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Tourism Guide Application for Heritage Sites in Surabaya Based on Augmented Reality and GPS Gamification

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***Abstract*—** One of the most important revenue streams for the nation's economy and development is tourism. The COVID-19 pandemic is, however, causing a reduction in tourism in Indonesia; Surabaya, the country's second-largest city, has seen a drop in visitors from 6.5 million to 500 thousand. To solve this problem, an innovation is required to boost the number of visitors to Indonesia's heritage sites who use contemporary technology, specifically smartphone with interactive media (with AR and GPS for instance). The author will develop an app that, depending on the user's location, will let them visit several Surabaya heritage sites and provide them with comprehensive details and instructions. Indonesia can stimulate its economy and return visitors to its heritage sites by employing this interactive gamification apps. However, on the examination to the user, we found a good implementation in detecting and measuring the nearest destination to the current user position, and how to parse into google map and guiding the destination to that heritage site. But we have some distraction when pointing the apps to the Augmented Reality (AR) marker on the site, since various historical places have various lighting, some devices are unable to take a clear picture of the marker due to its lack of lighting and abnormal size or form. Thus, it will be effective when the user points his smartphone camera to the AR marker, he/she supposed to use the smartphone lighting as well.

Keywords— Virtual Tourism Guide; Surabaya Tour; Heritage Sites; Immersive Game; Augmented Reality; Gamification.

I. INTRODUCTION

One of the biggest drivers of a nation's economy is tourism, which also has an impact on prosperity [1]. Regretfully, the COVID-19 epidemic is causing a decline in tourism in Indonesia [2]. The number of tourists to Surabaya, the second-largest city in Indonesia, is declining. While there were 6.5 million visits in 2019, there will only be 500 thousand by 2021. In order to solve this problem, tourism at Surabaya's heritage places needs to be reintroduced using new and enhanced technology.

Using interactive media that can pique people's interest is one way to revive tourism, we approach its media using the gamification concept. We believe with the gamification concept, the user will be increased on his/her engagement; gamification leverages the natural human desire for achievement, competition, and recognition. By incorporating elements such as missions and challenges, applications can make routine tasks more engaging and enjoyable. And other, for user's motivation, gamified elements can motivate users to continue using an application by providing immediate feedback and rewards. This can lead to increased frequency and duration of use, enhancing user retention of this apps.

However, the interactive media being discussed here is a self-tourist app that enables users to begin their journey with just a smartphone and its features: Augmented Reality (AR) and GPS. Here, AR is used to immerse the user with the site itself. We want the user fells like playing a game within his/her surrounding involved. Then**,** GPS is used to detect user's current position, means this game will navigate to the destinations based on his/her current location.

It is intended for the user to be able to use this app as a guide when visiting historical locations. The user of this app will be guided through Surabaya's top 5 heritage sites from the previous year [3]. Based on the user's present location, the GPS system will point them in the direction of the closest sites, and the augmented reality (AR) system will provide more detailed information about the site and its collections. In conclusion, within this game, we want to raise awareness of heritage sites' significance and stimulate public interest in visiting them.

II. RELATED WORKS AND LITERATURE REVIEW

A. Augmented Reality (AR)

Augmented Reality (AR) itself is a type of interactive media that combines the real and virtual worlds by projecting the virtual world into the actual world using a camera [6]. AR works by using an image processor in a camera to recognize an object's angle, corners, lines, and shapes. An AR camera will process the virtual object to be projected into the actual environment using the image and data captured by the camera.

AR itself has two detection methods: marker and markerless. Marker AR means that in order to display a virtual object, a real-world image must be used as the foundation. While markerless AR does not use a real-world image as a base for virtual objects, it does use a coordinate system to calculate the position of virtual objects in the real world.

Vuforia is one of the simplest and widely used AR technologies in app development, and we can utilize it in Unity

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as a tool for marker or markerless AR. When utilizing Vuforia as a developer, you merely need to upload an image to the Vuforia database and download the appropriate tools.

B. DiMadura

DiMadura is an AR and GPS game designed to educate Indonesians regarding the island of Madura's tourism industry [4]. Figure 1 illustrated some screenshot of DiMadura game.

DiMadura was developed utilizing the idea of gamification to entice users to download the applications and travel to some of Madura's tourist destinations [4]. There are a variety of minigames that may be played to earn points as you travel to your destination as part of the gamification features of the apps. While markerless AR is utilized to provide additional information, GPS is used to direct users to their destination.

