

Design an augmented reality application for Android smart phones

Abdelmageid A. Ali¹, Nahla F. Omran² and Maha F. Esmail³

¹ Faculty of Computers and Information, Minia University, Minia, Egypt.

² Faculty of Computers and Information, South Valley University, Qena, Egypt.

³ Department of Mathematics, Faculty of Science, South valley University, Qena, Egypt,

Abstract

Augmented Reality (AR) is a generic term for associating interactive 2D, 3D objects that blends with our physical reality, sometimes through a camera during this case, with an associated Android device camera. By definition, augmented reality (AR) will be alive, whether directly or indirectly, and will be able to distinguish items in the actual world that have been enhanced by computer-generated sensory input like sound, visual images, or GPS data.. The “AR system” mobile application is constructed by taking photos and videos of a specific building among a University (as example) and making a presentation (by scanning all pictures). While a user focuses his/her Android device camera on a specific image of any building inside faculty, the information associated with that specific department is displayed, when “recognizing” that building from the archived photos.

This paper aims to developing an Android augmented reality application that will have the aptitude to point out university field connected information like libraries, schools, and courses offered from a specific department. All this information is offered by obtaining sensing element knowledge from your Android device camera and overlaying pictures in real-time. This application will also help University students to induce information concerning events, faculty, department, or explicit department connected courses with only a click on this application. This AR application uses Vuforia as a package platform and C# as a programming language that provides superior vision-based image recognition and offers the widest set of options and capabilities to enhance the University field guide for the scholars to induce to understand their University faster and easier. The appliance has been prototyped of a set of field buildings.

Keywords: Augmented Reality, Location-Based, Virtual Reality, Android Os system, Vuforia

1. Introduction

A new technology called augmented reality, which places an interactive 3D object model over the real world, may be experienced with the aid of the Oculus, not while using a camera [1]. The main benefit of adding this layer is to give the physical environment more significance by enabling the user to see, hear, smell, and feel the virtual 3D representations that are heavily incorporated into it [2]. These examples aren't all that far from what might already be available on your smartphone thanks to advancements in AR technology.

The first AR was known as a virtual light in 1994. It was William Gibson's book [3]. He mentioned that the virtual light that was created by Stephen Beck which describe a form of instrumentation that produces the optical sensation in the eye. The first AR application was used in military, industrial and medical applications. In 2012 the AR technology was used in entertainment and other commercial industries. In 2016 the smart mobiles used the AR technology in learning.

Modern AR technology makes use of tracking technologies such wireless sensors, accelerometers, GPS, gyroscopes, solid-state compasses, and optical sensors and/or other digital cameras. The virtual object will be produced in real-time within the real-world

environment using tracking technology. Interacting with virtual objects is another feature of AR. There are various techniques, including speech recognition.

In fact, augmented reality is, exists over there and used in very myriad ways, Snapshot lenses, apps that help you spot your car in a congested parking lot, and a range of shopping apps that let you try on clothing without ever leaving the comfort of your home.

The most well-known application of augmented reality is perhaps the mobile game "Pokémon Go," which was released in 2016 for free and shot to popularity. Pokémon characters that appear in the real world on your pathway during the game are found and captured by gamers. Games aside, there are many applications for augmented reality in daily life, such as (Pikachu on the go) in Pokémon GO.

This research aims to explore AR technology especially the location-based AR technology. This technology is used to generate the virtual object in the real world environmental real-time. This object can be an image or graphics, audio, video, and GPS data. Global positioning system (GPS) data is a commonly available feature in a mobile phone such as Android, GPS is a utility that provides user positioning, navigation, and timing services (PNT). In this research, the GPS is used to generate the virtual object in the real world environmental real-time.

1.1 Example of using AR:

1. In order to bring the past to life, augmented reality will be used in historical sites like Pompeii in European countries.
2. To speed up loading times, the ground crew at Singapore's airfield uses augmented reality (AR) glasses to get information on cargo containers. However, the most popular way to use augmented reality (AR) these days is on a smartphone, in the form of applications and games. The Equipment AR pictures are displayed on a variety of devices including eyeglasses and spectacles (remember Google Glass?), headsets, and heads-up displays like helmet visors.
3. Improved navigation systems overlay a route on a live map of the road using augmented reality.
4. During soccer matches, broadcasters use augmented reality to draw lines on the field and analyze moves.
5. IKEA, a retailer of furniture and home goods, has an augmented reality (AR) application called IKEA Place that lets you visualize how a piece of furniture can fit into your home and look.
6. Military fighter pilots can view their altitude, speed, and other information projected in augmented reality on their helmet visor without having to spend their attention by looking down.

