

**KAUNAS UNIVERSITY OF TECHNOLOGY**  
**INFORMATICS FACULTY**

**Suriya Prakash Sekar**

**LOCATION DETECTION USING IMAGE RECOGNITION  
TECHNIQUES**

Master's Degree Final Project

**KAUNAS 2016**

**KAUNAS UNIVERSITY OF TECHNOLOGY**

**INFORMATICS FACULTY**

**LOCATION DETECTION USING IMAGE RECOGNITION  
TECHNIQUES**

Master's Degree Final Project

**Project made by**

(signature) Suriya Prakash Sekar

(date)

**Title of programme (code IFM-4)**

**Supervisor**

(signature) Assoc. prof. dr. Tomas Blazauskas

(date)

**Reviewer**

(signature)

(date)

**KAUNAS, 2016**



## KAUNAS UNIVERSITY OF TECHNOLOGY

Informatics Faculty

---

(Faculty)

Suriya Prakash Sekar

---

(Student's name, surname)

Final Degree Project (P000M106)

---

(Title and code of study program)

"LOCATION DETECTION USING IMAGE RECOGNITION TECHNIQUES"

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## **SUMMARY**

Finding location using image recognition method is a new emerging technique. This technique is used to find the precise location inside the building. In the absence of GPS inside the building it is difficult to find the location inside the building due to lack of LOS (Line of Sight). Finding the location outside the building will be precise by using this location detection application. Cloud database is used to store the image using Vuforia Target manager. Cloud server is also used to recognize the image.

In this work we are analyzing about the image recognition efficiency inside the building environment. Precise location inside the building is analyzed using points of interest method. The distance of the image to recognize is analyzed by experimenting the related distance of the image. When we move outside the building the location precision is analyzed by points of interest method. The long distance image recognition is analyzed by moving far away from the building and experimented. The angle of variance of the image can be analyzed by taking the angle points over the distance of the building. Results we achieved from the experiment tasks are image recognition in this environment is better while using this application and Maximum of 1.5 meters away from the image can be recognized efficiently. The result of the experiment task outside the building has better image recognition in outside environment. The maximum distance a image can be recognized outside building is 35 meters with the efficiency of 100%.

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# INTRODUCTION

Location detection using image recognition technique when there is no GPS connection inside the building or outside the building. In this work, we are going to say about what is the tool and technique used to recognize the image. Finding location without GPS makes it difficult. Discussing all the techniques used to recognize the images. Finally straight down finding the technique is which works with our tool and software is efficient. Discussing the tools used to recognize the images, as far as we are using android mobiles to recognize the images. Checking the hardware and software details of the mobile which is compatible with the application.

The detailed analysis of the images and feature extraction gives how the images are recognized. There are certain limitations and postures used to detect the image. Cloud storage is one of the fastest growing storage devices where it was used in many fields. It gives the access to the server if we have an internet connection in the mobile. The data can be retrieved without having any storage device with us. Researching on how the image is recognized in the real-time scenario. There will be some problems while recognizing the image, checking on some limitations over the image how it should be used and how it should be taken. In this case, it is about the distance, in the particular distance the can be recognized perfectly. Checking on different distances and positions to give the better results of location using the points of interest method. The Point of interest is like taking the number of viewpoints for the image to make location specific. More specification of places takes lots of data to upload. Making efficient values of data to make it economical.

Here object recognition also works around for some images. It depends on the place and a number of photos available to take for the location. We can also take some of the objects like chair, table, and door, window with some design or curtain. These types of images can be used to recognize by object recognition method. Here come the pattern recognition methods. There are 8 methods of pattern recognition.

- Classification Algorithm
- Clustering Algorithm
- Ensemble Learning Algorithm
- General Algorithm for Predicting Arbitrarily Structured
- Multilayer subspace learning algorithm
- Red valued Sequence Labeling Algorithm
- Regression Algorithm
- Sequential Labeling Algorithm

Working on these types of the algorithm gives a suitable algorithm for our project. It will be checked by using it in the tool. The tool which we employed in this project is Vuforia. It is a tool that was utilized for augmented reality software development kit (SDK) for Android mobiles. It uses computer vision technology to recognize images and 3d targets in real time. It can be worked on c++, java, and android platforms. They are providing multiple usages of image oriented fields.

Location detection is to locate the person and objects in an area or region. Locate the coordinates or position of the objects by gathering the information using some system. In this work, we are using image recognition system to find the location of the person and objects in both inside and outside the building. Location detection is a technique which is so important nowadays to locate the objects in an unknown area. To locate the person and objects by conducting experiment tasks in this work.

## **AIM**

The main goal of this work is to find the location of the individual inside and outside the building. Calculate the efficiency of the image recognition in the taken environment. Create a table and produce the result for the experiment tasks in this project.

## **TASKS**

The final result of the project can be achieved by conducting experiments in the taken environment using the system we created. The experiment tasks are separated into five main tasks, they are

Task 1: Find precise location inside the building.

Task 2: Calculate efficiency of the distance image recognition inside the building.

Task 3: Find precise location outside the building.

Task 4: Calculate efficiency of the distance image recognition outside the building.

Task 5: Calculate efficiency by the angular variance outside the building.

## 2. ANALYSIS PART

In this project, we are going to analyze the location detection of the person inside the building and outside the building. Also, analyze about Methods and technologies used previously to find the location inside and outside the building. Analyzing the tools used to deploy the concept of finding the location in this paper. Analyzing the methods applied in the previous work to determine the location detection in indoor and outdoor. We have a brief description all the methods and tools that we are going to analyze in this paper.

### 2.1 INDOOR POSITIONING SYSTEMS ANALYSIS

Indoor positioning systems are emerging technology in this era. Detecting the position of the person in the absence of GPS inside the building is very tough. In this part, we are going to analyze the technologies used in the indoor positioning.

#### 2.1.1 3D Indoor positioning using MEMS sensor

In this paper, the method used as the Micro-Electro-mechanical System (MEMS) to find the position of the user inside the building. The result of the location was improved from 2D to 3D view of the user walking in the building. In the previous work, they used the barometer to find the user walking location. It is hard to find the location of the user, and it has more error rates compared to this project. In this project, it has very fewer error rates and higher efficiency because of fusing barometer with an accelerometer in Kalman filter. The error occurred during the real-time experiments is 1%, the total distance traveled has less error than 1% in positioning the user.

In this paper, the author used Zero velocity update (ZUPT) algorithm to find the walking position of the user inside the building. It is used to eradicate the data drift errors in the positioning space. By using this algorithm, it is easy to get the accurate height of the user walking inside the building. The system architect is shown in the Figure 1. In the future by fusing gyroscope to the Kalman filter to get the long time stable orientation and position with the wide area will be increased.



**Figure 1 System of 3D Indoor Positioning Using MEMS Sensor(1)**

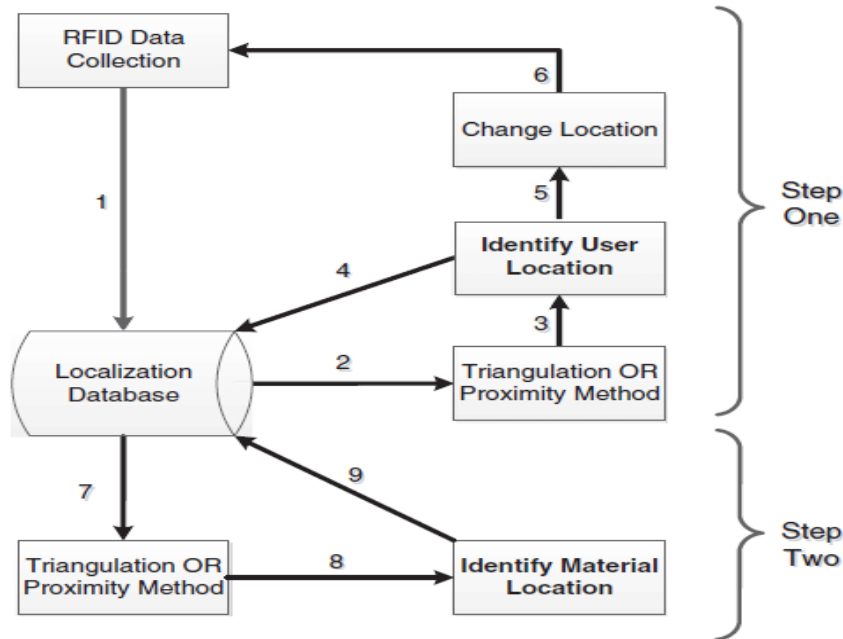
#### 2.1.2 INDOOR LOCATION USING RFID TECHNOLOGY

In this paper, the author faced a problem in construction building that how to locate the materials and working people inside it. Due to poor GPS signal inside the building finding the location inside the building is necessary. Using passive radio frequency identification (RFID) and ultra high frequency (UHF) to achieve the location on the site of construction building. Two-step algorithm method is used to determine the location of the worker and material in real time.

The worker will tag around the RFID tag with him within the prescribed zone of working we can find the motion of worker and equipment surrounded in that zone. Received Signal Strength Indicator (RSSI), Angle of Arrival (AOA), Time of Arrival (TOA) methods to measure the signal sent and received by the RFID tag in that zone. It shows that it is the low-cost method to find the location of the person inside the building. However, this is a bit costly to put the RFID tag and scanner to find it. In image recognition project we use android mobile to find the location by just taking the image of the

surrounding location. The result of this paper has 1.0 meter mean error and 1.9-meter error for worker location in the building.

Proximity and triangulation of two localization methods are used to determine the location of the worker. The scene analysis method is used to find the location of the signal source. Triangulation is used to predict the location of the object surrounds the zone. However, it requires an enormous amount of data to process for finding the location. The main disadvantage of this method is path loss model has to generate for each type of the RFID tags when triangulation method was used. Unrestricted noise signal and the potential effect of the device between tags and mobile user. The typical two-step algorithm is shown in the Figure 2.



**Figure 2 Process of RFID Technology in Indoor Positioning(13)**

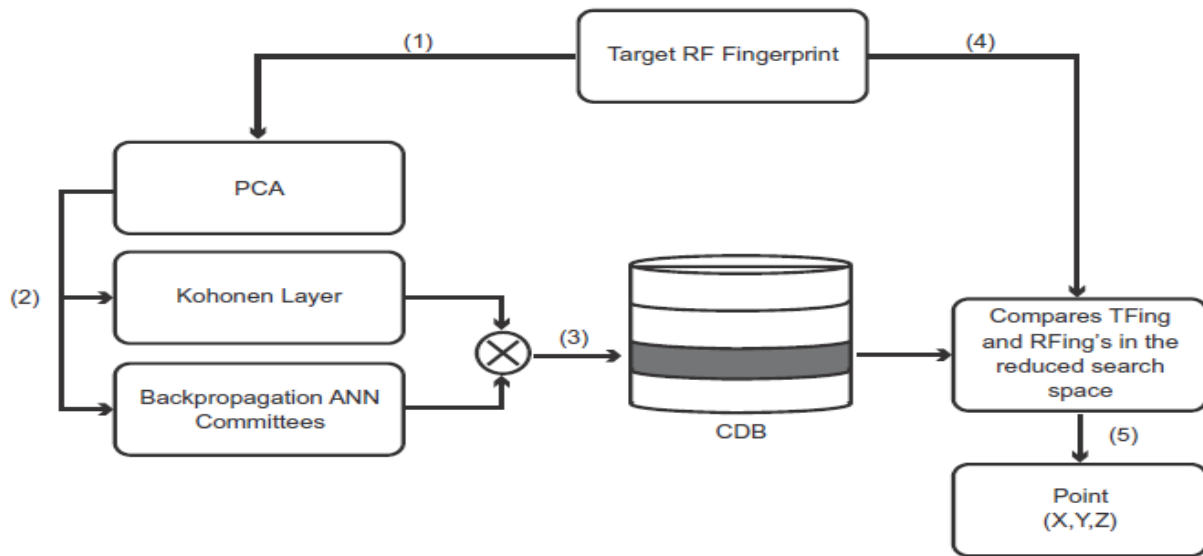
### 2.1.3 Wi-Fi multi-floor indoor positioning system

In this paper, author Rafael Saraiva Campos used Wi-Fi nodes to find the location of the user in the multi-floor building. Radio- frequency (RF) fingerprints are considered to be the target which can be measured by a mobile station (MS) is to be isolated. After the measurement of RF targets it will be matched with the pre-collected data stored in the correlation database (CDB). To find the position of the mobile station in the wireless sensor networks using Database Correlation Method (DCM). The system of Wi-Fi multi-floor indoor positioning system is shown in the Figure 3.