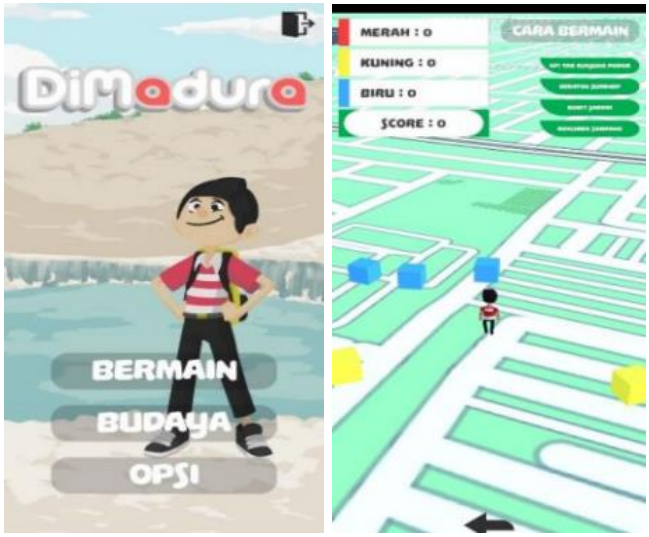

Figure1. DiMadura Main Menu and Gameplay

Due to the popularity of video games, children in Indonesia hardly ever play the traditional game of using sumput, also known as petak umpet. This classic game has to be updated utilizing augmented reality (AR) based on GPS in order to continue to exist [5].

Figure. 2. Ucing Sumput Main Menu and Gameplay

Figure 2 shows the outcome of this adaptation, that was a single-player game in which the user is positioned as the seeker and must find four virtual objects that the system has distributed and hidden. Since the location of the hidden virtual object has already been determined, only specific locations can be used to play the game. The mechanical game of this apps was a win-and-lose conditions are determined by the time; if the seeker finds every object before the time runs out, they win; if not, they lose.

C. Blackbox Testing

Blackbox testing where used as a method on this research is a technique for test the applications in which the tester is blind to the inner workings of the program but is nevertheless able to comprehend its input and anticipated output [7]. Verifying the application's input and output is the aim of blackbox testing, which aims to determine whether or not it functions as intended. Blackbox testing is often completed at the conclusion of the application's development phase or after each build [7].

III. RESEARCH METHODOLOGY

GPS is used by the smartphone to detect the user's current location based on the diagram shown in Figure 3.

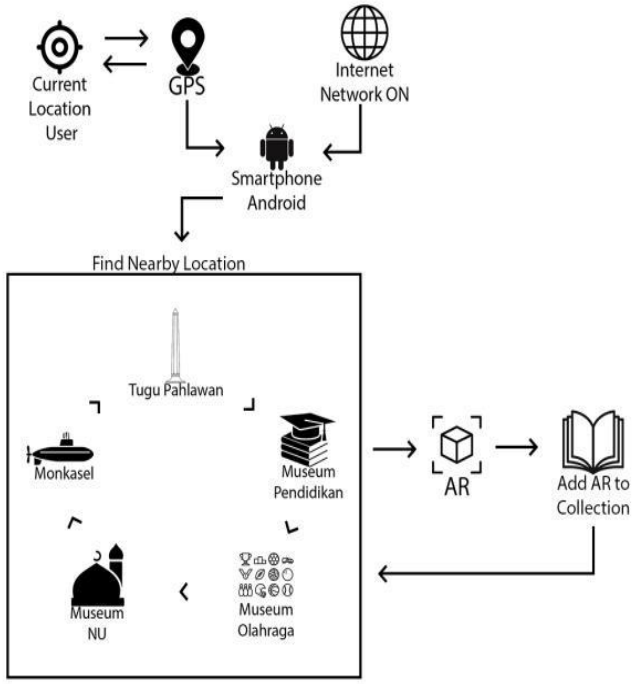

Figure. 3. Main Idea Diagram

The application will determine which location is closest to the user's current position by calculating the distance between the user and the destination based on the user's current location. The application will guide the user to the next location after determining which location is closest. Upon reaching a place, users can utilize the augmented reality function to gain additional knowledge about the area by gathering virtual objects that correspond to the destination's collection items. This assortment of objects might be seen at a later time and functioned as evidence that the user had visited the place.

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A. *User flow*

The user will be guided to the closest heritage sites based on their present location when they activate the application for the first time, as shown in Figure 4.

