

Cell Tower Placement

by

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Abstract

Network coverage is very important. Companies find many problems to find an accurate place to locate the antenna/cell-tower. This happens according to network coverage and many other aspects such as population, network traffic and distance between any other antenna,..etc . The process is done by getting the longitude and latitude of the place that need a cell tower. After that we make some measurements such as distance between cell towers, traffic of the area..etc. Also, by using a dataset for the needed features. According to this calculations the proposed project must decide which the accurate place to deploy it without having any failure.

Acknowledgments

We would like to thank our supervisor, Dr. Mohammed El-Gazzar for his patient guidance, encouragement and advice he has provided throughout his time as his students. We have been extremely lucky to have a supervisor who cared so much about our work, and who responded to our questions and queries so promptly. I would also like to thank engineer Haytham Metawie at Misr International University who helped me in my supervisors absence. In particular we would like to thank Misr International University for providing us the perfect atmosphere for learning from a very qualified staff.

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Chapter 1

Introduction

1.1 Introduction

1.1.1 Background

Nowadays, smartphone users are increasing [1], and new mobile editions are being developed, as a result, mobile networks must cover all places, users have a fast and a strong connections. To make the network available and fast, cell towers are being used, but some of them are being manually placed or fixed, and that caused time and cost wastage in repairing them if any damage had happened [2]. Due to the increase of building highs, signals were blocked or placing a cell-tower in a place that has no events or users. As a result of all of the following, finding the correct place for placing our cell tower is one of the important things that need to be determined at the being as it will be a gain in both costs and time for communication companies.

Due to the lack of knowledge that could be in any network engineer, they needed some help. That help was established with the usage of Network Operations Center(NOC), things became easy on them. As NOC is a central point for software distribution, updating and network troubleshooting, that made it the centralized location where can supervise, monitor and maintain client network[3]. Meanwhile, it helped in monitoring the infrastructure capacity and health. But if anything is flagged by the NOC. That means that the team (network engineers) must work to solve the issue manually, as they will have to go and see the issue happening in the location. That made time and cost wastage in that part.

So we proposed a project, that meanly focus on using machines, in order to know the right

place for allocating a new cell tower by having a good network without losing any data by the coverage holes. It depends on locations, as it finds the highest buildings, in order to be avoided, as the cause blocks or holes between the signals. That made things easy for use, so, when any issue in the Network appears, we will be able to know in which place is the issue located, and if this place is in need of more network. Machines will be the replacement of human in solving any problem. Further, There are some properties we should focus on. As the hole coverage, as the distance between every two antennas must be suitable, as not to have an blocks. These blocks could results from microwaves transmissions. Finally, a website is used to know the place you want to deploy the antenna, according to the cell tower traffic and distance between the cell towers. By the usage of some equations these properties made, by the usage of machine learning model SVC decisions are taken. A mobile application is used to know the cell ID and location area code of each cell tower, that was done by the usage of Decision tree, and to enter events that is used to build big data model in the future.

1.1.2 Motivation

Due to the market needs and the development of technology, some companies switch anything manually to automatic approaches. As not to have workers whom they are responsible for detecting and taking decisions, even if it was right or wrong in placing cell tower locations, that was made without any testing or experiments about even if this place will harm the users surrounding it, or even will it cover a high percents of surrounding areas with it's users or not.

Our proposed system will help to detect the exact/proper type of base station which will cover the required place without any coverage holes. Also it makes choosing the correct place for cell tower easier ,faster ,and transmission type. More efficient than manually detection of all that requirements.

By the usage Google maps and Machine learning to choose the proper location for the cell tower with respect to the accepted distance between antennas, suitable power use and school,building crowded with people to reduce it's harmful effect on human bodies.

1.1.3 Problem Definition

Several challenges had faced the automated system aiming to automatically find the best location for cell tower. This problem could be solved with several procedures.

Our target is to enhance the accuracy of finding the best location, along with reducing the confusion that may arise due to several similar features and finally saving time and energy for network engineers.

1.2 Project Description

1.2.1 Objective

The project aim is to make the deployment of any cell tower easier and automatic without the interference of any engineers. There are multiple struggles in placing the cell tower as it costs companies so much to detect the perfect location for placing the cell tower. Several algorithms are used before to recognize the best tower locations such as the Greedy approach then by ratio Heuristics and finally by Genetic algorithm, According to the paper Algorithmic Approach For Strategic Cell Tower Placement. Now we use equations to get some measurements needed to know the best location by machine learning. The Location is also decided according to the traffic in the area and the distance between cell towers. Also, the mobile application used to enter events and get the location area code.

1.2.2 Scope

1. The proposed system aims to find the finest places to deploy cell-towers.
2. Reducing time and high cost used for building cell tower in the best location.
3. Mobile application used for entering events and to get the location area code.
4. Future work build big data model for predicting the weakness in network.

1.2.3 Project Overview

The project aim is to find the best place for placing a cell tower, by finding the best location with the best dimensions and traffic of area. A web application plus a mobile application are implemented with different tasks to accomplish, but in the future they will serve each other.

First starting with our web application, we have implemented an easy interface to serve two

users.

The first step, the user pins the location on google maps, this location represents the needed cell tower position, then from this pin we start the preprocessing stage, which is getting all needed parameters as distance between two cell towers, traffic of the cell tower signals, RSCP (quality of the signal), ecno (strength of the signal), and area coverage by this cell tower. All the previous parameters are being saved inside our data base, to be used later on.

Moving to the processing stage, we start by retrieving our previous parameters, in order to predict the suitable location for establishing the cell tower, this prediction is done by the usage of SVC and saved in our data base, to be used later on.

Moving to the output stage, all predictions are being retrieved from the data base to be displayed to the user. These prediction shows wither the cell tower satisfies the pinned location or not.

Secondly, our mobile application, we have implemented an easy interface to serve one user. First in the preprocessing, the user starts entering the data for a happening event with it's location. Then this event is being saved inside our firebase.

Moving to the processing stage, we start getting the connected cell tower to the user location while using our application, this was done by the usage of Decision tree, in order to get the priority of which cell tower the event will work on. Also, Monitoring location area code and the cell tower ID.

Moving to the output, the user views the previous parameters that were generated in the processing stage.

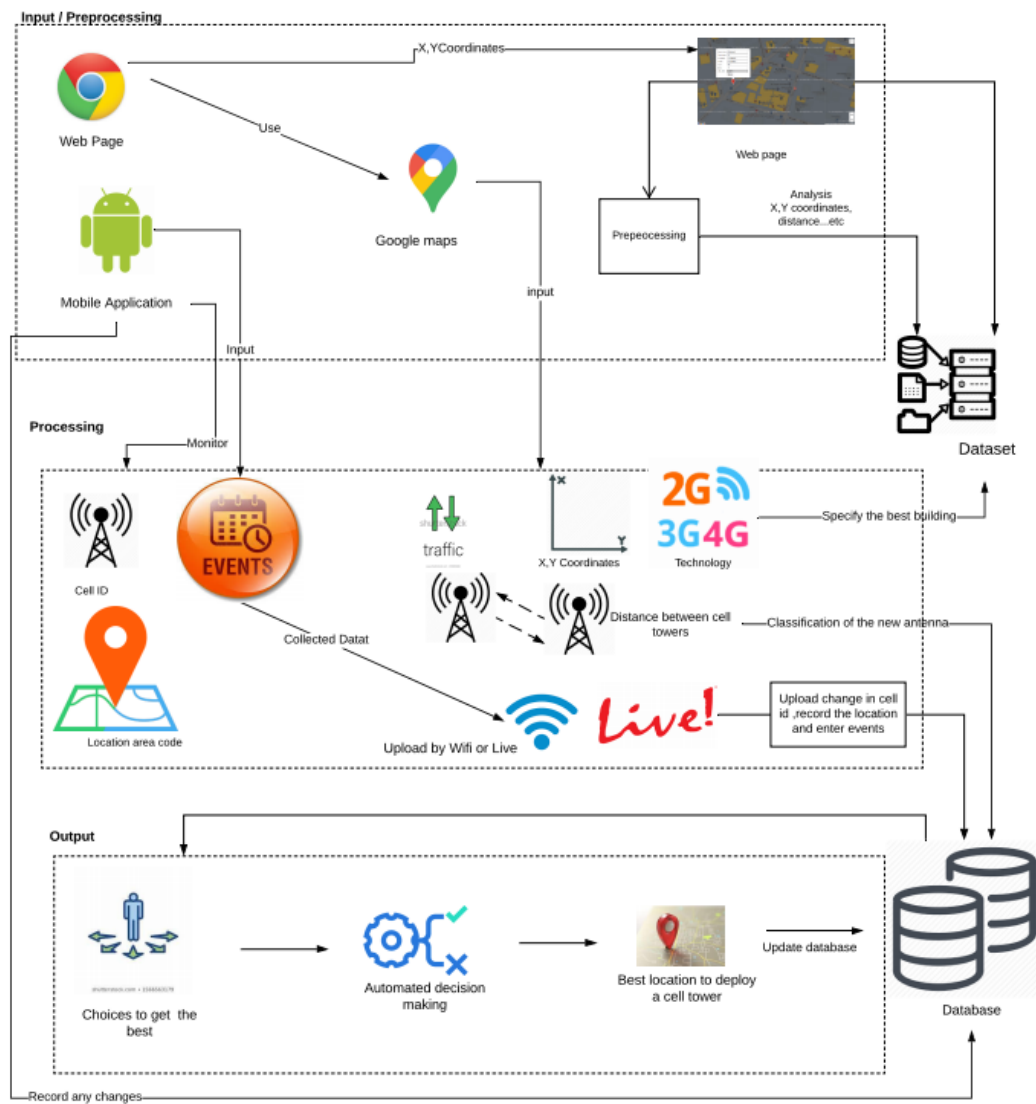


Figure 1.1: Overview Diagram

1.3 Project Management and Deliverable

1.3.1 Tasks and Time Plan

Task	Start Date	End Date
Choosing topic	26-7-2019	10-9-2019
Demo code	10-9-2019	1-10-2019
Proposal document	1-10-2019	7-10-2019
Proposal presentation	8-10-2019	8-10-2019
prototype	9-10-2019	9-11-2019
Dataset collection	10-11-2019	15-11-2019
Dataset classification	16-11-2019	20-11-2019
SRS writing	21-11-2019	10-12-2019
SRS presentation	Second week of dec	Second week of dec
Implementing app	15-12-2019	30-1-2020
SDD writing	1-2-2020	10-2-2020
SDD presentation	Second week of feb	Second week of feb
Prototype evaluation	3 days after midterms	3 days after midterms
Writing paper	-----	-----
Deliver the paper	2 nd sem	2 nd sem
Writing thesis	21-6-2020	30-6-2020
Final presentation	24-6-2020	24-6-2020

Table 1: Time Plan Table

1.3.2 Budget and Resources Costs

No budget will be needed to access all the services.