1.2 Types of Augmented Reality AR

- **Marker-based AR** as shown in figure 1 image recognition is used to identify objects that are preprogrammed into your AR device or application. Fiduciary markers make it easier for the AR device to confirm the location and orientation (referred to as pose) of its camera by placing something within the field of reading that may be utilized as a point of reference.



Figure 1. AR-Marker-QR-code Marker

This is how it goes: To expedite processing, the camera feed is first converted to grayscale. The device checks the information from the marker with all the markers stored in its memory when a marker, typically something basic yet distinctive like a QR code, is identified. Once a match is made, it uses the data from the marker to mathematically specify the stance before displaying the AR image in the exact appropriate spot Think about the example below:

The Franklin Institute museum is where you are. You might be able to instantly see more information about the artefact you're viewing by pointing your phone's camera at a marking on the associated data plaque. [4-8]

Marker-less augmented reality: One of the most often used applications in the sector is marker-less augmented reality. It is referred to as Location-based AR and has features that are readily available in tools that offer location recognition. Because it doesn't require a picture to operate, this sort of AR is more versatile than marker-based AR. The virtual object, which is a structure, depends more on the positional data gathered from a device's camera, GPS, digital compass, and accelerometer. created by something called SLAM (Simultaneous Localization and Mapping) that takes the camera feed and creates a triangular network from the environment. So the program remembers the environment as a 3D model. Hence, when a virtual object is placed in the environment, it is placed in a 3D model. So, even if the camera loses its sight when placed again, the virtual object will still be in the same location as figure 2 shows.



Figure 2. Markerless AR

As an example, let's use the best smartphone game, Pokémon Go. The hugely popular game analyses your whereabouts using GPS, then makes decisions anytime and anywhere that seems to have Pokémon characters by using your geographic knowledge and phone time. For instance, you might spot an animal that like the water if you were strolling by a river during the day. If you go out at night, you can encounter fairies or various forms of nightlife. Before using the camera to overlay a picture of Pikachu or Jiggly puff over the real world, the sport utilizes the phone's GPS, accelerometer, and compass to get itself aligned [4–7].

Projection augmented reality Figure 3 shows the illumination on a surface is projected in projection augmented reality. This AR is appealing and interactive since it projects light onto a surface, allowing users to engage by touching it with their hands. Without slow gadgets that restrict face-to-face engagement, users can interact with virtual objects [4–7].



Figure 3. Projection augmented reality

Superimposition-based augmented reality Superimposition-based augmented reality offers a standby image of a certain object. This is accomplished by exchanging the entire or a portion of the view for an enhanced perspective of the object. When merging an object view with an augmented view, object detection plays a crucial role. For instance, the IKEA catalogue application uses overlay augmented reality to let customers place the catalog's virtual furniture in their own homes, as shown in figure 4[4].



Figure 4. IKEA catalog application

1.3 Virtual Reality vs augmented reality

In contrast to virtual reality (VR), which simulates the real world, augmented reality (AR) enhances the vision by adding a computer-generated item that can move or remain static. The objects are identified with the use of various image processing methods, and relevant data is interactively contributed. It's similar to looking through a camera's viewfinder. Still, instead of only seeing basic lines and photographic information, you'll also be able to see a map facing the road you're on and get instructions to the closest restaurant. Or perhaps you'll be prepared to spot the book you just ordered from the catalog on the shelf. [Augmented Reality]

Since VR doesn't employ a real-time camera, it is the fundamental difference between the two technologies. Figure 5 illustrates a crucial comparison between AR and VR. All of the items seen in VR are either animations or recorded videos.



Figure 5. AR VS VR

In an AR system, 3D items are bound together by a computer programme in the actual world, creating an incredibly realistic representation that could influence how information is displayed in future user interfaces. [5, 6]

The Android platform's location-based augmented reality (AR) technology is used by the application in this article, Compass's AR Map, to provide students with a wealth of information about their faculty.

1.4 The Global Positioning System (GPS)

GPS is a utility that delivers the user's positioning, navigation, and time serving (PNT). The user segment, the control segment, and the space segment are the three main components of GPS. The space segment and the control segment in the GPS are developed, maintained and operated by US Air Force. The space segment has information about the constellation of 24 operating satellites. These satellites transmit one-way signal the current GPS position and time. The control segment will monitor the worldwide and control the stations that maintain the satellites. This control segment also tracks the GPS satellite, uploads the updates of the navigational data, and maintained the health of the status of the satellite constellation. The user segment is a GPS receiver that receives the signal from the GPS satellites and computes the user's three-dimensional position and time using the transmitted data. The American government has deployed a number of publicly accessible GPS augmentation systems to satisfy certain objectives. More information about GPS can be accessed in this link [9].