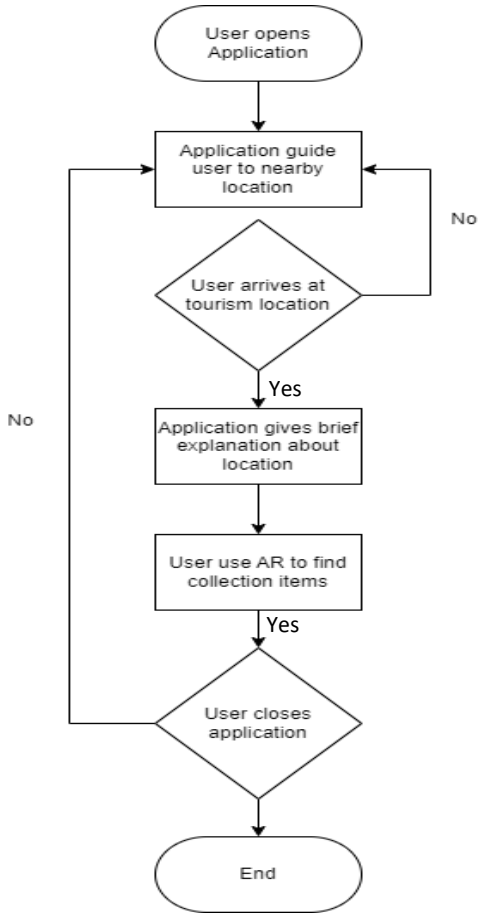

Figure. 4. Userflow Flowchart

As the user arrives at each spot, the software will provide a brief description to assist them comprehend the historical significance of the places they visit. Subsequently, the user will receive instructions to activate the augmented reality camera and begin collecting virtual objects to incorporate into the program's collection. Once the user has finished their tour or collected everything from this area, the application will direct them to the next adjacent heritage site.

B. *UI Design*

As the illustration flowchart on Figure 5, the first menu the user navigates to when the program loads are the GPS map, which displays a map with the user's current location, destination location, and distance to the place.

When the user reaches the target spot, a 3D representation of the region and its details will be displayed to them along with a brief description. The user will then navigate to the AR camera to begin accumulating objects, and when their time with it is up, they will return to the GPS map. There's also a collecting scenario that shows the things as markerless augmented reality and allows the user to see how many they have or haven't gotten.

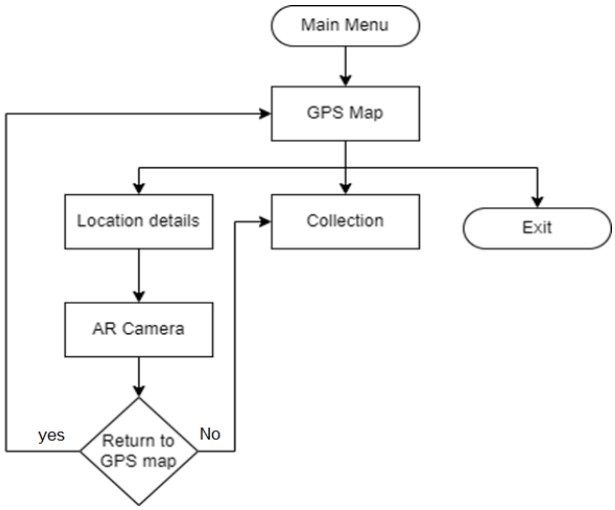

Figure. 5. Flowchart of User Interface.

IV. Result And Discussion

An application that will educate users about historical tourist destinations in Surabaya is the study's final product. This section will go over the project's current outcomes and the adjustments that should be made to its two primary components, GPS and AR.

A. *GPS Implementation*

Figure 6 illustrated the map for the application is using an API provided by Mapbox. Mapbox itself is a web that provide maps, ready for multiple usage including GPS function.

Figure. 6. Map Editing in Mapbox

To be able to use Mapbox in Unity, a package file is needed to be installed in the Unity. After doing this, the map itself can be customised by editing it in the Mapbox's site. Then the map also can be decorated with virtual object using coordinate location on the map.

The implemented map that may measure a user's location in relation to a target destination is shown in Figure 7. Drawing a straight line between the user and the desired place and measuring the distance along it is the technique used to measure distance in this case. This technique allows the program to determine which historical places are closest to the user's present location.