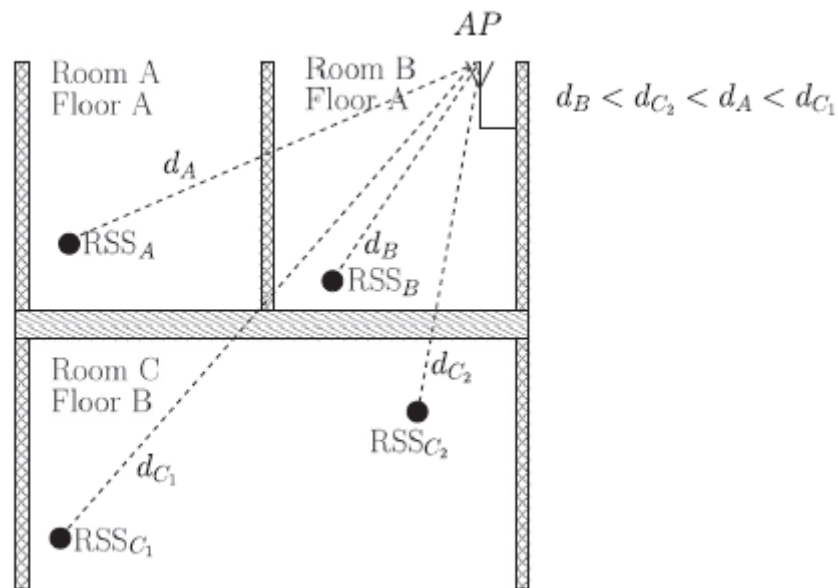
K-medians and Kohonen layers autonomous clustering and Artificial Neural Networks (ANNs) technique is used to increase the efficiency of localization accuracy. In the bigger corporate building, there will be more Wi-Fi routers used it is like a densely populated Wi-Fi access points (AP). Most of the devices like mobile phone, tablets, and wearable devices are Wi-Fi facilitated. For accessing the RF targets, the user needs to get the device permission to make this as MS points to access it. This type of method is used to eliminate the possibility of data leak in the network. The indoor planner positioning is shown in the Figure 4.

The small planner errors can be neglected when they are not in the use. If the usage area was wider than the working environment, then the MS should be in the range of 3 to 5 meters. It leads to more errors while calculating the location inside the building. In this paper, they stated that the efficiency was about 191% to 97%. The average position of the 2D image was scaled from 4.5m to 1.7m. In future author

proposed to use a hybrid database which stores the measurement from all types of networks like Wi-Fi, Zigbee, 2G and 3G cellular. The compressed sensing leads to low data.



**Figure 3 Wi-Fi Based Indoor Positioning System**



**Figure 4 RFID Tracking Inside the Room(5)**

### 2.1.4 SMARTPHONE-BASED INDOOR NAVIGATION SYSTEM

In this paper, author Olaf Czogalla used Smartphone to provide the navigation inside the complex structure of the transportation buildings. The travelers who are new to the city with complex transportation building finds difficult to navigate them inside the building. With this technology, they can navigate inside the transportation building.

Essential features of the Smartphone are used to acquire the data for dead reckoning system; they used Bluetooth, camera, pressure sensor and Wi-Fi for collecting data. For the multilevel building they use geographical surveys and Open Street Map data to create an escape route for the building during an emergency. The system uses the gyroscope, accelerometer, and magnetometer sensor to detect the step of traveler and heading direction. After collecting all the data, the user embeds the data into the Feed the Location (FOC) component. Pathfinder component uses breadth-first path search between the start and end of destination coordinates to evaluate reachable distance and transfer points between various levels of the complex building. The hexagonal shaped grid network was engendered, and this structure is used in Simultaneous Localization and Mapping (SLAM) to monitor the hurdles inside and outside the building. The workflow of smartphone based indoor navigation system is shown in Figure 5.

The QR code is used to get the maps inside the building from the information center. The QR code will be generated to access the data from the internet. It can be easy to access by the travelers through an internet connection.

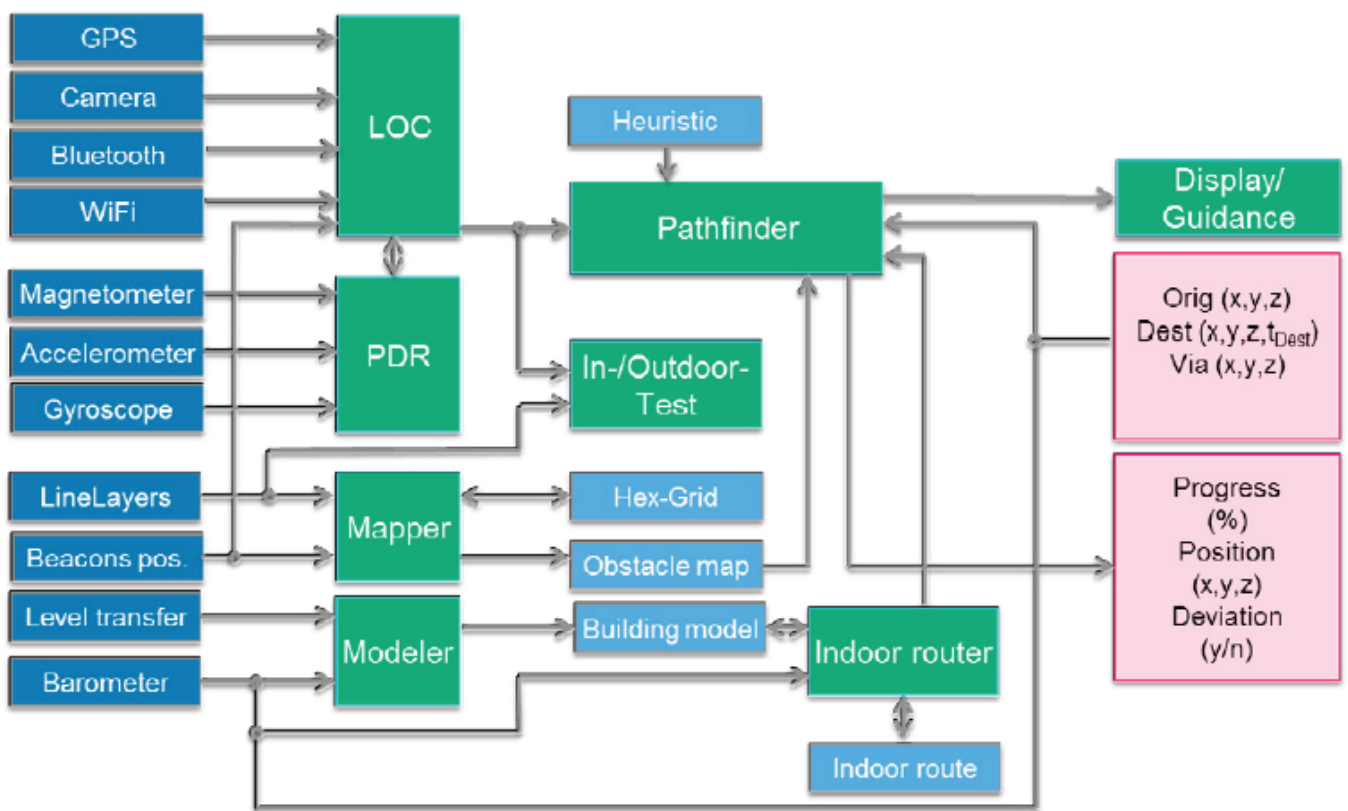


Figure 5 Workflow of Smartphone Navigation System (8)

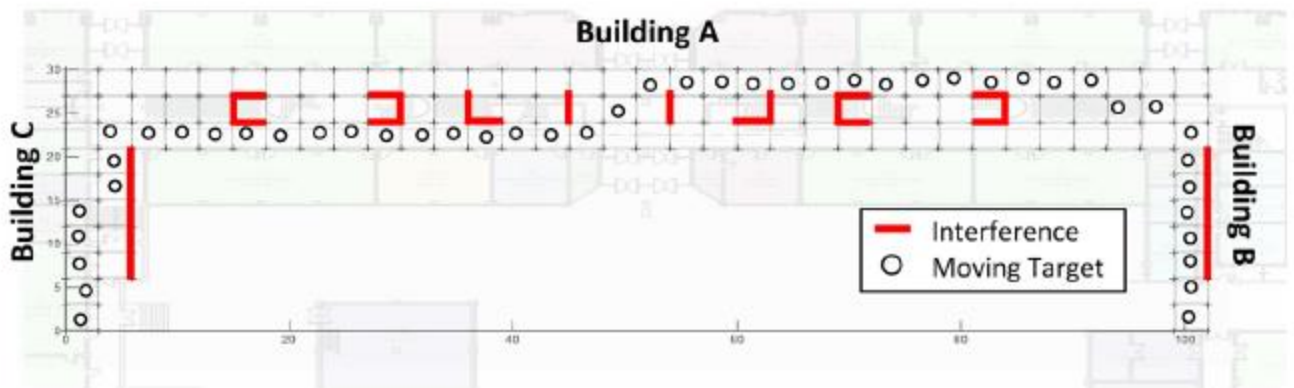
### 2.1.5 RSS BASED INDOOR LOCALISATION WITH PDR LOCATION TRACKING

Indoor localization technique was achieved by classic ways like radio frequency signals, sensors, geomagnetic field and sensors. The Received signal strength (RSS) method is which was used in finding the indoor localization. The accuracy of this method was degraded due to Non-Line of Sight (NLOS). The line of sight is most important to the signal receiving and transmission side. Received signal strength is collaborated with PDR location tracking for the better detection of indoor localization.



RSS method was mainly based on Time of Arrival (TOA), Angle of Arrival (AOA), time difference of arrival (TDOA). These measurements are used to find the indoor localization technique. The least square method is added to the RSS method to estimate the location. It does not require radio map for location estimation. While using the least square method to contain the LOS conditions, PDR location tracking is used to contain the NLOS conditions.

RSS-LS method is used to reduce the error caused by LOS conditions. It was combined with PDR to make the localization estimation accurate and efficient. This method mainly proposed to reduce the errors caused by LOS and NLOS. In future work is to improve the new detection algorithm which can maintain the accuracy even if multi-interference NLOS conditions.



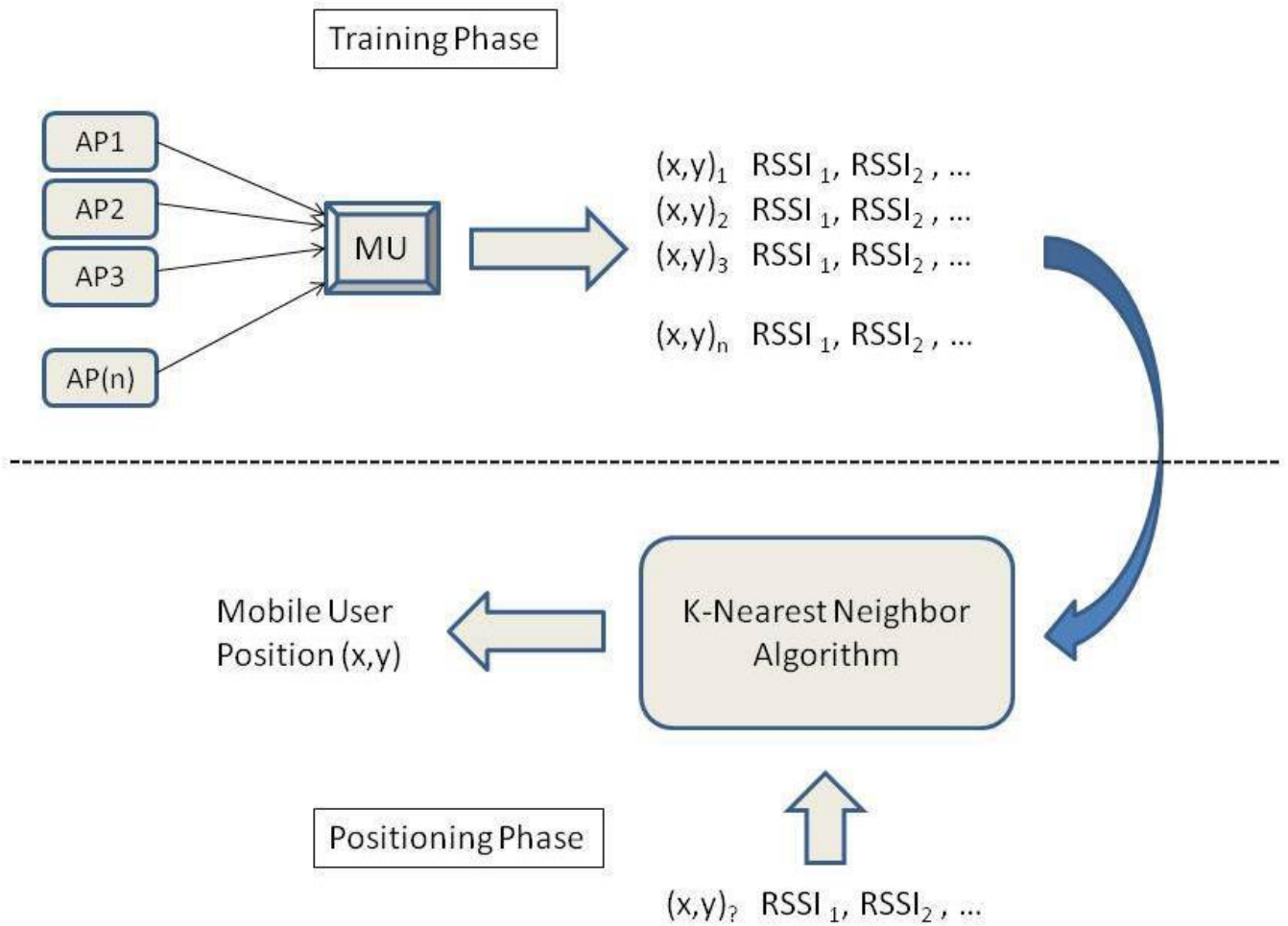
**Figure 6 Points of Interest inside the Building**

### **2.1.6 IEEE 802.11 WLAN Based real-time indoor positioning**

The indoor positioning is made the world turn around to see what it can do. The researchers and industrialists are working on the indoor positioning to find the accurate location of the person. To attain the accurate location detection in indoor, we must use additional devices which cannot be afforded by the low-level organization. Additional equipment makes the device costlier and unavailable for everyone. To reduce the cost of the additional device, they used the existing technology to find the indoor location.

