Ain Shams University
Faculty of Computer & Information Sciences
Scientific Department

TU7FA

Augmented Reality For Marketing

June 2019

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This documentation submitted as required for
the degree of bachelors in Computer and Information Sciences.

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June 2019

Acknowledgements

For ending of our tertiary level and completion of this documentation on our Graduation Project TU&FA_AR Application All praise and thanks to ALLAH, who provided me the ability to complete this work. we hope to accept this work from us.

And this work can not be completed without the great effort and cooperation from our team and all help we found from doctors.

So we would like to offer our sincerest gratitude to our supervisors, *Dr. Mariam El-Berry support, motivating and help at all the times with her patience, experience and understanding.*

We also want to thank our teacher assistant for helping us during all our project phases T.A/Doaa Ezzat who supported us throughout this with her patience, knowledge and experience.

We are grateful for *our parents* and *our family* who are always providing help and support throughout the whole years of study, we hope we can make them proud of us, we would thank our friends for these very special moments and for these times which make our years of study great memories we cannot forget.

Finally, We thank everyone who gave us help, support and encouragement.

Abstract

Augmented Reality (AR) is the combination of virtual objects (3D computer models) overlay on of real-world scene, provides real time integration of digital content with the information available in real world. AR enables direct access to implicit information attached with context in real time. AR enhances our perception of real world by enriching
what we see, feel, and hear in the real environment.

Applications of Augmented Reality can be ranged from advertising, edutainment, education, engineering, medicine to industrial manufacturing
In basic applications, like in advertisement or games, users only see the actions or interact with part of the screen designed for initiate some actions. In order to make users have realistic experiences, Since Virtual objects can have their own dimensions, volumes or weights, virtual objects in Augmented Reality must be restricted to the law of Physics.

Our application is marker based augmented reality offline application using AR in advertising and marketing uses Vuforia augmented reality SDK and it is compatible with android smartphone.
TU7FA application lets you virtually place any of our accessories in your place, includes 3D models of table lamps, wall lamps, ceiling lamps.
TU7FA gives you accurate impression of the accessories and full control to scale, Rotate and overview for chosen piece. you can stop wasting your time and start use TU7FA.
Just hold your smartphone open TU7FA application, Search the list of available products and select one, Scan the image target to place the product there and rotate, scale and change the product as you want.

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Chapter One

Introduction

1.1 Problem Definition

1.1.1 What is AR?

Augmented Reality (AR) as a real-time direct or indirect view of a physical real-world environment that has been enhanced / augmented by adding virtual computer-generated information to it. AR is both interactive and registered in 3D as well as combines real and virtual objects, AR is comprehensive information technology which combines digital image processing, computer graphics, artificial intelligence, multimedia technology and other areas.

Simply, augmented reality (AR) uses computer-aided graphics to add an additional layer of information to aid understanding and/or interaction with the physical world around you.
Augmented Reality aims at simplifying the user’s life by bringing virtual information not only to his immediate surroundings, but also to any indirect view of the real-world environment, such as live-video stream. AR enhances the user’s perception of and interaction with the real world. While Virtual Reality (VR) technology, or Virtual Environment as called by Milgram, completely immerses users in a synthetic world without seeing the real world, AR technology augments the sense of reality by superimposing virtual objects and cues upon the real world in real time.

1.1.2History

The first appearance of Augmented Reality (AR) dates back to the 1950s when Morton Heilig, a cinematographer, thought of cinema is an activity that would have the ability to draw the viewer into the onscreen activity by taking in all the senses in an effective manner.

In 1962, Heilig built a prototype of his vision, which he described in 1955 in “The Cinema
of the Future”, named Sensorama, which predated digital computing.

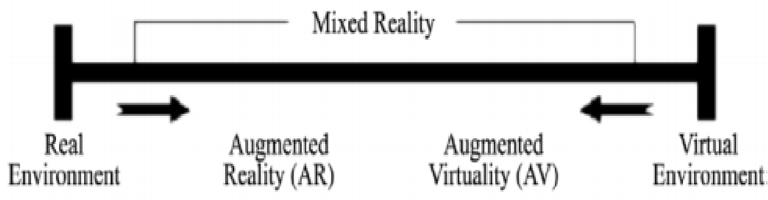

Figure.1 Milgram’s Reality Virtuality Continuum

Next, AR makes its real debut many years later – in 1968. The computer scientist Ivan Sutherland developed the first ever VR and AR head-mounted display (HMD) system, called “The Sword of Damocles”. It used computer-generated graphics to show users simple wireframe drawings.
Six years later, in 1974, computer artist Myron Krueger established an “artificial reality” laboratory called “Videoplace”. It combined projectors, video cameras, and special purpose hardware that emitted onscreen silhouettes, surrounding the users in an interactive environment.
They also started discussing the advantages of Augmented Reality versus Virtual Reality (VR), such as requiring less power since fewer pixels are needed. In the same year, L.B Rosenberg developed one of the first functioning AR systems, called Virtual Fixtures and demonstrated its benefit on human performance while Steven Feiner, Blair MacIntyre and Doree Seligmann presented the first major paper on an AR system prototype named KARMA. The reality virtuality continuum seen is not defined until 1994 by Paul Milgram and Fumio Kishino as a continuum that spans from the real environment to the virtual environment. AR and AV are located somewhere in between with AR being closer to the real-world environment and AV being closer to the virtual environment. In 1997, Ronald Azuma writes the first survey in AR providing a widely acknowledged definition of AR by identifying it as combining real and virtual environment while being both registered in 3D and interactive in real time. The first outdoor mobile AR game, ARQuake, is developed by Bruce Thomas in 2000 and demonstrated during the International Symposium on

Wearable Computers. In 2005, the Horizon Report predicts that AR technologies will emerge more fully within the next four to five years; and, as to confirm that prediction, camera systems that can analyze physical environments in real time and relate positions between objects and environment are developed the same year.

This type of camera system has become the basis to integrate virtual objects with reality in AR systems. In the following years, more and more AR applications are developed especially with mobile applications, such as Wikitude AR Travel Guide launched in 2008, but also with the development of medical applications in 2007. Nowadays, with the new advances in technology, an increasing amount of AR systems and applications are produced, Research on augmented reality has been done for more than a decade.

Only in the past few years, due to the advancement of the technology especially in hardware like smartphones and tablet, make it possible for real applications. Applications like navigation, edutainment, audiovisual aids, museums, medical, industry and advertising are among the most popular applications. For some applications in the area of medical and engineering that needs realistic interactions between virtual objects or between user and virtual objects, there still need more research. In the field of manufacturing, augmented reality has been used for supporting assembly process for many years.

1.1.3 Applications

According to a Statistic forecast, the market of augmented and virtual reality is expected to reach the size of $215 billion in 2022

1.JigSpace

JigSpace supplies a variety of educational augmented reality animations, exploring the functionality of everything from car engines to locks. You can tour the solar system on your table top, with captions and explanations to guide your understanding.

Figure.2 JigSpace

2.Snapchat

Snapchat isn’t having a great time. While it’s the #3 app on the iOS App Store, it also has two out of five stars. This is thanks to a despised redesign, which mangled user feeds to jam promoted content in their faces. However, the app is still one of the most popular photo-based social networks currently running. Snapchat’s AR features are incredibly effective, and things like the dog filter and face swap have become a meme in their own right. The redesign might be trash, but the augmented reality functionality is extremely impressive.

Figure.3 ***Snapchat***

3.IKEA Place

IKEA Place is one of the better-known AR apps. The app can download 3D models for IKEA furniture and place them in your own home. See size- and color-accurate representations of how that couch would look in your living room or if the side table would match the coffee table, IKEA Place uses ARKit and is compatible with iPhone 6s and newer. See below for iPad compatibility.

Figure.4 IkEA Place

4.TU7FA_AR

Now it is our turn our application TU7FA is marker based augmented reality offline application using AR in advertising and marketing

TU7FA application lets you virtually place any of our accessories in your place, includes 3D models of table lamps, wall lamps, ceiling lamps.

TU7FA gives you accurate impression of the accessories and full control to scale, Rotate and overview for chosen piece.

Just hold your smartphone open TU7FA application, Search the list of available products and select one, Scan the image target to place the product there and rotate, scale and change the product as you want.

Figure.5 TU7FA

1.2. Motivation

Save time and efforts

Customers have to move from place to place and from store to store spending much effort, much time and stand in queues in cash counters to pay for the products that have been purchased by them. Now with TU7FA they can shop from their home or work place, do not have to spend time traveling and saving wasted effort and time as the customers can also look for the products that are required by them by entering the key words or using search engines.

Taking Overview

user of online stores cannot ensure of the quality, appearance and the overview of the piece which choose for accessories the user cannot be ensure if the chosen piece is suitable or not now you can.

Return

it is something complex to return things when they are purchased online, you have to take into account the conditions of each page before buying something to avoid disappointment with what is received because it can also cost money to make the return.

Test products

The most common case is that of accessories that one can try on a physical store just to see if the size is right or color is suitable Online it is difficult to estimate the size of the products properly so you can end up making a bad purchase. The detail here is that it only applies to a few things because even in physical stores not everything can be tested.

1.3. Objectives

Developing an Offline Application That Using Augmented Reality in Marketing Aims at simplifying the User Life

That Enable User to Visualize How Virtual Accessories Would Look in Given Space.

Now with TU7FA any piece of accessories can be tested and check if it looks like what are you looking for or not, if it is suitable or not, taking a real overview about what you are going to pay for, so you can save your money and saving these waste effort so avoid the problem of pay for a product and then had to return it for any of the previous reason.