1.3.3 Supportive Documents

Proposed Paper 🖨️ 📧

Mark Mark Nabil Mehanni Yousab <mark1604514@miuegypt.edu.eg> 2:39 AM (0 minutes ago) ☆ ↶ ⋮

to getsmarter01, mmhassan ▾

Dear Abdullah , Mohammad ,

Hope this mail find you well, I am Mark Nabil Mehanni i am a student in Misr International University, Egypt. I am working on a group project concerning The cell tower management system I was hoping kindly if you can help me and send me the data set you used in your project concerning the [Using GIS for Measuring MobileTower Radiationon Human] .

Thanks in advance, really looking forward to hearing from you.

↶ Reply ↶ Reply all ➡ Forward

Chapter 2

Literature Work

2.1 Related work

There are several researches that had proposed similar systems to CTP. Digging deep inside these papers. A paper written by Hammad Hafiz, Harjeet Aulakh and Kaamran Raahemifar [2], they had implemented a system by the usage of both branch and bound algorithms in order to solve the Antenna Placement Problem (APP) in Cellular networks. As the new generation in technology needed to develop the highest network and to have the full coverage of network in certain places.

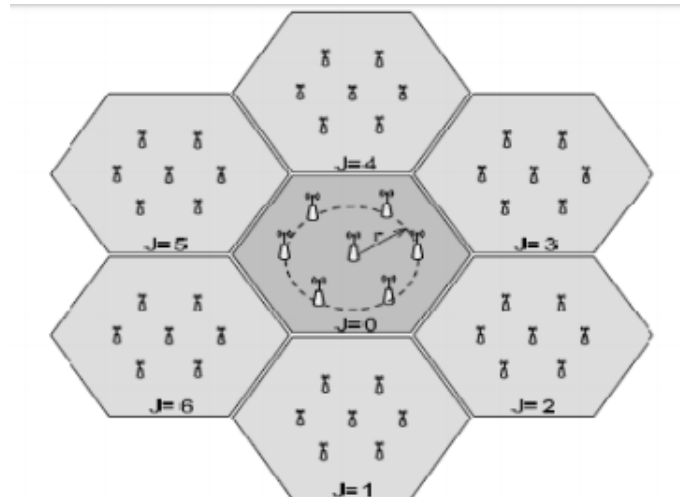


Figure 2.1: Structure of antenna system in cellular networks

Another paper written by Dr.HaiderKadhimHoomod et. al. [4], they have stated that through time cell phones and other applications requires the use of wireless communication systems, as Global Positioning System(GPS), that requires a full coverage of network. So, placing a cell towers in the right position requires effort such as network planning and that costs so much money, as the equipment's used for getting the right location is expensive. There main aim was to reduce effort and cost for cell placement. There proposed technique is done with the usage of self-organizing map (SOM) neural network with the addition of some effective modification and the usage of some suitable models in order to loss some propagation paths.

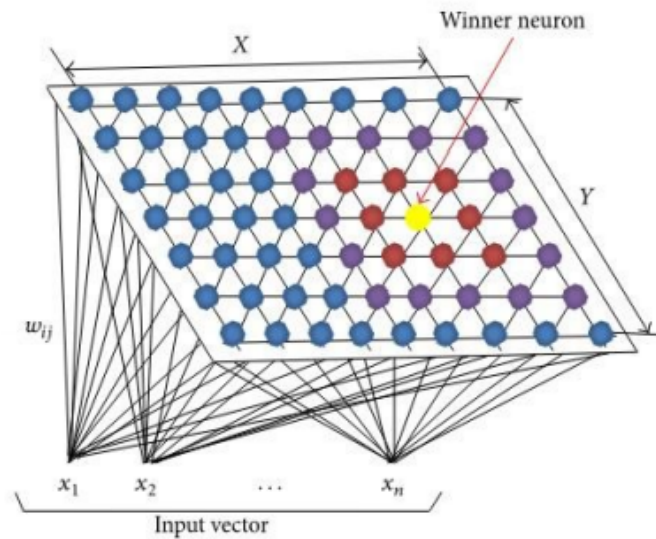


Figure 2.2: SOM Network Structure

Another paper writteb by Al-Sahly et. al. [1], they have stated that since the increase of using smart devices users, they will be in the need of increasing communication medias for mobile connections, especially in crowded cities and urban areas. Now by using Radio Frequency (RF) waves in order to establish communication among users to be used in their mobile networks, bu on the other side these waves are harmful to human beings. Their purpose was to help the government and the health organizations for calculating the distributed radiations in the area, based on the location of mobile towers. They will also propose to establish the towers in green and hot areas, in order to be away from human

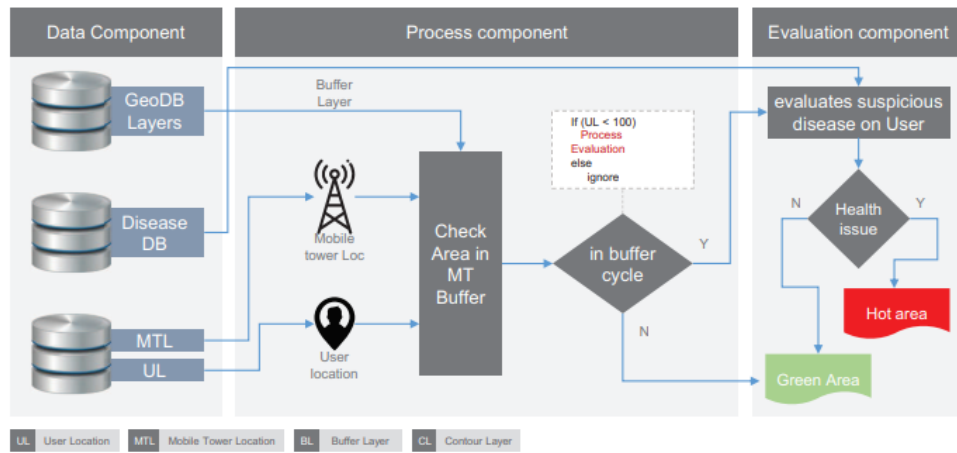


Figure 2.3: System Architecture

beings so they wont be affected by any radiations. This research had passed with severarl stages they are:

- Specify mobile towers
- Transfer data
- Analyze collected data
- result

2.2 Comparison with Proposed Project

Comparison System				
	Paper 1	Paper 2	Paper 3	Our Proposed Paper
Method	Using Bound and Branch algorithm	Global Positioning System (GPS)	Geographical Information System	Google maps and Machine learning
Accuracy	Not Mentioned	Not Mentioned	Not Mentioned	95%
Data-sets	Not Mentioned	GPS Maps	GIS Maps , Data-set Contains: data collected, processed and stored	Events and Cell-Tower Data-set contains: data collected and processed

Chapter 3

System Requirements Specifications

3.1 Introduction

3.1.1 Purpose of this chapter

The main purpose of this Software Requirements Specification document is to outline the requirements for our system Cell Tower Placement: which is to detect the best location for pointing a new antenna and to extend on the existing one, that is done with the aid of our system. This document will provide a detailed overview of our system product's parameters and goals and explain the purpose and the features of CTPS and describes its needs from the point of view of interfaces, hardware, software requirements and explains what the system will do. This SRS document defines how our stakeholders and team see the product and its functionality.

3.1.2 Scope of this chapter

Cell Tower Placement scope is to find the finest places to deploy cell-towers and help companies to decrease the cost of surveys.

3.1.3 Overview

In the system we aim to find the best location for placing a cell tower, by finding the best building with the best dimensions and network coverage, that was accomplished with

the usage of GPS and extracting any needed features. As that was done in the first stage that our system passes through, which is the input data and Preprocessing stage. At that stage some images are being captured from the GIS application, and preprocessing is being executed on these images, so we could capture objects from the images easily. When these objects are being captured, we start operating on them some mathematical operations to get the heights, distance, and other needed data. Then these data are added to our data set with some external data-set in order to deploy all cell layers.

Moving to the processing stage and at this stage some measurements as (Distance between buildings, the population of the location, distance between the building and the base station, and network coverage from this building) are made, to be collected in the final integrated layer, so it could be saved inside the data base.