WLAN technology inside the building is used to find the indoor location. WLAN will be spread all over the building for providing a network connection. When using the WLAN technology to find indoor location makes the indoor localization very cheap as this was used in many devices like desktop PC's, mobile and tablet. GPS cannot find the exact location of the person inside the building due to Line of Sight (LOS). It misses the LOS due to the various disturbances like building, weather and noise. The phases of this work is shown in Figure 7.

The WLAN protocol which was used in this WLAN indoor localization method is IEEE 802.11. The tradition protocol which known for years without any doubt. This technology was used in almost all the devices which we use in every part of working with mobile, desktop, tablets, etc. when installing a method in a place one have to analyze the environment issues carefully and take more conditions and limitation before deploying the devices.



**Figure 7 Finger Print Approach in WLAN Method (11)**

### 2.1.7 Summarize

The above discussion proves that the location detection inside the building can be achieved by different methods. These methods lose the precision about the location inside the building. Image recognition is a new method to test the location detection inside the building. As we know, location detection outside the environment can be located by GPS. In the absence of GPS, it is tough to find the location. There is a loss of precision while using GPS tracking facility. To overcome those problems we are going to test this application by conducting experiment tasks.

## 2.2 IMAGE RECOGNITION METHODS

In this section, we are analyzing the image recognition methods used to detect the images. In this project, we are going to find the location by using image detection method in that case we need to analyze which image recognition method is suitable for this project. We are going to analyze, how the images are detected and how efficient the algorithm works. We will discuss in detail about the methods used to detect the images.

Image recognition is a method which comes under computer vision, machine vision and image processing problems. This method is used to find the various objects present in the images. The objects in the images can be detected even though the object is scaled, rotated, sheared and resized. The image

recognition methods consist of various algorithms and technique to find the objects in the images. The algorithms which are used to detect the images are analyzed in this section.

### **2.2.1 Pattern recognition**

Pattern recognition is the method used to recognize the object and images by recognizing their patterns. Patterns are straight which has some similar shape or similar features to match and detect the object. Pattern recognition can be used for machine learning purpose. Pattern recognition method can be trained by the previously measured data. It works like artificial intelligence. Some of the algorithms can be used to study the process of discovery of an unknown pattern of the object. It is tough to separate the pattern recognition, knowledge discovery in databases (KDD), data mining and machine learning. It has its equal reputation in the engineering field.

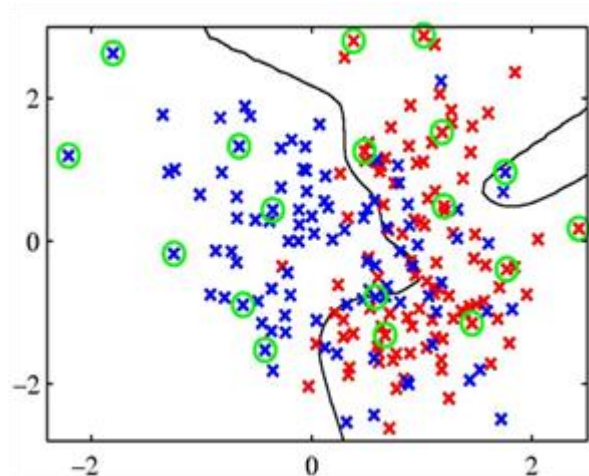
The input values given by the pattern recognition are different in statistical problems. It provides a result for all the combination of input values. It mostly matches to the input value which is taken already. It also looks for a perfect match of the input values in the pre-stored pattern databases. Regular expression matching is similar to the pattern recognition matching. Pattern matching method was widely used in the word processor for sentence and word matching process. By using learning algorithm, everyone who uses the pattern recognition method can provide the better results in the end. The pattern recognition technique is shown in Figure 8(10).

Algorithms used in the pattern recognition method are

- Classification algorithm
- Sequential labeling algorithm
- Regression algorithm
- General algorithm for predicting arbitrarily structured
- Clustering algorithm
- Multilinear subspace learning algorithm
- Ensemble learning algorithm
- Real valued sequential labeling algorithm

#### **Uses of pattern recognition**

- Pattern recognition method is used in the medical field to guide with interpretations and finding of damaged part of the body.
- Used in the defense system to navigate the troops and recognize the targets.
- Used in the traffic applications to detect the number plate and type of the vehicle.
- Used in the security purpose of matching the fingerprint pattern and facial pattern
- Used in the forensic to find the dead person and objects in the scene.(9)



**Figure 8 Pattern Recognition (25)**

### 2.2.2 Blob detection method

Blob detection method is used to find the regions in the image. To find the regions in the image this has different properties like color and brightness around the image. The points in the blob detection method were same as each other which is also a constant or approximately constant. Blob detection method was classified into two types they are

- Differential method
- Local extreme

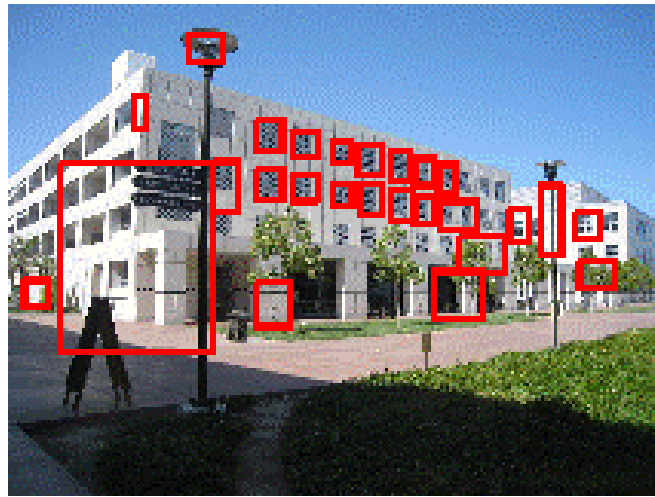
Differential methods are the method based on the derivative of a function in respect of the position of the images. Local extreme is based on the values of local maxima and local minima function. Blob detection can be named as interest point operators or interest region managers. This method was raised due to the flaw in edge detection and corner detection algorithm. Those algorithms cannot provide information about regions so that blob detection method came.

After getting information on regions from the blob detection method, then the application move to the next process. The regions in the image can provide important information like the presence of the object and parts of an object present in the image taken. This was used in the object tracking and recognition application. It is also used in the histogram of Photoshop to find the regions of the objects in the image to change the contrast values. It is also used in the search for the peak value and segmentations in the region of images.

Algorithms used by blob detection are

- Affine adapted differential blob detectors
- Lindeberg's watershed-based grey-level blob detection algorithm

The basic algorithm used in blob detection algorithm is filtering the Gaussian at various scales which can be attained by repeated filtering the same Gaussian which we used. The image filtered using one type of scale can be reduced by image filtered at previous scale and also finding the minima and maxima points of interest. The blob detection method is shown in the below Figure 9(16).



**Figure 9 Blob Detection(22)**

### 2.2.3 Feature detection

Feature detection method is using the key points in the image for detection and tracking. The key points of the image can be extracted by feature extraction method and stored in the database. When tracking the image through scanner or camera the key points or features of the image will be scanned and matched with the previously stored key points in the database to find the image. The key point is a point which is a small circular region which is different from the surrounding regions of that point. If the edges are sharper better, the key points are, usually edge points act as end points. Points will have the gradient directions which are surrounded by another point. The gradient direction will be from in or out.

Feature detection method is used less in the image processing operation. This method first examines the pixels in the image to find there is any feature present in the pixel. If it is a larger algorithm, then it searches for the features in the regions. To find the better features in the region we use Gaussian method to smooth the image and process multiple image features.

The computational speed of the feature detection algorithm is complex. Time constraints are heavier while using this algorithm. Because of these limitations, the algorithm can find only certain parts of the image features are detected. Feature detection algorithm was used as the starting step for most of the computer vision algorithm.

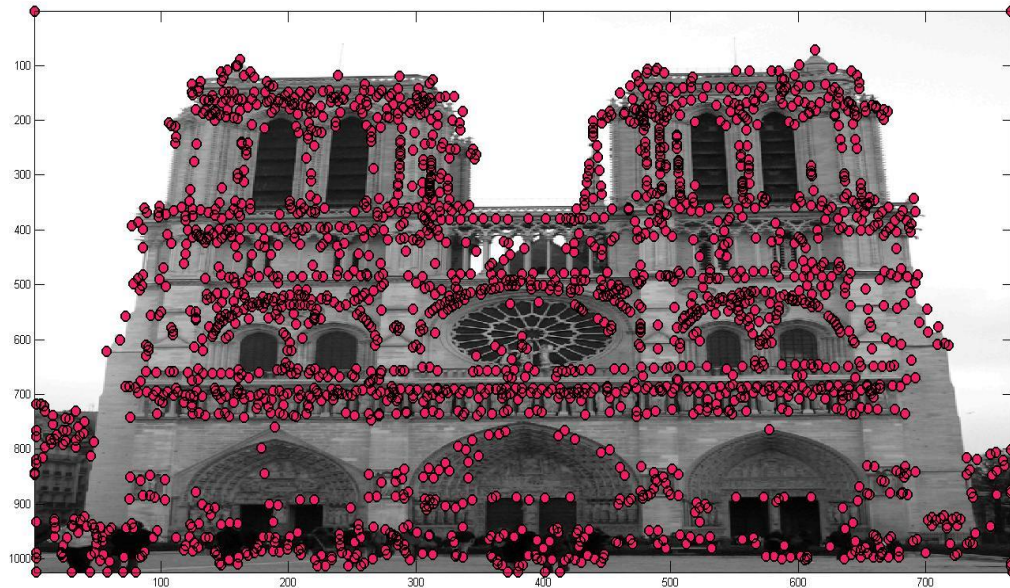
There are four types of image features in feature detection they are,

- Ridges
- Corner points
- Edges
- Blobs or region of interest points

Ridges method was used for the scaled objects which are also a grey level image in the medial axis. It can be viewed as one-dimensional curve from the viewpoint which shows the axis of symmetry. Corner point has the local two-dimensional structures in the region of the image which has a point like features. It starts with the edge detection and moved to the corners to find the features.

Edges are like the boundary line between the two images which looks distinct. The regions of images are splitting the image and find the edge in it. Edge possess the strong gradient magnitude to find the features. By connecting the high gradient magnitude points the complete region of an image can be formed. Feature extraction is shown in the Figure 10.

Blob method gives the regions of the image in reciprocal to the features provided by the edge method. Blob method uses the blob detectors to find the regions in the image which is smooth. Blob detector is used to find the regions of the image by selecting the edge or corner of a picture. Some of the properties of the blob detector can detect the regions of images which are on different scales. There are various blob detectors are there, MSER, PCBR, SUSAN, FAST, and Sobel (12)(6).



**Figure 10 Feature Detection (18)**

#### **2.2.4 Texture analysis method**

Textures are categorized into complex visual patterns and characteristics like color, size, shape, and brightness. The texture is nothing but grouping a same type of features in a single image. Local sub patterns posse's properties like linearity, density, randomness, phase, frequency, and smoothness. Texture analysis method has for major problems are listed below.

