Software Requirement Specification Document for Safe Social Distancing Project

Youssef Khaled, Ahmed Mohamed, Mohamed Abdelghany, Ziad Emad El Azhary
Supervised by: Dr. Taraggy Mohey, Eng. Mennat Allah Hassan

April 9, 2021

Table 1: Document version history

Version	Date	Reason for Change
1.0	7-Dec-2020	SRS First version's specifications are defined.
1.1	24-Dec-2020	Adding use case for User and Admin. Adding Function requirements. Adding Class diagram. Adding GUI.

GitHub: https://github.com/MohamedAbdelghanyy/SafeMove

Abstract

The main idea of the proposed projects is to make it easy and practical for anyone with a smartphone to practice social distancing and keep themselves safe and out of harm's way. By using Wireless Fidelity (Wi-Fi) and Bluetooth capabilities in the phones, we aim to create a mobile application that accurately pinpoints the app-user's location and then dynamically draws it on a real-time updated map. It shows the whole nearby area marked with people around the app-user and sends a toast notification when the user is approaching an unsafe or crowded zone.

1 Introduction

1.1 Purpose of this document

The purpose of this Software Requirements Specification (SRS) document is to bring to light and illustrate the requirements needed for combating the widespread virus known as COVID-19. And this can be achieved by practicing safe social distancing in crowded places, with the respect to our market and customers. This document will provide a comprehensive and detailed description of each part and the constraints of the system. Mainly, this SRS is a guideline that our audience, team, and stakeholders can use to fully understand what the system is and its functionality.

1.2 Scope of this document

Safe Social Distancing was an idea that was brought to light in a time and age where social distancing could be the difference between life and death. Our system's main purpose is to limit and prevent the spreading of COVID-19, and help people practice social distancing. This SRS is aimed at specifying and analyzing all the requirements of the software to be developed later on.

1.3 System Overview

Our Project consists of many stages, the first one being collecting data from signals that are emitted by WI-FI routers, upon receiving this information on the user's device, a background service that stores and process this data in order to create a data set of the received signals is created, and it is then sent over to the sever for further processing and applying our tracking algorithms on it, last but not least this enables us to pinpoint the location of the user to nearest meter and place him on a dynamic updated live map, and give out notifications and alerts when approaching a crowded possibly contaminated zone.

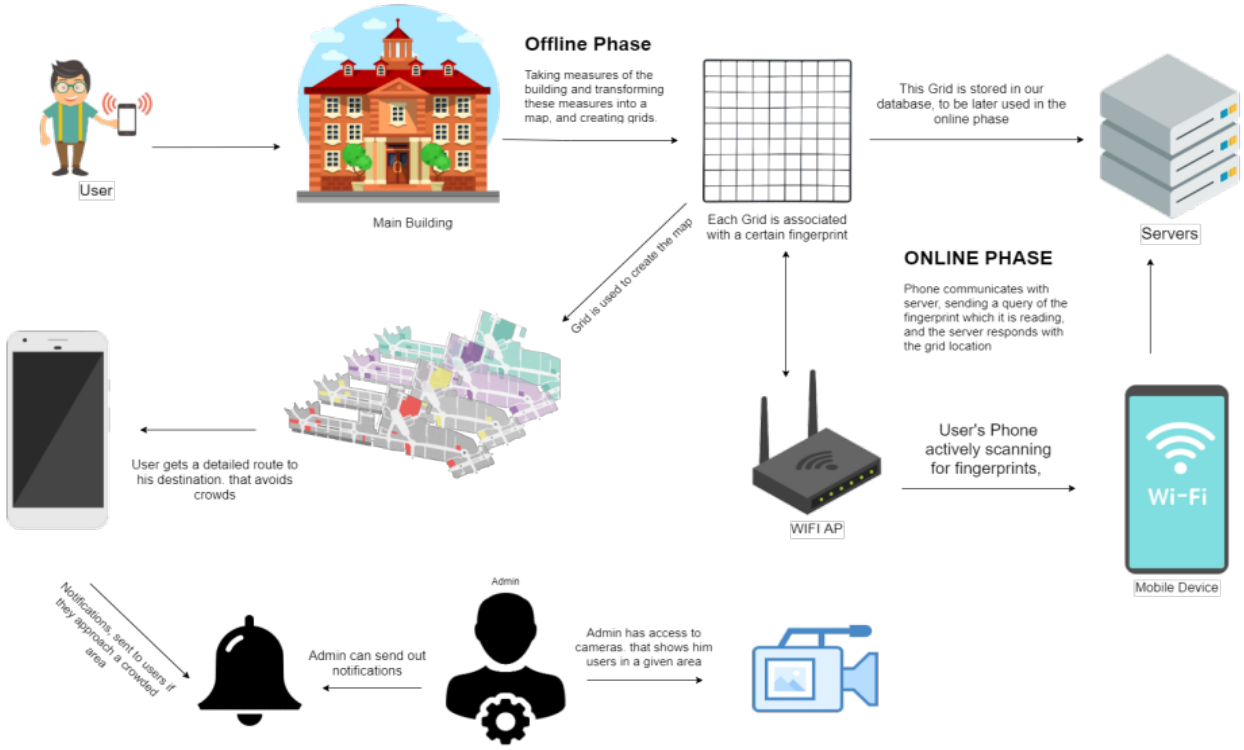


Figure 1: Overview diagram

1.4 System Scope

The scope of this system includes:

- The system shows the user an indoor map with live location.
- The system will offer to the user paths to his chosen destination.
- The system will offer to the user alternative paths if the path is crowded.
- The system sends notifications in order to save the social distancing between people.
- The system generates daily reports with the average of people entering the rooms.
- After finishing the application it will be more safe for people to go any where without contacting too much people.

2 Similar Systems

2.1 Academic

In **An Online Sequential Extreme Learning Machine Approach to Wi-Fi Based Indoor Positioning** [1] Wi-Fi technology has been already used in our houses and offices for years now, and

this makes it a great candidate to keep in mind when thinking about creating an indoor positioning system, the Wi-Fi's already existing infrastructure makes it really convenient to use as Location Bases Service, this will greatly reduce deployment costs and is easy to implement because all major IPSs adopt the fingerprinting technology and sends all the data the user needs to determine his location. But there are 2 major flaws within this system the huge costs of manpower and the time it takes to make an offline site survey.
Algorithm: They used normal fingerprinting methods to estimate the user's location, the process consist of making an offline fingerprint database of the location and then when the online phase is started, the user sends a location query, this query hold valuable fingerprint information like the RSS and compares this fingerprint with the ones in the local offline database already created in the phase before this one, and tries to estimate the user's location based on this information. But this wasn't enough because it takes a lot of manpower to create the offline fingerprint map for a certain location, as well as this location may be altered in many ways during the live phase and many environmental factors can lead to signal deterioration as well. This is why they proposed a system based on online sequential extreme learning machine, which reduces the time and the manpower needed to create the offline fingerprint database, as well as takes all the environmental dynamics into account, to come out with a more reliable and accurate system. OS-ELM makes use of ELM which can provide great generalization performance at a very fast learning speed. OSELM has the online sequential learning ability which does not require retraining when new data are received.
Results: Extensive testing and experiments were made to test the system's efficiency and determine whether there is an accuracy bump or if the system didn't make any real changes to the already proposed used algorithms. At 10 different points of interest OS-ELM provided a location accuracy of 2.928m, which means that the results have been enhanced by a whopping 30% over the Batch ELM, the below figure shows a direct between the 2 proposed algorithms, it clearly shows that the OS-ELM is the more robust and better algorithm.