Finally, moving to the last stage, which is the output stage, at that stage the perfect location for establishing the cell tower has been found. That was done by machine learning KNN, for getting an automated decision making, and at the end of these results are displayed in the form on zero's and one's

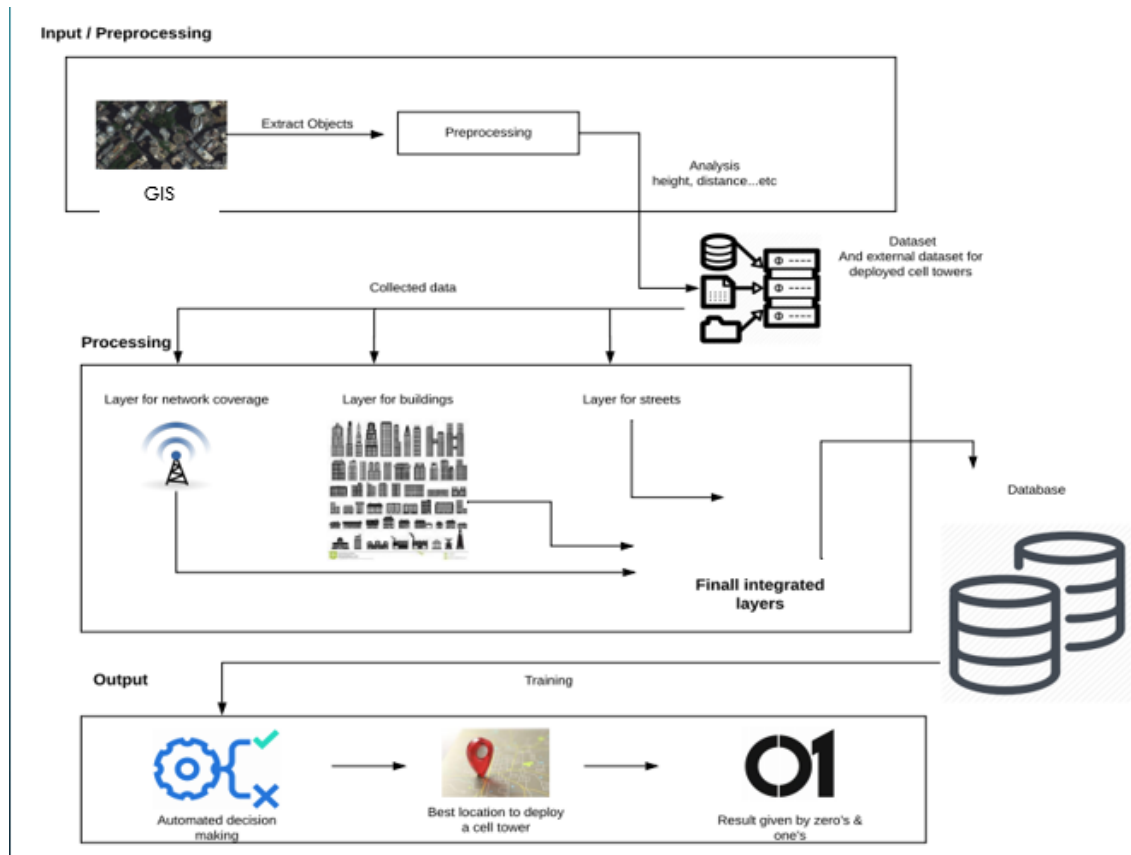


Figure 3.1: System Overview

3.1.4 Business Context

Finding the best location for building any antenna/cell tower could be a waste of time and money if it's established in the wrong place. As much paperwork and loads of surveys were made to help workers in finding an accurate position for the towers. The mission of our project is to the easiness of applying an antenna/cell tower without coasting any money.

3.2 General Description

3.2.1 Product Functions

1. Customer can do a complain on the area that have error in network.
2. Network team can validate the customer complain.
3. Network team can set X,Y coordinates to the core team.

4. System Admin can set requirements.
5. Technician can get the best location from the core team.
6. Core team can find and defer antenna by pointing another one or extend it.
7. Core team can plan to find the best location.

3.2.2 User Characteristics

1. Customer:
 - Must have basic knowledge in using web applications.
2. Network team:
 - Must have the knowledge in using web applications and maps.
 - Must have the knowledge to differentiate the valid complain from the invalid.
3. Core team:
 - Must have the knowledge in using web applications and maps.
 - Know the existing antenna.
4. System Admin:
 - Must have the knowledge in using web applications.
5. Technician:
 - Must have the knowledge in using web applications and maps.

3.2.3 User Problem Statement

Finding the accurate place to fix over cell tower station costs mobile operators big chunks of money. Our target is to provide automated cell tower allocate system.

3.2.4 User Objectives

By using the Cell tower placement, the user can pin X,Y Coordinates to know if this is the accurate placement for a cell tower. And the system will take the decision.

3.2.5 General Constraints

One of the main constraints of the system is the automated decision. Only by giving the system X,Y coordinates and show if it is the accurate placement or not. Doesn't any workers to know the place. So doesn't consume time. Also, more accurate.

3.3 Functional Requirements

FR1

Title	Sign up
Description	Registration function for the engineer in the company who are in charge for the antenna management and allocation
Input	Name , Email , Password , Telephone , Gender
Action	Check all fields are filled and submit the data
Output	Home Page and Acceptance message or error message
Pre-condition	None
Post-condition	Redirect to the home page and update the database with a new record
Dependencies	None

Figure 3.2: Sign Up

FR2

Title	Log in
Description	For existing engineers to log into accounts
Input	Username and password
Action	Check if all fields are filled and compares data entered to the record in the database
Output	Home Page and Acceptance message or error message
Pre-condition	None
Post-condition	Redirect to the home page
Dependencies	FR1

Figure 3.3: log In

FR3

Title	View report
Description	Users may report weakness of signal in certain locations so these reports are archives by the customers service to enhance the service
Input	None
Action	Retrieve reports from database
Output	Reports page containing all reports
Pre-condition	None
Post-condition	Reports page
Dependencies	FR1 FR2

Figure 3.4: View Report

FR4

Title	Report location
Description	Cropping part of the map surrounding the report location and displaying it
Input	X, Y-Coordinates for the report location
Action	Taking the X,Y-Coordinates as an input and adding some values to them to crop the surrounding area
Output	Certain map for report location
Pre-condition	None
Post-condition	Certain map page
Dependencies	FR1 FR2

Figure 3.5: Report Location

FR5

Title	Find Antenna
Description	Some antennas may be available for renting and broadcasting through it and this is a cheaper and better option than finding place for new antenna
Input	X,Y-Coordinates
Action	Searching for antennas nearby the location that are available for renting
Output	Suitable antenna and its location
Pre-condition	Defining the antennas in the dataset whether it belongs to the company or not
Post-condition	Marking the antenna on the map
Dependencies	FR1 FR2

Figure 3.6: Find Antenna

FR6

Title	Finding best location
Description	Searching for the best location to place the antenna to enhance or cover new area according to the regulations
Input	X,Y-Coordinates
Action	Filtering locations and building to find the best location according to certain parameters and a well-trained data-set
Output	Multiple suggestions for most appropriate locations
Pre-condition	Normalized data set where all attributes are well defined
Post-condition	Marking the best locations on the map
Dependencies	FR1 FR2

Figure 3.7: Finding best Location

FR7

Title	View map
Description	Displaying the whole map for the country displaying a layer containing all the antennas
Input	None
Action	Retrieving the map associated with antennas dataset using GIS tool plug in
Output	Map showing the antennas
Pre-condition	None
Post-condition	Map page
Dependencies	FR1 FR2

Figure 3.8: View Map

FR8

Title	Add Engineer
Description	Adds new engineer to the system
Input	Name , Email , Password , Telephone , Gender , National ID
Action	Check if all fields are filled and insert an object in a database.
Output	Acceptance message or error message
Pre-condition	Check if the engineer exists
Post-condition	New engineer is created
Dependencies	FR1 FR2

Figure 3.9: Add Engineer

FR9

Title	Editing an engineer's record
Description	This function edits the engineer existing information to the system
Input	Name , Email , Password , Telephone , Gender , National ID
Action	Make sure that the record of the engineer is updated.
Output	Acceptance message or error message
Pre-condition	Check if the engineer exists
Post-condition	The record of the engineer is updated into the database
Dependencies	FR1 FR2

Figure 3.10: Editing an Engineer's record

FR10

Title	Deleting an engineer's record
Description	This function deletes the engineer's record
Input	Name
Action	Make sure that the record of the engineer is deleted
Output	Acceptance message or error message
Pre-condition	Check if the engineer exists
Post-condition	The record of the engineer is deleted from the database
Dependencies	FR1 FR2

Figure 3.11: Deleting an Engineer's record

FR11

Title	Searching for an engineer record
Description	This function searching for an engineer record
Input	Name
Action	Retrieves information about the engineers
Output	Preview engineer's record
Pre-condition	Check if the engineer exists
Post-condition	None
Dependencies	FR1 FR2

Figure 3.12: searching an Engineer's record

3.4 Interface Requirements

3.4.1 User Interfaces

Our system's user interface is easy to use and clear. Our web-application mainly serve two users, they are whether an admin or an engineer, both can login, but they have got different screens with different functionalities. As the admin could manipulate engineers while engineers could deal with their client/problems.