- It 's hard to generate a 3D surface geometry from the texture information through analysis.
- Segmentation of images into separate regions despite the homogeneous texture is difficult.
- Finding the texture properties by calculating the features in the digital image.
- Finding the difference between the homogeneous texture regions of image from the physically defined class.

Feature extraction is the starting stage of the feature analysis method. The results from the feature extraction are used to process the images for texture analysis stated above. Feature analysis is done by four methods they are,

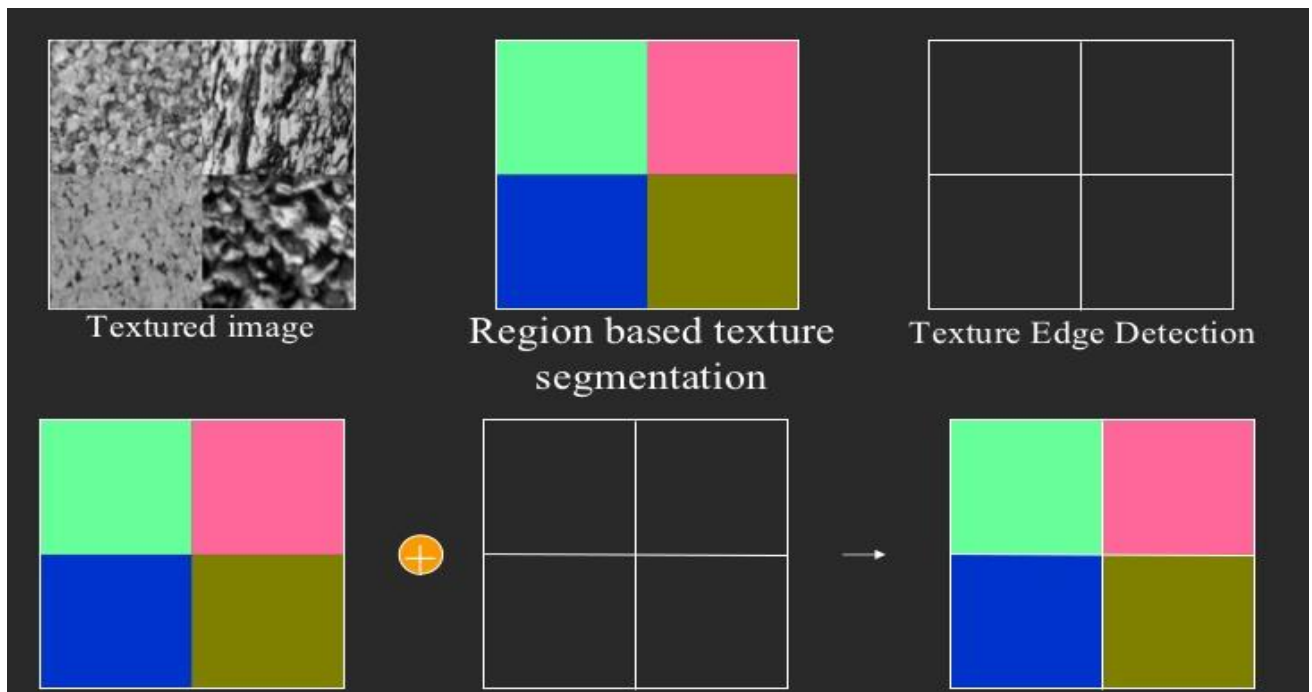
- Transform
- Statistical
- Structural
- Model based

The structural approach is based on the well-known primitives and hierarchy of spatial arrangements. The placement rules and primitives are required to say about the texture. The symbolic description of the image can be given by the structural approach. It works well on synthesis process. By having different micro, macro and non-clear perception between them makes the dead defined for natural textures.

Model-based uses the stochastic and fractal model to interpret the digital image texture. By using stochastic model and productive image model, we can interpret the image texture. The framework of the model was calculated, and the values are used for texture analysis. It is not good for explaining about local image structures and loss of orientation selectivity. Transform model uses Fourier and wavelet transform to mean a picture in space whose coordinates systems are interpreted and used for texture analysis. Fourier transform is not good to work in practical for texture analysis. Wavelet transform has multiple advantages in finding texture analysis.

Statistical is not taking the hierarchy seriously for texture analysis. However, they represent the image indirectly by non-deterministic properties of a grey level image. To achieve the higher discrimination rates than the power spectrum by using the second order statistics method. The discrimination process is spontaneous if the texture in a grey level image was used. The statistics of second order is more important than the first order in the texture analysis. Depth of texture analysis method is shown in the Figure 11 (15).

By analyzing all the methods used for image detection process we conclude that feature detection method is more reliable and spontaneous to find the image match. Feature detection just needs the part of the image feature to detect and track image easily. It also uses the image track and detect in a single algorithm which makes the interpretation of image work easier.



**Figure 11 Texture Analysis Method (28)**

### 2.2.5 Summarize

From the above analysis, we came to conclusion that there are different methods used to detect the images. Feature extraction method can detect the images of irregular shape and size. This method can detect the images by extracting the features of the image and match the feature of the scanned image. The other methods can also detect the images, but they have a problem in finding the complex image structure. The main advantage of using feature extraction method is that it can detect the complex structures easily.

## 2.3 TOOLS ANALYSIS

In this section, we are going to discuss in detail about the tools used to deploy the project. Analyzing the different platforms that it can work and check the durability of the tool. We should be more focused on what is more required for our project. We need to analyze about cloud recognition method and image tracking ability of the tool. By using the image recognition method analyzed in the previous section can be implemented in the tool to detect the image. It should also include the cloud service for storing and tracking the image and also compatible with the image detection algorithm.

### 2.3.1 Metaio

Metaio SDK is commutable groundwork which has various components like sensor interfacing, rendering, tracking and capturing. Metaio SDK can interface between the application and commutable components. Metaio SDK can work on all the platforms like IOS, Android, Windows, and Unity3D. It backup the platform specific interface to interact with any development environment. It has so many important features to work on the Android platform. It mainly works with a Marker, QR code, barcode and 3D tracking.

Features:

- High calibration of abstraction which makes the developer to think that low-level application, design, and implementation in great comfort, improved productivity and efficient.
- It has an efficient scripting language which interacts with augmented reality to the base of XML, HTML5, and JavaScript which is AERL.
- It had efficient 3D rendering engine and improved tracking to develop the application free of visual artifacts with low time and low-cost devices.
- The contemplation of OpenGL will support the 3D model to load directly makes it work faster and efficient use of Smartphone device resources like memory. It also reduces the I/O load time (23).

### 2.3.2 Vuforia

Vuforia is a platform which uses improved, durable and efficient computer vision technology. It provides multiple features like mobile application and frees the technical limitation for the developers. Vuforia consists of target management system which is used to store and process the targets for feature extraction. It has targets like image targets, user defined targets, multi targets and text targets.

The images which was used for processing is stored in the cloud through target manager by creating a database. It uses cloud and device database for the storing of images. Vuforia uses tracker detection algorithm for detect and tracks the images which are uploaded in the cloud. When the images are taken through mobile and send to the Vuforia engine which identify and track the images in the real world.



Vuforia SDK supports native development application for both Android and IOS. It does not support for Windows and web development. Unity application also supports both the platforms and used for gaming consoles.

Provides numerous features for the developers like bringing back life to the toy, insufficient details of the images can be recognized easily, creating normal AR experience which works anywhere, detects objects like cylinder and boxes (21).

### **2.3.3 Wikitude**

Wikitude is a tool used for augmented reality which provides the key to Wikitude SDK, studio, Wikitude app and cloud recognition. Wikitude SDK is the crux of the augmented reality key set which is used to create robust augmented reality mobile application. The recent version of the Wikitude SDK has extra features like geo-based AR, tracking, extended 3D modeling, presentation layers and image recognition.

Wikitude is compatible with smartphones, tablets, and digital eyewear. The developer can choose the platform for AR mobile application between IOS and Android. It has the additional solutions like WikitudeStudio which can create AR in web-based platforms. It is easy to use by just dragging and dropping the images, deploys it in a Wikitude application or developer application. A person who does not know programming also can work easily in the WikitudeStudio.

Cloud recognition is another feature which is used to store thousands of images in cloud database and works with image targets of about 50,000 in a quick response time and improved recognition speed. It provides user to choose between the continuous search or scan for the large targets. The Target API, which converts automatically from digital image version to the target image collection. In the business empowerment, Wikitude app can create augmented reality crusade in a short amount of time. When Wikitude app combines with WikitudeStudio, this makes the user to create an AR very easily in a matter of time (27).

### **2.3.4 D’Fusion**

D’Fusion is a suite which is created by total immersion. D’Fusion is a tool which is used all over the world for creating augmented reality. It is accessible by many numbers of devices multiple platforms. The users can secure the augmented reality contents for a variety of uses like live actions, industrial operations, and interactive marketing.

D’Fusion AR engine can be accessed by tablets, mobile phone, and PC. Total immersion has thinned the line between the virtual world and the real world by using patented technology of augmented reality. D’Fusion Mobile was used for creating a huge capacity distribution of augmented reality on smartphones or tablets. It has new upgraded version of tracking solution have been set up for smartphone and tablets. It also has the 3D rendering and GPS services for tracking technology.

D’Fusion home was designed for desktop PC for a better quality of augmented reality. It helps to lodge the mini games and services for it on the desktop which works without using internet connection. Augmented reality application which uses TI augmented reality Pro SDK for professional use and it has numerous features like using a different type of sensors, HD video, infrared camera and multiple cameras for on stage performance, presentations, virtual screen in meetings.

D’Fusion Studio is the main tool to create the augmented reality applications for multiple purposes. This tool is used to track the real-life scenarios into the 3D visuals. To experience the better-augmented

reality in the home, we use D'Fusion Adobe Flash. It improves the marketing and delivering the brands to the customer through augmented reality (20).

### **2.3.5 ARToolKit**

ARToolKit is a tool which user can create or develop the augmented reality application in various means. Augmented reality can be used in various departments like media, industry, gaming, research and marketing. The root code for this project was deployed in GitHub for various platforms like Android, IOS, and Linux. There will be so many tutorials and sample application code to learn for the beginners to expertise themselves in the augmented reality field.

The features available in the ARToolKit are completely Unity3D and OpenSceneGraph support for gaming. It supports multiple languages and configured for mobile devices. It can track multiple target images simultaneously by scanning and uses the stereo camera. Calibration of the camera can be supported easily by this tool. It also uses feature tracking ability to track the target images stored in the database.

It is tough to create an augmented reality application in the user point of view to align the virtual images as it looks like in the real world. It uses computer vision technology to measure the camera calibration and to show virtual objects orientation. ARToolKit provides guidance to the 2D barcode, square marker, multi-marker and natural feature tracking. ARToolKit is fast and highly precise to create the augmented reality application.

ARToolKit supports video and images augmented reality this makes the images are glaze on the live video which took in the real world. When computer graphics are glazed over the real world video directly is done by optical see-through augmented reality. The features of the tools are similar, but the processing and analyzing differ in a different platform.

Some of the augmented reality frameworks created using ARToolKit are FLARManager, FLARToolKit, NyARToolKit, and SLARToolKit. These tools are created for 3D rendering, custom markers, natural feature tracking and 3D video graphics (24).

### **2.3.6 ARmedia**

ARmedia 3D SDK is a tool which is created only for the 3D model tracking. It can work great with the planar images and also with the complex 3D objects irrelevant to the size and shape of the images. ARmedia rendering engine can render 3D model, track the image target over many targets and for capturing frames from the camera. It also has the interface between the Android and IOS operation system. It is a cross-platform tool in which it can use C and C++.

To work on the ARmedia developer has to take the photo in which user can see the 3D model. Then 3D model is designed should be glazed on the tracker this was created on the SDK server which provides online services. It provides three different types of tracking databases like OpenNI, OpenCV, and natural feature tracking. The line between indoor and outdoor augmented reality is blurred by creating an application in the ARmedia SDK.

It was used in various fields like marketing, gaming, industry and research. It can be accessible only by smartphone and digital eyewear. It will be introduced in Windows and Mac soon. Features provided by ARmedia Augmented reality are tracking the real-life objects into the virtual 3D world by 3D tracking. It can be easily implemented in any other AR platforms by changing the frame to OpenCV Mat

objects and introduce into the tracker. The management of target images was done by cloud database. We can get the better result by changing the configuration in the tracker.

From the above discussion we came to the conclusion that Vuforia Augmented reality tool which meets our requirement for this project. It has cloud source, image tracking ability and it can also provides the online tracking manager to access the images in a cloud database. It has extended tracking, localized occlusion detection. Even if the image is far away, it can be detected and track (26).