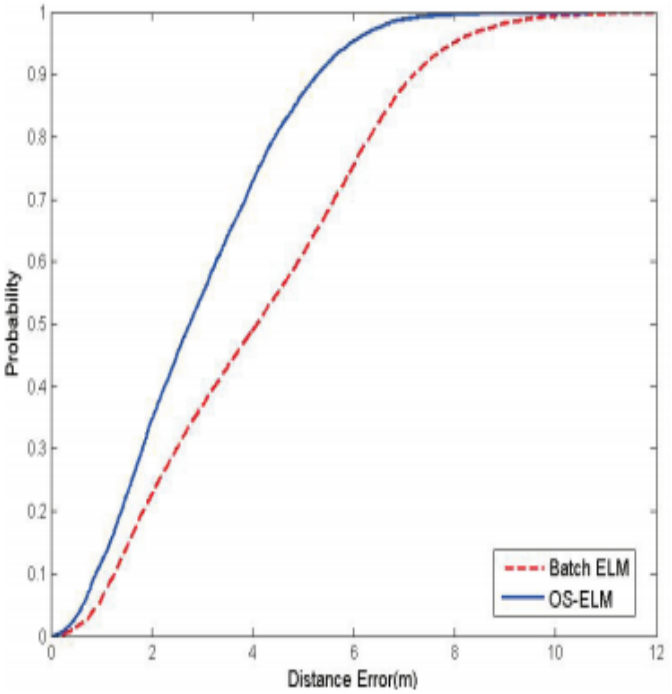


Figure 2: Probability vs distance

Future Work: They aim to make a more concise and better Batch ELM algorithm alternative in order to have better online phase, better speculation and prediction of where the user really should be, increase the accuracy and take into consideration more environmental disturbances than they currently do.
Criticism: This paper doesn't discuss the application they created, it doesn't mention whether is it cross platform or is it based on one platform.

In **Random forest and Wi-Fi fingerprint-based indoor location recognition system using smart watch** [2] presented the intersection between the Bluetooth Technology with the Indoor positioning system (IPS).
Algorithm: Researchers has solved this problem by using the Received Signal Strength Indicator (RSSI) value of bluetooth signals in order to find the location of the devices. In order to receive strong signals they used BTM222 Bluetooth Modules and used its RSSI in tracking devices [3]. Researchers has passed with different phases during this project, they have paired the mobile devices with the BTM222 as normal Bluetooth they activate the bluetooth and start searching for other devices. The module has its default name "Serial Adapter" and pin "1234" or "0000". At first they created their first project its main aim is to find the nearby Andriod devices and show their name, address and RSSI value, that was the first step in testing the limitation and accuracy of Bluetooth Positioning System. They have fixed the range of meters that they are searching in to 10 meters. They discovered that 9 seconds refresh time is the optimum number of seconds to find an accurate number of bluetooth devices. However, 9 seconds was a huge time interval so they decided to restrict Bluetooth devices to recognize bluetooth modules only not bluetooth smartphone

in order to detect their location. It helped in reducing the refresh time to only 7 seconds in addition to placing by maximum 2 bluetooth adapters in each room. In their final application, after estimating the refresh time of the bluetooth device to discover a bluetooth module, they have to use the blutooth beacons in order to identify the location of the android smartphone.
Result:As a result for all these trials, they have reached 90% accuracy at the time interval 9 seconds but it has a delay in current position. On the other hand, they have achieved 80% accuracy during refresh time of 7 seconds and also the current position gets updated faster and earlier.

Test No.	Actual Location	Location Detected	Refresh Time
1	Room 143	Room 143	7 sec.
2	Room 158	Room 158	7 sec.
3	Room 143	Room 143	6 sec.
4	Room 158	Room 153	6 sec.

Figure 3: Final results of actual location vs detected location after achieving the optimum number of seconds

Criticizm: The paper has only 3 references, also the researchers has not clarified the source of their dataset.

In **Indoor Positioning** [4] the main problem was that GPS signal strength indoors are so limited and complex so it can't find an indoor position for a device.
Algorithm: In order to solve this problem, researchers have discovered 2 dominant methods, first one was Radio Frequency Identification (RFID) based, this method must have 4 components which are software, readers, tags and antennae. Starting with the components of the software it is responsible for the RFID system integration [5]. Its front end components manage the readers and the antennae, on the other hand, Middleware component deliveres information to servers. The main use of the readers is to inquiry or read all the tags in fast progression. Moving to the tags, they are used in identifying the specific location of the object that this tag has placed on. Eventually, the antennae, in comes in many forms and shapes, its receivings are depends on the size of the antennae and the square meters it covers. Instead of the distortion of radio waves from RFID, the researchers has another method to detect the indoor position. The second method is Wi-Fi location method, it measures the signals of the location of the person who carries the device, it absorbs waves at 2.4GHz.
Dataset: LBS (location based services) system here used a dataset for the locations, it is simply any system provides a service based on the location of the device. There are many types of LBS applications...

Service category	Example application	Characteristics	
		Telecommunication method	Indoor positioning method and technique
Infotainment services	In a ubiquitous tourism perspective, use urban Wi-Fi or cellular network to access information concerning relevant local events in the surroundings	Wi-Fi (WiMax), wide-area cellular and AGPS	Wi-Fi, proximity technique
Tracking services	In a business-to-business perspective, place and track automatically an order to a hardware supplier, by billing and managing warehouse inventory through RFID technology	Wi-Fi, WLAN	RFID, statistical analysis
Selective information dissemination	In an hospital, allow for the transmission of the patient file on PDA (personal digital assistant) only to nurses entering the patient's room; control the access of hospital restricted areas	Bluetooth, Wi-Fi	Wi-Fi, geometric technique, scene analysis
Location-based games	With Web-based games, propose a default setup (language, country, etc.) according to the location of the gamer (IP address, cellular zone)	Cellular, GPS/UWB, IP address	Wi-Fi, proximity technique
Emergency support services	Upon a fire alert, provide automatically the detailed building map on PDA to the firefighter, indicate life-threatening situations, and track him in risk areas (e.#8239;g., toxic products)	Wi-Fi, Wide-Area Cellular, AGPS	Wi-Fi, geometric technique
Location-sensitive billing	Automatic RFID tag reading for continuous flow through highway tolls, an invoice is sent periodically by mail	RFID/Wireless (Wi-Fi) or Bluetooth	RFID, proximity technique

Figure 4: Categories of indoor LBS applications and their characteristics

Results: As a result for these methods, finding devices now has better accuracy and algorithms in that field are being developed. Also geographic information systems will be built on the indoor positioning system.
Criticism: results are not clearly mentioned in statistical way or in a numeric probabilities compared with the years before creating this feature.

In **How Feasible Is Wi-Fi Fingerprint-Based Indoor Positioning for In-Home Monitoring?** [6] Is it feasible to use a Wi-Fi fingerprint based indoor localization method for in-home monitoring? This technology has risen to fame and became of growing importance in the recent years, this technology is mainly used in systems where accuracy is a must, like remote healthcare where continuous monitoring is a of extreme importance. Numerous experiments have been conducted and an astonishing 96% success rate in estimating the location was reached in identifying and accurately pinpoint the location of the user in his/her house. And an average of 98% in all of the seven studies that were conducted. Fingerprinting doesn't even require for the user to own the access point, but instead any Wi-Fi access point can be used which in turn makes this algorithm or strategy really easy and feasible to use.
Algorithm: Wi-Fi Fingerprinting positioning systems are based on measuring the signal strength received from a set of wireless access points, the intensity is measured at some points of the region of interest. These measures are used as a reference database or radio-map. Wi-Fi fingerprinting works with the Received Signal Strength Indicator (RSSI) level from the detected WAPs. The set of all fingerprints for all points forms a map. Given a new user's fingerprint, a location algorithm uses the map to best locate the user by returning the most suitable point in the mapped region. To create this map. There are two stages one must follow the first one would be the configuration state, this state is where the radio map or the training database is created and the other part is the operation part, this is where the user's device obtains the signal strength of all visible WAP's which is used to locate the user on the radio map. In order to achieve the second stage, a mobile application to obtain the Wi-Fi fingerprints is used, this application runs in the background and doesn't need any user interaction, the application process the Wi-Fi fingerprint in the background to estimate the user's location. The estimated location can be sent to a server.
Results: After 7 scenario cases in which the creators got conflicted result, they decided to narrow down the test into only 3 scenarios of the already proposed 7, them being 1,3 and 4 since they had the best and the worst classification rate, below is a figure that shows the maps of these 3 experiments. Scenario one got a 87.85% correct predictions, while scenario three got a 72.64% of the spaces correctly predicted, and last but not least scenario 4 proved to be the best one by far and got a whopping 96% of the predictions correctly. They have managed to prove that it is really feasible to use Wi-Fi fingerprinting as an indoor tracking solution.