3.4.1.1 GUI

- Web site



Figure 3.13: Home Page

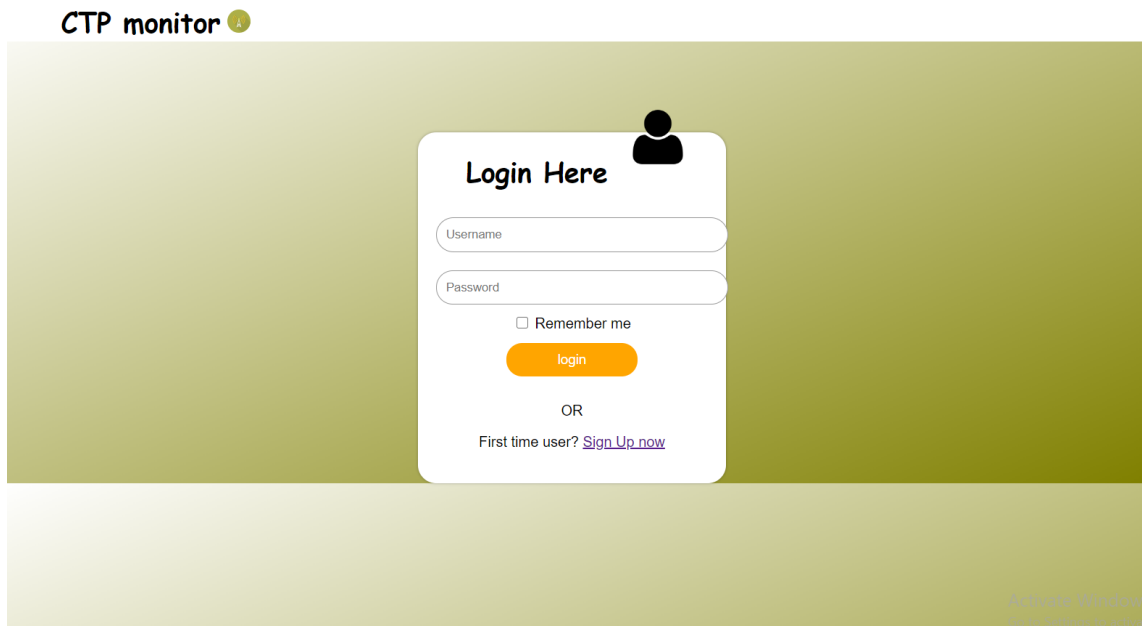


Figure 3.14: Log-In

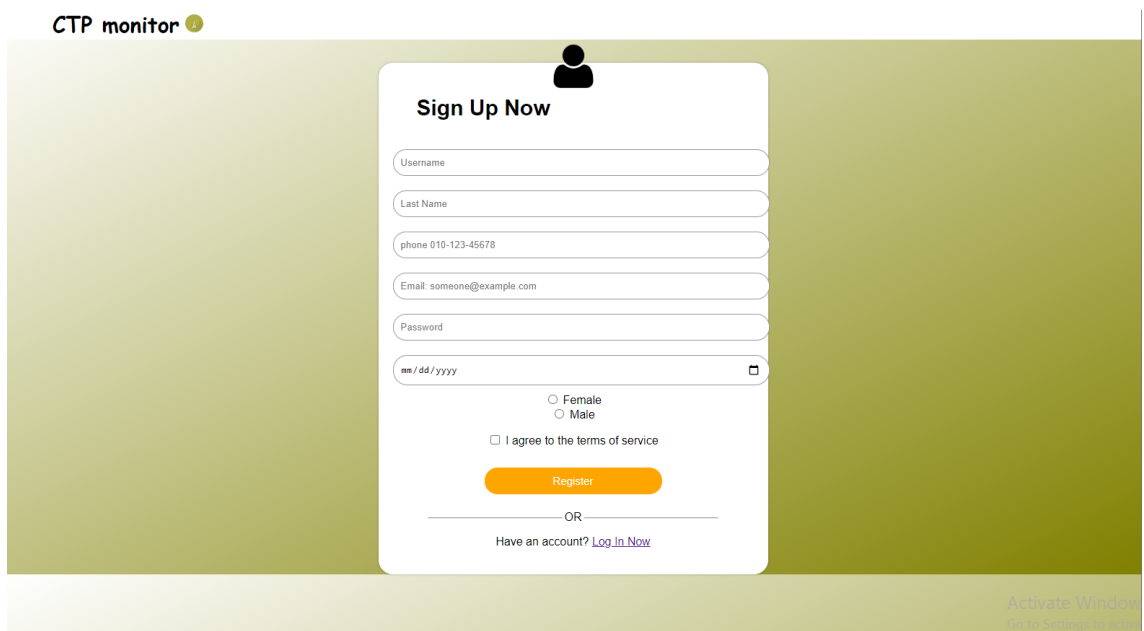


Figure 3.15: Sign-Up

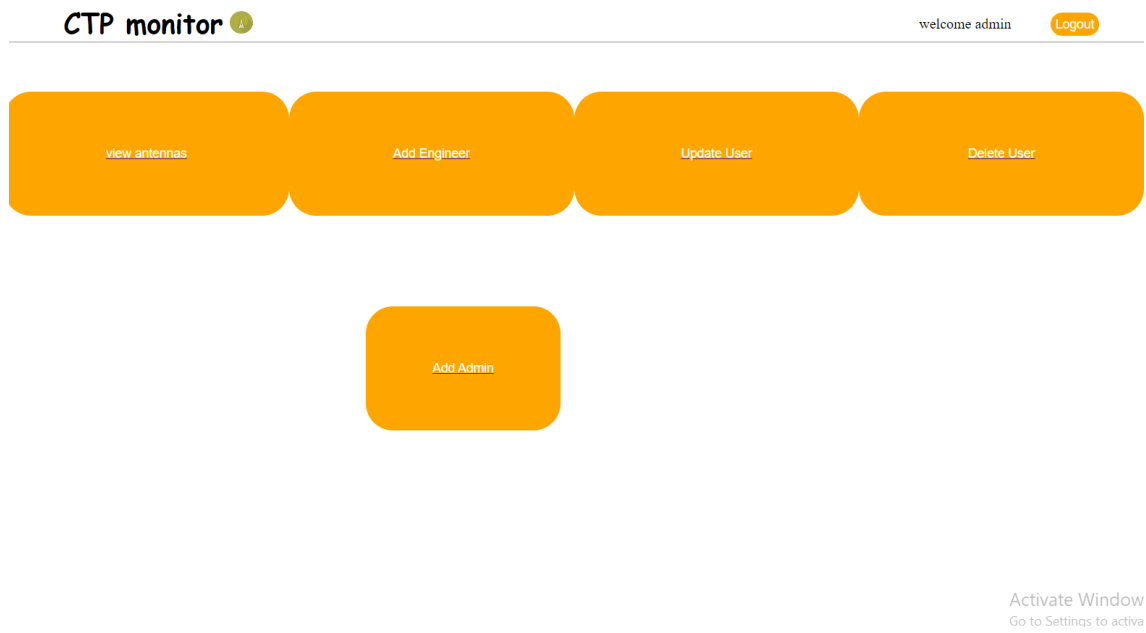


Figure 3.16: Admin Sideview

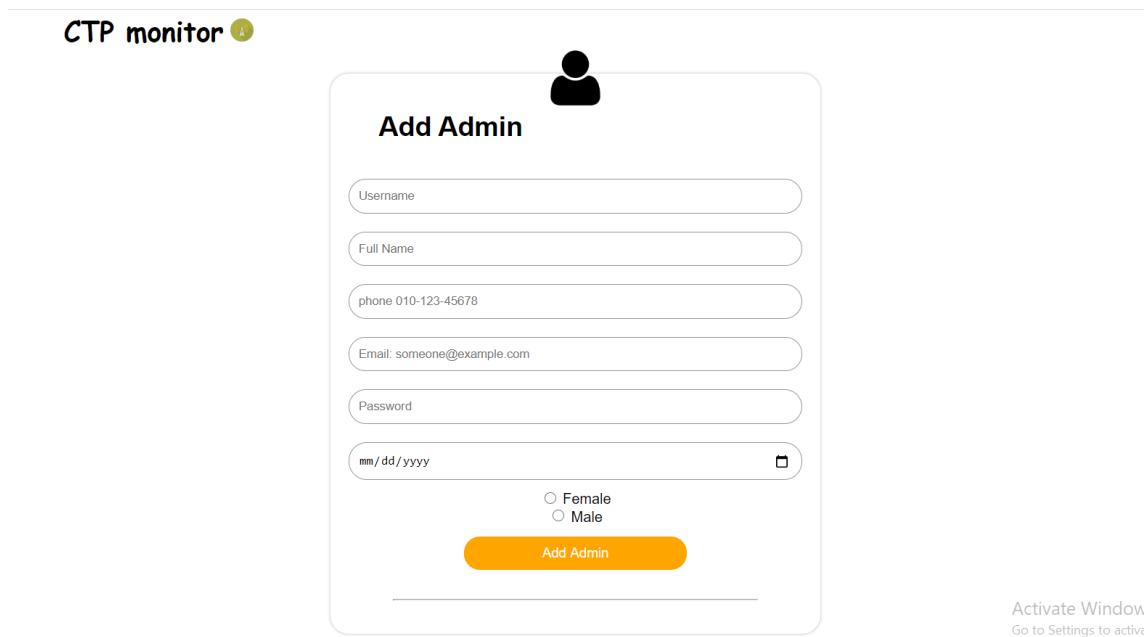



Figure 3.17: Add Admin Form

CTP monitor ●



Add Engineer

Female
 Male

Activate Window
Go to Settings to activate

Figure 3.18: Add Engineer Form

CTP monitor ● welcome admin

User Name	Full Name	User Type	Action
joy	Abdelmasseh	engineer	Update Information
Nour	Elhuda	engineer	Update Information
reta	romny	engineer	Update Information
Mark	Samir	admin	Update Information
Ali	Ahmed	engineer	Update Information
Hussam	Mohamed	engineer	Update Information
Marknabil	Mark Nabil Mehanni	admin	Update Information
Nermeen	Nermeen Haggag	Admin	Update Information

Activate Window
Go to Settings to activate

Figure 3.19: Update Users

CTP monitor welcome admin [Logout](#)

User Name	Full Name	User Type	Action
joy	Abdelmasseh	engineer	Delete
Nour	Elhuda	engineer	Delete
reta	romny	engineer	Delete
Mark	Samir	admin	Delete
Ali	Ahmed	engineer	Delete
Hussam	Mohamed	engineer	Delete
Marknabil	Mark Nabil Mehanni	admin	Delete
Nermeen	Nermeen Haggag	Admin	Delete

Figure 3.20: Delete Users

The screenshot shows a Google Map of a city area in Cairo, Egypt. A yellow pop-up dialog box is centered on the map, containing the following text:

- Description:
- Prediction:
- Confirm Cell Tower:
-

The map background shows various landmarks and streets, including the Embassy of Jordan, Russian Council, and several hotels and banks. The text 'For development purposes only' is repeated across the map. The Google logo and 'Map data ©2020 Google, ORION-ME | Terms of Use' are visible at the bottom left.