### **2.3.7 Summarize**

From the above discussion the tools used for this project should meet the requirement to run the project. Vuforia can detect the image and use the cloud for storing and detecting the image. There are some tools which are better than Vuforia, but it lacks in the main features like cloud server, feature extraction method and easy to use. From this, we are going to use Vuforia tool in this project.

## **2.4 Vuforia**

Vuforia is an augmented reality development kit (SDK). It provides the user to create an augmented reality application for the mobile devices. It uses computer vision technology for recognizing images and simple 3D objects such as boxes in real time. In the virtual world, the objects have to be registered, positioned and oriented as virtual objects such as 3D objects and projection plane. When we view the images through mobile device camera, the virtual images will track the position and orientation of the image in real time. The viewer's perspective object in the virtual world is part of the real world scene (29)(30).

Vuforia is a leading platform for augmented reality because it provides unparalleled reliability, creative empowerment, maximum reach, advanced vision. It provides best class computer vision, ensuring reliable experience in a variety of environments. It provides developers the creative freedom to build a unique experience. It provides support to the Android, IOS, tablets and digital eyewear. The developer can create Vuforia apps in Eclipse, Xcode, and Unity cross-platform games. It can find the wide range of objects in real time through augmented reality and image recognition.

Vuforia provides wide range recognition and they are still improving their recognition limits to find more things simpler and easier. The things which Vuforia can recognize are objects, images, user-defined images, cylinders, text, boxes, frame makers (21).

### **2.4.1 Vuforia Engine**

Vuforia engine was otherwise called as rendering engine which does the process of collecting 2D and 3D models by computer programs through scene files and making an image, the result of this process is called rendering. Scene file consists of defined language or data structure and it also contains geometry, viewpoint, texture, lighting and shading description of the virtual scene. Rendering had been used in design visualization, movie, simulators, video games, TV visual effects, and architecture. The streams which are taken in the process are light physics, visual perception, and mathematics, software development.

In the case of 3D graphics, the process of rendering is categorized into two parts they are pre-rendering and in real time. Pre-rendering is a computationally intense process that is used for movie creation. Real-time rendering is used only for 3D video games which use the graphics card with 3D hardware accelerators for supporting. The techniques used for rendering are ray casting, Ray tracking and scan line rendering and rasterization (29)(30).

## **2.4.2 Vuforia cloud server**

Vuforia provides their own cloud server to store images and metadata file about the images. The cloud storage was linked with the Vuforia software development code, and it has its own server and client password for accessing the Vuforia cloud server. Cloud server works normally as a physical server, but the features are little different from the physical server. The clients are renting a virtual server rather than the physical server for its cheap cost and space. Small scale industry cannot afford for the physical server because the cost and maintenance for the server are more so they are moving to the virtual server called cloud server. The users are virtually connected to the server by using internet connection. It makes the user to access all the resources from one place.

The two main types of hosting are shared hosting and dedicated hosting. Shared hosting has several disadvantages, like the setup is inflexible and it cannot handle heavy traffic. Dedicated hosting is more advanced that client uses the whole physical server. It means that whole server was dedicated to users, and other clients won't share it. However, in some instances, the client cannot use other servers when their server is down. In such cases, the shared server users can use other servers in the shared servers list.

Cloud hosting clients have best things about hosting in the cloud is resources can be scaled up or scaled down easily. It makes more flexible and more cost-efficient, when there is more demand placed on the server capacity can be increased automatically to match the demand placed on the server. The additional capacity of the cloud server is that it can be temporarily accessed by websites it has more redundancy. The key benefits of cloud servers are flexibility and scalability, cost effectiveness, ease of setup, reliability (31).

## **2.4.3 Vuforia Object Recognition**

Object recognition is used to detect the object which used to be in 3D shape and tracks the shape of the object. This method is used to find the objects in the real-time environment and bring this inside the virtual reality space. Object recognition gives life to the 3D object toy to make it a reality in the virtual world in turns of games and animation. It gives the better interaction with the 3D objects for superior experiences. The manual which was used for operating electronic devices is changed to augmented reality to give the better understanding about operating the devices.

This method can be used in markets to recognize the object and give the details or to open a new application to work on it. Object targets are digital portray of the complex geometry of physical images and features of the complex object structures. Target source of the object target is scanning the features of the images by scanning through a camera of mobile devices. It will be used on detecting toys, products, complex geometries. Scanning of the objects can be scanned through Vuforia object scanner to generate object data file. It has the details about the image and features of the images. The object file will be uploaded to the Vuforia target manager for the object recognition process (21)(29)(30).

## **2.4.4 Vuforia Image Targets**

Image targets are the images which was stored in the Vuforia target manager which can be accessed by Vuforia SDK can find and track the images. Dissimilar classic fiducial markers, QR codes and Data Matrix codes, Image targets does not require any appropriate black and white regions or codes to detect the images. Vuforia SDK is used to find the images or object which are naturally found in the images by comparing it to the images which are stored in the Vuforia target manager for recognition. It will be easily found the image which is partially got inside the view of the camera.

The images which are used to find should be taken under the balanced lighting. Light should uniformly enlighten the surface of the image targets (21)(29)(30).

## 2.5 Android Studio

Android Studio is the integrated development environment (IDE) for Android platform development. It was licensed by Apache under Apache license 2.0. It was specially designed for Android development it replaces eclipse Android development tools (ADT). It has multiple features like gradle based built support, lint tools, pro-guard, template based wizard, layout editor, Android wear apps, Google cloud platform, app engine, etc.

Android Studio will work with Vuforia for Android development. Android studio will work on all operating systems like Windows, Linux, and Mac. This project is worked in Windows operating system which have lesser hardware requirement for this project, but it can also be worked in other operating systems. There is also integrated development software like Eclipse, but there are some features which are missing in Eclipse.

Android software development kit includes a comprehensive set of development tools like debugger, libraries, handset emulator, sample code, and tutorials. The minimum version of Windows required to run this project is Windows XP or later versions. The development tools can help an Android device interact with external electronics includes IOIO, Android open accessory development kit, micro bridge and trigger trap. The current version android studio used in this project is android studio 2.0. System requirements for an Android studio to work are described below (19).

	Windows	OS X	Linux
OS version	Microsoft Windows 10/8/7 (32- or 64-bit)	Mac OS X 10.8.5 or higher, up to 10.11.4 (El Capitan)	GNOME or KDE desktop
RAM	2 GB RAM minimum, 8 GB RAM recommended		
Disk space	500 MB disk space for Android Studio, at least 1.5 GB for Android SDK, emulator system images, and caches		
Java version	Java Development Kit (JDK) 8	Java Development Kit (JDK) 6	Java Development Kit (JDK) 8
Screen resolution	1280x800 minimum screen resolution		

**Figure 12 Comparison of Operating System (32)**

The features which are missing in the Eclipse integrated development kit (ADT) from the android studio are explained by comparison table. It proves that AndroidStudio works better than the Eclipse development tool.

<b>Feature</b>	<b>Android Studio</b>	<b>Eclipse ADT</b>
<b>Build system</b>	<b>Gradle</b>	<b>Apache Ant</b>
<b>Maven-based build dependencies</b>	<b>Yes</b>	<b>No</b>
<b>Build variants and multiple-APK generation</b>	<b>Yes</b>	<b>No</b>
<b>Advanced Android code completion and refactoring</b>	<b>Yes</b>	<b>No</b>
<b>Graphical layout editor</b>	<b>Yes</b>	<b>Yes</b>
<b>APK signing and keystore management</b>	<b>Yes</b>	<b>Yes</b>
<b>NDK support</b>	<b>Yes</b>	<b>Yes</b>

**Table 1 SDK Tools Comparison (32)**

### 3. PROJECT PART

#### 3.1 System functionality

In the use case diagram (see Figure 13) there are provided major functions of the application which is designed as a tool for experiments.

The use cases are:

- **Scan Environment** – application receives camera preview, analysis it and sends (**Access Cloud recognition server**) extracted features to Vuforia cloud recognition server in order to **Recognize Image**.
- **Get Location** – if recognition is successful, the application extracts location information from metadata.
- **Show Location** – the location information is shown on the screen.

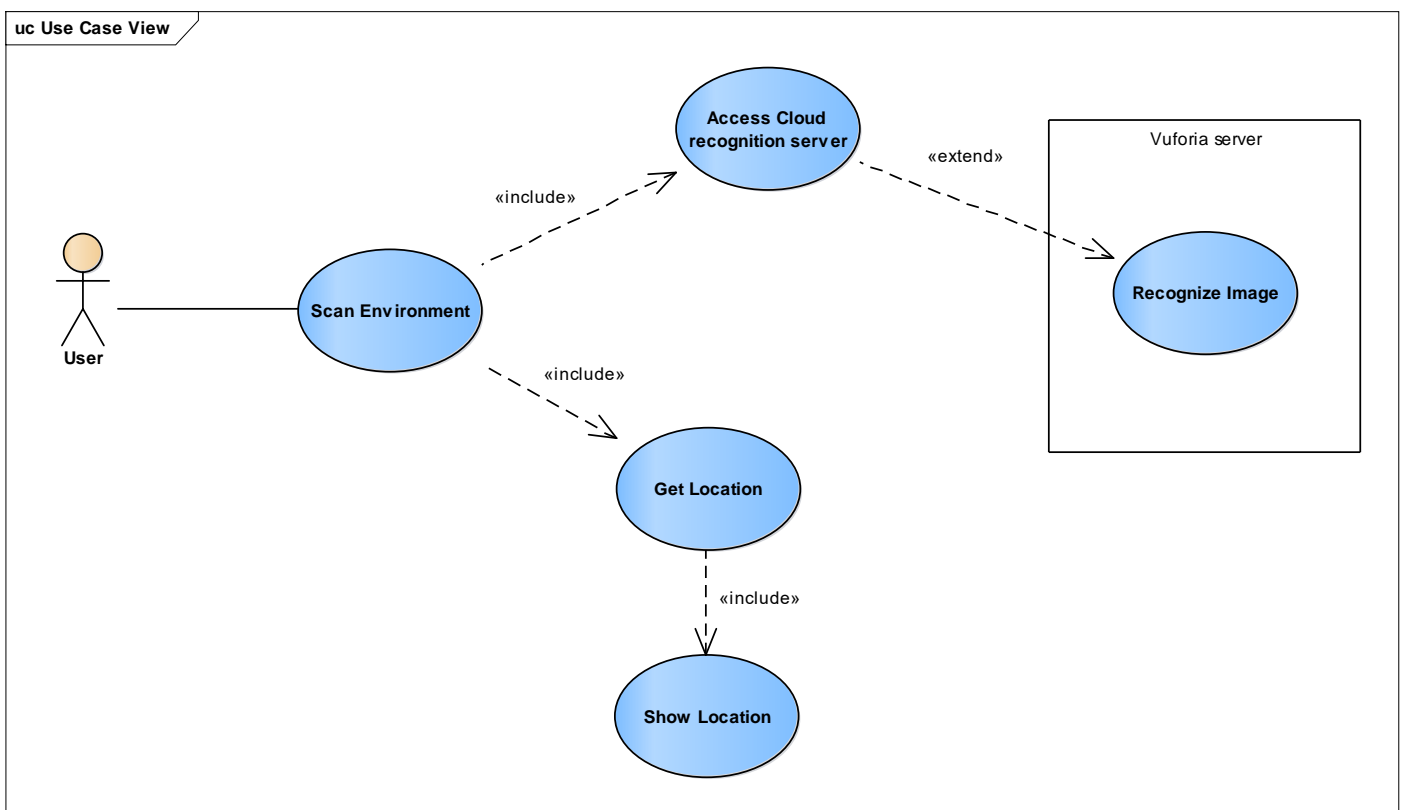
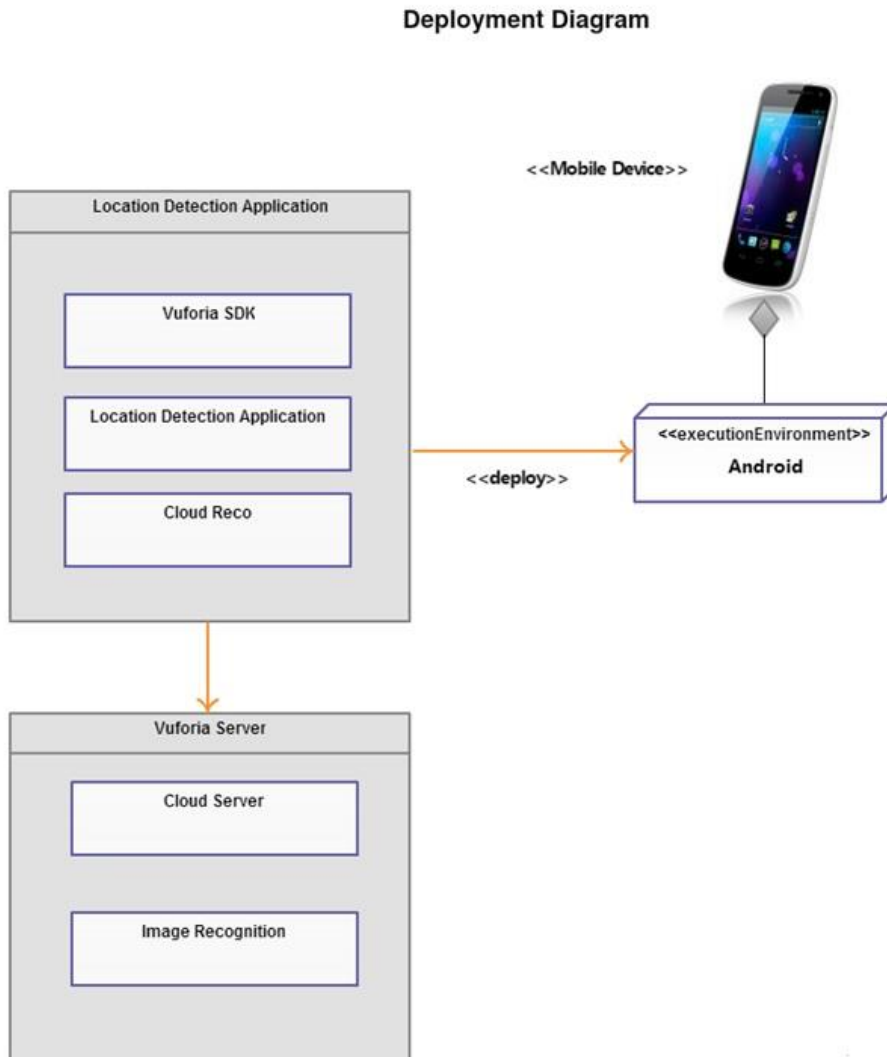