1.4 Time plan

Figure.6 Time plan

1.5 Documentation Outline

Chapter 2: Is a detailed description of the project field, the scientific background related to the project and that field, Survey of the work done in the field, description of technique which bien used and description of some existing similar system.

Chapter 3: the description of system architecture, all modules, Functionality and non-functionality requirements and to whom the system is built and how the group of users will use the system.

Chapter 4: A detailed description of main component of implementation of system architecture and functions in the system and of all used techniques is implemented and technologies used in the system.

Chapter 5: How can we test the application and check validation on of the system.

Chapter 6: A complete summary of the whole project with the result obtained, state the advantages and disadvantages of the application and what can be done in the future to improve the performance of the application and what is the additional functionality can be added.

TOOLS: The tools, APIS and platform we use in our application and the uses of each one of them.

References: All Articles, papers and research we use as references along the project to complete and finish the project**.**

Chapter 2

Background

2.1 Project Field Description

The expression “Augmented Reality”, usually abbreviated with the acronym AR- refers to the emerging technology that allows the real time blending of the digital information processed by a computer with information coming from the real world by means of suitable computer interfaces.
Augmented reality is comprehensive information technology which combines digital image processing, computer graphics, artificial intelligence, multimedia technology and other areas.

The term virtual reality is defined as “computer-generated, interactive, three-dimensional environment in which a person is immersed”. Augmented reality allows the real time blending of the digital information processed by a computer with information coming from the real world by means of suitable computer interfaces.

There is a clear difference between the concept of virtual reality and augmented reality, the real world and a totally virtual environment are at the two ends of this continuum with the middle region called Mixed Reality. Augmented reality lies near the real-world end of the spectrum with the predominate perception being the real world augmented by computer generated data. Augmented virtuality is a term created by Milgram to identify systems that are mostly synthetic with some real-world imagery added, such as texture mapping video on virtual objects.

AR system consists of three simple steps: Recognition, Tracking, and Mix. In recognition any image, object, face, a body or space is recognized on which virtual object will be superimposed. During tracking real-time localization in space of the image, object face, a body or space is performed and finally media in the form of video, 3D, 2D, text, etc are superimposed over it.
Marker-based AR Systems uses physical-world symbols as a

reference point for computer graphics to be overlaid. In this system camera continuously snapshots the target object and process the image to estimate the position, orientation and movement of the visualization display with respect to the target object. For example, a 2-dimensional printed marker is placed in front of a webcam. The computer then interprets this symbol to overlay an on-screen graphic as if it were directly on top of the marker in the physical world. Lighting and focus related problems limit the performance of AR services using this system.

2.2 LITERATURE SURVEY

In this section we cite the relevant past literature that use of AR SDK’s. Most of the researchers tend to use vision-based AR SDK due to more accuracy of superimposing 3D object on real world environment.

A system called ASRAR is created to help a deaf person, which shows what the narrator says as a text display to deaf people. System combines augmented reality with, automatic speech recognition and TTS technology to help people to communicate with deaf persons without use of sign language. ASR engine is used to recognize the narrator's speech and convert the speech to text. The TTS engine is used to convert the input text into the speech for communication between the deaf person and the narrator. AR engine is used to display the text as a dynamic object in an AR environment.AR engine is constructed with help of FLARManager and OpenCV used for facial recognition, object detection and motion tracking. The FLARToolkit library is used as tracking library to make flash supported AR applications. More than one narrator in the environment can be detected using multiple marker detection. Instead of the marker, face detection is used so that user can move easily.

Authors have developed an AR based support system for teaching hand drawn machine drawing used for used for training of sketching and orthographic projection drawing in which users can watch virtual object from various orientation. This system developed using ARToolKit which overlays a virtual mechanical 3D object recognized by a cubic AR marker on the screen. The position and the orientation of the AR marker define the position and orientation of the virtual object. During the registration process direction and distance of virtual object from the camera is calculated through recognizing edges of an AR marker process. User can watch 3D object in various aspect like front, back, top, under, left and right through rotating the cubic AR marker.

Researchers have built advanced gardening support system called the Smart Garden (SG) which provides information about what to plant where. Guides user of planting seedlings where different symbols on the screen indicated steps to be taken also virtual plants are overlaid on real image which helps growers to understand the outcomes of their decisions intuitively.SG uses NyARToolkit for processing. Fiducial marker, a square black frame with unique symbol inside, is used which differentiate markers. Fiducial marker is recognized in the image captured by the camera and the positions and orientations of the markers relative to the camera are calculated. The position information is then used to render virtual objects in the image when unique symbols are matched to pre stored templates. One of the limitation is that only few marker where detected when camera was pointed direction of sun.

This paper specifies the significance of AR-media functionality like fiducial marker, natural feature and model based, GPU and IMU sensors-based tracking in context of different market segments like contextual and geo-located information, advertising, multimedia, and entertainment, education with reference to publishing products like books, magazines, newspapers, and collectibles.

A prototype system is designed to superimpose 3D animal model living in tideland over user defined target using Vuforia SDK using vision-based augmented reality technology which is based on computer vision algorithm to process feature points of 2D planes or

3D polyhedrons from camera images in real world and superimpose 3D content on those image in real time .Data structure was created to superimpose several 3D animal models on image targets. With Vuforia real time image target are generated, which helps the user to superimpose 3D animal model when user clicks photo of any scene. With this user can put 3D model at any place they want.

Campus event application was implemented which updates the users with daily campus events by visualizing the event over real world and providing real time map and route to the event. It is GPS location-based AR application developed using marker less tracking feature of Metaio and Android SDK. When user points the camera toward a direction, virtual billboards of nearby events in that direction visualized and placed over the reality will be displayed on the screen. Complete event detail is provide on clicking on virtual billboards. Addresses of event where provided as LLA coordinates which was used to visualize events and align it with static images accurately on the screen.

The author proposed a method for creating an interactive virtual training system based on AR. With D'Fusion framework an interactive learning platform was provided for agriculture training. To provide realistic training experience virtual model of strawberry was constructed. D'Fusion Augmented Reality technology was used for tracking, data alignment and integration of virtual object. Information about virtual object is presented with audio and animated clips, where one can rotate marker to see different features and parts of object. Interactive game explains strawberry cultivation process.

A prototype system is designed for e-learning using FLARToolkit where student can see real objects to understand experiment contents rather than illustrations. Web based instruction manual tracks simple black squares for positioning some instruction information and then showing teacher 3D models with some instruction text. Multiple markers where used to superimpose instruction image over different items of experiment. To describe the experiment flash movie was used supported by FLARToolkit.

Researchers have built a tool for wheelchair users using geo location techniques, filtered internet search and Wikitude API, which guides user regarding adaptations of wheelchair in elevators, restrooms, ramps and other places [1]. Map view augments the user at the centre of place selected and also presents detail information about that place.

Wikitude SDK was used to produce AR camera view with specific icons displayed on screen for selecting places.

2.3. AUGMENTED REALITY SDK

Augmented Reality SDK facilitates many components within the AR application: AR recognition, AR tracking and AR content rendering. The recognition component works as the brain of the AR app. The tracking component can be stated as the eyes of the AR experience, and the content rendering is simply imaginative virtual objects and scenes on the real time information. An array of tools is provided to developers through SDK, required to recognize, track and render AR application in the most efficient manner.

Augmented Reality SDKs can be organized in these broad categories: Geo-located AR Browsers, Marker based, Natural Feature Tracking AR Browser SDKs allow users to create geo-located augmented reality applications using the GPS and IMU available on today's mobile and wearable devices. Marker based SDKs employ special images, markers, to create augmented reality experiences. Natural Feature Tracking SDKs rely on the features that are actually present in the environment to perform the augmentation by tracking planar images or based on a SLAM (Simultaneous Location and Mapping) approach.

2.3.1 Metaio

The Metaio SDK is modular framework which consists of different components like rendering, capturing, tracking and the sensor interface along with the Metaio SDK interface which interacts between the application and the other modular components. Implementations details are encapsulated and different functionalities are realized through simple SDK APIs which connects with the other parts of the SDK, thus provide easy implementation of AR applications.

The Metaio SDK is compatible with all major platforms for software development: Android, IOS, Unity3D and Windows. The platform-specific interfaces of the Metaio SDK supports easy interaction with any development environment. Its feature set contains marker or marker-less 2D and 3D tracking, POI's tracking, support for QR code and barcode reading, built in 3D renderer, optimizations for mobile chips, LLA Marker tracking, etc.

2.3.2. Vuforia

The Vuforia platform uses superior, stable, and efficient computer vision-based image recognition technique and provides several features, enabling capability of mobile apps and frees developers from technical limitations.

Vuforia platform consists of different components like Target Management System available on the developer portal (Target Manager), Cloud Target Database and Device Target Database and Vuforia engine. A developer simply uploads the input image for the target that he wants to track. The target resources are then accessed by the mobile app either through cloud link or directly from mobile app local storage.

A Vuforia SDK-based AR application consists of Camera which capture frame and pass contents to the tracker, Image Convertor simply converts image taken by camera to a format suitable for OpenGL ES rendering and for internal tracking, Tracker which can load and activate multiple dataset at same time which basically contains the computer vision real-world objects in camera video frames, Video Background Renderer to render camera image stored in the state object, Application Code which for newly detected targets query the state object which results in updating of application logic with new input data and rendering the augmented graphics overlay, Device Database to store marker targets in device itself and lastly cloud database which stores the target in the cloud.