Figure 3.21: Admin Map

CTP monitor 

Logout



View Antennas

Activate Window
Go to Settings to activa

Figure 3.22: Engineer Sideview

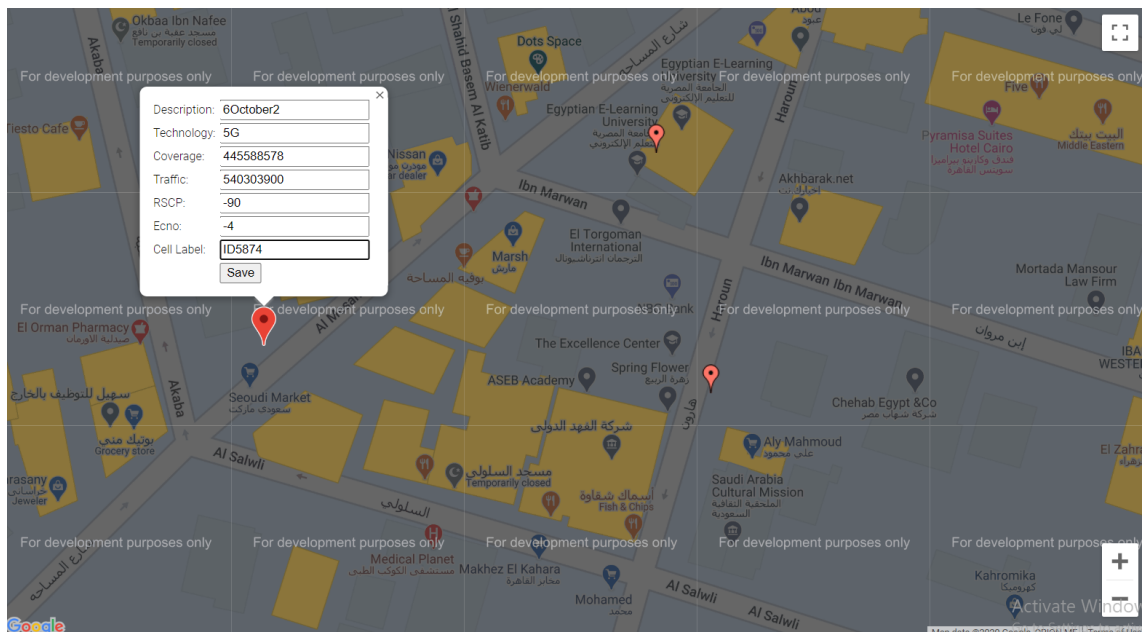


Figure 3.23: Engineer Map

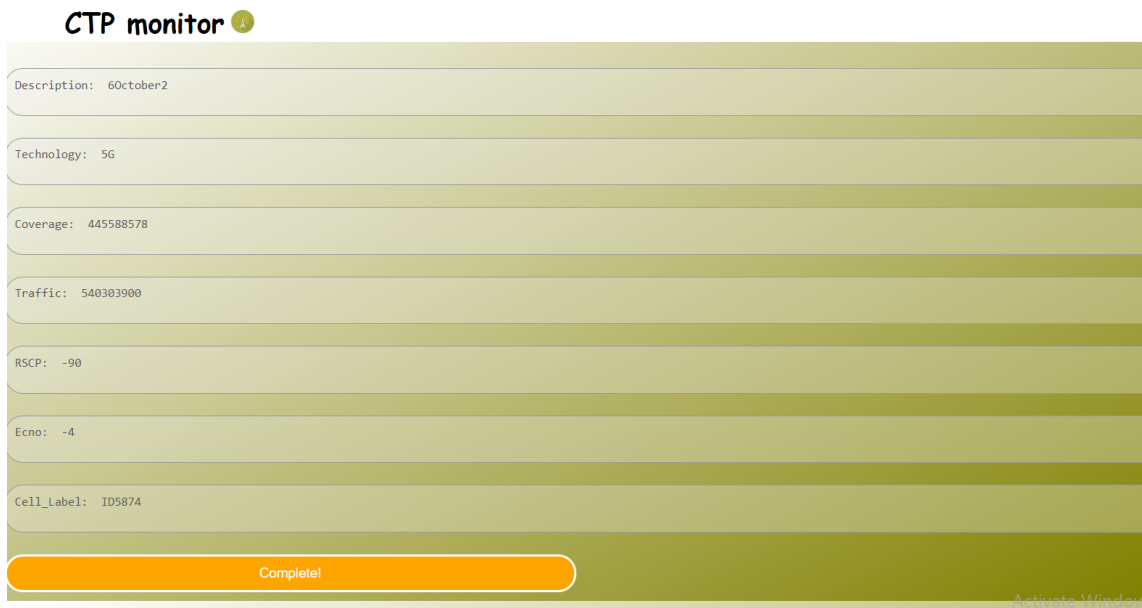


Figure 3.24: Confirmation Data

- Mobile application

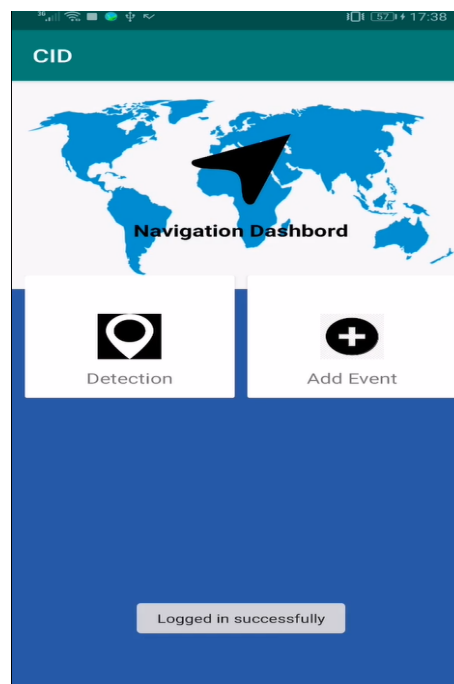
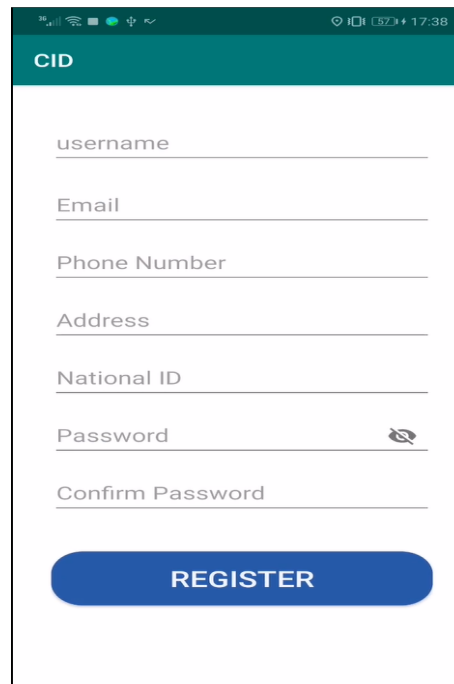
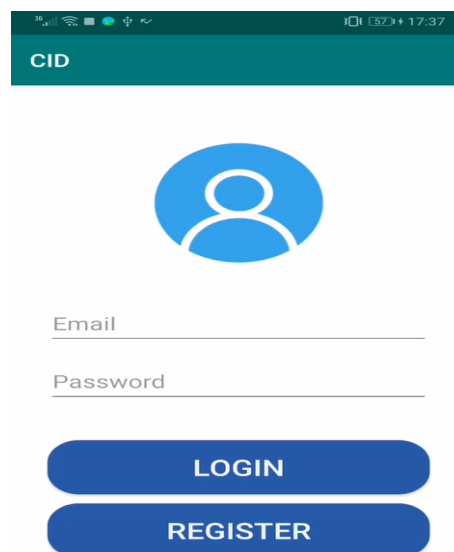


Figure 3.25: Main Menu



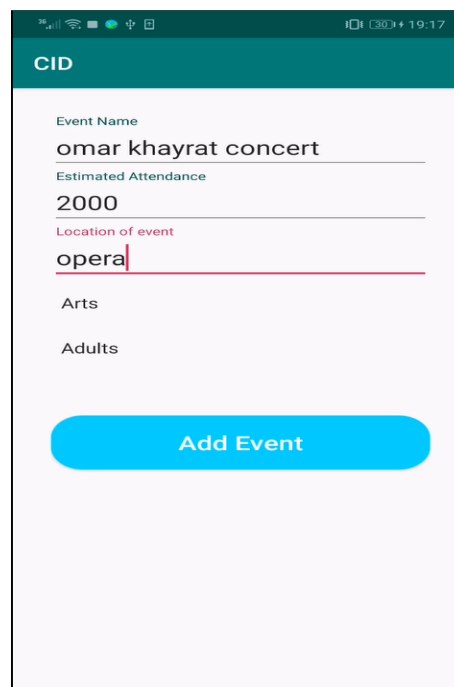
The screenshot shows a mobile application interface for registration. At the top, there is a dark teal header with the text "CID". Below the header, there are seven input fields stacked vertically, each with a light gray label and a horizontal line for text entry: "username", "Email", "Phone Number", "Address", "National ID", "Password", and "Confirm Password". The "Password" field has a small eye icon to its right. Below the input fields is a large, rounded blue button with the text "REGISTER" in white capital letters.

Figure 3.26: Register



The screenshot shows a mobile application interface for login. At the top, there is a dark teal header with the text "CID". Below the header, there is a large blue circular icon containing a white silhouette of a person. Underneath the icon are two input fields stacked vertically, each with a light gray label and a horizontal line for text entry: "Email" and "Password". Below the input fields are two large, rounded blue buttons stacked vertically, both with white capital letters: "LOGIN" and "REGISTER".

Figure 3.27: Log-In



The screenshot shows a mobile application interface for adding an event. The title bar is green and labeled "CID". The form fields are as follows:

- Event Name: **omar khayrat concert**
- Estimated Attendance: **2000**
- Location of event: **opera**
- Arts: (empty field)
- Adults: (empty field)

A blue button labeled "Add Event" is positioned at the bottom of the form.

Figure 3.28: Event Form



Figure 3.29: Cell-ID and Location area code

3.4.1.2 Performance Requirements

For Cell tower placement, the system shall be able to conform the X,Y coordinates that entered by the user for the placement of a cell tower. The system must be handle a large data-set to ensure system accuracy. Sample run time for the different parameter in data-set.

3.4.2 Communications Interfaces

The communication interface is one of the most important requirements of our software as it will need a connection to the internet or a local host connection.

