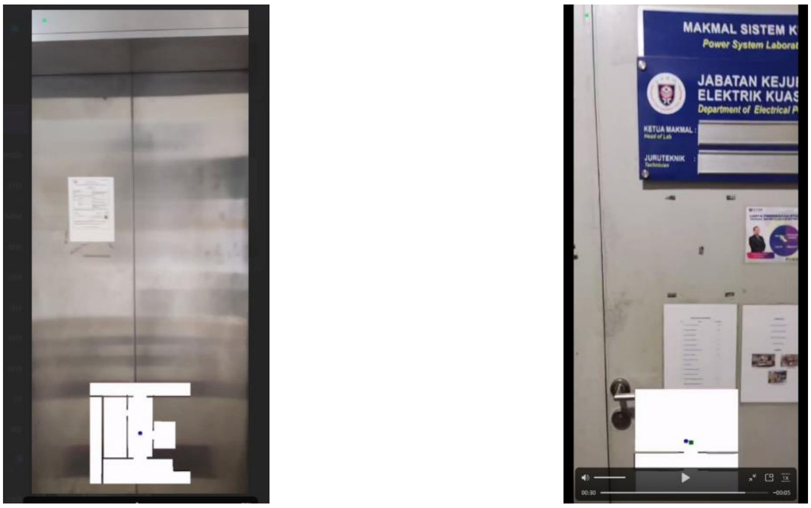
(a) (b)

Fig. 6 *(a) SetNavTarget acts as a component, (b) TopDownCamera working properly.*

3. Results and Discussion

Fig. 7 shows real-time tracking is functional 100% where IndicatorSphere was seen standing in front of the elevator. When approaching TargetCube, the minimap user is seen to be already inside Makmal Sistem Kuasa. Multiple tests were performed ten times to see its accuracy.

After testing the system ten times, the system accurately tracked user movement from the starting point to the endpoint seven times. The other three tests have shown moderately not accurate in tracking user movement when users are moving horizontally as shown in Table 1.



(a) (b)

Fig. 7 *(a) IndicatorSphere at front of the elevator, (b) IndicatorSphere seen to be inside Makmal Sistem Kuasa.*

Table 1 *The accuracy of movement.*

No of Testing	Accurate/Not Accurate
1	Accurate
2	Not Accurate
3	Not Accurate
4	Not Accurate
5	Accurate
6	Accurate
7	Accurate
8	Accurate
9	Accurate
10	Accurate

3.1 Evaluation

Nine students were willing to take part in testing and evaluating the system's accuracy, usability and reliability via questionnaire. Fig. 8 shows four students chose a scale of five highly accurate and the system is consistent without error. Then three students chose scale four as moderately accurate, the system mostly tracks movement but may have small inaccuracy. Lastly, 2 students are choosing moderately inaccurate based on their user experience, this shows that the system developed misidentified the location resulting in a navigation error.

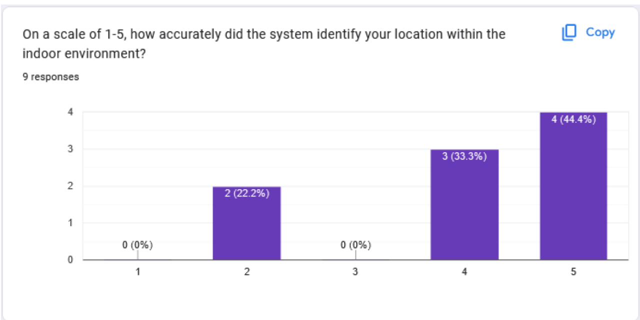


Fig. 8 *Surveys-related accuracy.*

Fig. 9 shows five out of nine students voted extremely easy to understand the AR interface. After that, three students choose moderate understanding. Lastly, only one student chose neutral and he/she had mixed experiences where the instructions were clear but led to confusion when using it.

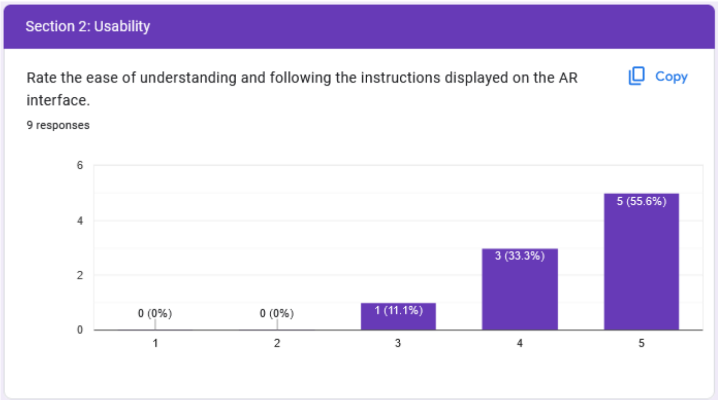


Fig. 9 *Surveys related to usability.*

Next, Fig. 10 shows five students voting no system lagged or delay in updating tracking movement. The next three students voted yes which indicates the system lagged or delayed. Lastly, only one student said that the system lagged and delayed when starting the system but not during testing