Figure 5: Different offline grids for fingerprinting

Future Work: The creators of this research paper hope to find real effective solutions to attenuation, signal confliction and other kinds of signal deterioration causes, this would make all the future work way more reliable and produce better results more consistently.
Criticism: The System isn't cross platform it only uses android, as well as the results really vary widely from place to place and are not always accurate.

In **Wi-Fi-Based Indoor Positioning System** [7] presented other functions for mobile phones other than communication, so the find that mobile devices can be used as navigation tools. The main problem for the researchers was to make mobile a navigation tool in order to make life more comfortable and easier.
Algorithm for solving problem: They used Triangulation algorithm to find the location of the device using satellites, this was efficient only for outdoor positioning, however indoor positioning wasn't efficient as out outdoor. Indoor positioning has its own ways in order to be detected, Bluetooth, Wi-Fi and Infrared are preferable. They used Wi-Fi in different indoor experiments, such as using antennae in Antennae-centric algorithm, it requires high computations during training phase. It converts RSSI to a measured distance and calculate and determine the location of the device. Other way is using Wi-Fi in one of the most known and from the first indoor positioning systems which is RADAR, this method used the signal strength of the Radio frequency in measuring distance between the AP (access point) and the mobile device. [8]
Results: A radio map will be created by RSSI from the MAC addresses of the detected access points, this radio map will consists of samples taken at specific point on the map which called fingerprints. This fingerprints consist of the name of the location and the measurement vector where all detected Aps and their corresponding signal strength are located. Euclidean Distance compares the fingerprint in the database with the current fingerprint of the mobile application and finds the minimal distance between these sets of fingerprints.
Future work: They are looking forward to increase the accuracy of the system by adding new techniques such as backtracking, it can go back again to the user's last location and compare between the candidate locations which will be the user's next destination.
Criticism: Using Antennae-centric algorithm is not efficient because there is signal attenuation that can affected by the environment.

In **Random forest and Wi-Fi fingerprint-based indoor location recognition system using smart watch** [9] presented a system that use an Arduino based smartwatch in order to create an indoor location recognition system. The system uses Wi-Fi AP installed in an indoor location coupled with the smartwatch that is extend from a smartphone running their application in order to accurately pinpoint the user's indoor location down to the nearest centimeter.

Algorithm: The paper discuses a lot of potential algorithms like, fingerprinting, triangulation, and random forest algorithms, but they end up not using triangulation because in order to use this method we ought to have at least 3 access points and we would use the Pythagorean theorem and use the coordinates of the 3 access points to determine the location on the user. They ended up using fingerprinting which depends on Basic Service Set Identifier (BSSID) and the Received Signal Strength Identifier (RSSI) [10], which are inherent values of the Access Point, then the AP would use these values and create a grid out of these values, in this technique the accuracy and location vary depending on the size of cells that divide the space, the larger the size of the grid the higher the accuracy, but it is really important to define the appropriate size of the gird, going to big

or to small could lead to really bad inaccurate results . And finally, the Random forest algorithm is being used as an ensemble algorithm, used for classification and regression analysis, is randomly extracts data from data and each result is combined to make a prediction model. although random forest achieves a good generalization because it makes a decision tree using random data from among the learned data, it cannot explain the process that the result comes out.

Results: The system ended up producing very good results with an excellent location recognition accuracy of about 97.5 percent, while the existing method only gave about 90.6 percent, moreover, when it comes to the time aspect, the more the number of data is, the longer the time takes to create learning object for the random forest algorithm to utilize. On the other hand, in terms of location accuracy, the existing model preforms a learning with all data, the signals with similar intensity are considered one, this problem is mitigated with this system because of the usage of the BSSID value.

Future Work: No future work plans were mentioned but they did mention the desire to even further improve their accuracy by taking into consideration Wi-Fi noise and signal decline of the transmitting device.

Criticism: This system uses an Arduino based smartwatch as a tether between their application and the AP instead of directly using the application, this not only increases the costs of the system but also makes it necessary to include another piece of hardware besides the phone to make the system work.

In **Research on Wi-Fi indoor positioning in a smart exhibition hall based on received signal strength indication** [11] presented a system that aims to improve the management of science and technology museums by creating an indoor positioning system that is based on Wi-Fi fingerprinting, it is composed of two stages, an offline acquisition state where a grid of the proposed place is composed and then the difference AP's available in the place start transmitting Wi-Fi waves with fingerprints, and the device pick them up and creates a list of them in the database. And the other phase is known as the online positioning stages, this phase uses a lot of algorithms to accurately pinpoint the location of the user inside the exhibition room.

Algorithms: Wi-Fi fingerprinting is the main idea behind this application's success, it starts of by declaring a well-known reference point, the below figure shows that it's L7, then the AP's start emitting their waves and a lot of meta data is collected, these metrics range from TOA (Time of Arrival), AOA (Angle of Arrival), TDOA (Time Difference of Arrival) and Received Signal Strength (RSSP). These aren't the only data collected, the broadcasted frame also contains very important data like the BSSID, the SSID and most importantly the RSSI, these three assets provide very valuable information for their positioning algorithm to deal with.

Also they use the KNN algorithm as their matching algorithm [12], alongside many mathematical equations like the Euclidian's distance as well as Gaussian probability distributions.

Results: This paper has reached a better algorithm than the proposed old ones because they kept refining and upgrading the current algorithms and creating new ones that should be more accurate. This paper also provides a lot of methods for working on the RSSI raw data of the fingerprint algorithm, it also manages to improve on the KNN matching algorithm 3 times and improved the viability and of fingerprint data and managed to increase the accuracy of locating the uses.

Future Work: This paper only considers the location fingerprint information in two-dimensional space. While in the real environment the room is three dimensional, Therefore, to obtain higher positioning accuracy, it is necessary to consider the construction of the location fingerprint database

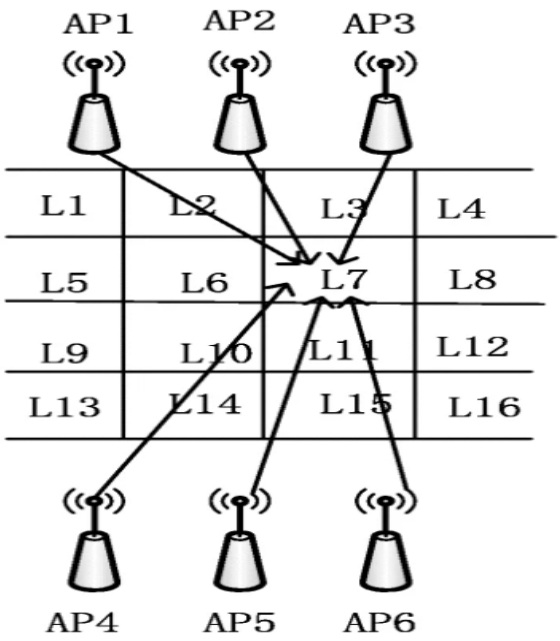


Figure 6: Access Points and ther

in three-dimensional space.
Criticism: This paper fails to portray the real-world changes and environment because they only deal with two-dimensional space, as well as their paper failed to specify which platform they are targeting, their work isn't cross platform.

In **BLE Beacon Based Indoor Positioning System in an Office Building using Machine Learning** [13] presented an experiment to assist people man oeuvre to the office gear, meeting rooms, and so forth, in a workplace operating AI calculations. This can support the staff to operate and perform better and helpfully sparing time.
Algorithms:A fingerprinting procedure for indoor installation is read and applied for the assemblage of the RSST values and (x,y) area coordinates from the fixed beacons. A narrative review is carried out on different AI models suitable for indoor situating. Specific models were tested and contrasted based on their capabilities using performance metrics such as CDF curve, MAE, RSME, and Euclidean distance error. The general presentation of long short-term memory network excelled the Ada boosting, XG boosting, multiplayer Perceptron and Gradient boosting.
Results: As a result for this experiment, researchers found that the performance of the Long-short term memory network better than Ada boosting, XG boosting , multiplayer perception and Gradient boosting.