2.3.3. Wikitude

Wikitude includes image recognition & tracking, supports 3D model rendering with overlaying of video and provides location-based AR. The Wikitude SDK [19] combines geo-based and image recognition capabilities to provide hybrid tracking and it is built heavily on web technologies (HTML, JavaScript, and CSS) which allow writing cross platform augmented reality experiences coined as ARchitect worlds and are basically ordinary HTML pages that can utilize the ARchitect API to create objects in augmented reality. Wikitude SDK into can be integrated to apps are by adding the platform specific view

component called Architect View to the app user interface.
Wikitude SDK is a commercial solution but is also available as a trial version with some limitations like Wikitude logo in cam view etc.
Wikitude SDK is currently available for Android and iOS platform.
Wikitude AR browser was first released on Android platform then extended to Blackberry, Bada, Windows Phone and iOS.
Wikitude also provide Wikitude studio which eases the development procedure, where no programming skills are required and app can be created by simply dragging object on the studio screen.

2.3.4. ARToolKit

ARToolKit is an open source marker-based AR library. It is a programming library for implementing augmented reality application which overlays 3D virtual object on AR marker taken by the digital camera. Position and orientation of the virtual object is defined by recognizing the position and the orientation of the AR marker based con computer vision algorithms.

ARToolKit supports multiple platforms and for the rendering part uses OpenGL; GLUT is used for the windows/event handler aspect and video library is hardware dependent and has standard API is provided for each platform. ARToolKit API is available in C.
ARToolKit library consists of AR module which contains marker tracking routines, calibration and parameter collection, Video module having video routines for capturing the video input frames, sub module is a collection of graphic routines based on the OpenGL and GLUT libraries, Gsub_Lite module has a collection of graphics routines, which is platform independent.
It was designed for personal computers and not for embedded devices. Hence porting it directly to
mobile platforms was difficult and impractical because it uses a lot of FPU calculations. But over
the time lot of ARToolKit extension have been developed which support mobile platforms also.

2.4. COMPARISON OF AUGMENTED REALITY SDK'S

2.4.1. Based on license type

Metaio, Vuforia, Wikitude, D'Fusion and ARmedia are available as free as well as commercial
SDK. ARToolKit is available as commercial as well as open source license.

Table 1. Comparison based on license type.

AR SDK / Type		Vuforia	Metaio	Wikitude	ARToolKit
License	Open source	×	×	×	✓
	Free	✓	✓	✓	✓
	Commercial	✓	✓	✓	✓

2.4.2. Based on platform supported

Metaio supports development of AR apps for android, iOS, Windows, Flash platforms. Vuforia supports development of AR apps for android and iOS platforms. Wikitude supports development of AR apps for Android, iOS and BlackBerry OS. D'Fusion supports development of AR apps for Android, iOS, Windows, Flash platforms. ARmedia supports development of AR apps for android, iOS, Windows, Flash platforms. ARToolKit supports development of AR apps in Android, iOS, Linux, OSX, Windows platforms.

Table 2. Comparison based on platform supported.

AR SDK / Type		Vuforia	Metaio	Wikitude	ARToolKit
License	iOS	×	✓	×	✓
	Android	✓	✓	✓	✓
	Window	✓	✓	✓	✓

2.4.3. Based on marker generation

Table 3. Based on marker generation.

AR SDK / Type	Vuforia	Metaio	Wikitude	ARToolKit
Marker generation	Online target manger. Support generation of frame, image markers.	No online tool. Provides readymade 512 different ID markers	Online target manager tool. Provide creation of target collection of multiple targets.	Online tool to create marker. Provide set of predefined square markers in a PDF file.

2.4.4. Based on tracking

Table 4. Comparison based on tracking.

AR SDK / Type		Vuforia	Metaio	Wikitude	ARToolKit
Tracking	Marker	Frame markers, image target, text targets.	ID, picture and LLA marker, QR and Barcode	Image, barcode tracking	Square marker, multiple marker tracking
	GPS	×	✓	✓	×
	IMU	×	✓	✓	×
	Face	×	✓	×	×
	Natural Feature	✓	✓	✓	✓
	3D object	✓	✓	×	×
	Others	Extended tracking, Localized Occlusion detection	Instant 3D maps tracking, 3D SLAM ,extended image tracking	Hybrid tracking, extended tracking	6D marker tracking(real -time planar detection)

2.5. Related-Work

2.5.1. IKEAPlace

Anticipating poor design choices before you ever make them can be key to ensuring that you never again bring an ugly couch into your home. With a new app from Ikea, you can use augmented reality to "see" potential pieces of furniture in your home before pulling out your credit card, and save yourself a whole lot of consternation when it comes to (re)decorating your home.

Ikea Place, customers will be able to experience and experiment with furniture from the retailer. You can place chairs, desks, and just about anything else in your kitchen, backyard, or heck, on the street, just to see how it all looks. And while Ikea Place was initially an iPhone only app, Android users can now take advantage of this AR technology as well. In March, Ikea launched its visualization app for non-iOS folks, too, giving customers the ability to virtually place some 3,200 Ikea products into their homes.

"When we first launched Ikea Place, we gave our customers the opportunity to 'try before you buy' for the first time since Ikea was established," said Michael Valdsgaard, leader of digital transformation at Inter Ikea Systems. "Customers truly appreciate that and we are now helping them to create a better life at home using our AR technology. Today's release is about bringing the ease of Ikea Place to over 100 million Android devices."

In addition, the updated version of the app also now features Visual Search, which allows users to take a photo of any piece of furniture they fancy, then find similar or identical Ikea products through the app.

All items available in the app promise to be true to scale so you can ensure that you're seeing precisely how an armchair would look in that particular corner of your room. Ikea Place claims to automatically scale products based on a room's dimensions with up to 98 percent accuracy. Moreover, Ikea claims that the AR technology is precise enough to allow customers to see the texture of a fabric, and even the interplay of light and shadows on potential furnishings.

To use the app, simply scan the floor of a room, browse the list of products available in the app, and select the product you'd like to place. The iPhone version of the app will require iOS 11 to function, while Android phones will need ARCore in order to run the software.

"Now, technology has caught up with our ambition. AR lets us redefine the experience for furniture retail once more, in our restless quest to create a better everyday life for everyone, everywhere," Valdsgaard concluded

True-to-scale

"IKEA Place lets you place true-to-scale 3D furniture in your home using the lens of your iPhone camera," explains Michael Valdsgaard, the Leader of Digital Transformation at Inter IKEA Systems B.V. "You see the scene as if these objects were real and you can walk around them and interact with them, even leave the room and come back. It's really magic to experience."

2.5.2. Pokémon Go

Pokémon Go is an augmented reality (AR) mobile game developed and published by Niantic for iOS and Android devices. A part of the *Pokémon* franchise, it was first released in certain countries in July 2016, and in other regions over the next few months. The game is the result of a collaboration between Niantic and Nintendo by way of The Pokémon Company. It uses the mobile device GPS to locate, capture, battle, and train virtual creatures, called Pokémon, which appear as if they are in the player's real-world location. The game is free to play; it uses a freemium business model and supports in-app purchases for additional in-game items. The game launched with around 150 species of Pokémon, which had increased to over 480 by 2019.

Pokémon Go was released to mixed reviews; critics praised the concept, but criticized technical problems. It was one of the most used and profitable mobile apps in 2016, having been downloaded more than 500 million times worldwide by the end of the year. It is credited with popularizing location-based and AR technology, promoting physical activity, and helping local businesses grow due to increased foot traffic. However, it attracted controversy for contributing to accidents and creating public nuisances. Various governments expressed concerns about security, and some countries regulate its use. The game has crossed 1 billion downloads worldwide as of February 2019, and has 147 million monthly active users as of May 2018. As of December 2018, the game has grossed over $3 billion in worldwide revenue.

Gameplay

Figure.7 **Pokémon Go**

Players must physically travel to explore the game's map and visit Poké Stops (the smaller circular [purple, visited] or cube [blue] icons, depending on proximity) and gyms (the one large tower shown).

Encountering a Treecko while in the augmented reality mode; the Poké Ball must be "thrown" to capture it by tapping on the ball and flicking it up towards the Pokémon.

After establishing a game account, players create and customize their own avatars. Once created, an avatar is displayed on a map based on the player's geographical location. Features on the map include 'Poké

Stops' and 'Pokémon Gyms'. These Poké Stops can be equipped with items called 'Lure Modules', which attract additional wild, and occasionally rare, Pokémon. Gyms serve as battle locations for team-based king of the hill matches. Poké Stops and Gyms are typically located at places of interest. These locations are re-purposed portals from *Ingress*, Niantic's previous augmented reality (AR) game. This has led to Poké Stops and Pokémon Gyms being placed at dangerous or inconvenient locations, such as a now-deleted Gym at the Korean Demilitarized Zone.

As players move within their real-world surroundings, their avatars move within the game's map. Different Pokémon species reside in different areas of the world; for example, Water-type Pokémon are generally found near water. When a player encounters a Pokémon, it may be viewed either in AR mode or with a live rendered, generic background. AR mode uses the camera and gyroscope on the player's mobile device to display an image of a Pokémon as though it were in the real world. Players can take screenshots of the Pokémon they encounter either with or without the AR mode activated.