2. Related Works

In the contemporary world, technologies are disseminated swiftly, and augmented reality is no exception. Today, the majority of augmented reality systems operate on android platforms since they are easier and more affordable to develop for. Numerous augmented reality applications developed by various classes using Android introduce various methodologies and constraints.

Table 1. Existing current ARMap projects

<i>N</i>	<i>Title of Project</i>	<i>Advantages/Features</i>	<i>Tools used</i>
2	Development of Anchoring Support System Using AR Toolkit [11].	-Assist the inexperienced pilot with accurate anchoring	The 3Dmodel,webcamera,ARtoolkit
1	Based on AR and GPS, a mobile campus tour system [10].	- Learn about the complexity of the campus setting and outdoor cultural activities	Eclipse platform, Wikitude Android SDK, MySQL
4	A Tour Guiding System Of Historical Relics Based On Augmented Reality [13].	Enhancing traveler's experience of authenticity while improving learning motivation and guiding systems - Experience augmented reality by	Mobile phones, GPS, camera, MAGIC EYES
3	Implementation of Augmented Reality System for Smartphone Advertisements [12].	Reserving system	Vuforia SDK, MySQL, Unity
6	Drone-Based Augmented Reality Application for Cultural Heritage Based on Geolocation [15].	-Use drones to reconstruct historic structures without human labor -Drone orientation and rotation aid in tracking	Drone, Unity3D
5	Kudan SDK-Based Location-Based Augmented Reality Game [14].	-monster's location GPS data giver --If a monster is nearby, the user receives a notification.	Unity3D, Kudan SDK ,Android, GPS

3. Methodology

For this method, the AR system is implemented using a marker-based method. The block diagram for the AR system has one input and one output, as seen in figure 6. The smartphone will serve as the input. The process' result, the software, is depicted in figure 7's detailed block diagram.

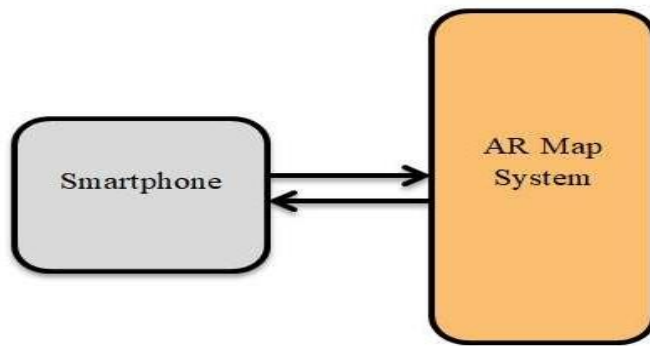


Figure 6. AR Map Block diagram of the.

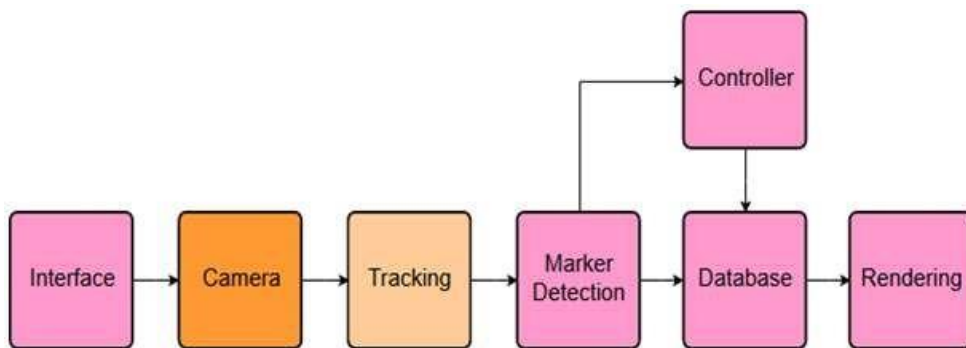


Figure 7. AR Map System(Detailed Map System Block diagram)

1. When you begin your application, first the camera will be on, then
2. It starts to concentrate on the required object or a picture
3. Then it identifies the object that it tracked from the camera.
4. Then this image is compared with the stored database; the database is either stored within a local device or in a cloud database (In our application this is often achieved by Vuforia device database, where we store images on to Vuforia database and then transfer it to our native device).