In **The Quick Radio Fingerprint Collection Method for a Wi-Fi-Based Indoor Positioning System** [14] presented an experiment and comparison between different techniques and methods in order to take less time and to more accurate in detecting the indoor position of the device.
Algorithms and dataset: the researchers proposed quick radio fingerprint collection (QRFC) algorithm in order to collect the sampling information. This method makes the sampling process much

simpler, they collect data by letting the user walking with his smartphone from point to another in order to create his fingerprint of the path, the smartphones record the RSSI values of each step, then they use the data recorded to calculate an approximation location for each point on the path.
Results: After doing some experiments using the QRFC and NVA, it concluded that both methods are easily implemented into smartphones and they have the same performance and accuracy, however, QRFC took much less time than that required for static sampling (SS), also researchers see that in the future, QRFC will be the most important technique for signal sampling.
Criticism: No future work clearly explained, also there is no related works section to be easier for the reader to go wherever section he wants.

In **A BLE RSSI Ranking based Indoor Positioning System for Generic Smartphones** [15] presented a system that wanted to create a tool that would help in retail stores, it would aid the user in the navigation to find physical items and different aisles. Instead of using the most popular and widely used method that is Wi-Fi fingerprinting, they decided against it because it's typical positioning accuracy ranges between 2.0 to 3.0 meters, which isn't accurate enough to distinguish between narrow aisles and physical items. They decided to take the BLE approach and come up with a system that uses the RSSI and a fingerprinting based method called Kendall Tau Correlation Coefficient (KTCC). [16]
Algorithm: The Algorithm used by this paper is BLE RSSI signals in cooperation with KTCC, they used this approach instead of causal Wi-Fi fingerprinting because it enables them to use cross platform devices, Wi-Fi may not be accessible everywhere, and the Wi-Fi RSSI is not accessible by all types of phone. Apple iOS phones don't have APIs for 3rd parties to develop Wi-Fi-based indoor positioning apps. This is why Bluetooth seemed to be they way to go, many tests were conducted in order to make sure the algorithm is as efficient as it can be. They made an equation to account for difference in hardware, and another one to make up for signal path loss.
Results: Their system managed to reach an error percentage of 0.87 meters which is an improved result compared to existing current state of the art systems. They have also managed to proof that KTCC based RSSI is more smartphone independent than ED based RSSI.
Future Work: They aim to conduct more experiments in different areas to account for climate changes, signal attenuation, they also want to find a way to make the human body absorption of the signal a nonfactor
Criticism: They didn't create the IOS variant of the application, and thus they can't confirm how it would work. Additionally, how to build radio map faster and track moving users better needs further investigation.

2.2 Business Applications

Our application is not the first indoor positioning application aiming to save the social distancing between people, there are also some applications that can create a map building and start their indoor navigation:

1. **Infsoft** [17]: It is a software development kit (SDK) [18] it is available as third party apps plugins, it is available on iOS and android operating systems. This system used for indoor

positioning or indoor navigation, in order to cover the buildings and its floors, the system offers "infsoft Maps Editor". You have only to import the blueprints of the building and it will automatically map this building with its rooms. Not only GPS who can find your current location in the outdoor position, but also Wi-Fi and Bluetooth beacons can detect the indoor position inside this building. The system provides seamless outdoor and indoor positioning and simulate your location using longitude, latitude and building floor. Moreover it offers drawing tools to create paths used for indoor navigation, it is automatically displayed in the user's position and start navigating him, if the user selected another route or any other destination, the route will be recalculated again.[19]

Figure 7: Infsoft Maps

2. **Mapwize** [20]: It is an indoor mapping platform that has its own studio for creating any indoor map and mapping it to a building. It has many important features like the ability to

insert blue prints of the required building, aligning it on the already existing map, as well as assigning nodes inside the building these nodes being the important places that needs to be marked (Stairs, Elevators, ATM's, Offices, Bathrooms, and much more). Mapwize uses GPS to track its users and get them to their destination, but once they are inside the building the tracking stops and the user is met with the indoor map of the place they are visiting, the application then uses a pre recorded set of paths that were created by the creator of the indoor map they are viewing, this was created by making the creator put all the important nodes we discussed and drawing manual paths between them as well as naming them distinctively. Mapwize was created with indoor navigation in mind but they don't use any type of indoor navigation techniques, be it BLE signals, Wi-Fi tracking or even Infrared tracking. The application supports QR codes that in case of it being scanned the user would be placed on the map where he just scanned the Code. The application is free for any user to download, and its cross platform making it a very good choice for indoor location tracking.[21]

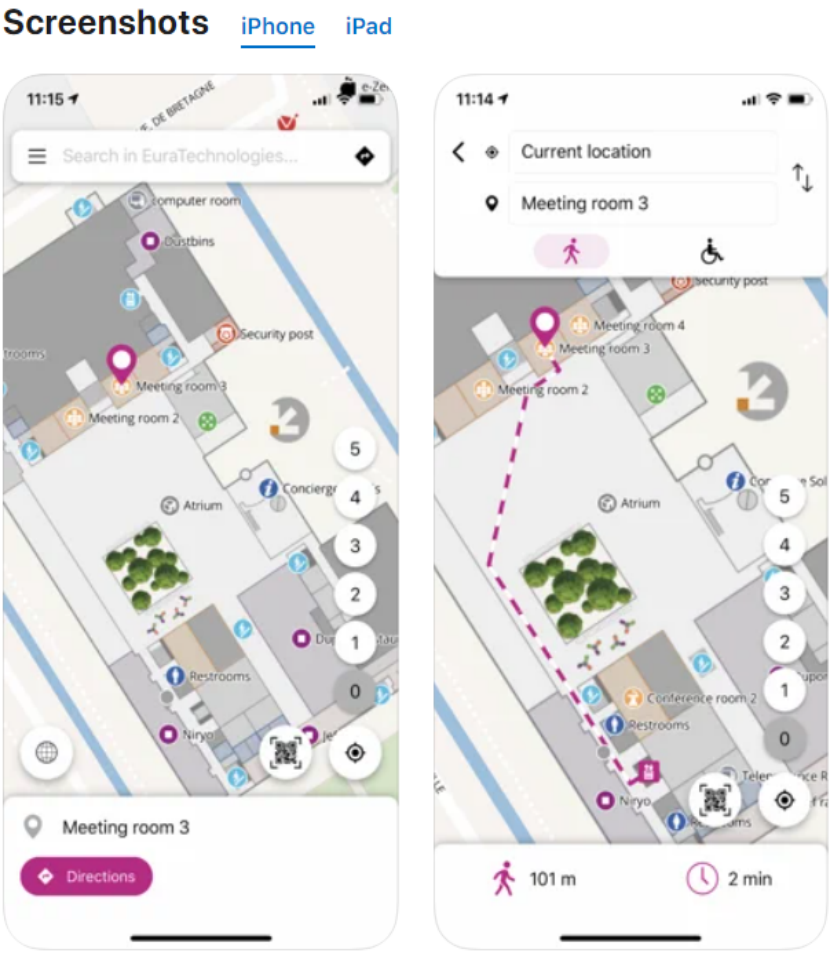


Figure 8: MapWize results

3. **COVIDSafe** [22]: is a published cross platform app developed by the Australian Government Department of health, that aims to warn the residents of Australia in case they come in contact with someone that has reported himself as an infected individual.[23]