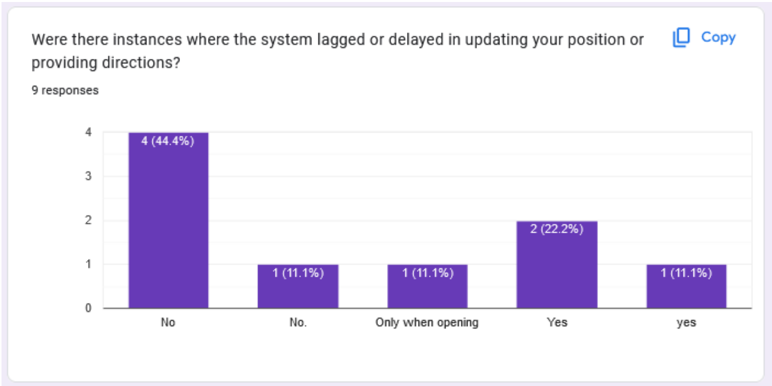


Fig. 10 *Surveys-related reliability.*

The questionnaire also managed to get additional feedback from all the students who participated as testers. All of the students praised that the real-time movement tracking is working well. They also suggested that the system should have a bigger minimap, adding guidelines to desired places, adding voice navigation and surrounding information as shown in Fig. 11.

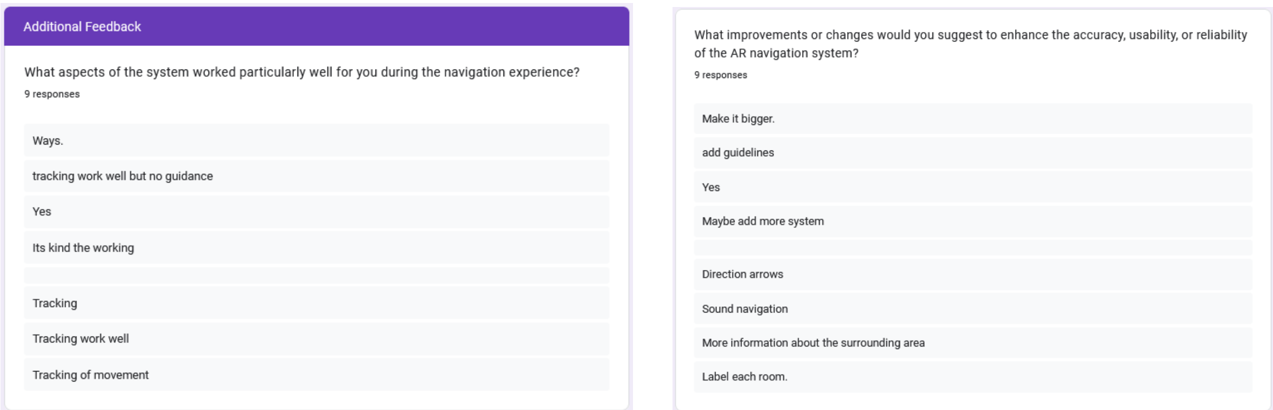


Fig. 11 *Additional feedback from respondents*.

4. Conclusion

This work is considered successful because all of the objectives accomplished which were to design mapping of QB block, to design an AR real-time movement tracking and to evaluate its accuracy, usability and reliability by conducting user testing and collecting feedback. The recommendation for future work is to incorporate cloud-based data processing and investigate ways to combine multiple sensors to enhance indoor positioning accuracy.

Acknowledgement

Evolution in Electrical and Electronic Engineering Vol. 5 No. 1 (2024) p. 358-363

The authors would like to thank the Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia for its great deal of support.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Mu'az Sufyyan;* ***data collection:*** *Mu'az Sufyyan;* ***analysis and interpretation of results:*** *Mu'az Sufyyan, Rafizah;* ***draft manuscript preparation:*** *Mu'az Sufyyan, Shamsul and Rafizah. All authors reviewed the results and approved the final version of the manuscript.*

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