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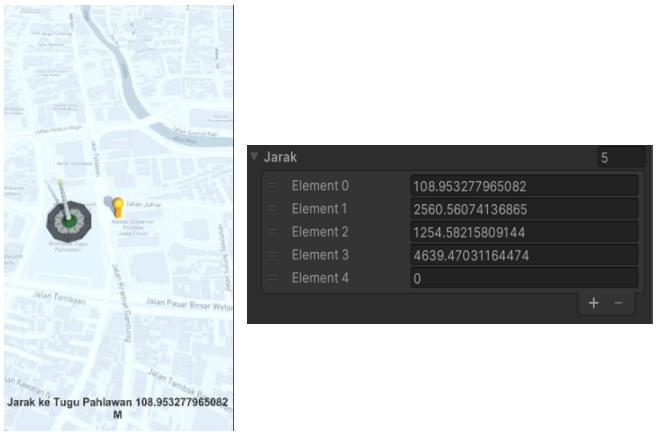

Figure. 7. GPS Map and Locations Distance

Figure 8 illustrates how drawing a straight line to measure distance helps determine which nearby locations users should visit first. However, as Figure 9 illustrates, the actual distance users must travel is not very accurate; although the application detects 108 meters, the actual distance users must travel is actually 230 meters measured from the same point.

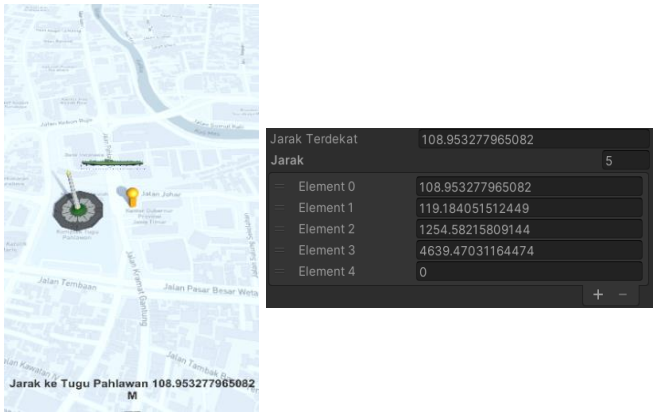

Figure. 8. Program Choose the First Option as the Closest

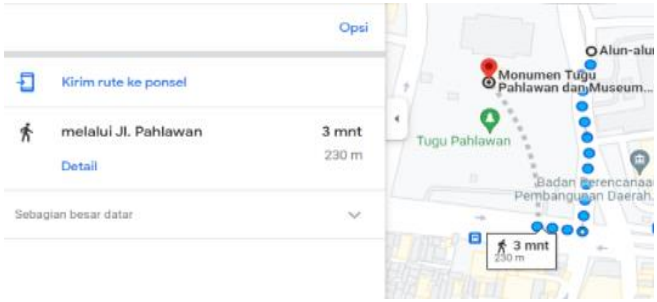

Figure. 9. Actual Distance Comparison

B. AR Implementation

For this project, AR is implemented utilizing an API that Vuforia Engine provides. Vuforia requires a license key and database in order to be used with Unity. Then, we require a reliable and relatable marker in order to employ AR. An identification or explanation card for each of the heritage sites' collection items is used to create a marker for this project. An example of its marker is illustrated on the Figure 10.

Figure 10. An Example of Marker Used in This Application

When creating an AR marker, the quality of the marker itself must be high, with sufficient illumination and clarity. This is because a low-quality marker will impede the AR camera's ability to detect motion, as seen in Figure 11.

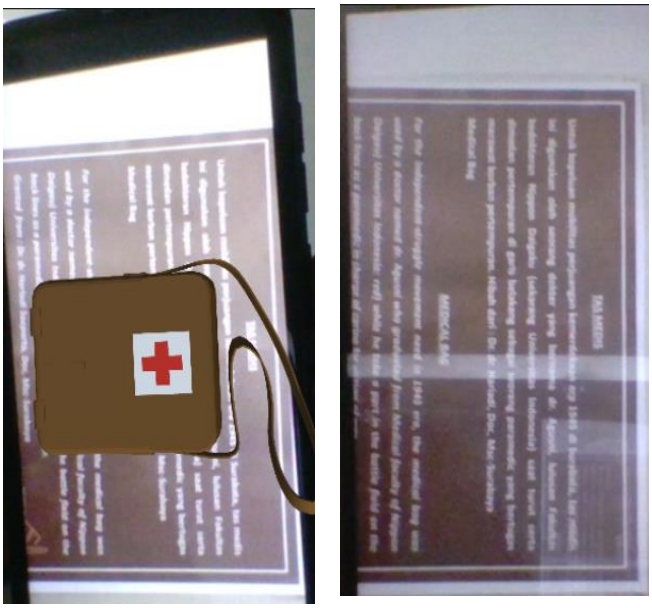

Figure. 11. Difference In Lighting In The Same Marker

The accompanying illustration shows the outcome of using a marker from one of the places. In bright light, the AR camera can see the marker more clearly than in low light. This example's lighting illustrates how reflections can reduce a marker's clarity. This makes it difficult for the AR camera to detect the marker's true shape, which is essential for integrating virtual items into the real environment. Because in order to display the virtual object, the AR camera needs to be able to recognize shape. It is crucial for the developer to ensure that the marker will function as intended in both bright and dark environments.