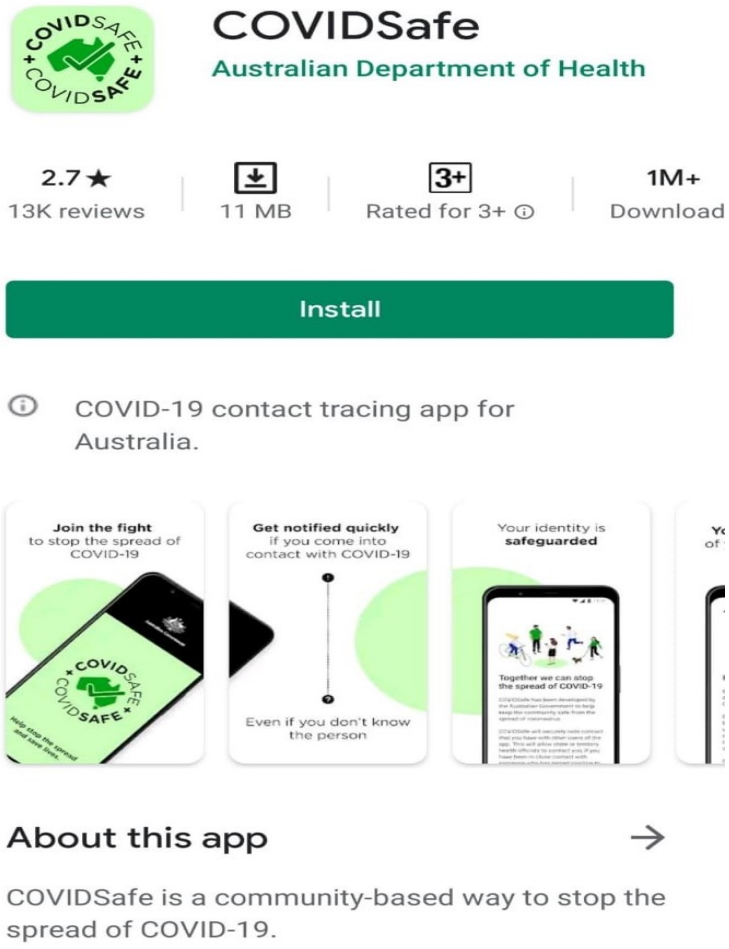


Figure 9: COVIDSafe

4. **COVIDWISE** [24]: is an android application certified by google as an official catalyst in the fight against COVID-19, this application along side many other like CRUSH COVID RI (Rhode Island), as well as COVID Alert PA (Pennsylvania) and COVID Alert DE (Delaware) are all apps that are used for contact tracing and are endorsed by both google and local or national authorities, google is doing its best in order to create a local application like this one for every possible region.[25]

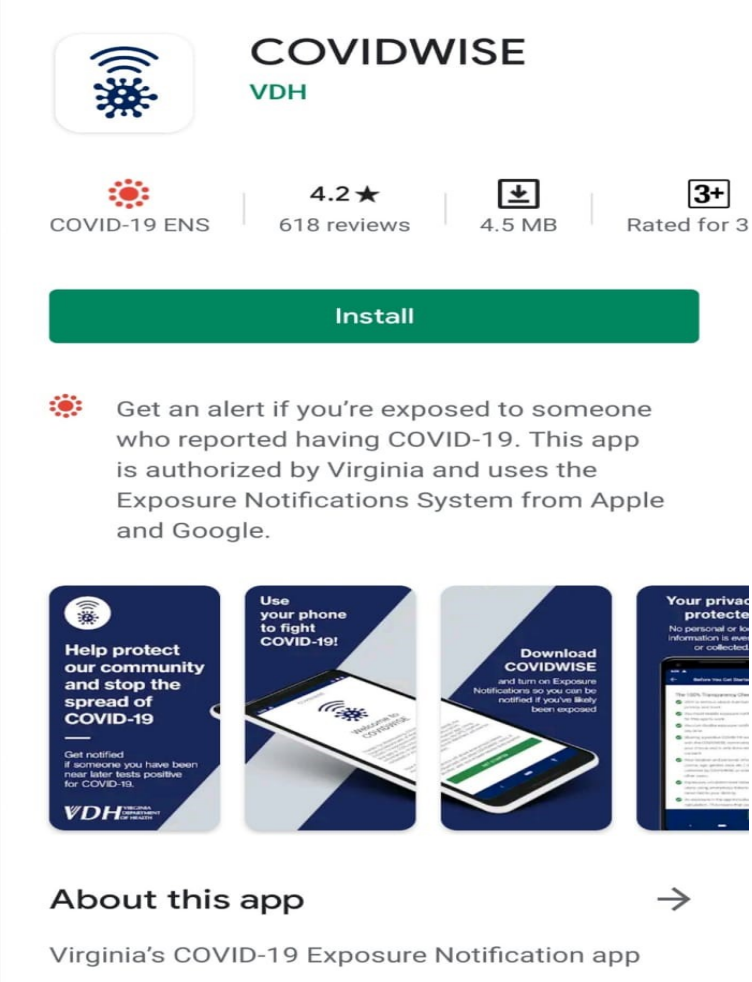


Figure 10: COVIDWise

5. **Crowdless** [26]: It is a free app that helps people observe social distancing to slow the spread of coronavirus has launched, it is developed by Lanterne, a small UK start-up company supported by The European Space Agency, it uses satellite data and artificial intelligence to identify where people are congregating anywhere in the world.[27]

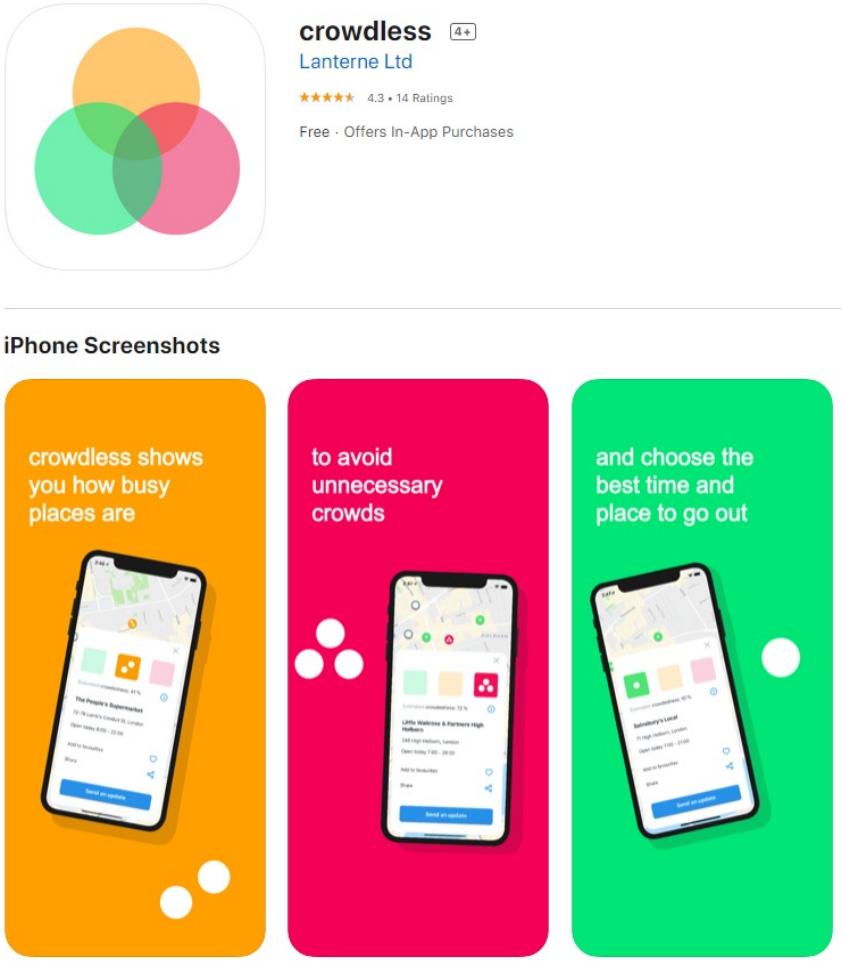


Figure 11: Crowdless

6. **Steerpath** [28]: It is an excellent indoor map creation location and manipulation tool, Steerpath has created many systems that are all certified and working and they use many algorithms in order to come out with the amazing end product they have come out with.They have created these two out of the box applications that are available on both the Play store, and the App, these applications give users the ability to navigate their previously created maps, the company creates these maps for the users for a certain fee, then the user can freely and easily navigate them using their applications, whether you want a native application on each platform or using it online on any device, Steerpath has got you covered.They have created a campus wayfinding application that uses that same technology. This application has a very impressive working demo that can be found here:[29] The most important features that are

promised in the application is Interactive Floor Plans and Maps, Indoor Wayfinding App for Mobile and Web, CAD to interactive maps, Powerful floor plan and map editor, Dynamic map styles, Engage with QR codes.[30]
Algorithm: The algorithms used by Steerpath aren't declared for the public because they are a profitable company that charge heavily for the use of its products, but what is very likely is that they use Bluetooth beacons because in their set up guide they have a Bluetooth beacon installation section.
Results: Steerpath has managed to make a native application for both major platforms as well as a web alterative for both of them, they have managed to create systems for Hospitals, universities as well as offices. Numerous features have been implemented in their applications and most of them were met with grand success.
Ratings: This application doesn't have any ratings on both play stores because their applications are demo applications that only give you a glimpse of what the company can do for you, the smart campus version on the application has a 5-star rating out of only 5 ratings for the application over on the play store.