5. During the comparison stage, if the image matches with one of the images stored in the database then the related information will be displayed on your android device

The user will begin input to the smartphone's augmented reality system based on the detailed block diagram, and the augmented reality map will output results to the user. The user's engagement, in which the user clicks on the AR system, will provide as input to the AR Map. The output of the AR system will be the outcome that the user desires. A specific number of applications, devices, and peripherals are required to build the system:

Android phones, AR Core, Unity, Vuforia, Blender, 3D models, databases, and the C# programming language.

The use of Blender, Unity, and Vuforia is crucial since these programs serve as the basic building blocks for the AR Map system [15, 16]. The flowchart for the AR Map will be shown in figures 8 through figure 13. We'll go into great depth about the procedure.

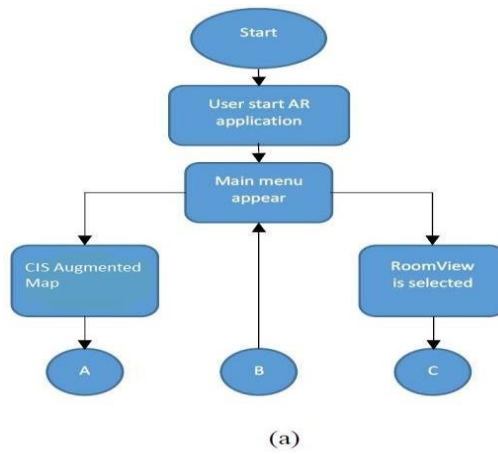


Figure 8. Flowchart for AR application main menu

After the introduction trademarks (Unity, Vuforia, etc.) are displayed, the user will be taken to the main menu from figure 8. The user will have two options in the main menu, one of which is "CIS Augmented Map" and the other is "Room View."

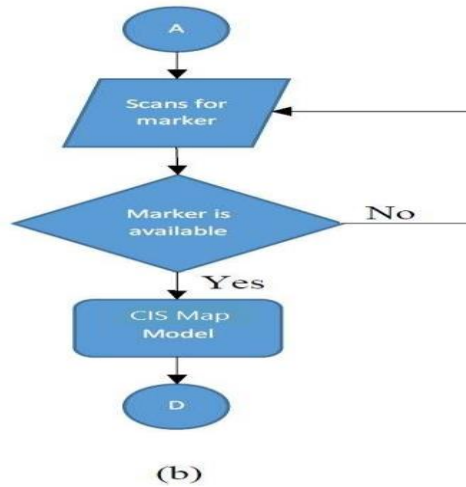


Figure 9. Flowchart for CIS Augmented Map

If the user chooses "CIS Augmented Map," they will be invited to scan the marker in order to view the "CIS Map Model," as indicated in the process flow in figure 9. If the marker is not present, the application will keep looking for it until it is discovered or until the user is prompted to depart immediately.

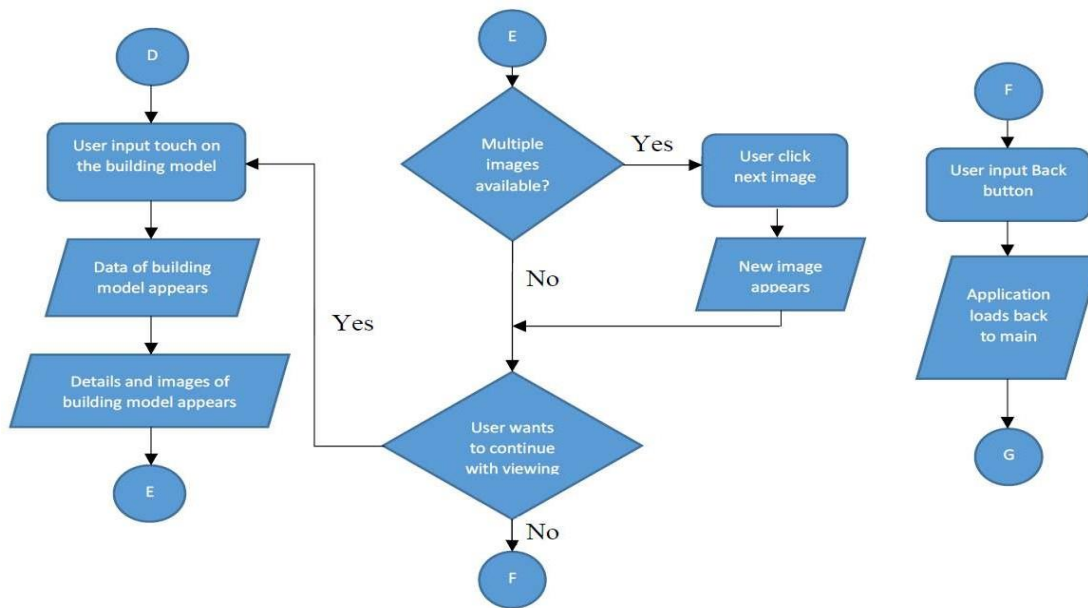
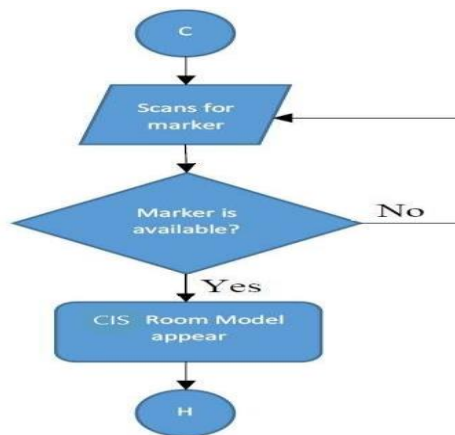