C. Some Important Application Scense

We begin by creating the application's GPS and AR features before integrating them to create a functional whole. The application's results for each scene are shown below.

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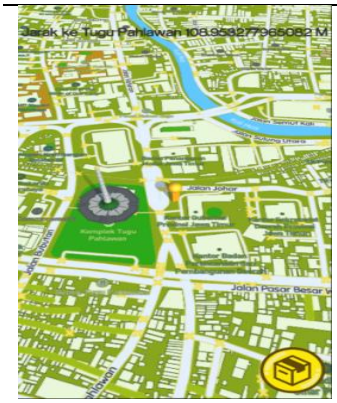
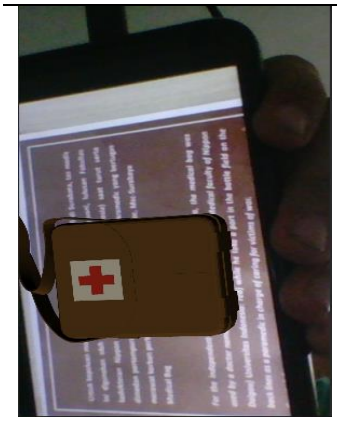
TABLE I
SOME SCENES PROVIDED IN THIS APPLICATION

Scene	Notes
	The user can traverse both their present location and the target point on the application's main GPS map, which also shows the distance between the user and the destination sites.
	Once the user has focused on the desired locations, they can get a succinct description of the heritage site to gain insight into the significance of the sites. After then, the user will be allowed to continue using the AR camera.
	The user can utilize the camera on their phone to look for collection objects that are strewn throughout the locations in this AR camera environment. This collection item is displayed utilizing augmented reality as a virtual 3D object.
	The user will be able to observe in the collection scene which objects from each heritage site they have collected and which they have not, with the colored objects being collected and the blacked ones being uncollected.
	The user will be able to access a menu that provides more information about the collection items once they have been collected.

D. Testing and Results

This section will cover the testing that was conducted on the completed application as well as the testing findings. Ten individuals, each with a distinct kind of smartphone, participate in this testing. This is intended to give information about the application's compatibility with various devices. As the pie diagram which illustrated on Figure 12, the application's functionality, including GPS, augmented reality, and button functionality, were tested to see if it performs as expected.

Figure. 12. Button Functionality Test

According to the statistics resulted which illustrated on Figure 13, every button in the program functions as planned on all testers' devices.

Figure. 13. GPS Functionality Test

Every tester who completes the GPS capability test is able to use the GPS function with the destination and user locations

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matching exactly. Additionally, as pie-diagram illustrated on the Figure 14, the application has no trouble figuring out how to get the user to the closest historical locations.

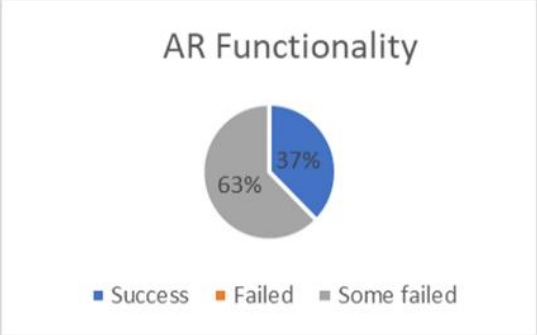

Figure. 14. AR Functionality Test

Because different heritage sites have different lighting, some devices are unable to take a clear picture of the marker, which causes the shape of the marker to become unclear and prevents the AR camera—which depends on each device's camera—from detecting it. This is evident from the AR functionality test, where most testers are having trouble detecting some of the markers.

V. CONCLUSION

Following the completion of the application's creation and testing for this project, there are a few key points to consider when creating an application for self-tourism that highlights the significance of historical locations. Mapbox and the Vuforia API are required to make the application to easily incorporate GPS and augmented reality features.

Certain AR markers are more difficult for certain devices to identify due to a lighting issue. Instead of measuring trip distance with a straight line, the GPS function needs to be improved to be able to determine the true distance a user has to travel.

Overall, the application's core features operate as planned and correctly, but further development is required to bring the program up to a more polished state and prepare it for business use.

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