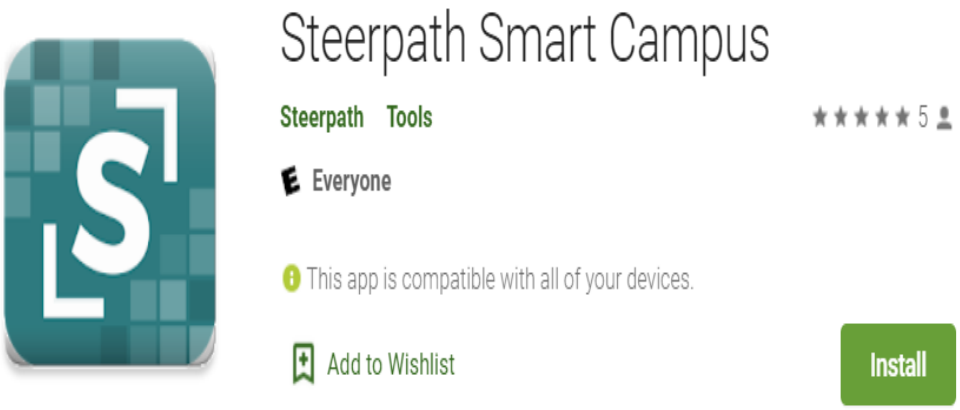


Figure 12: Steerpath ratings

Criticism: The application didn't get many criticisms, the only problem is that there is no free version, only paid versions are available with abundant featured that you have to pay for but might not end up using.

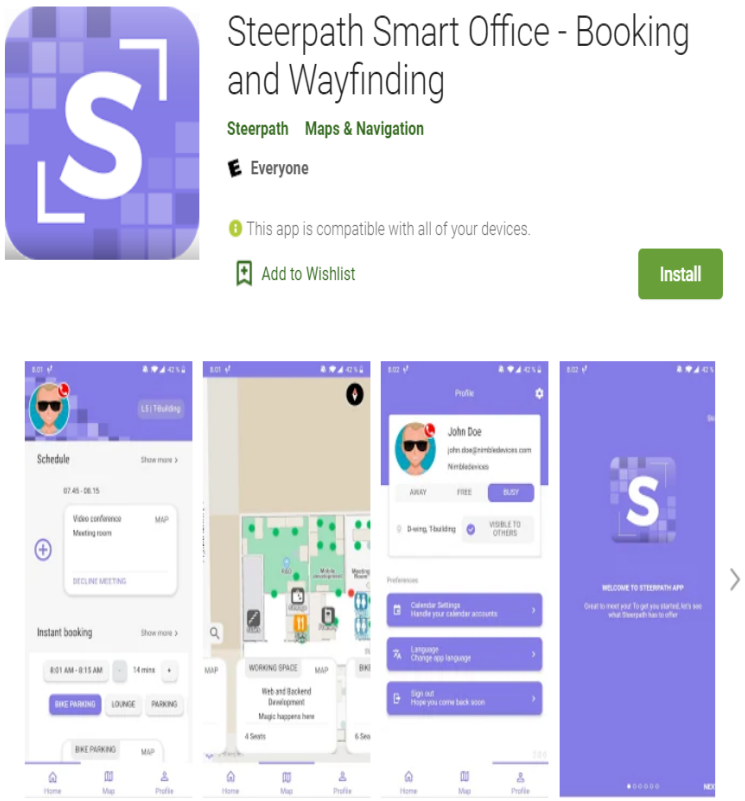


Figure 13: Steerpath App

3 System Description

3.1 User Problem Statement

Helping people practice correct social distancing and warning them by giving them toast notifications when they are approaching potentially dangerous crowded places. In addition to suggesting alternative paths and places for the app-user to go.

3.2 User Objectives

The application will help the user stay safe by trying to make sure he only passes through places that are not crowded and by giving him alternative paths or routes to go for when the user tries to go for a place.

3.3 User Characteristics

1. **User:** Have basic knowledge of dealing with maps, and for sure having a smart phone.
2. **Admin:** Have basic knowledge of using smart phones and sending notifications.

3.4 System Context

Our system context deals with Routers as hardware components, collecting signals and store it in firebase server. Also the proposed system uses Google maps API in order to offer users paths away from the crowd areas. Moreover, Camera helps admin in detecting the crowded areas to inform people that they are in critical places.