3.5 Design Constraints

3.5.1 Standards Compliance

Any Computer that include stable internet connection to deal with Google Maps .

3.5.2 Hardware Limitations

Windows 10 , Minimum processor Inter i7 , preferable to have RAM Memory 16GB , 64-bit processing operating system , enough hard-drive .

3.6 Other non-functional attributes

3.6.1 Security

Our app deals with credential data for each telecommunication company so there must be difficult authenticated for every user and engineer who will use the app. As well as our data set is being hashed and stored in a secure database.

3.6.2 Performance and Speed

Cell tower placement app must be speed and powerful as it is based on well-trained data-set so the more the data-set is accurate and trained the more the app is powerful and fast.

3.6.3 Reliability

The system needs a map to be working 24-hours, so the system is loaded with google map, to work all the type and to be up-dated in any land changes.

3.6.4 Scalability

The Cell Tower Placement is scalable. It should be easy to maintain to minimize the amount of changes that would be done to the code.

3.6.5 Usability

Proportion of functionalities or tasks mastered doesn't need time to be learned. Also, this system is easy to be memorized due to the small number of tasks the user will do.

3.7 Preliminary Object-Oriented Domain Analysis

3.7.1 Inheritance Relationships

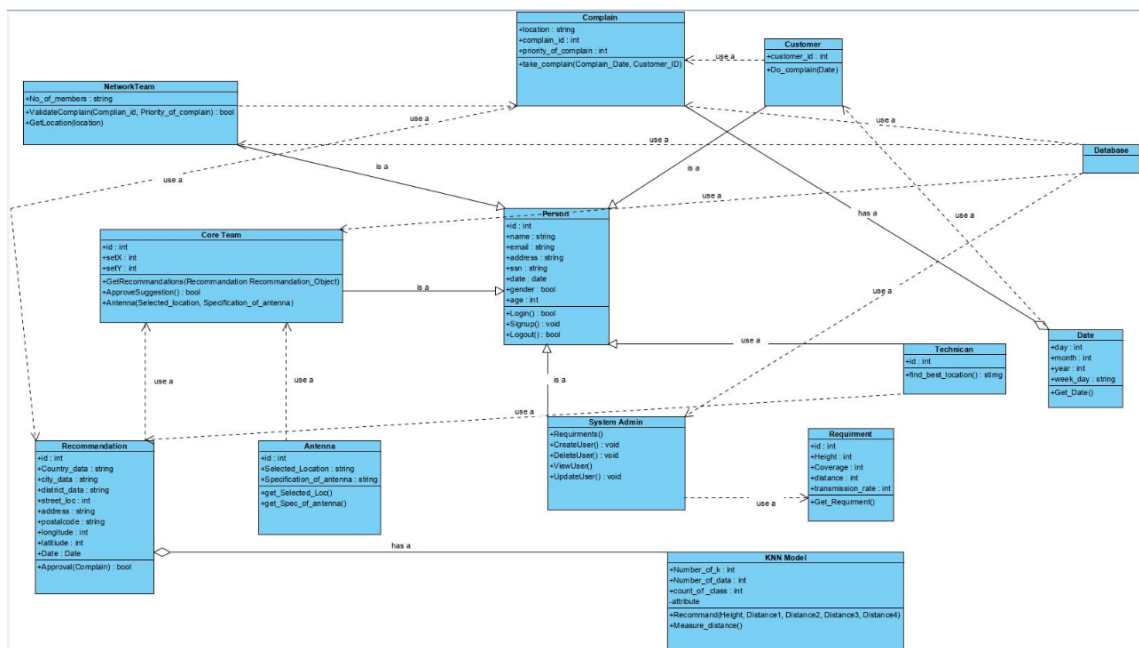


Figure 3.30: Class Diagram For System.

3.8 Operational Scenarios

1. Scenario 1: Customer complain

The customer send a complain. Then the network team start to validate this complain and set X,Y coordinates by the area of the customer.

2. Scenario 2: System process

The network team set X,Y coordinates for a new place or from a valid complain. The system gives the core team the existing antennas to know if they need to be extended or to point a new one. So, the system gives the best location to both core team and technician.

3. Scenario 3: System admin set the requirements

The System admin set the requirement that will be needed such as the network coverage, distance and other parameters that will help the core team to find antennas or to work on pointing a new one.

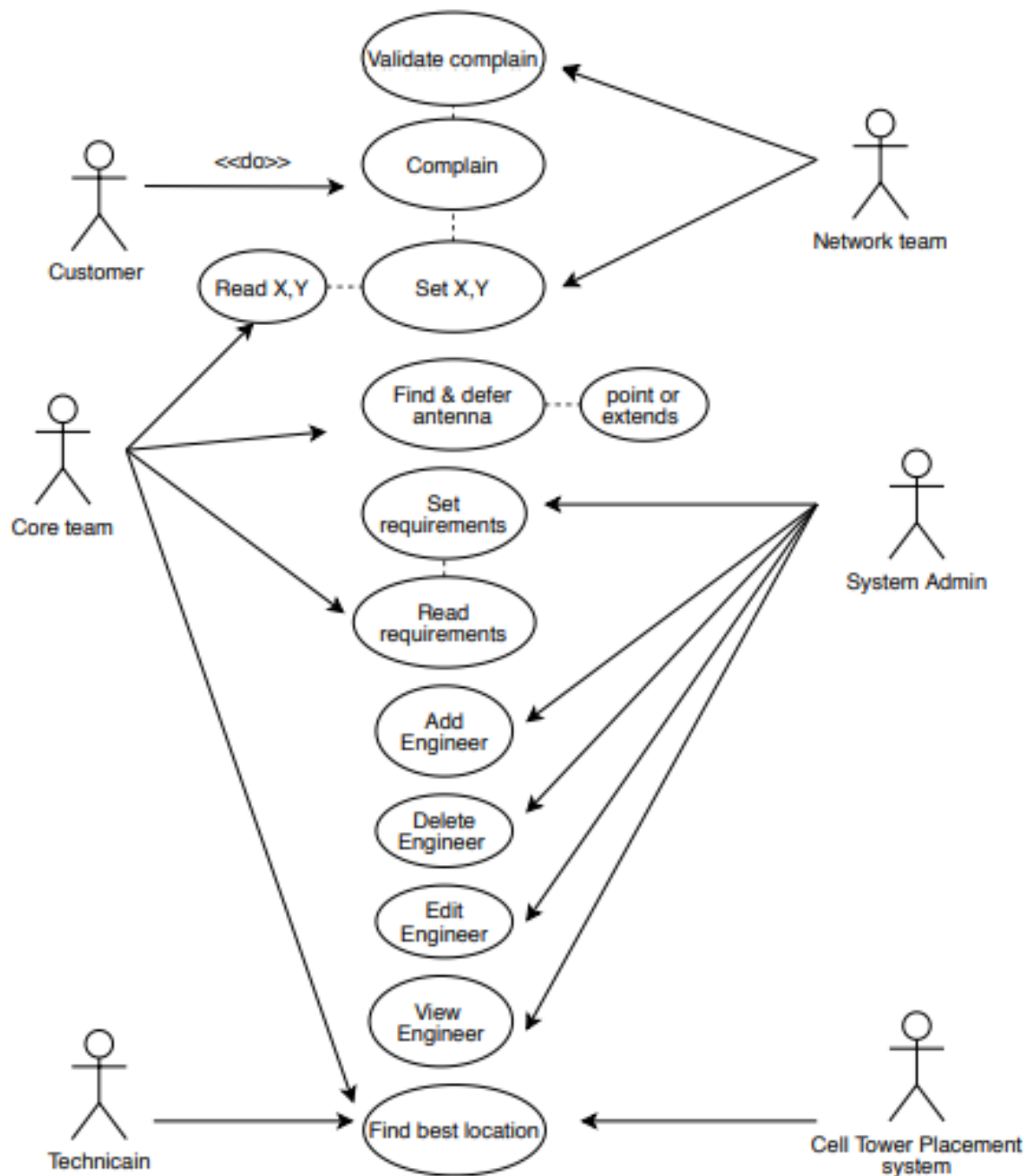


Figure 3.31: Use case Diagram for System.

3.9 Appendices

3.9.1 Definitions, Acronyms, Abbreviations

Cell Tower: A cell tower, or cellular base station is a cellular-enabled mobile device site where antennae and electronic communications equipment are placed—typically on a radio mast, tower, or other raised structure—to create a cell in a cellular network.

Table 3.1: Definitions, Acronyms and Abbreviations

Term	Definition
Cell Tower	A cell tower, or cellular base station is a cellular-enabled mobile device site where antennae and electronic communications equipment are placed—typically on a radio mast, tower, or other raised structure—to create a cell in a cellular network.

Chapter 4

Software Design Document

4.1 Introduction

4.1.1 Purpose

This software design document purpose is to fully describe the architecture of our Cell Tower Placement system. Our system is two parts. The First is a web application that pin the coordinates, distances between other antennas after that the X,Y coordinates used in the SVC classifier to suggest the best location. The second mobile application that mainly monitor the change in the Cell ID and record the location of the change Cell ID. We also provide a fulfilled description about each single stage input,output and algorithms used in this stage, along with a full illustration for each stage requirements and development process.It illustrates the system components and how they interacts with each other.

4.1.2 Scope

This document targets the communications companies that would use the Cell Tower Placement Application to help them for getting accurate place for pointing an antenna which will save much more time rather than manual inspection. Our purpose project is an automated system to suggest the best location. It is a pin on google maps and use distances from GPS then preforms pre-processing, feature extraction and classification. The system has the ability of learning from data set tests to enhance the future accuracy of the system.

4.1.3 Overview

The software design document includes eight main sections. The first section is an introduction to our system including our scope and purpose. The second section is the system overview illustrating our system workflow. The third section is the architecture design of the system, activity diagram and class diagram. The fourth section illustrates the database design in details. The fifth section illustrates our component design including the used algorithms and techniques. The sixth section illustrates the human interface design and describe how the user will interact with our system. The seventh section is the requirement matrix that show which components satisfy each of the functional requirements. The final sections are appendices and references.