Figure 13 System functionality

### 3.3 Deployment view of the system

- Deployment diagram (see Figure 14) shows the physical deployment of the nodes.
- It also shows the hardware components used in the project and software components runs in the project.
- It shows the working procedure of different part of the system in the project.

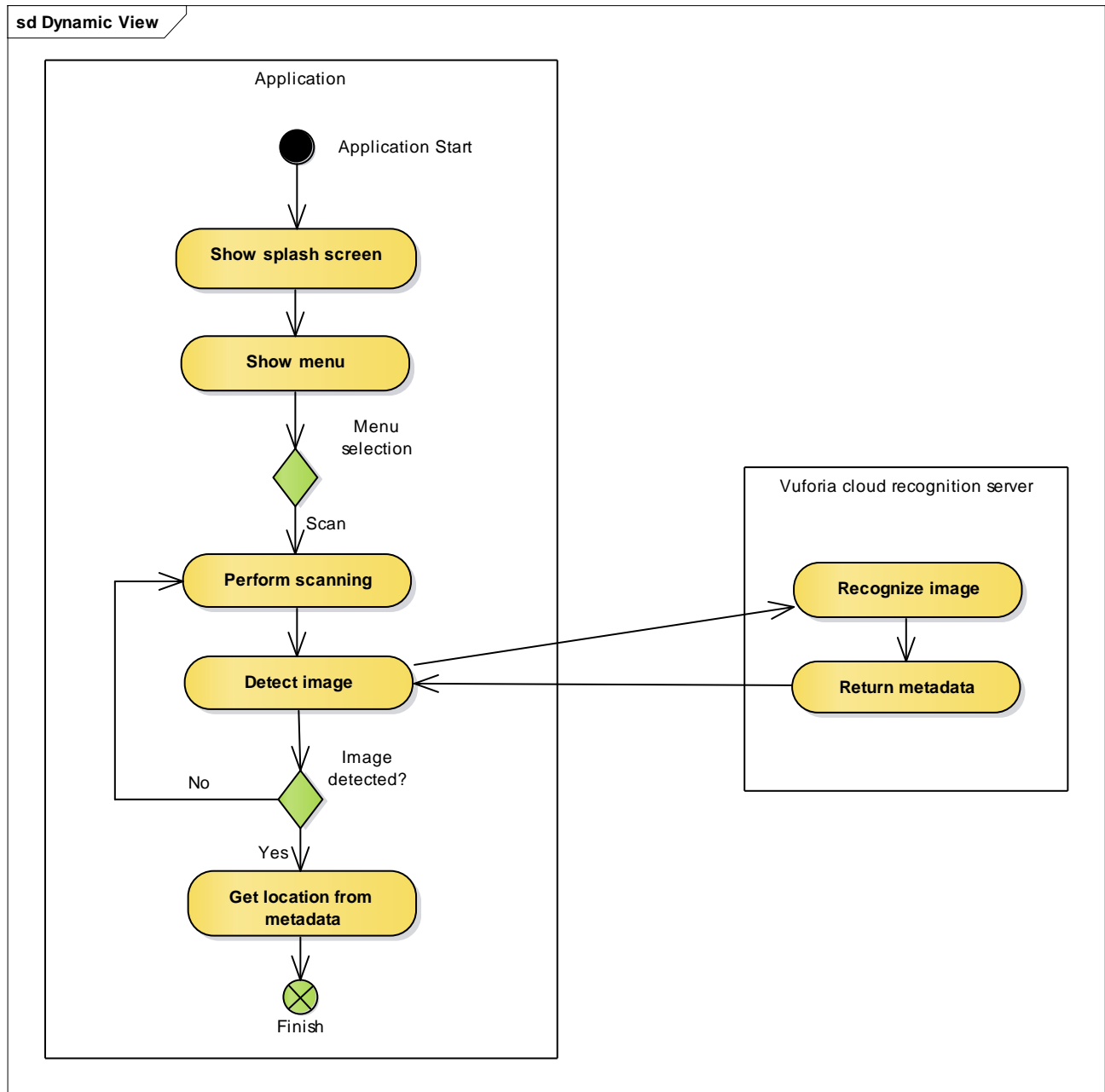


**Figure 14**Deployment view



### 3.2 Dynamic view of the system

This activity diagram (see Figure 15) describes about the workflow of the application. It shows the scenario describing how image location is implemented.



**Figure 15** Location detection scenario

### 3.4 Static view of the system

#### 3.4.1 Application classes and its specification

Class specification shows the different types of classes used in this work. The class activity list includes

**Initial Screen:** In the class initial screen consist of text view, web view, buttons, and image view. This is the standby screen to the user for UI.

**Activity splash screen:** This class is used for screening the image get from the cloud database.

**Activity Launcher:** Activity launcher is used to handle the activity done by the user in the UI.

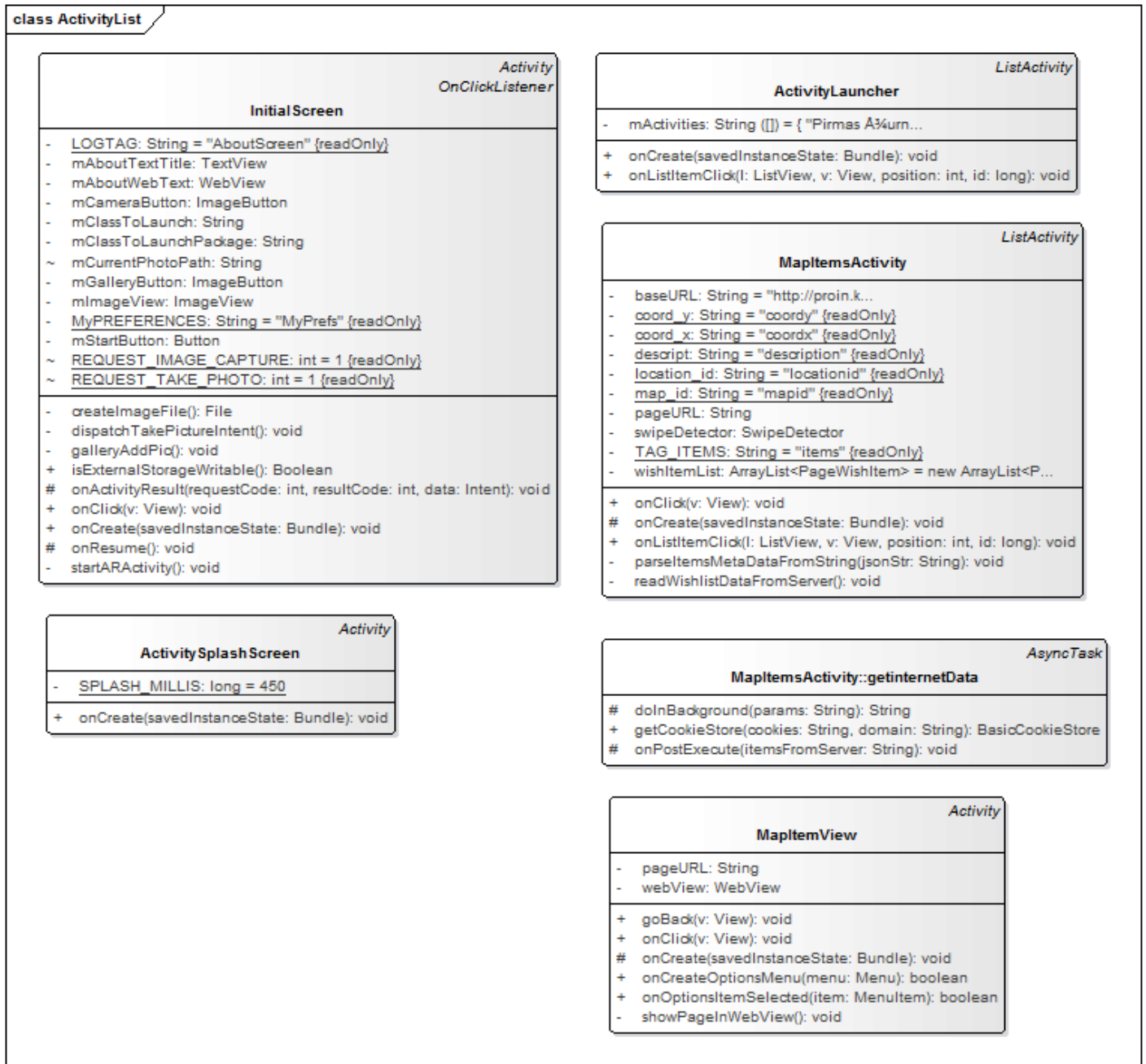
**Map Items Activity:** This class shows the details of the map like coordinates, ID, description and Location.

**Get internet data:** This class is used to get the access form the internet.

**Map item view:** This shows the description about the map to the user in the mobile UI.

**CloudRecoender:** This class is used to render the image in the cloud database and provide the image recognition technique in cloud server.

**Cloud Reco:** Cloud Reco is the important class of this work which has the detailed information about how to recognize the image. It is used to scan the image and match the image with the image stored in the cloud. The class diagram of this work is shown in the Figure 16 and Figure 17.