Unlike other installments in the *Pokémon* series, players in *Pokémon Go* do not battle wild Pokémon to catch them. During an encounter with a wild Pokémon, a player may throw a Poké Ball at it by flicking it from the bottom of the screen up toward the Pokémon. If the Pokémon is successfully caught, it will come under the ownership of the player. Factors in the success rate of catching a Pokémon include the Pokémon's catch rate, the timing and the type of Poké Ball used. After catching a wild Pokémon, the player is awarded two types of in-game currencies: Candies and Stardust. The Candies awarded by a successful catch depend on what evolutionary chain a Pokémon belongs to. A player can use Stardust and Candies to raise a Pokémon's "Combat Power" (CP). However, only Candies are needed to evolve a Pokémon. Each Pokémon evolution tree has its own type of Candy, which can only be used to evolve or level up. The player can also transfer the Pokémon back to the Pokémon Professor to earn one more Candy and create room for more Pokémon. The ultimate goal of the game is to complete the entries in the Pokédex, a comprehensive Pokémon logbook, by catching and evolving them to collect everyone in it.

Although the game is free to play, it supports in-app purchases, where players can purchase additional Poké Balls and other in-game items. These items include Incense (which attract Pokémon to you as you move for thirty minutes), Lure Modules, to attract Pokémon to a fixed location, and Lucky Eggs, which double experience points gained for a thirty-minute period from use. All Pokémon are displayed with a Combat Power. A Pokémon's Combat Power is a rough measure of how powerful that Pokémon is in battle. Generally, as players level up, they catch Pokémon with higher CP.

Players earn experience points for various in-game activities. Players rise in level as they earn experience points (XP), with various features being progressively unlocked. Most notably, at level five, the player can battle at a Pokémon Gym and join one of three color-coded teams (red for Team Valor, blue for Team Mystic, or yellow for Team Instinct), which act as factions battling for control of Gyms within the *Pokémon Go* world.

In September 2016, Niantic introduced a "Buddy Pokémon" feature, which allows players to pick a Pokémon to appear alongside them on the profile screen, and receive in-game rewards and bonuses based on the chosen Pokémon. The feature was released later that month. During that same update, Niantic updated *Pokémon Go* to prevent players with rooted or jailb reaked devices from logging into the game in an effort to reduce and prevent cheating.

In June 2017, Niantic announced that the game mechanics of Gyms would be revamped for a more teamwork-oriented experience; Gyms were disabled on June 19, 2017, with the new Gyms being released with the next app update a few days later. As of the update, Gyms included a spinnable component to receive in-game items such as Potions and Poké Balls. Additionally, Gyms are capped at containing six Pokémon, each of which must be unique in that Gym. Coins are now earned based on the amount of time the defending Pokémon has been in a Gym, as opposed to a one-per-day gym defender bonus of 10 coins per current defending Pokémon. In July 2017, Raid Battles were introduced. Raid Battles consist of a group of players gathering to confront an over-leveled Pokémon located in a Gym. If the Pokémon is defeated, the players gain the chance to catch a regular version of it. Raid difficulties range from 1 to 5, with 1 being of the lowest difficulty, and 5 being the most difficult to defeat. Level 5 raids are exclusive to Legendary Pokémon. The first of these, Articuno and Lugia, were released on July 22, 2017, after the Go Fest, with Moltres and Zapdos following. From September to

November, the 3 Legendary Beasts: Entei, Raikou and Suicune, were released shortly after, rotating regions every month. Following their departure, the Legendary Pokémon Ho-Oh appeared in Raid Battles from November 27, 2017, to December 12, 2017.

After the 0.85.2 update, Niantic released 50 Pokémon originally discovered in Hoenn region, with two of them, Mawile and Absol, becoming raid bosses. On December 16, the first Legendary Pokémon from Pokémon Ruby and Sapphire, Groudon, was released. On January 12, Kyogre was released. On February 9, the last Pokémon of the 'Weather Trio', Rayquaza, was released alongside the latest batch of Hoenn Pokémon. Another update on March 31 added a quest system, which can be completed to obtain mythical Pokémon such as Mew.

2.5.3. JigSpace

I initially held off on discussing any of the new ARKit developed apps when iOS 11 launched for one main reason - I couldn't actually use most of them! My iPhone 6 was hanging by a thread as I waited out the X whilst my iPad Air 2 is doing just fine and I have no plans to upgrade it any time soon. Neither of them could run the vast majority of the ARKit apps though as they simply weren't powerful enough. Now I have the iPhone X, I have finally been able to dig into these new offerings though.

To be honest, I've been a little disappointed so far with the range of educational ARKit apps, though it is early days of course. When you look at the depth and quality afforded by established AR apps like ZooKazam, NASA's Spacecraft 3D or Curiscope's Virtuali-Tee, there really isn't much on that level yet in this new generation. Don't get me wrong - the way these new apps function (i.e. without triggers and much more stable rendering of the models) is definitely impressive, I just hope 2018 will see more depth and detail to the educational AR offerings.

That being said, one new app has really impressed me already and that's JigSpace. It's been referred to as the evolution of Wikipedia/ WikiHow and I can see why. Jigspace offers a bank of AR experiences with an educational focus, categorised by topics – Science, Machines, Space and even History, which is great to see included! It also has a special "how-to" category which contains an eclectic bank of AR guides to things like assembling an office chair, reverse parallel parking and even building some Lego Star Wars models! The range is good and expanding regularly but is the quality of the experiences that really makes JigSpace stand out.

Chapter Three

System Architecture

3.1. System Architecture

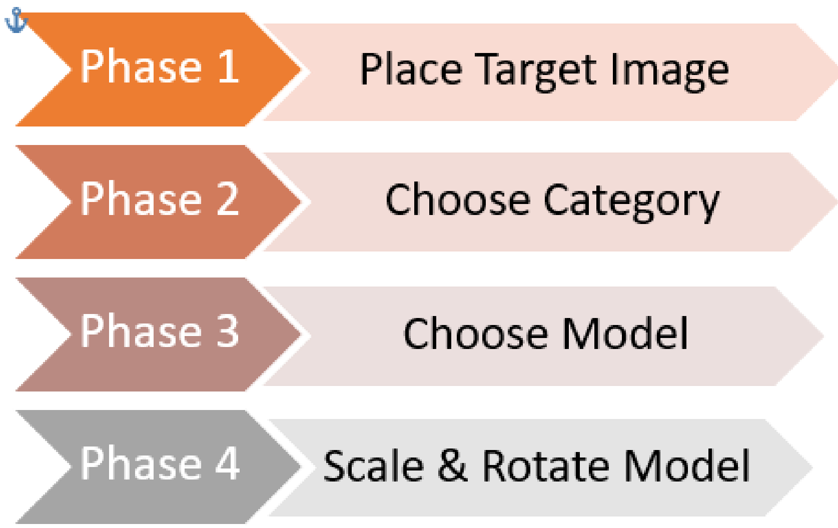

Figure.8 system architecture

- **Phase1:**

User Place the target in specific place, So virtually place any of our accessories in his place, So verify quality, appearance
and the overview of the piece which choose for accessories the

- **Phase 2:**

User choose between three main categories of Accessories
table lamps, wall lamps, ceiling lamps. By Searching the list of available products.

- **Phase 3:**

After choosing Category, user select one of the available accessories then start scanning the image target to display the chosen model.

- **Phase 4:**
  The selected model will be Overlaid in the real-scene through the user device who has a full control and functionality to rotate, scale and translate for chosen piece and change the product as you want.