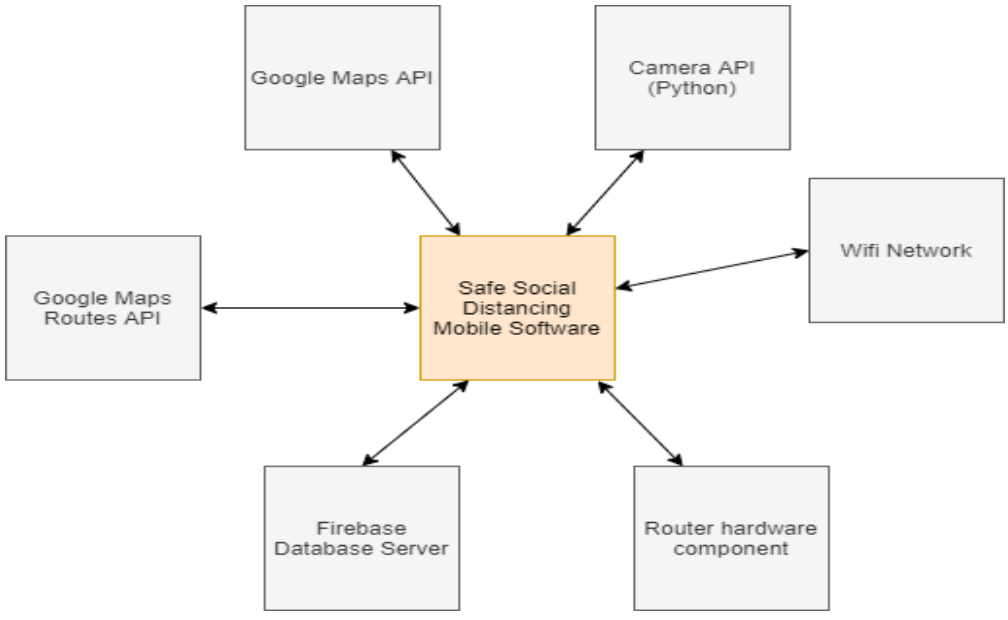


Figure 14: Context diagram

4 Functional Requirements

4.1 System Functions

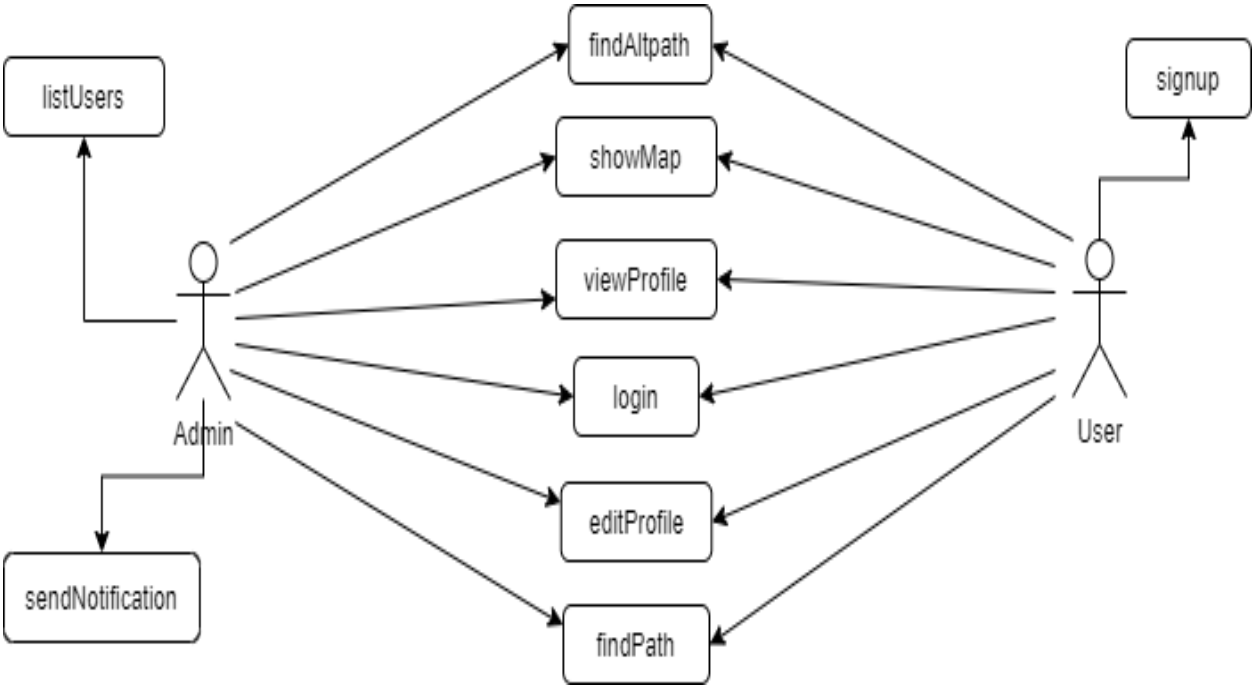


Figure 15: Usecase diagram

4.2 Detailed Functional Specification

Name	login
Code	FR01
Priority	Extreme
Critical	If the mobile does not connected to internet, the user cannot login
Description	This Function allow all users to login into the system using their accounts.
Input	Email and Password.
Output	Boolean acceptance login.
Pre-condition	Functions and data couldn't be accessed
Post-condition	Login successfully, redirect to homepage. OR Login failed, retry.
Dependency	FR02
Risk	Database error connection.

Table 2: Login Function

Name	signUp
Code	FR02
Priority	Extreme
Critical	If the mobile does not connected to internet, the user cannot signup.
Description	This function allows the user to create his own account if he doesn't have one.
Input	Email
Output	New user created
Pre-condition	Functions and data couldn't be accessed
Post-condition	Signup successfully, redirect to homepage. OR Signup failed, retry.
Dependency	FR01
Risk	Database error connection.

Table 3: Signup function

Name	forgotPassword
Code	FR03
Priority	Extreme
Critical	If user does not have an account, he couldn't reset his password.
Description	This function allows the user if he forget his password, he can reset it again.
Input	Email
Output	New password created
Pre-condition	User cannot login if he forgot his password.
Post-condition	Password edited and user must login with this new password.
Dependency	FR01
Risk	Database error connection.

Table 4: Forgot password function

Name	listUsers
Code	FR04
Priority	High
Critical	————–.
Description	This function allows the admin to view all users of the application with their locations.
Input	No input.
Output	List of all users of the application.
Pre-condition	No list shown.
Post-condition	Showing all users in a list to the admin.
Dependency	FR01
Risk	Database failed to find users.

Table 5: List users function

Name	viewProfile
Code	FR05
Priority	High
Critical	Only the logged in user can access profile and view it.
Description	This function allows the user to show his profile.
Input	No input.
Output	Routing the user to profile page.
Pre-condition	No profile shown(Homepage shown).
Post-condition	Showing the profile of the logged in user.
Dependency	FR01
Risk	Database failure.

Table 6: View Profile function

Name	editProfile
Code	FR06
Priority	High
Critical	Only the logged in user can view profile and edit it.
Description	This function allows the user to show his profile and edit it.
Input	No input.
Output	Routing the user to profile page.
Pre-condition	No profile shown(Homepage shown).
Post-condition	Showing the profile of the logged in user to edit in.
Dependency	FR01
Risk	Database failure.

Table 7: Edit Profile function

Name	sendNotification
Code	FR07
Priority	High
Critical	Admin only can send notifications so it must be an admin account.
Description	This function allows the admin to send notifications to the application users.
Input	No input.
Output	Notification sent to users.
Pre-condition	Writing the message to be sent as a notification.
Post-condition	Message sent to the users as a notification.
Dependency	FR01
Risk	Database failure.

Table 8: Send notification function

Name	findPath
Code	FR08
Priority	Extreme
Critical	User must be logged in to find his path.
Description	This function allows the user to find his path through his destination.
Input	Destination where the user will arrive.
Output	Path that drives the user to his destination.
Pre-condition	Writing the destination where the user will arrive.
Post-condition	User gets the shortest path to arrive to his destination.
Dependency	FR01
Risk	No internet connection.

Table 9: Find path function

Name	findAltPath
Code	FR09
Priority	Extreme
Critical	User must be logged in to find his path.
Description	This function allows the user to find alternative path to his destination away from crowdness.
Input	Destination where the user will arrive.
Output	Alternative path that drives the user to his destination.
Pre-condition	Writing the destination where the user will arrive.
Post-condition	User gets alternative path to arrive to his destination safely without contacting people.
Dependency	FR01,FR08
Risk	No internet connection.

Table 10: Find alternative path function

Name	showMap
Code	FR10
Priority	Extreme
Critical	User must be logged in to find his path.
Description	This function allows the user to open indoor map.
Input	No input
Output	Indoor map showed to the user.
Pre-condition	No map shown.
Post-condition	Showing indoor map for the user.
Dependency	FR01,FR08,FR09
Risk	No internet connection.

Table 11: Show map function

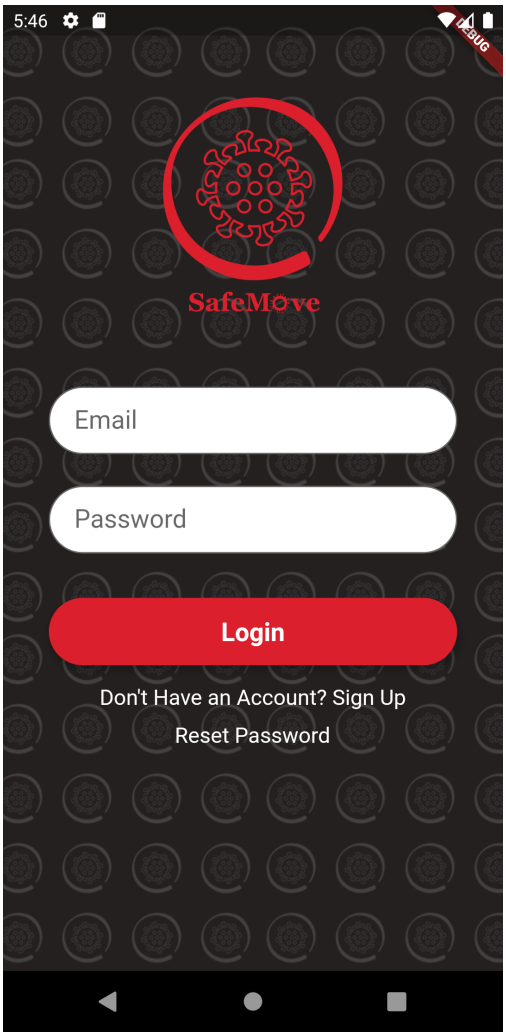
Name	generateReport
Code	FR11
Priority	Low
Critical	Admin must be logged in.
Description	This function shows the admin daily reports about the crowdness of the rooms.
Input	No input
Output	Reports generated.
Pre-condition	No report shown.
Post-condition	Showing reports to the admin.
Dependency	FR01
Risk	Database failure.