**Figure 16** Application classes

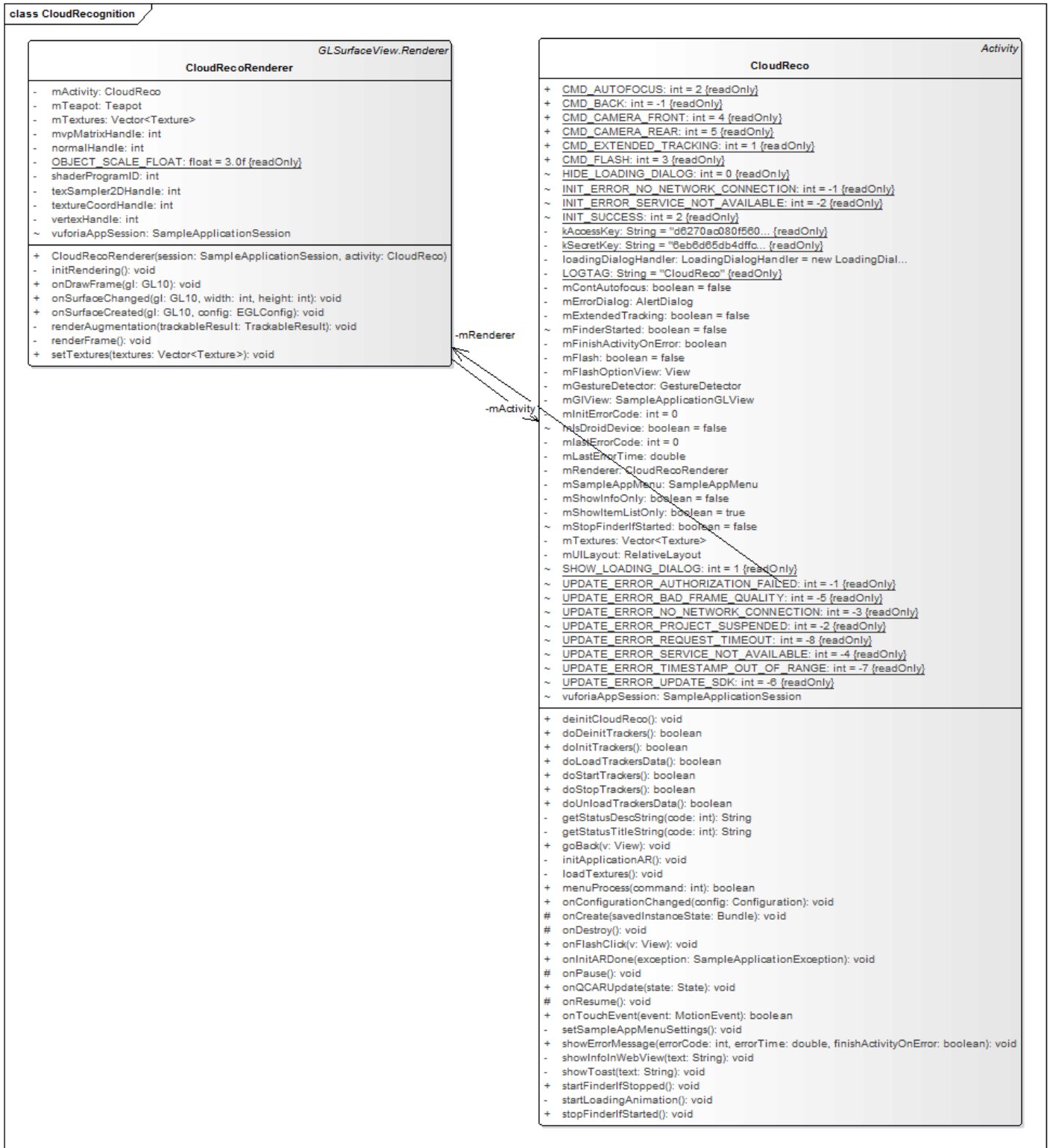


Figure 17 Cloud recognition and rendering classes

## 4. Experimental analysis

To detect the precise location of the person inside the building when there is no GPS service. We can also find the location outside the building. Google street view is only for certain places and a certain distance. By using this application, we can find the location anywhere even the remote areas by accessing the internet. GPS cannot work inside the building due to the weak signal strength and line of sight of GPS tracker. Here we are going to analyze how precise the location can be detected and how efficient the image can be tracked by using the specific application.

Here in this paper, we are using Vuforia SDK to create an application for finding the location. We are using the Android Studio to create the application in Android platform. Cloud recognition method is used to access the image from the cloud server for tracking and image-matching. This process was managed by target manager in Vuforia.

In this paper, we are using feature extraction method to extract the features from the image and store it in the cloud database. When the image was scanned through the camera, the features of the image is compared with the feature stored in the cloud database. If the features are matched, the location stored in the metadata file with the image will be screened to the user in the mobile.

We are going to experiment on the distance and perfection of the image to be scanned. The experiment was conducted in both inside the building and outside the building. Inside the building, we are going to experiment on the distance from which the image to be scanned and also where the image can be scanned instantly and produce a quick result. For the precision of location inside the building can be experimented by conducting point of interest technique by calculating the distance.

The other experimentation is going to conduct outside the building. This experimentation can be separated into three stages. The first stage of experimentation is taking the point of interest by calculating the distance for location precision. The second stage is calculating distance image recognition, how far the image or building can be recognized. The distance was measured from three steps from the image or building. It also experimented with different point of interest taken from the previous experiment. The third stage of the experiment is conducting on image recognition precision by angle variance. The image was taken in different angle and from different distance of the image to find which angle the image recognizes. We will obtain the angle of variance from this experiment.

### 4.1 Indoor location precision experiment

#### 4.1.1 Aim

The main goal of this experiment is to find the precise location of the user inside the building. We need to calculate the distance of the images which provide the precise location while detecting the images. Calculate the efficiency of the location precision inside the building and produce the result.

#### 4.1.2 Experiment setup

Initial setup for the experimental analysis was taken inside the building. Taking a part of the building let's say corridor of a building. The length of the corridor is 50 meters in length and 2.5 meters in breadth. The equipment which was used in this experiment is Android phone LG L90. The important hardware required for this project is a camera which has 8 Megapixels and resolution of 540 \* 960 pixels (~ 234 PPI pixel density). Location detection application was deployed in the Android smartphone for scanning the images. Images which can be taken for finding a location in the corridors are crucial. The length between the image and camera is 1 meter which is kept as a constant length throughout the experiment. There should be some images to be taken from windows, name boards,

notice boards and wall paintings,etc. The brightness of the place and image also affect the factor for image detection. After considering all the limitations of the projects experiments is conducting.

### 4.1.3 Experiment procedure

The experiment should be conducted in step by step procedure. In this experiment, we are going to take the images from the corridor in each 10 meters, 7 meters and 4 meters gap. The point of interest of the corridor is taken by the distance of each image. The point of interest for each distance will differ from the next distance to be measured. There are two sides in the corridor left and right. The images were taken and stored in the Vuforia cloud. Images were scanned through the application created from Vuforia SDK developer. The images are scanned and checked whether it is detected or not. The location of the image was stored with the image taken at that point as a metadata file. When the image has recognized the location of the image will be sent to the user.

- First, the point of interest of image in 10 meters gap is taken and stored. There are 5 points on one side of the corridor, so total images for the corridor of 10 meters gap are 10 images.
- Second the point of interest of image in 7 meters gap is taken and uploaded. From this, there are 7 points on one side of the corridor, and total images taken are 14.
- Third the points of interest of image in 4 meters gap are uploaded in the cloud database. There are 24 images taken in total, each side it has 12 images or point of interest.

After taking all the images and stored with the location in the cloud it is checked for the location detection. The results of the experiments are given in a tabular form.

### 4.1.4 Experiment result

From the above experiments location precision of the person inside the building was checked and the table was created by using all the data gathered from the experiment. In the table values are showed in binary values like 0 and 1. When the image was detected successfully, the value is 1. If it is unsuccessful, the value is 0. Unfilled rows in the table show that there are no images taken in that point of interest. The distance calculated has a different point of interest which shows different error values. The values are shown in the below table.

Distance	Point of Interest											
		2	3	4	5	6	7	8	9	10	11	12
10 meters		0	1	1	1							
7 meters		1	1	1	0	1	0	1	1	1		
4 meters		1	1	1	1	0	1	1	1	1	1	1

**Table 2**Indoor Image Recognition in Points of Interest

Above results indicate that the image recognition in this environment works better. This application works flawlessly in this environment for the image recognition process. The location precision of this application is better despite the distances. The distances which we measured have some error percentage in it. From the Table 2, The 10 meters distance gap has one error percentage that means the efficiency is

95%, 7 meters distance gap has two errors whose efficiency is 90%, and 4 meters distance gap has 95% efficiency.

## **4.2 Indoor distance recognition of image**

### **4.2.1 Aim**

The main aim of this experiment is to find the distance of the image recognition from the image. We need to calculate the distance from the image in which the image recognition method works better. After this experiment, the efficiency of the image recognition distance is calculated. While detecting the images, there will be limitations in the environment for taking the images.

### **4.2.2 Experiment setup**

In this experiment consider ten images taken randomly from the corridor for this experiment. Upload the images to the cloud using Vuforia target manager. Each image should be taken from 2 meters gap as a constant and upload it to the cloud database. The equipment used for this experiment is LG L90 smartphone. The camera used in this experiment has 8 Megapixels and resolution of 540 \* 960 pixels (~ 234 PPI pixel densities). The memory used in this experiment is 1 Gigabytes. Location detection application is installed on the mobile device for scanning the image. Check the application in the mobile device and camera for working.

### **4.2.3 Experiment procedure**

In this experiment the images are taken and loaded into the cloud database. Images are fixed to the wall and the camera is placed in front of the image for scanning. The image recognition is taken from three different distances from the image taken. The distance used to recognize the images are 0.5 meters, 1 meters and 1.5 meters. The camera is placed at each distance to scan the image. The measurements are taken when the image was detected successfully. When the image was not detected we have to find the reason for not detecting the image.

This experiment clearly explains how the image should be scanned through the camera of the mobile device. In this experiment 0.5 meters has the closest position of the camera. If the image is too big it 's hard to fit the image inside the camera frame, only part of the image can be scanned. Image scanned from 1 meter distance will be calculated and the image will be fit approximately in the camera frame according to the size of the image. If we scan the image from 1.5 meter distance the whole image will be covered in the camera frame. If the features of the image scanned matches with the feature of the image stored in database the image will be detected. We conducted the experiment in order to find the image detected from different distance.

### **4.2.4 Experiment result**

Form the above experiment we calculated the distance of the image to be measured. The values are described in the form of table. The values in the table are given in binary values as 1 and 0. If the image is detected from the distance we taken are noted as 1. If the image is not recognized is noted as 0. This experiment was taken from the sample of 10 images. The values are represented in the below table

Distance	Images (from point of interest)									
	1	2	3	4	5	6	7	8	9	10
0.5 meters	1	0	0	1	0	1	1	0	1	1
1 meters	1	1	1	1	0	1	1	1	1	1
1.5 meters	1	1	1	1	1	0	1	0	1	1

**Table 3**Distance Image Recognition

From the results it is clear that the distance where the image can be fixed in inside the camera frame detects better. The shorter distance to detect image also works if the feature in that region matches with the feature stored in the cloud database. The main advantage using Vuforia is that image can be detected form the long distance. In this experiment the distance of 0.5 meters doesn't recognize most of the images because of the shorter distance. from the Table 3, It has the efficiency of 80%. The 1 meter distance has the efficiency of 95% of only one error while detecting the image. The 1.5 meter distance has the efficiency of 90%. The environment around the image plays major role.

### 4.3 Outdoor location precision experiment

#### 4.3.1 Aim

Aim of this experiment is to calculate the efficiency of precise location using image recognition outside the building. Finding the exact location outside the building or in a street is very difficult. Even with the GPS it is hard to find the exact location other than the street view. But street view restricted to certain place only other than that street cannot be used. This experiment made to find the precise location outside the building. Calculate the efficiency of the location precision outside the building.

#### 4.3.2 Experiment setup

In this experiment, consider a building of length 150 meters. Take the picture of the building from different distances to find the better location precision. The pictures are taken from 35 meters, 25 meters and 15 meters according to points of interest. The images are stored in the Vuforia cloud service using target manager. The location details of the images are stored as a metadata file in a cloud database. The distance between the building pictures taken is 10 meters as a constant. The device used for this experiment is LG L90 smartphone. It has the camera resolution of 8 Megapixels and screen resolution of 540 \* 960 pixels (~ 234 PPI pixel density). The location detection application was installed on the smartphone.

#### 4.3.3 Experiment procedure

The experiment is conducted outside the building. The camera is placed in front of the building at the distance of 10 meters. The points of interests are marked for every distance gap of 35 meters, 25 meters, and 15 meters. The building was scanned from all the points and noted which images are detected and which are not detected. The values are stored in the table form to calculate the efficiency. The images which are taken outside the building have many issues in the environment.



There are four points of interest in 35 meters distance which has only four images of the building, in 25 meters it has six points of interests and for 15 meters it has ten points of interests. When these images are taken, there will be some other objects also present in the image. The same objects will not be present in that place while scanning. It comes under the limitations of the experiments.

#### 4.3.4 Experiment result

From the above experiment, the values are stored in the table form. The values are given in the binary values like 1 and 0. The value 1 was given for the successful recognition. If the image is not recognized, the value given as 0. The empty space represents the image was not taken in that point of interest. The values are represented in the below table.

Distance	points of interest									
	1	2	3	4	5	6	7	8	9	10
35 meters	1	1	1	0						
25 meters	1	1	1	1	0	1				
15 meters	1	1	1	1	1	1	0	1	1	1

**Table 4** Outdoor Image Recognition in Points of Interest

From the above results it shows that the image is detected better in this environment. When we move away from the building, the image recognition is little difficult to detect. From this experiment it shows that the location is precise in this environment. From the Table 4, this application works better in this type of outside environment. We can get the precise location of the image using this application. There are some limitations to detect the images in the outside the building.

### 4.4 Outdoor distance image recognition

#### 4.4.1 Aim

The main goal of this experiment is to find that image is recognized if we take the image far away from the distance of origin. Calculate the image recognition efficiency if we move far away from the building. This makes the application better in image recognition even the image is far away.

#### 4.4.2 Experiment setup

In this experiment, we are taking the same building taken in the previous experiment part. The images are taken from three different distances from the building. The length of the building is 150 meter. Three different distances of the images are 10 meters, 15 meters, and 20 meters. 10 images are taken randomly from the point of interest. The distance from where the image was taken is 25 meters as a constant. Upload the images to the Vuforia cloud database using target manager.