Figure 10. Flowchart for when user selects the CIS Augmented Map

The user will be able to move the map model and view them depending on the model's structure once it emerges. Based on the database for each building, data has already been entered into the model. When a building is chosen, the database will reveal the building's details on the side. Users will be able to view the photographs in the database. If the user chooses not to view the model after finishing viewing it, they can return to the main menu by pressing the "Back" button.



(d)

Figure 11. Flowchart for the Room View

The user can select "Room Display" in addition to "CIS Augmented Map" to view the room model in CIS. Similar to figure 9, the user will be asked to scan the marker before it displays the "Room View" as stated in the process flow in figure 11. If the marker is not there, the application will keep looking for it until it appears, at which point it will ask the user if they want to depart immediately.

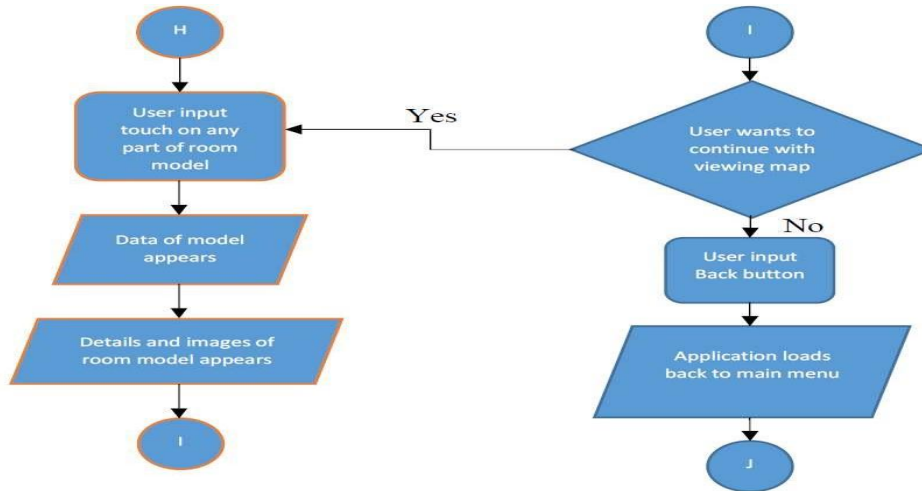


Figure 12. Flowchart for when the Room View is selected

The user will be able to move the map model and view them depending on the model's structure once it emerges. The database where the specifics of the room segment can be viewed is also included in the room model. The database will reveal information about the chosen room portion when an area of the room is selected. Users will be able to view the photographs in the database. If the user chooses not to view the model after finishing viewing it, they can return to the main menu by pressing the Back button.

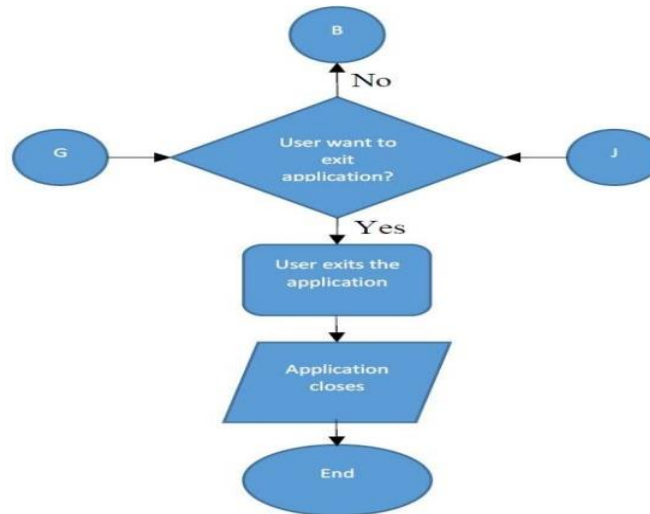


Figure 13. Exiting the AR Map

The user can close the application when they exit it just like they would with other applications. The process flow will return to that of figure 8 if they choose to use the AR Map to continue using the program.