3.2. Use Case Diagram

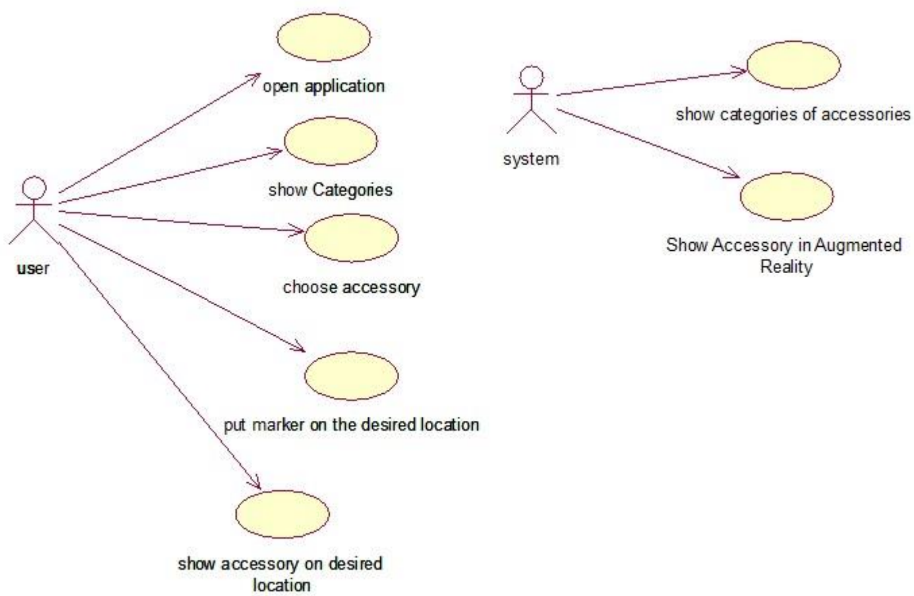

Figure.9 Use case diagram

3.3. Sequence Diagram

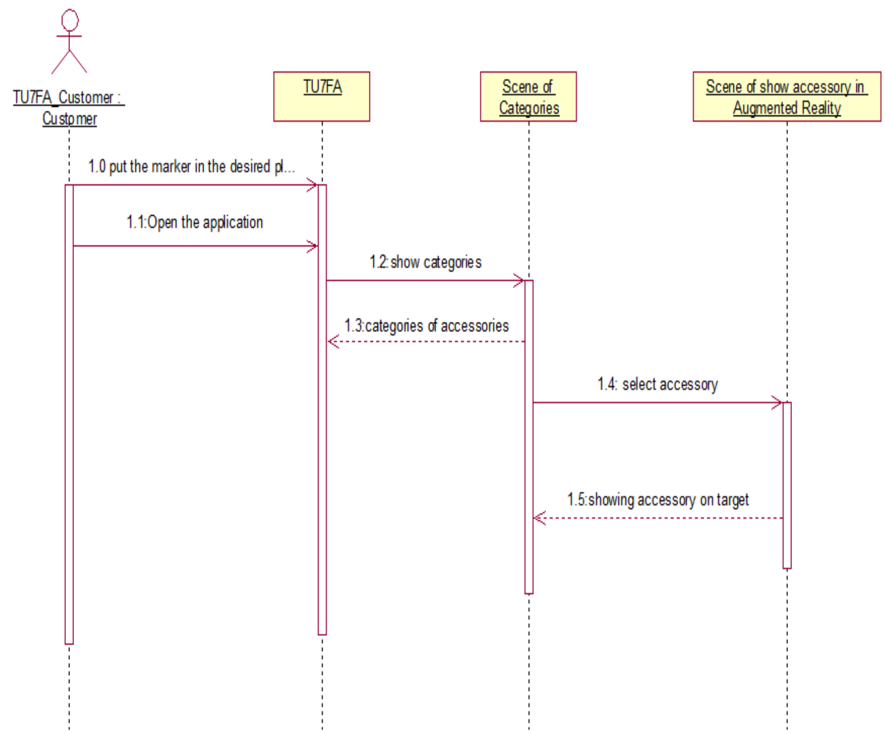

Figure.10 Sequence diagram

3.4. Class Diagram

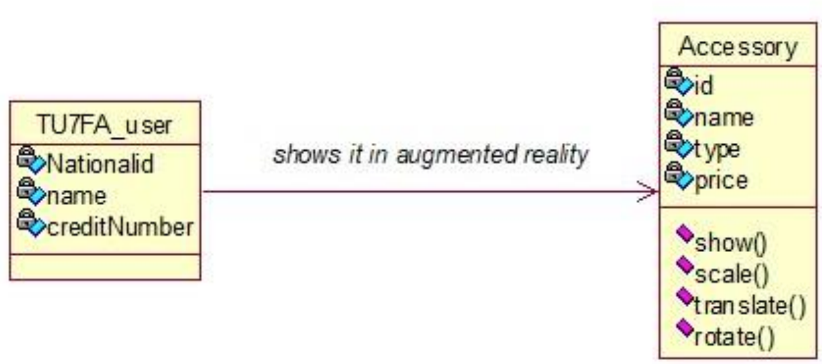

Figure.11 Class diagram

Chapter Four

System Implementation

4.1 Augmented reality

- Augmented reality (AR) is an interactive experience of a real-world environment where the objects that reside in the real-world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory, and olfactory. The overlaid sensory information can be constructive (i.e. additive to the natural environment), or destructive (i.e. masking of the natural environment). This experience is seamlessly interwoven with the physical world such that it is perceived as an immersive aspect of the real environment. In this way, augmented reality alters one's ongoing perception of a real-world environment, whereas virtual reality completely replaces the user's real-world environment with a simulated one. Augmented reality is related to two largely synonymous terms: mixed reality and computer-mediated reality.

- The primary value of augmented reality is how it brings components of the digital world into a person's perception of the real world, not as a simple display of data, but through the integration of immersive sensations that are perceived as natural parts of an environment. The first functional AR systems that provided immersive mixed reality experiences for users were invented in the early 1990s, starting with the Virtual Fixtures system developed at the U.S. Air Force's Armstrong Laboratory in 1992.The first commercial augmented reality experiences largely took place in entertainment and gaming businesses. It is now expanding to other commercial industries such as knowledge sharing, educating, managing the information flood, and organizing distant meetings. Augmented reality is also transforming the world of education, where content may be accessed by scanning or viewing an image with a mobile device or by bringing immersive, markerless AR experiences to another classroom.

- Augmented reality is used to enhance natural environments or situations and offer perceptually enriched experiences. With the help of advanced AR technologies (e.g. adding computer vision and object recognition) the information about the surrounding real world of the user becomes interactive and digitally manipulable. Information about the environment and its objects is overlaid on the real world. This information can be virtual or real, e.g. seeing other real sensed or measured information such as electromagnetic radio waves overlaid in exact alignment with where they actually are in space. Augmented reality also has a lot of potential in the gathering and sharing of tacit knowledge. Augmentation techniques are typically performed in real time and in semantic contexts with environmental elements. Immersive perceptual information is sometimes combined with supplemental information like scores over a live video feed of a sporting event. This combines the benefits of both augmented reality technology and heads up display technology (HUD).
- A key measure of AR systems is how realistically they integrate augmentations with the real world. The software must derive real world coordinates, independent from the camera, from camera images. That process is called image registration, and uses different methods of computer vision, mostly related to video tracking.
- Many computer vision methods of augmented reality are inherited from visual odometry.
- Usually those methods consist of two parts. The first stage is to detect interest points, fiducial markers or optical flow in the camera images. This step can use feature detection methods like corner detection, blob detection, edge detection or thresholding, and other image processing methods. The second stage restores a real-world coordinate system from the data obtained in the first stage. Some methods assume objects with known geometry (or fiducial markers) are present in the scene. In some of those cases the scene 3D structure should be precalculated beforehand. If part of the scene is unknown simultaneous localization and mapping (SLAM) can map relative positions. If no information about scene geometry is available, structure from motion methods like bundle

adjustment are used. Mathematical methods used in the second stage include projective (epipolar) geometry, geometric algebra, rotation representation with exponential map, kalman and particle filters, nonlinear optimization, robust statistics.[citation needed]

- Augmented Reality Markup Language (ARML) is a data standard developed within the Open Geospatial Consortium (OGC), which consists of XML grammar to describe the location and appearance of virtual objects in the scene, as well as ECMAScript bindings to allow dynamic access to properties of virtual objects.
- To enable rapid development of augmented reality applications, some software development kits (SDKs) have emerged.
- The implementation of Augmented Reality in consumer products requires considering the design of the applications and the related constraints of the technology platform. Since AR system rely heavily on the immersion of the user and the interaction between the user and the system, design can facilitate the adoption of virtuality. For most Augmented Reality systems, a similar design guideline can be followed. The following lists some considerations for designing Augmented Reality applications.
- Augmented reality has been explored for many applications, from gaming and entertainment to medicine, education and business. Example application areas described below include archaeology, architecture, commerce and education. Some of the earliest cited examples include augmented reality used to support surgery by providing virtual overlays to guide medical practitioners to AR content for astronomy and welding.
- Main article: Industrial Augmented Reality:
  AR allows industrial designers to experience a product's design and operation before completion. Volkswagen has used AR for comparing calculated and actual crash test imagery. AR has been used to visualize and modify car body structure and engine layout. It has also been used to compare digital mock-ups with physical mock-ups for finding discrepancies between them.

4.2 Types of Augmented Reality

- ***Marker Based*** Augmented Reality
  Marker-based augmented reality uses a camera and some type of visual marker, such as a QR/2D code, to produce a result only when the marker is sensed by a reader. Marker based applications use a camera on the device to distinguish a *marker* from any other real-world object. Distinct, but simple patterns are used as the markers, because they can be easily recognized and do not require a lot of processing power to read. The position and orientation are also calculated, in which some type of content and/or information is then overlaid the marker.

Figure.12 marker-based AR

- ***Projection Based*** **Augmented Reality**
  Projection based augmented reality works by projecting artificial light onto real world surfaces. Projection based augmented reality applications allow for human interaction by sending light onto a real-world surface and then sensing the human interaction (i.e. touch) of that projected light. Detecting the user's interaction is done by differentiating between an expected (or known) projection and the altered projection (caused by the user's interaction).

Figure.13 projection-based AR

- ***Markerless* Augmented Reality**
  As one of the most widely implemented applications of augmented reality, markerless (also called location-based, position-based, or GPS) augmented reality, uses a GPS, digital compass, velocity meter, or accelerometer which is embedded in the device to provide data based on your location. A strong force behind markerless augmented reality technology is the wide availability of smartphones and location detection features they provide. It is most commonly used for mapping directions, finding nearby businesses, and other location-centric mobile applications.

Figure.14 marker-less AR

- ***Superimposition Based*** Augmented Reality
  Superimposition based augmented reality either partially or fully replaces the original view of an object with a newly augmented view of that same object. In superimposition based augmented reality, object recognition plays a vital role because the application cannot replace the original view with an augmented one if it cannot determine what the object is. A strong consumer-facing example of superimposition based augmented reality could be found in the Ikea augmented reality furniture catalogue and TU7FA augmented reality Application. By downloading an app and scanning selected pages in their printed or digital catalogue, users can place virtual ikea furniture or virtual TU7FA accessories in their own home with the help of augmented reality.