This experiment has the upper bound of 30 meters and lower bound of 5 meters. The image cannot be recognized when we cross the limits. The equipment used in this experiment is LG L90 Android mobile. It has the camera specification of 8 Megapixels and resolution of 540 \* 960 pixels (~

234 PPI pixel density). The application is deployed in the equipment and get ready for scanning. The camera is positioned in front of the building to detect the image.

#### 4.4.3 Experiment procedure

This experiment was conducted on the random image. The camera was positioned to scan the building from different distances. The following procedure gives that in which maximum distance the image can be recognized better. When there is more number of objects or colors it is easy to detect the image.

First the image was scanned from the distance of 10 meters. The images which are recognized are noted in the form of table. Second the image was scanned from the distance of 15 meters. Third the image was scanned from the distance of 20 meters. The image is taken from the distance of 25 meters which has enough features for matching when we take the image from short distance to long distance. The images which are not recognized are comes under the some error issues. The errors are later discussed in the limitations of the image recognitions. Single image can be scanned multiple times gives the same result.

#### 4.4.4 Experiment result

From the above experiment, we can say that the image can be detected from the long distance or from the shorter distance. The values in the table are given in the binary value like 1 and 0. If the image recognition is successful, the value is 1. The value will be 0 if the image recognition is unsuccessful. From the above experiment, values are given in the below table.

Distance	Images									
	1	2	3	4	5	6	7	8	9	10
10 meters	0	1	0	1	1	1	1	1	0	1
15 meters	1	0	1	1	1	1	1	1	1	1
20 meters	1	1	1	1	1	1	1	1	1	1

**Table 5** Outdoor Image Recognition

From the Table 5, we can conclude that the images which we take in long distance can be recognized easily. The image which is shorter will lose some of the features to detect the image. The efficiency of image recognition in 10 meters is 85%, the efficiency of 15 meters is 95%, and the efficiency of 20 meters is 100%. From this experiment, we can recommend taking the images far from the building. It will have the better results of image recognition.

### 4.5 Outdoor image recognition by angle variance

#### 4.5.1 Aim

The main aim of this experiment is to find in which angle of variance image can be detected better. By increasing the angle of an image taken and check, in which angle the image cannot be recognized. We need to find a position in the certain stage the image cannot be recognized. After finding the angle of variance, the value is noted in the form of a table.

#### 4.5.2 Experiment setup

Consider the building which has a length of 150 meters. The image was taken from the different angle and different distances. The distances from the building are separated as 10 meters, 15 meters and 20 meters. The distance between the two angles is 15 meters from this the angle can be measured. By considering the length of the building, there are 10 angle points within the building range. We consider the angle between the building lengths only.

The angle was measured from  $50^\circ$  to  $140^\circ$  from the building. In this experiment, we have upper and lower bound of 5 meters and 30 meters respectively. The images are taken and uploaded to the Vuforia cloud database using target manager. The equipment used for this experiment is LG L90 Android mobile. It has the camera specification of 8 Megapixels and resolution of  $560 * 960$  pixels (~ 234 PPI pixel density). Location detection application is installed in the equipment for image recognition process. The experiment is taken place in the daytime only.

#### 4.5.3 Experiment procedure

The image was scanned from the different distance of building and angle points are marked. The image was scanned from the distance of 10 meters from the building and check whether the image recognition is successful or not. Second step image was scanned from the distance of 15 meters. Third step the image was recognized from 20-meter distance from the building. There are total 10 images in each distance to measure. The angle can be extended beyond the building, but there is no use of finding the image after the building visibility. The 10 images represent the angle of variance that we measured before starting the experiment.

#### 4.5.4 Experiment result

From the above experiment, the values are measured and described in the form of a table. The values used to express the measurement in the table are binary values like 1 and 0. When the image was recognized successfully, the value is 1. If it is not recognized successfully, the value is 0. The whole table was described below. The values are represented in the below table.

Distance	Angle									
	$50^\circ$	$60^\circ$	$70^\circ$	$80^\circ$	$90^\circ$	$100^\circ$	$110^\circ$	$120^\circ$	$130^\circ$	$140^\circ$
10 meter	0	1	1	1	1	1	1	1	0	0
15 meter	1	1	1	1	1	1	1	1	1	0
20 meter	1	1	1	1	1	1	1	1	1	1

**Table 6** Angle of Variance

From the Table 6, the result of this experiment, we can conclude that when we move far away from the building in sideways the image cannot be recognized. When we are closer to the building and try to recognize the image by moving further away in sideways, it will be very difficult to detect. When we are far from the building, we can detect the image by moving little further in sideways to detect it.

The above table shows that image recognized in 10-meter distance has the efficiency of 85%, in 15-meter distance the efficiency is 95% and if it is 20 meter it has the efficiency of 100%. Because farther we move the image is more visible to the camera frame, so it is easy to detect the image.

## 4.6 Limitations

While conducting these experiments, there are some error percentages. It reduces the efficiency of the application we used. The limitations mostly depend on the environment issues. The limitations are listed below.

- When we take the image inside the building, we need to check for the lighting, brightness, and size of the image. It is very difficult to detect the images in the dark.
- When we take the outside the building, it has to be taken in the daytime with brightness and lighting.
- The image cannot be scanned in the closer view of the building. Some of the features will not be recognized.
- The image scanning should not exceed the boundary limit of the building. If it exceeds, it will be difficult to recognize the image.
- We cannot stand in the circular path of the building view to recognize the image. The circular image or panoramic view cannot be recognized using the normal camera.

## 5. Conclusions

In this work:

1. The location detection methods inside and outside the building has been analyzed. Image recognition techniques were investigated in order to apply it for the location detection purpose.
2. This application was designed to detect the location of the user inside and outside the building by mapping target images to the specific locations.
3. Feature extraction and recognition method was used to recognize the image in the real world. This method is implemented in Vuforia SDK and was used in our application.
4. The application was used for conducting the experiments in order to determine the precision of location detection in a specific environment.

Experiment results show that:

6. The location detection precision inside the building is pretty high (around 90%, see Table2), if there are enough quality image targets (in the experiments these are called points of interest).
7. While detecting indoor location, the most effective distance from camera to detectable object (target image) was around 1 meter (see Table 3). We also observed that detection worked well with shorter and longer distances.
8. The location detection outside the building is quite difficult, although it might work well if quality target images are selected (see Table 4).
9. While detecting indoor location, the most effective distance from camera to detectable object (target image) was the furthest one (20 meters, see Table 5). It could be discussed that this is affected by parallax effect and visible object parts. It can be confirmed by another experiment analyzing the detection from the different angle of the building (see Table 6).

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## **7. APPENDIX**

### **7.1 SMARTPHONE**

The smartphone is a device that has an advanced operating system that combines the features of both personal computing operating system and handheld use. The features of a cell phone with other popular mobile devices like a personal digital assistant (PDA), GPS navigation unit and digital camera. Smartphones can access the internet and third party apps. They have touch screen user interface, with LCD, LED, and OLED. Smartphones play a vital role in various fields of computer technology. The mobile device that has been used in the research of the project is an Android mobile model LG Optimus 190 runs on the Android version 5.0.2 KitKat.

### **7.2 ANDROID**

Android is mobile operating system (OS) developed by Google corporation. It is based on the Linux kernel version designed primarily for touch screen mobiles. The user interface used in Android is based on direct manipulation. To manipulate on-screen objects in Android devices we use touch gestures like swiping, touching and tapping. Google has further developed Android technologies like Android TV, AndroidAuto and Android Wear in various fields each with a specialized user interface. Android has the largest installed base of any other operating system. Google has made Android as an open source for software developers this, in turn, has provided an opportunity for creating numerous applications in Android platforms.

Android APIs can be completely accessed by Java programming, it also includes c/c++ to give the better support for non-default runtime process. The development tools like Eclipse and Android Studio have features like debugger, software libraries, handset emulator, documentation, sample code, and tutorials these helps to develop Android in a better way. The hardware architecture platform used in Android is ARM, the main version of Arm architecture are ARMv7 and ARMv8-A. The latest version of Android supports 64-bit variant with the additional support of 32-bit variant. The minimum amount of RAM required to run the Android APIs is 512MB.

Android is one of the fastest growing technologies started in 2003 with Android 1.6 donut, till now it has been upgraded year by year up to Android 6.0 Marshmallows in 2015. The different versions of androids are listed below.

- Android 1.6 Donut
- Android 2.1 Éclair
- Android 2.2 Froyo
- Android 2.3 Ginger Bread
- Android 3.0 Honey Comb
- Android 4.0 Ice Cream Sandwich
- Android 4.1 Jelly Bean
- Android 4.4 Kitkat
- Android 5.0 Lollipop
- Android 6.0 Marshmallow

In this project, we use the latest version of Android 5.0 Lollipop. It provides a better user interface and multi-screen capability for this project. The latest update for Android Lollipop is 5.1.1.



## **Android 5.0 Lollipop**

The most spectacular design in the Android version is Lollipop. Visual efficiency of Lollipop is more than KitKat, it is a bit less electronic superstore and bit more IKEA catalog. Not only surface visual was improved, the performance of the device is completely improvised. This version of Android will work only in the high configured hardware device. If android lollipop has to work without malfunctioning, then the hardware configuration must be 2 GB RAM and quad core processor. It reduced the power usage of the camera because of this specification this version of android was taken for the project.

## **7.3 Vuforia other services**

### **7.3.1 User Defined Targets**

The image targets which are generated on the runtime from the camera frames which are selected by persons or users. This type of image targets will not support virtual buttons in the standard image targets. The user can choose the image beforehand of time that the application can recognize the images over image targets. The user can select an image at runtime is called user defined targets. So that user can sense virtual reality at anywhere and anytime by just picking up an image at runtime for this user does not have to carry a pre-defined targets of the database with him (21).

### **7.3.2 Vuforia Cylinder Targets**

The images can be found if it is in the shape of cylindrical and conical Cylinder targets can find that objects or images easily. By generating cylinder targets by uploading the crucial information of the cylinder objects like the height of the cylinder, side of the cylinder, diameter, and radius of the cylinder. By uploading all the data, the cylinder target can recognize the images of cylinder structure. This may be used to find the images which closely look like the cylindrical or conical shape of the package which was distributed.

Cylindrical or conical shaped objects like a cola can, mugs, coffee cups, beer can, barrels and spray cans. The cylindrical object should not be glossy or flashed while taking pictures. The features of the pictures should be smoothly found all over the pictures to recognize it easily (21).

### **7.3.3 Vuforia Text Recognition**

Vuforia SDK can find the text which is already predefined and stored in the database which consists of 100,000 words. Those words are the commonly speaking and written words to analyze and find it easily. If the words does not match to the existing words also can be added to the predefined list of words. The user can also unblock the words which are blocked and locked in the list of words. To find the separate words and series of words we can also use Text recognition method. This method can be used separately or jointly with some targets of Vuforia to make the application better than the regular target recognition application. This methodis used in the teaching of small children in the home and school. It also used as a visual input mechanism for adding the additional words to the dictionaries used in the mobile phones. This method uses UTF-8 character encoding standard in Vuforia text analysis engine to recognize with the texts. The fonts and styles used also included improvising the text recognition to next stages. The normal text varies from the style texts which make the text recognition method difficult (21).

### **7.3.4 Vuforia Multi Targets**

Multiple images targets in a complex geometric arrangements to form a Multi targets. The position and coordination of image targets inside the multi targets are important. The each and every image inside the multi-target image can be separated by their boundaries and shapes which make it easy to recognize the multi-target image. All the postures of the multi-target can be easily traced at the same time of scanning because they possess predefined multi-target origins in taken image.

They split the multi targets into small child targets. Once the child target has been traced down it will be easy to detect the multi-target image. They provide the similar tracing reference for the child target. The result of the multi-target will have individual status for the separate child targets and they have the pose details about the child targets inside multi targets. Multi targets can be generated by joining the separate images from Vuforia target manager. This will be done under XML file dataset configuration (21).

### **7.3.5 Vuforia Frame Markers**

In the border of the marker image, there is unique ID of a frame marker is entrusted into the binary pattern. A frame marker method allows every image to be placed within the marker border. This method looks natural than any other method in the classical fiducial markers available in the Vuforia. When we view the image through the camera, the binary pattern and the frame must be visible completely. There are totally 512 frame markers available in Vuforia.

Frame marker method is a unique technique to differentiate the same type of image, or they have to detect simultaneously in the lots of small images. The images in and out of the frame are not used for recognizing. However, this type can affect the working and efficiency of the frame marker. If they have the complicated patterns of the marker's inside and outside marker borders can use this method (21).