4. Design and development

Due to the availability of AR Core programs that can be interfaced through Android and Windows, Android smartphones are frequently utilized in this technique as a testing tool

for AR systems. Google's SDK, AR Core, enables the development of AR applications using a variety of APIs. A virtual 3D object is designed using a game engine like Unity. Additionally, with the help of appropriate library components, Unity is also utilized to build augmented reality simulations. Applications for AR maps can also be made with Vuforia [18]. Image Targets are employed since it has the advantage that is used in this application. After that, a 3D model for this application is made using Blender. The Campus Computer and Information System (CIS) of "ARMAP Minia University "Main Campus is the location selected for this technique, and a 3D model is made to replicate the map of that location. Users can view a detailed map of CIS through the 3D model and, if necessary, learn associated information. The database has a list of the specifics. The XML database utilized for this technology makes it possible to simplify data availability and exchange. Additionally, the AR system's interactivity is made possible using the C# programming language..

5.1 Modeling

The 3D model is made specifically for the AR Map system to display the CIS map at its full scale. Models are based on the existing CIS structures. In order to generate a complete model, Blender uses combinations of many forms and little models. A plane is put to the map as the primary ground in order to construct the model. The buildings that can be constructed are then determined by the addition of various block forms. Additionally, models with roads, fields, fences, and trees are incorporated. Following the insertion of block forms, the length is then adjusted to reflect the scale size of

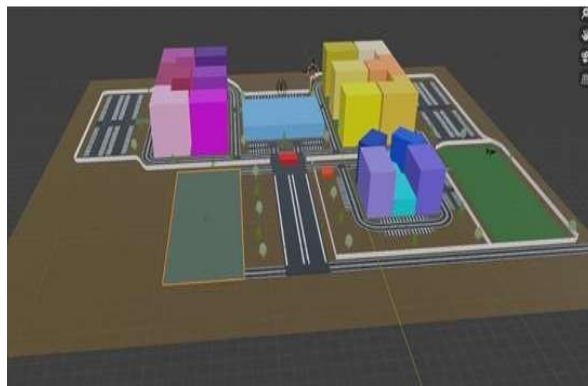


Figure 14. The complete model used in AR Map.

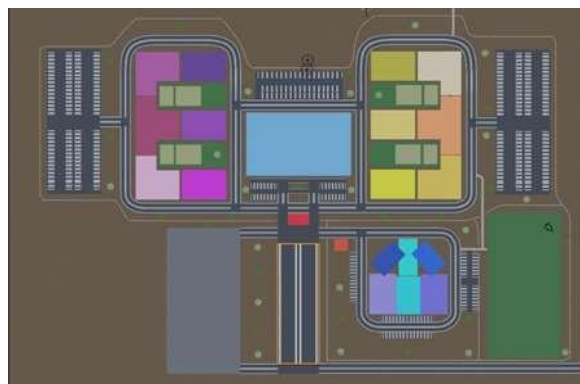


Figure 15. Exiting the AR Map h(Top View)

Structures in PFI 2. Colors are applied to the structures to enhance discretion and to show that each CIS building is unique. After 3D model creation is complete, the model is exported as an

FBX file so that Unity may import it. As seen in figure 15, scenes can be added to the model by importing the FBX file into Unity.

5.2 Image target design (marker)

The model's image target or marker is added using the Vuforia engine, as seen in figure 16. The image marker is made to look like the image when viewed through the smartphone's camera [4]. The Vuforia engine will identify and track the features detected in the image based on figures 17 and 18 by comparing the database that was set using Unity. As long as the targeted image is at least partially visible to the camera, it is tracked. The user may be held in a good manner, allowing a full view of the model, or an acceptable manner, allowing a partial view of the model. This indicates that some parts of the model may appear depending on the scanned parts of the marker. The recognition of a marker depends on its position, scale, and rotation because the model is mobile depending on the user's point of view. Star ratings are assigned to image targets. More accurate tracking and easy detection are associated with higher star ratings. Vuforia will choose the image that is rated. The completion of the rating determines the completeness of the database. For the purpose of building the database, an image marker is created for the target and added. The figure 18 shows the downloading and importation of the database into Unity.

Add Target

Type:

Single Image Cuboid Cylinder 3D Object

File:

Choose File Browse...