4.2 System Architecture

4.2.1 Architecture Design

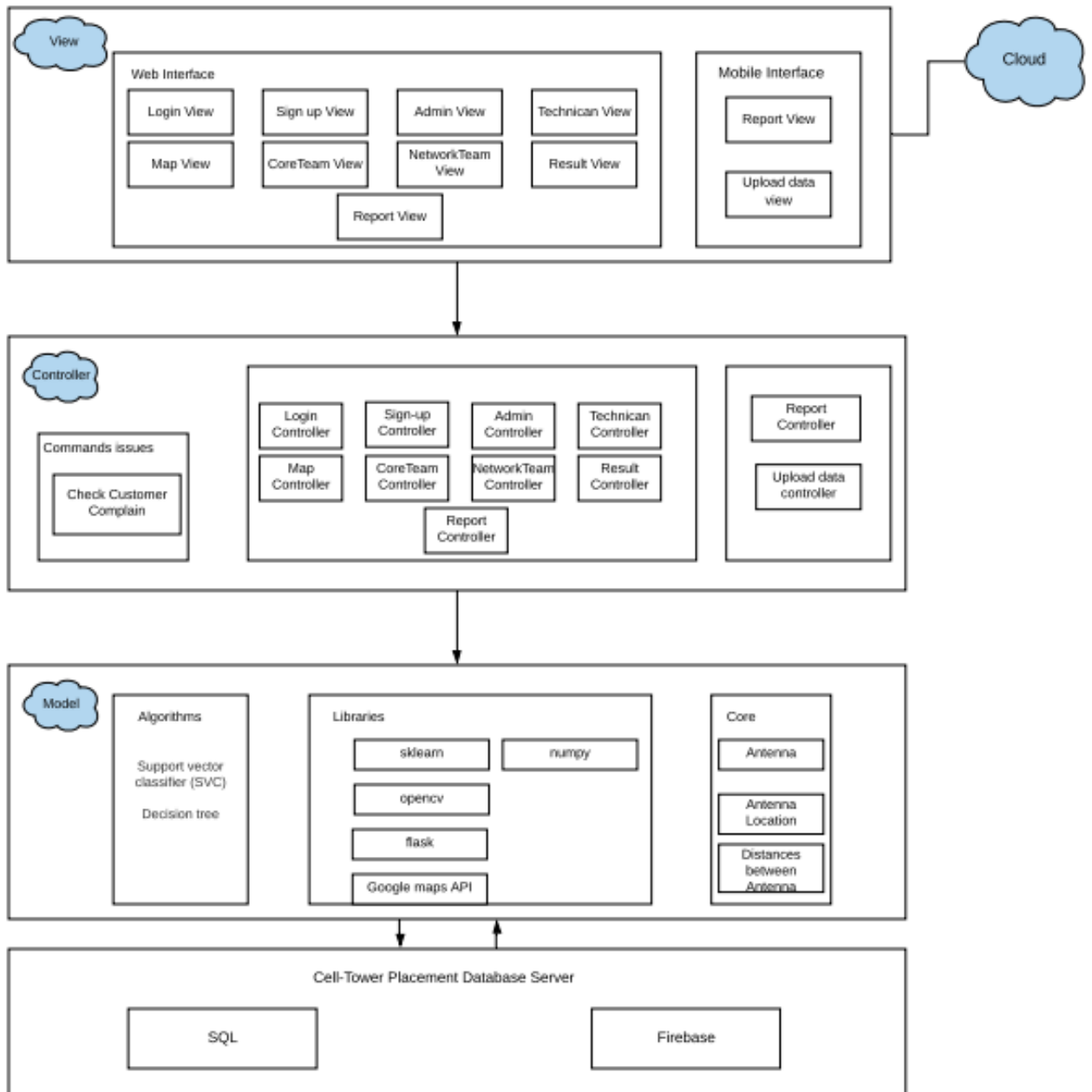


Figure 2: Software Architectural Design

4.2.1.1 View

It is responsible for the presentation of data and representing the User interface. We have two types of view. The first type is web page for the input forms and view maps. The second view is mobile application used to view reports and to upload any changes.

4.2.1.2 Controller

It is responsible for binding the view and model. The interactions and requests made within the view are taken and sent to the database to fetch data with the use of models then it forward data to view again to be shown. Some of the controllers we are having; Admin controller that responsible for handling the requirements that other users will work on. Report controller that responsible for viewing reports to the users when the results are shown.

4.2.1.3 Model

- The Model is used to connect the web application with the mobile application.
- Algorithm: Support vector classifier (SVC) is machine learning algorithm based on supervised learning technique. The nearest between the new data with the available data and put the new data into the category that is most nearest to the available categories.
- Libraries: Google Maps is a web mapping service developed by Google. It offers streets maps and real-time traffic conditions. We use Google maps API for extracting the features for getting the X,Y Coordinates and the distances between antennas. We use numpy library for handling of the array in python. The Sci-Kit learn library which contains the classifier we are using in our system. GSMCellLocation to detect the location area code and the cellid.
- Core: Antenna Location to get the X,Y coordinates from any region to classify the antenna and get the best location. Also, the distances between the antennas to work with the SVC.

4.2.2 Decomposition Description

4.2.2.1 Class Diagram



Figure 1 : Class Diagram

Class Name	Antenna
Super class	None
Sub class	SystemAdmin , GoogleMaps , SVCModel
Purpose	Main class that is use collect antenna data.
Collaboration	SystemAdmin Association
Attributes	ID , LocationOfAntenna , Traffic, RSCP ,Ecno , Coverage , CellLabel
Operations	getCurrentLocation(GeolocationY ,GeolocationX) , CalculatedDistance(Longitude ,

Table 4.1: Antenna Class

Class Name	Person
Super class	None
Sub class	SystemAdmin , NetworkTeam
Purpose	Main class that is used to encapsulate different types of users.
Collaboration	SystemAdmin Association
Attributes	ID , Fullname , Email , Gender , Usertype , Date of birth , password
Operations	Login(string username ,string password), Logout(), Password(string pwrld)

Table 4.2: Person Class

Class Name	Event
Super class	None
Sub class	FirestoreDB
Purpose	Main class to collect data needed for the event.
Collaboration	SystemAdmin Association
Attributes	ID , eventName , EventLocation, Estimated Attendance ,TypeofEvent ,Estimated ag
Operations	Login(string username ,string password), Logout(), Password(string pwrld)

Table 4.3: Event Class

Class Name	Network Team
Super class	Person
Sub class	Antenna
Purpose	Main purpose for the network team to add a new pin in google map for adding a new
Collaboration	SystemAdmin Association
Attributes	
Operations	CRUDInterface() , addAntenna(Antenna AntennaObjec)

Table 4.4: Network Team Class

Class Name	System Admin
Super class	Person
Sub class	Google Map
Purpose	CRUD all system users, Approve Antenna.
Collaboration	SystemAdmin Association
Operations	CreateUser(),DeleteUser(),ViewUser(),UpdateUser(),ConfirmAntenna()