Figure.15 superimposition-based AR

4.3 Vuforia Augmented Reality SDK (Marker-based)

Figure.16 Vuforia AR

- Vuforia is a cross-platform Augmented Reality (AR) and Mixed Reality (MR) application development platform, with robust tracking and performance on a variety of hardware (including mobile devices and mixed reality Head Mounted Displays (HMD) such as the Microsoft HoloLens). Unity's integration of Vuforia allows you to create vision apps and games for Android and iOS using a drag-and-drop authoring workflow. A Vuforia AR+VR samples package is available on the Unity Asset Store, with several useful examples demonstrating the most important features of the platform.
- Vuforia supports many third-party devices (such as AR/MR glasses), and VR devices with back-facing cameras (such as the Gear VR). See the Vuforia page on Devices for a full list of supported devices. See the Vuforia API reference for more information about classes, properties and functions used in the SDK
- You can use any device with a camera to test AR/MR games and applications built in Unity with Vuforia.
- In AR or MR, markers are images or objects registered with the application which act as information triggers in your application. When your device's camera recognizes these markers in the real world (while running an AR or MR application), this triggers the display of virtual content over the world position of the marker in the camera view. Marker-based tracking can use a variety of different marker types, including QR codes, physical reflective markers, Image Targets and 2D tags. The simplest and most common type of marker in game applications is an Image Target.
- Image Targets are a specific type of marker used in Marker-based tracking. They are images you manually register with the application, and act as triggers that display virtual content. For Image Targets, use images containing distinct shapes with complex outlines.

- Hardware and software requirements:

Mobile devices

Device OS		Development OS		Unity Version	
Android (1)	4.1.x+	Windows (2)	7+	Windows (2)	2017.2+
iOS (2)	9+	OS X	10.11+	OS X	2017.2+
Windows (2)	10 UWP				

Table 5. mobile devices

Device		Device OS		Development OS		Unity Version	
HoloLens	Current version	Android (1)(2)	4.0.3+	Windows (3)	7+	Windows (3)	2017.2+
ODG	R7+	Windows (1)	10 UWP	OS X	10.11+	OS X	2017.2
Epson	BT-200						

Table 6. Vuforia required OS

VR SDK	Versions
Google VR SDK	Unity 2017.2
Cardboard Android SDK	Unity 2017.2
Windows Mixed Reality (HoloLens only)	Unity 2017.2

Table 7. Vuforia SDK integration support

App	Devices	OS Version
Calibration Assistant	Moverio BT-200 ODG R-7	Android 4.0.3+
Object Scanner	Samsung Galaxy S8+ Samsung Galaxy S8 Samsung Galaxy S7 Samsung Galaxy S6	Latest supported OS on the device

Table 8. Vuforia tool Supported HW

Android	iOS	Windows
OpenGL ES 2.0 OpenGL ES 3.x	OpenGL ES 2.0 OpenGL ES 3.x Metal (iOS 8+)	DirectX 11 on Windows 10

Table 9. Graphics API support

- Vuforia Engine is the most widely used platform for AR development
- It uses computer vision technology to recognize and track Image Targets
- Provide support for advanced computer vision functionality to Android and IOS
- Vuforia Engine API includes C# APIs for Unity, C++ APIs for IOS and Universal Windows Platform (UWP) and Java for Android
- Vuforia is able to recognize and track targets by analyzing the contrast based features of the target
- Improving the performance of a target by improving the visibility of these features through adjustments to the target's

4.4 flowchart and pseudocode

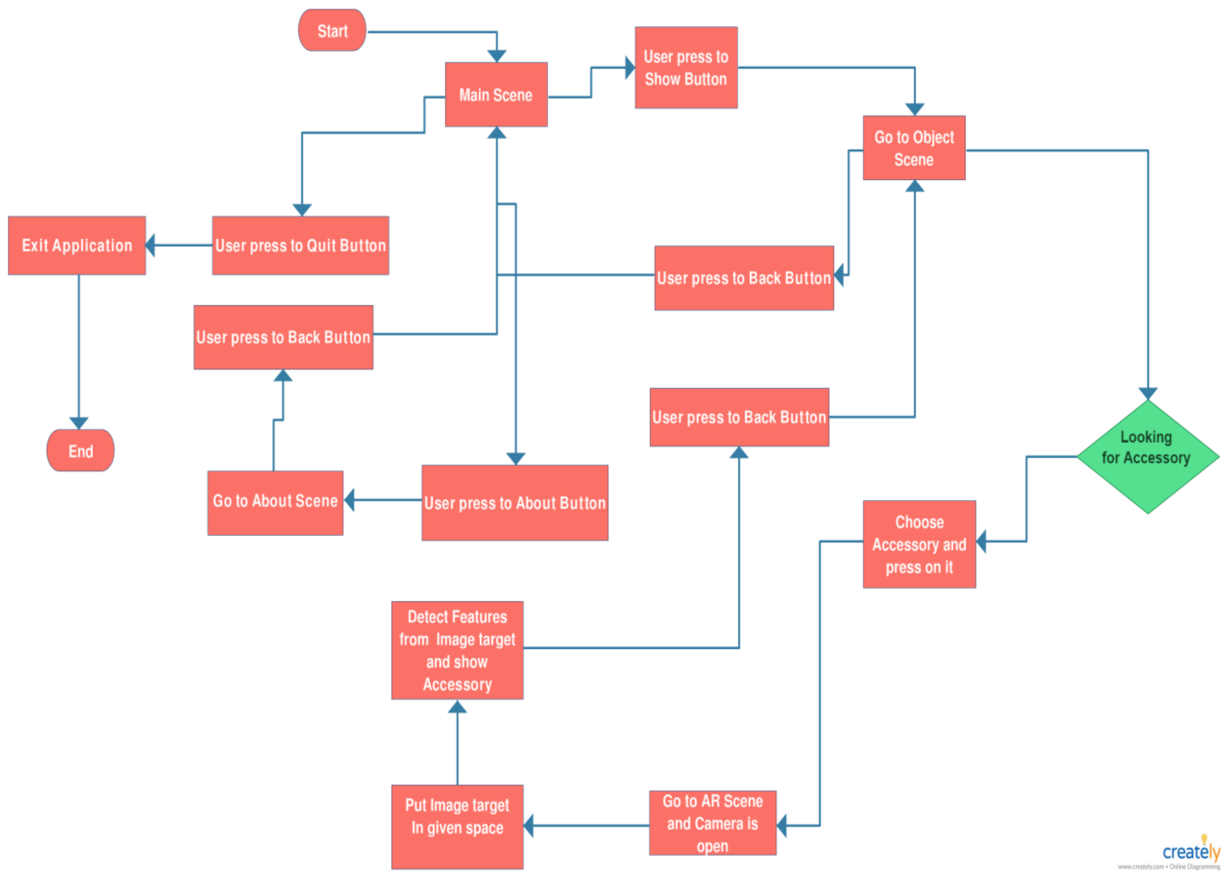

Figure.17 flowchart

1-User must have the Image Target used in the Application

2-Main Scene will open when user open Application and in scene, user found three buttons (Show-About-Quit)

3-When user press to show button Object Scene will open and in scene, user found four buttons (Table Lamp- Ceiling Lamp -Wall Lamp- Back)

4-When user press to Table Lamp button all Table lamp objects will Appear to   user to Choose one of them and press on to open Table Scene then Camera will open and detect Features from Image Target then show Accessory in given space by user and in Table Scene user found Back button and if press on it the Object Scene will open again

5-When user press to Ceiling Lamp button all Ceiling Lamp objects will Appear to user to Choose one of them and press on it to open Ceiling Scene then Camera will open and detect Features from Image Target then show Accessory in given space by user and in Ceiling Scene user found Back button and if press on it the Object Scene will open again

6-When user press to Wall Lamp button all Wall Lamp objects will Appear to user to Choose one of them and press on it to open Wall Scene then Camera will open and detect Features from Image Target then show Accessory in given space by user and in Wall Scene user found Back button and if press on it the Object Scene will open again

7-When user press to Main Menu button Main Scene will open again

8-When user press to about button in Main Scene the About Scene will open and in scene user found Main Menu button if user press on it the Main Scene will open again

9- When user press to quit button Application will be close

4.5 About Implementation

In this Project we will use Vuforia Augmented Reality SDK (Marker-based) in unity

And C# Scripts

And we make many C# Scripts such that

Transformation Script which have (Translate, Scale and Rotate)

-Change Scene Script (used for Open Scene From another Scene)

- Change Scene with Parameter (used for Open Scene From another Scene with parameter and in this case we use static function and pass to it Scene name and object ID which user press on it from Object Scene)

–Show Object Script (used for Show or Hide Object in Object Scene)

- Show _Hide Object Script (used for Show or Hide Object in Augmented Reality Scene and in it we call static function which return object ID and Display object to user in given space)

– Exit Script (used for Exit Application)

4.6 results and discussion

When User press to Ceiling Lamp button and choose Ceiling Lamp the static function PlayerPrefs.Set() will Pass to it (Scene name and Ceiling Lamp ID)
Then call PlayerPrefs.Get() in Ceiling Lamp Scene
And Display Ceiling Lamp

Figure.18 ceiling lamps

When User press to Table Lamp button and choose Table Lamp the static function PlayerPrefs.Set() will Pass to it (Scene name and Table Lamp ID)
Then call PlayerPrefs.Get () in Table Lamp Scene
And Display Table Lamp

Figure.19 table lamps

When User press to Wall Lamp button and choose Wall Lamp the static function PlayerPrefs.Set() will Pass to it (Scene name and Wall Lamp ID)
Then call PlayerPrefs.Get () in Wall Lamp Scene
And Display Wall Lamp