.jpg or .png (max file 2mb)

Width:

Enter the width of your target in scene units. The size of the target should be on the same scale as your augmented virtual content. Vuforia uses meters as the default unit scale. The target's height will be calculated when you upload your image.

Name:

Name must be unique to a database. When a target is detected in your application, this will be reported in the API.

Cancel Add

Figure 16. Add a target and choose its type on the Vuforia Development page.

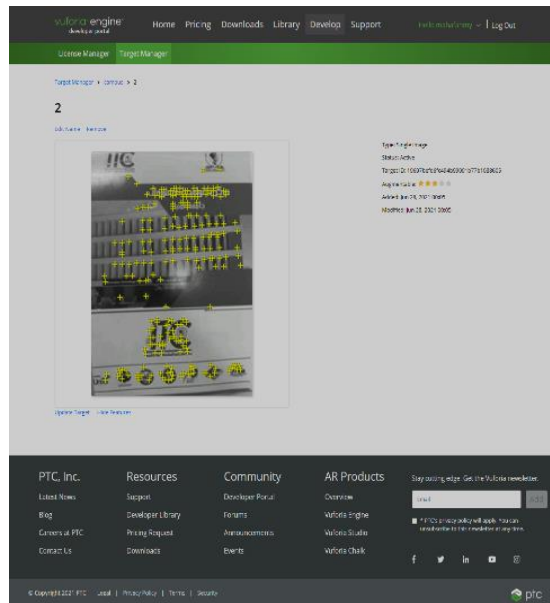


Figure 17. Image target rating and detection point.

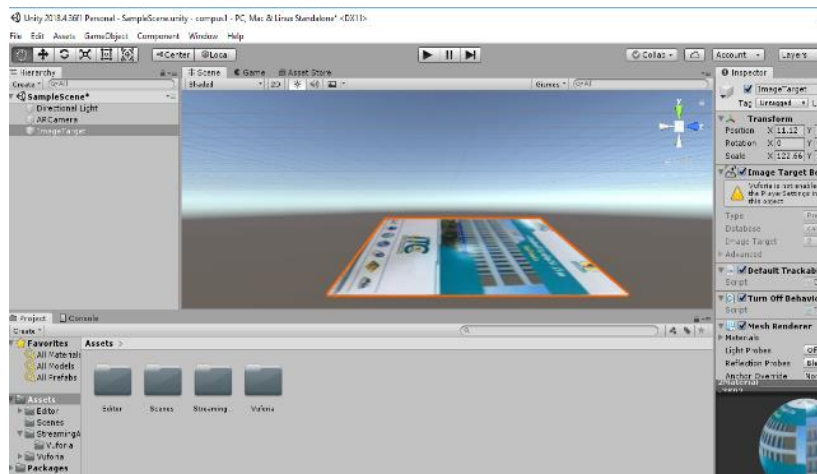


Figure 18. New database in inspector

5.3 Programing

Building and location-specific information from CIS is stored in an XML database. Referring to figure 19, header encoding is added with tags and details for the buildings' details, which are represented by the 3D Model that was previously built. In order to leverage the Unity engine and enable interactivity in the AR Map system, C# programming codes and scripts are produced using a text editor and added.

```

<?xml version="1.0" encoding="utf-8" standalone="yes"?>
<InventoryItems>
  <InventoryItems ID="Menage floor" Type="None">
    <ItemTitle>"Menagement Floor" </ItemTitle>
    <ItemDesc> contains the deen and vice deen offices and you can get all formal signatures from </ItemDesc>
    <image> first door </image>
  </InventoryItems>
  <InventoryItems ID="Lecture halls Floor" Type="None">
    <ItemTitle>"Lecture halls Floor" </ItemTitle>
    <ItemDesc> contains Lecture halls and staff rooms </ItemDesc>
    <image> Lecture halls Floor</image>
  </InventoryItems>
  <InventoryItems ID="Labs floor" Type="None">
    <ItemTitle>"Labs floor" </ItemTitle>
    <ItemDesc> contains the Labs floor and you can get all information about your department from security office </ItemDesc>
    <image> Labs Floor </image>
  </InventoryItems>
  <InventoryItems ID="Activities Floor" Type="None">
    <ItemTitle>"Activities Floor" </ItemTitle>
    <ItemDesc> you can Know about sintefic Jurnies from activities office </ItemDesc>
    <image> Activities Floor </image>
  </InventoryItems>
</InventoryItems>

```

Figure 19. The XML Database.