Table 4.5: System Admin Class

4.2.2.2 Activity Diagram

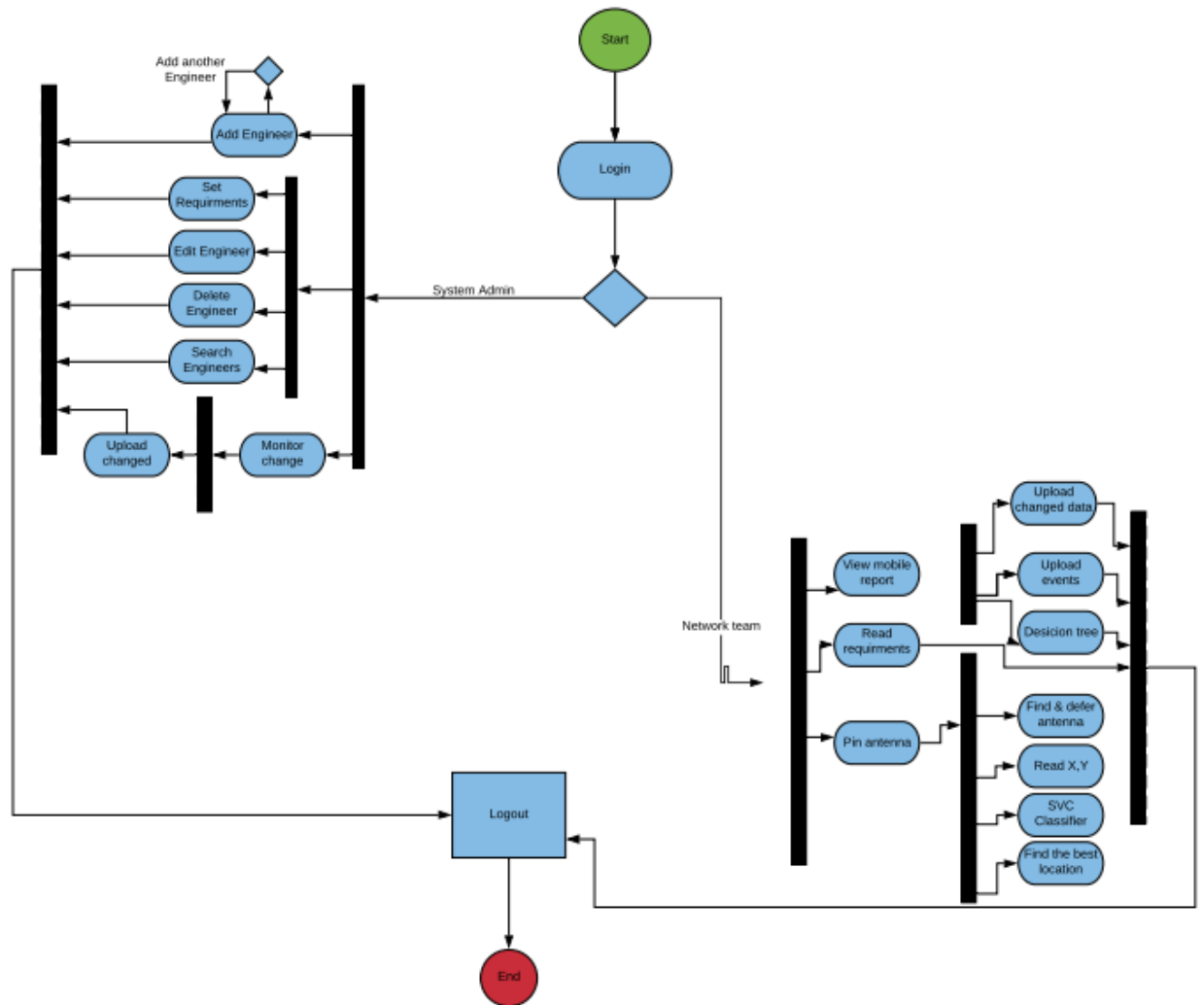
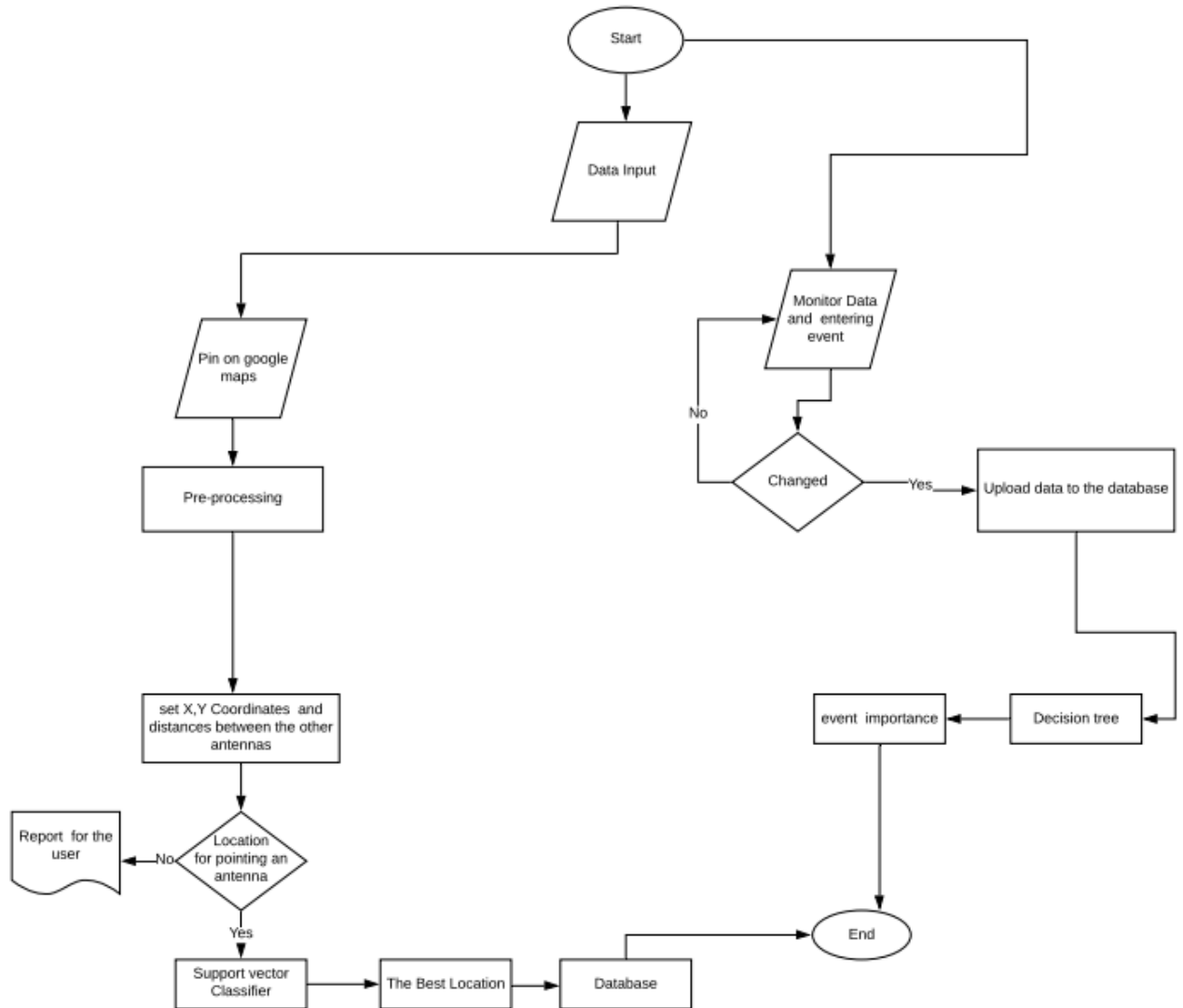


Figure 10: Activity Diagram

4.2.2.3 State Diagram



Chapter 5

Evaluation

5.1 Introduction

After the system finishes the implementation process where all the system's functionalities are implemented, the system should pass through the evaluation process. In this phase, the system is tested through many experiments. The experiments of the web site are divided into three different experiments in which the first experiment aims to show a comparison between different algorithms and how we selected the best one, the second one shows how we applied this algorithm in the whole system and finally shows how we improved the performance of the algorithm. For the mobile application the experiment is

5.2 Experiment 1 - Pre-Experiment

5.2.1 Setup

Datasets divided into two. The first one build from scratch because we didn't find for Egypt that satisfies our requirements and the second one obtained we just use some parameters of it for our need. But it has some changes according to our parameters. Then dataset was divided into test and train data. Different classifiers were tested with set of features computed per experiment.

5.2.2 Goal

This experiment aims to determine the algorithm that fits our problem, also to detect what are the most accurate features the model will work on.

5.2.3 Result

After testing several algorithms, it was clear that SVC algorithm achieved the best accuracy among all the experiments that were done as shown in Table 5.1.

Exper.No	Features	Classifier	Accuracy
1	Distance,Traffic, RSCP,Ecno.	SVC	72.09%
2	Distance,Traffic, RSCP,Ecno.	Decision Tree	52.43%
3	Distance,Traffic, RSCP,Ecno.	Naive Bayes	65.22%
4	Distance,Traffic, RSCP,Ecno.	Random forest	45.9%

Table 5.1: Testing algorithms by distance, traffic, RSCP and Ecno

5.2.4 Explanation

SVC Algorithm have the best accuracy according to the four features but still doesn't achieve the prediction needed for the system.

5.3 Experiment 2- Testing Features

5.3.1 Setup

After using four features didn't gives the target predictions so We decided to, so we try two of them. RSCP and Ecno was removed because both of them gives not accurate predictions. Also, we test to increase our dataset records to train the model well.

5.3.2 Goal

Here we try to increase the accuracy and prediction so we decide to try only 2 of our features so we get it more accuracy and prediction .

5.3.3 Result

After training and testing stages for the 2 features we have got SVC also with high accuracy percentage and more prediction.

Exper.No	Features	Classifier	Accuracy
1	Distance,Traffic	SVC	80.12%
2	Distance,Traffic	Decision Tree	58.23%
3	Distance,Traffic	Naive Bayes	70.62%
4	Distance,Traffic	KNeighbour	67.43%

Table 5.2: Testing algorithms by distance and traffic

5.4 Experiment 3-Features Selection

5.4.1 Setup

After testing distance and traffic didn't satisfy the target needed so we decided to test the models on the distance.

5.4.2 Goal

This feature experiment goal choosing the most accurate features that gives highest accuracy and the most accurate predictions.

5.4.3 Result

Support Vector Classifier(SVC) is used to fit data provided and return the best prediction for it. After testing all the algorithms SVC gives us the most highest accuracy.

Exper.No	Features	Classifier	Accuracy
1	Distance	SVC	95.03%
2	Distance	Decision Tree	65.78%
3	Distance	Naive Bayes	80.24%
4	Distance	KNeighbour	71.56%

Table 5.3: Feature Selection

5.5 Experiment 4-Event Testing

5.5.1 Setup

In this phase, we get a dataset, and select the attributes needed for my model. Selected attributes are Audience Number, Audience Type , Event Category are the most important attributes for the event selection.

5.5.2 Goal

This features experiment achieve us the highest accuracy and right prediction we expect.

5.5.3 Result

Decision Tree which takes three attributes Audience Number, Audience Type , Event Category and predict the event importance on scale of 1 to 5.

Exper.No	Features	Classifier	Accuracy
1	Audience Number, Audience Type, Event Category	Decision Tree	89%

Table 5.4: Events

5.6 Experiment 5-Mobile Integration

5.6.1 Setup

After adding the event information through android application the data is stored in firebase realtime database then we fetch this data through python script that depends on pyrebase library, after fetching the data it will be passed through flask app in order to predict its importance then representing it in webpage.

5.6.2 Result

Decision Tree which takes three attributes Audience Number, Audience Type , Event Category and predict the event importance on scale of 1 to 5.

Chapter 6

Conclusion

In this document, we have presented the design, development and evaluation of an automated decision for Cell Tower Placement (CTP) with the usage of machine learning models. The system mainly detects Cell Towers/Antennas along with their types. The process starts when the user suggest a place for building a new cell tower, giving all features needed such as traffic, as well as, when the user place the pin on google maps, the distance is calculated automatically according to the nearest cell tower for this pin. We have achieved an accuracy of 95%. By the usage of SVC (classifier support vector classifier), no engineer was needed in taking decisions for placing cell towers.

A mobile application is implemented to be independent of our website. As it will be used to get the location area code and the cell ID of the nearest cell tower and to enter events of a place by using Decision tree.

6.1 Future directions

In the near future, we aim to accomplish an overall system for Cell Tower Placement. As we aim to build and increase the size of the data model to maintain system stability. Meanwhile, we aim in updating our system by adding more features as prediction for any connection inf any cell tower will be lost or not in a particular event before it happens. Further more we aim to link the website with the mobile application to build our big data mode.

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