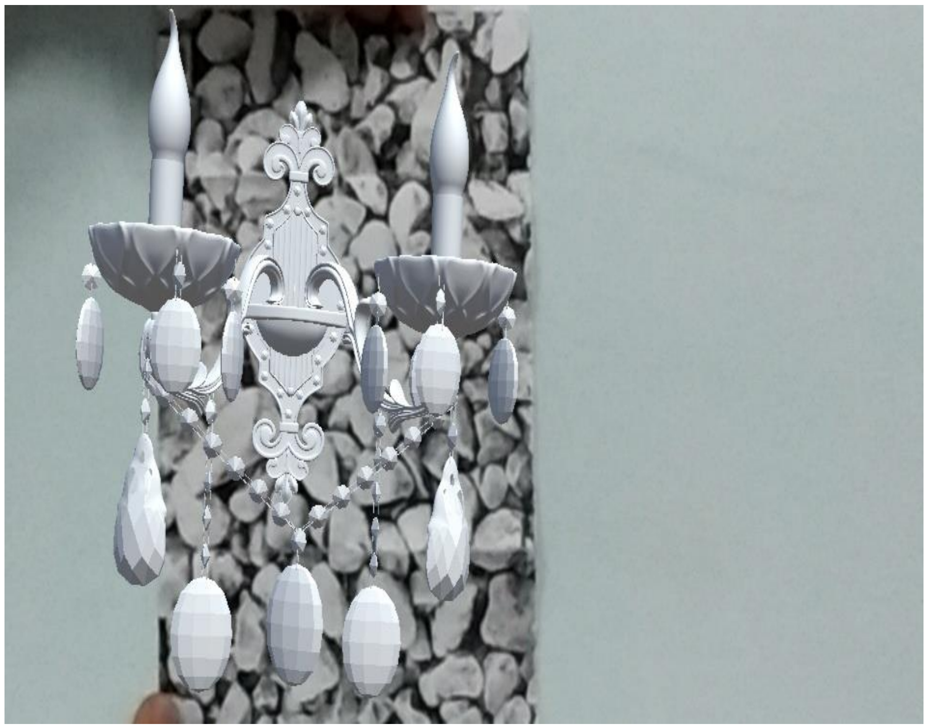

Figure.20 wall lamps

Chapter Five

System Testing

5.1 Main scene (main menu)

this scene contains main button the provide user with full control, will able user to go through TU7FA app and choose between categories or read about our application or Quit.

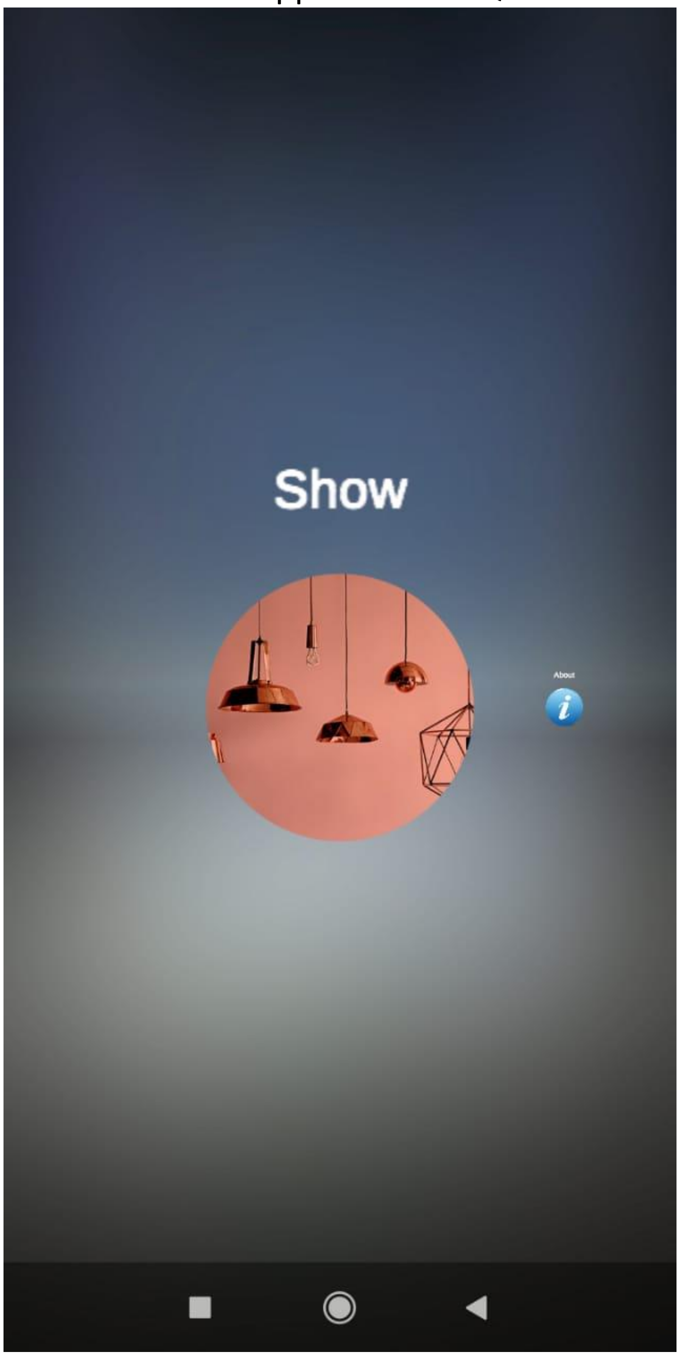

Figure.21 main scene

5.2 About section

know more About TU7FA application and motivation of our team to create and the terms of TU7FA

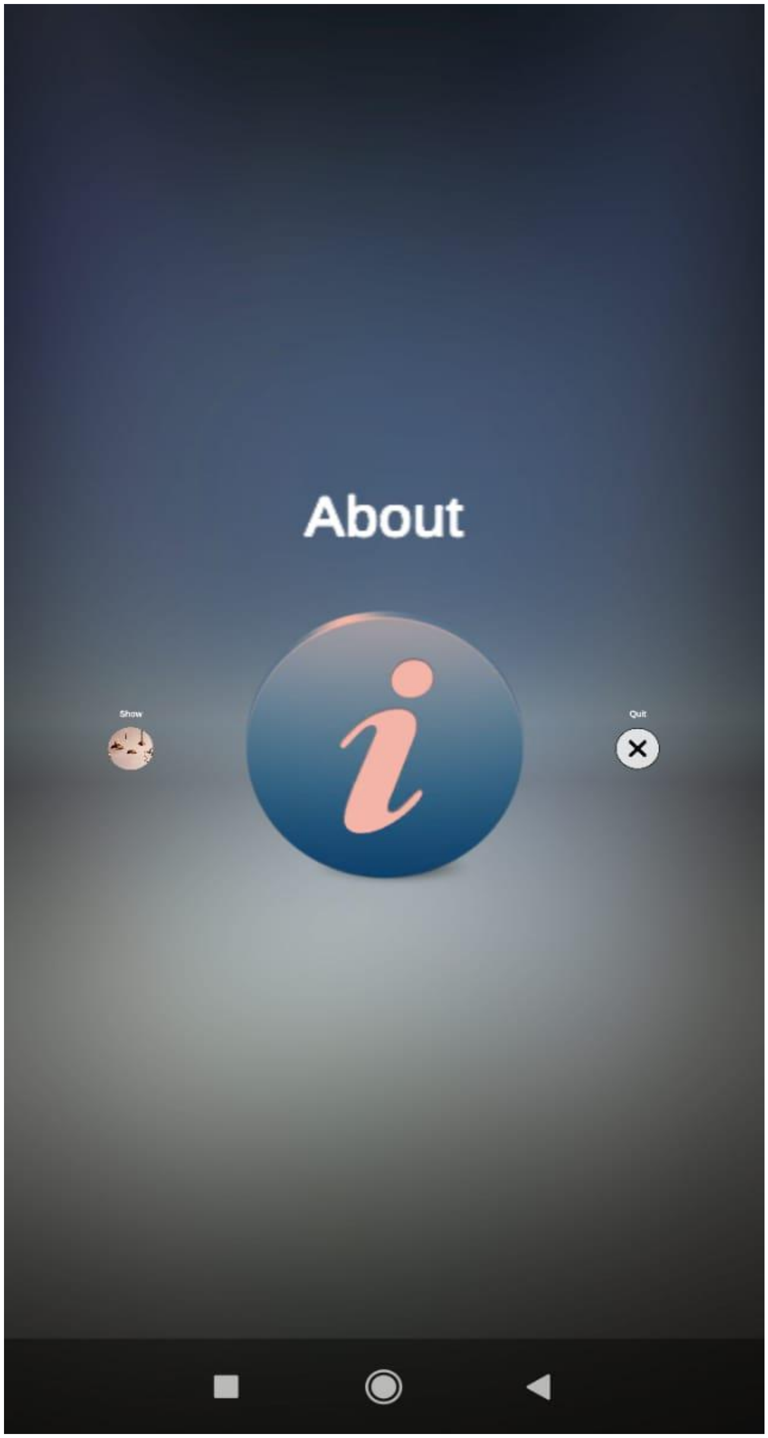

Figure.22 About button

5.3 Quit section

This quit will out the user from TU7FA immediately

Figure.23 quit button

5.4 Show Section

The show button directly access scene contains a three button to choose between the three categories, Table Lamp, ceiling lamp and wall lamp when user choose a category will be able to select between a list of these category objects and to choose one of them to display and this is example on ceiling lamp