5. Result and discussion

The user will have two options when they first launch the AR application: Room View or CIS Augmented Map. As seen in picture 21, the user must scan the marker. Users can scan markers in one of two ways: directly from a screen monitor or by scanning them while they are on paper. Figure 22 displays the once-scanning interface option.

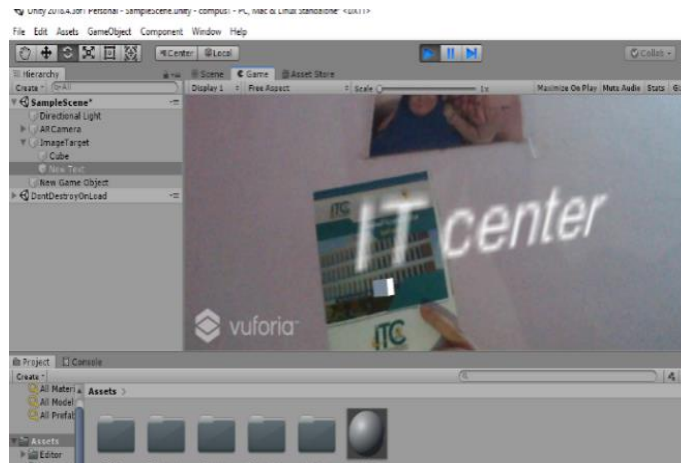


Figure 20. Image target rating and detection point.



Figure21.First GUI for the application



Figure22.second GUI for the application



Figure23.when detecting the photo it will display a fundamental video about faculty

We can alter the virtual object's color and display the information box on the screen when the virtual object is clicked by using the C# code as the backend to gather data and respond to user input. XML Database is used to reduce load time because it only has to retrieve data from the XML database and display it on a single information box rather than constructing an information box for each virtual object.

To determine the impact of virtual objects appearing in actual environment scenarios, verification based on user testing will be required prior to the implementation of the AR application. This is because real-life circumstances are uncertain and the actual environment is different from the one depicted in the picture marker. Several images based on various

calculations and angles are utilized in the technique's testing to address this issue. Twenty users participated in the testing process, and they were asked to complete a survey by responding to questions about the application's functionality and user experience. Participants in the survey are required to complete a satisfaction scale that ranges from 1 to 5, with 5 being the highest score, for each survey criterion that has been developed. There are two components to the survey. Demographic data about users and the effectiveness of the AR application are included in the sections.

Table 2: Analysis based on user testing AR application surveys

	Study Criteria	Percentage Based on Satisfaction				
		1	2	3	4	5
1	The AR application is simple to use for beginners.	0%	0%	10%	50%	40%
2	The AR application's instructions are simple to follow, making it simple to utilize.	0%	0%	0%	50%	50%
3	The use of AR is incredibly creative and new.	0%	0%	20%	30%	50%
4	Through its use, this application has fostered a sense of community among its users.	0%	10%	20%	40%	30%
5	Information that is difficult to locate can be easily found	5%	5%	15%	50%	25%
6	The AR application is difficult to use.	0%	5%	5%	5%	80%
7	I will recommend others to use the AR-application	0%	5%	10%	55%	30%
8	Application effectively helped decision-making while using a mobile device.	5%	5%	10%	20%	60%

The majority of users are satisfied with the AR application's ability to assist them in making decisions while using their mobile devices, according to a poll done to determine user happiness with the app. Since the application includes instructions for new users, the majority of users are happy with the user interface. Only two criteria—"Information that is hard to obtain can be gained readily" and "Application effectively assisted in making judgments when on mobile"—had a satisfaction rating of "1".

6. Conclusion

With the help of the Internet, everyone can access a plethora of knowledge. It would be beneficial in our method to have the AR Map created by a respected business. This is due to the fact that AR Map has been shown to be able to simplify users' lives and, as a result, reduce the tension that is produced in them because they do not have to deal with issues that visitors and students to universities have in the past. Additionally, as there is no waste of non-renewable materials, AR Map has been demonstrated to be environmentally benign. The goal has been accomplished by utilizing programming like XML and C#, as well as Blender, Unity, Vuforia, and AR Core. Throughout the procedure, a number of problems were discovered while creating the AR Map. Integrating unity objects with XML data is one of the main problems. We can test and rerun the program to ensure that it functions as intended after the problem has been fixed. There is still more that can be added now that this strategy has been successful. One of them will be the introduction of navigation. As of right now, the CIS Residential area is where we make the majority of our AR Maps, which will primarily be used by CIS students. In the future, we expect that the software can be enhanced with more features to increase utilization by CIS students, professors, guests, and other AR MAP enthusiasts.

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