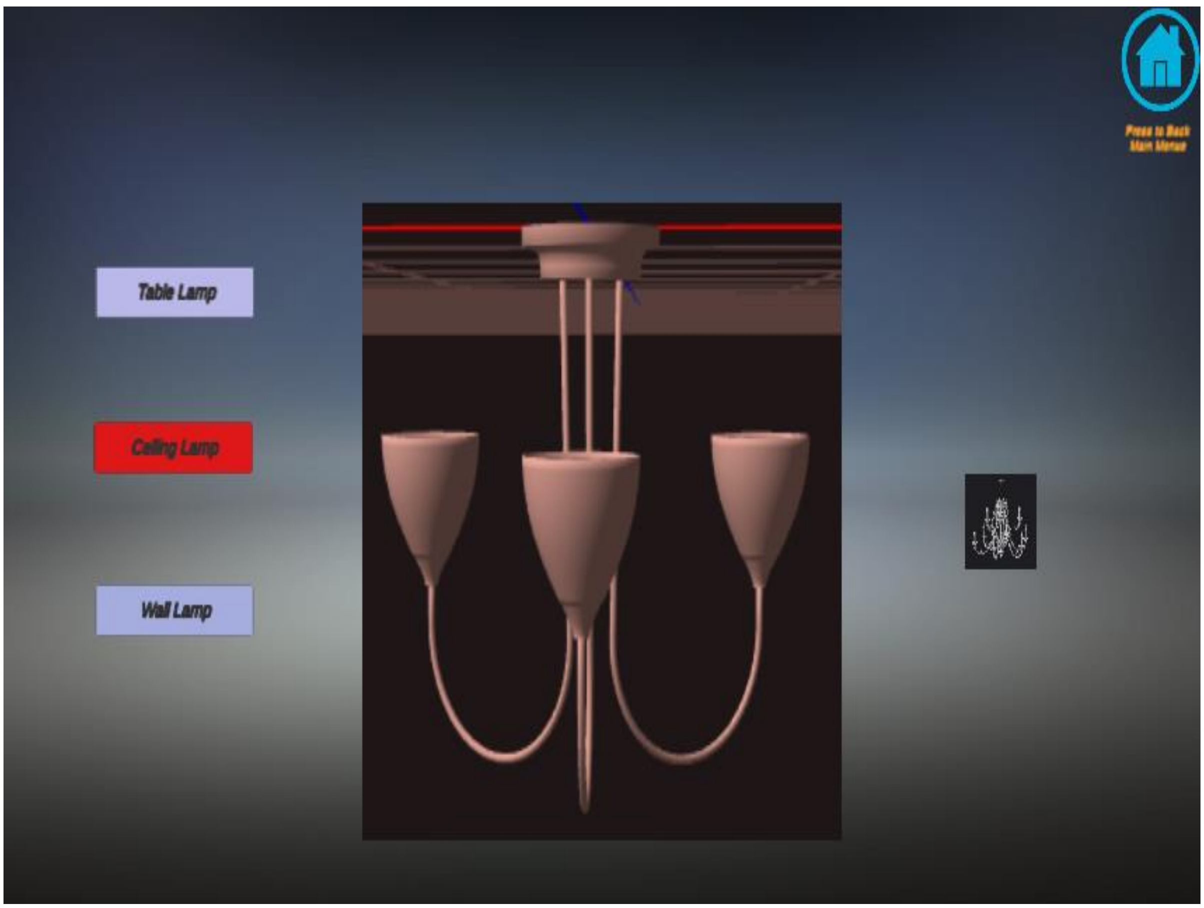

Figure.24 ceiling lamp scene

5.5 TU7FA Model

Ceiling lamp

user can now display the object which chosen previously on the target by scan the image target to place an object in a specific place.

in the figure [25] an example of ceiling lamp place on ceiling based on image target position which already place on ceiling previously by the user.

Figure.25 displayed ceiling lamp

Wall lamp

Now turn to choose between TU7FA wall lamp only the user should press button wall lamp from show scene then just select one of the objects in the list and scan the target to display the object and the user can control the scale, rotation and transformation of the object.

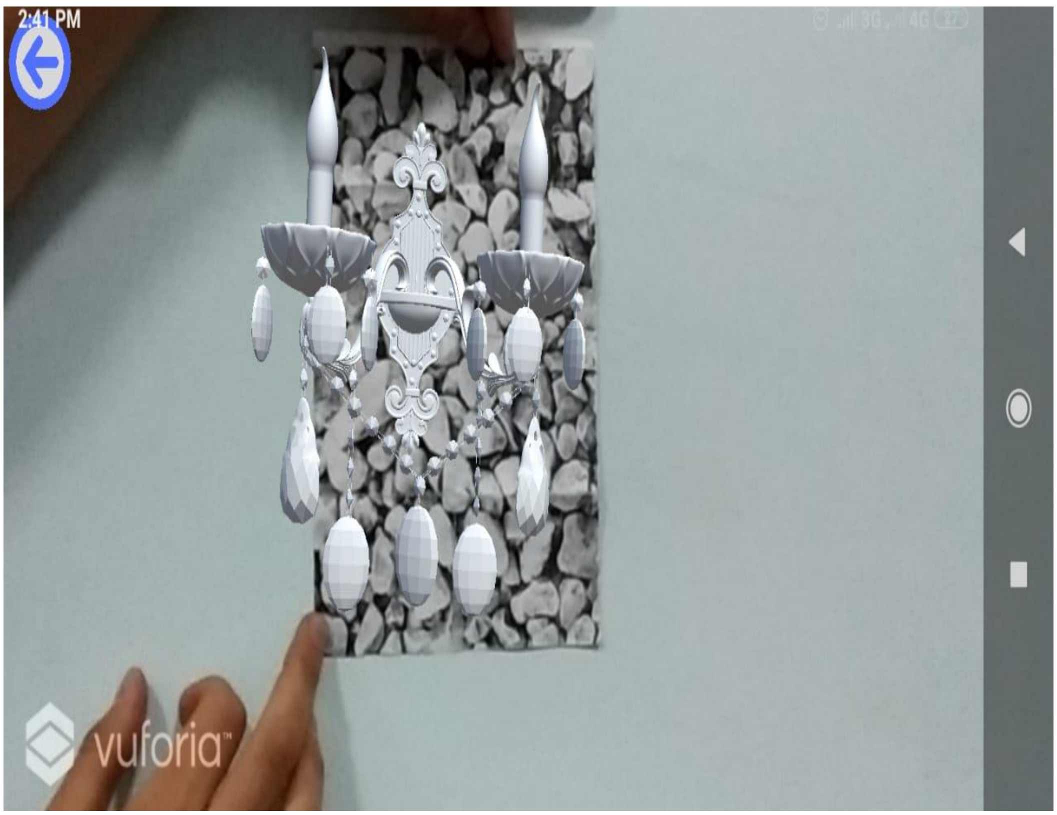

Figure.26 displayed wall lamp

Table lamp

User can display the different object by return to the show menu and choose specific category and select an object to display

Figure.27 displayed table lamp

Chapter Six

Conclusion and Future Work

6.1 Conclusion

AR amplifies actual reality to enhance real time information, which is performed through the provision of additional contexts and content over real information. As it was mentioned in this documentation there are different types and different techniques and can build a very different AR system, application and games with AR, such that AR Actually Widely Used in Multiple Industries Like Healthcare, E-commerce, Architecture and Many Others, as all of this varieties we developing AR System based on Vuforia Marker based Technique, TU7FA An Offline Application That Using Augmented Reality in Marketing That Enable User to Visualize How Virtual Accessories Would Look in Given Space.

According to an intensive research we figure out that vuforia marker-based technique despite it have many disadvantages it will the most appropriate AR technique for our essential objective, that developing an offline application simple to use and have a compatibility to be available on any smartphone with any operating system or any potential.

The application is tested, the result was acceptable such that the object is appears very stable and located within the scene and with some option can be attach the model to the floor, wall or ceiling.

Since every new technology comes with its own set of challenges and limitations. Augmented reality (AR) is no exception.

6.2 Future Work

AR will further blur the line between what's real and what is computer generated by enhancing what we see, hear, feel and smell. AR has a great future as it promises better navigation and interaction with real and virtual world in ways which has previously been unimaginable.
According to a Statistic forecast, the market of augmented and virtual reality is expected to reach the size of $215 billion in 2022.

As a Tu7FA developers' team we looking forward enhancing the application in many ways.
First, we intended to extend the app to cover IOS platform to achieve wider dissemination.

In the Next step create a Cloud contains more models so that the user can only download the pieces that want to check it.

The mainly step we aspire to accomplish that to contact different furniture shops and companies to create our own model for their products such that we Will be the link between User the user and the accessories stores

TOOLS

We are planning to use the following components for developing an application that can run on smartphones

- ## Unity

Unity is a graphics and physics engine that is used to build scale-able applications that can be built for multiple platforms with the same codebase. Supported platforms include Linux, Mac, Windows, iOS, Android and WebGL.
Unity also allows the user to select a graphics API of their choice (DirectX 9, Direct X11, Direct X12, Vulkan, OpenGL, Metal, OpenGL ES 2.0, OpenGL ES 3.0, WebGL 1.0, WebGL 2.0).
Unity uses C# for internal scripts and logic.

- ## Vuforia

Vuforia is an SDK that provides detection and tracking of image targets by using feature detection. A feature is any point in an image that is on the edge of multiple coloured sections. A coloured cube has 4 feature points. It was available as a plug-in for Unity and has been integrated into the engine with the release of Unity version 2017.2

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