Table 12: Show map function

5 Interface Requirements

5.1 User Interfaces

5.1.1 GUI



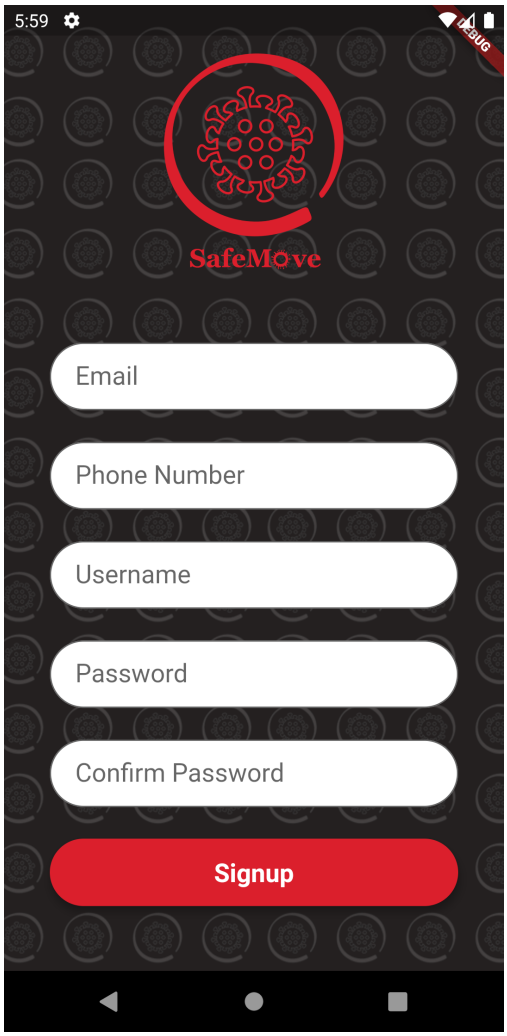


Figure 16: Login form

Figure 17: Sign up form

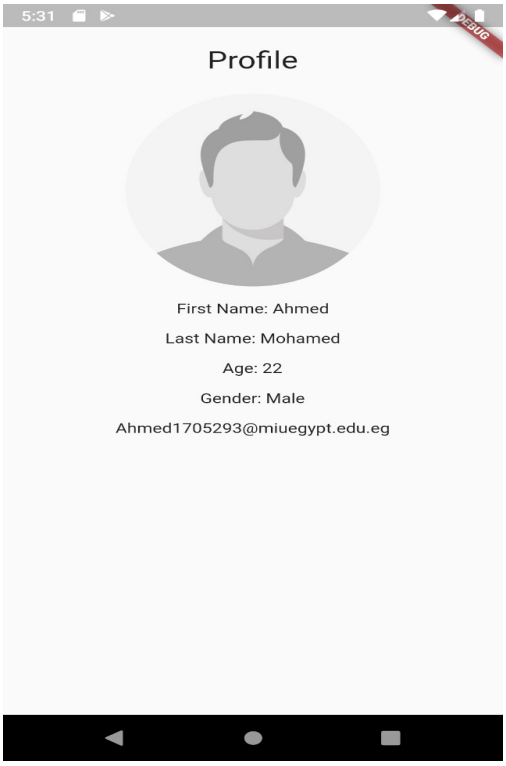


Figure 18: Profile

5.2 Hardware Interfaces

We are using routers as hardware interface in order to detect the location of the sent and received signals.

5.3 Communications Interfaces

Our application needs internet connection to be able to connect to the real time map interface.

5.4 API

- Google Maps API
- Google Maps Routes API

6 Design Constraints

The application must be easy to use and have a simple interface in order to be easy for users to interact with.

6.1 Hardware Limitations

Smart phones with play tore or app store, GPS, and WI-FI antennae.

7 Other non-functional attributes

7.1 Security

Our system is secure and works on preventing user breaches. User's data is in a safe place.

7.2 Performance and Speed

Performance is not an issue when it comes to our application, it can work perfectly and smoothly on any smartphone.

7.3 Reliability

Our application works on real time database, so it will be secure and there is no chance for failure.

7.4 Maintainability

Our application is maintainable so the same team can easily maintain the application and get the same output, no need for two teams iOS team and Android team to get the required output.

7.5 Portability

Our application is a flutter application (cross platform application) in which users can install either on iOS or Android operating systems.

8 Data Design

8.1 Data Description

Our System will use Firebase, our data gets stored in key value pairs, where they key will be the MAC-Address because of it being unqiue, and all other attributes of the WIFI signal are stored beneath it as it's children, these pairs being the BSSID, Frequancey, RSSI, SSID and time stamp.

8.2 Database design description

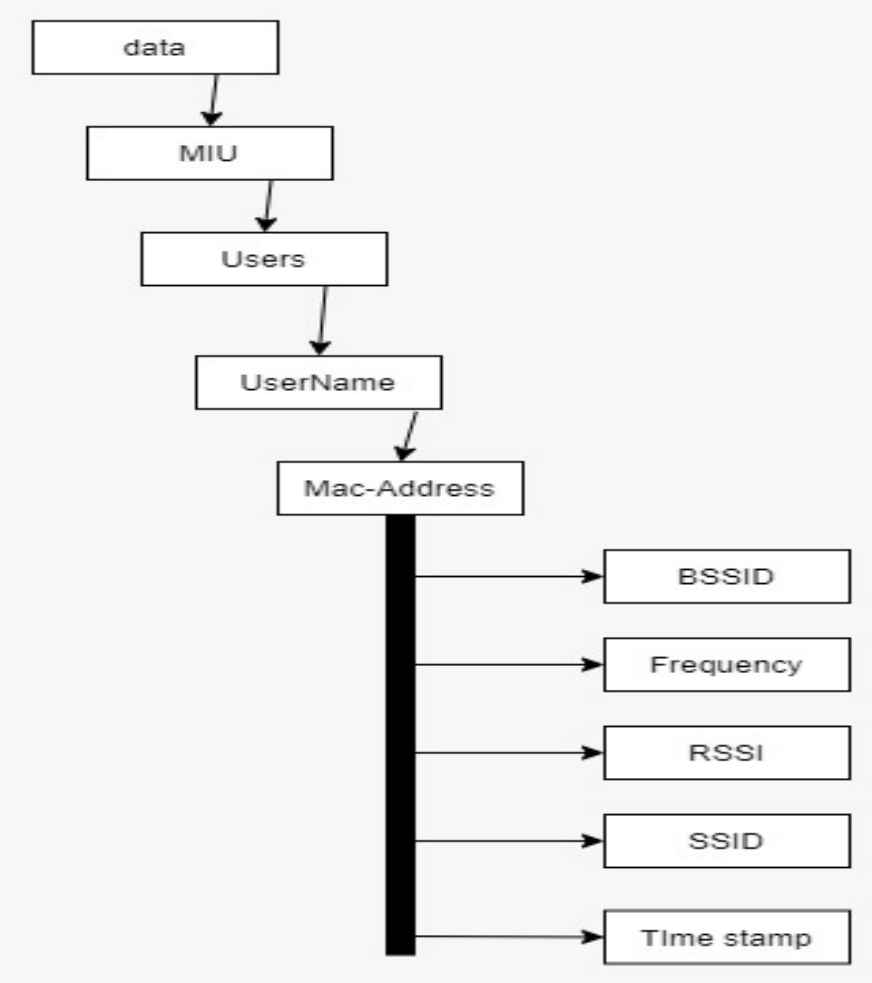


Figure 19: Database Diagram

9 Preliminary Object-Oriented Domain Analysis

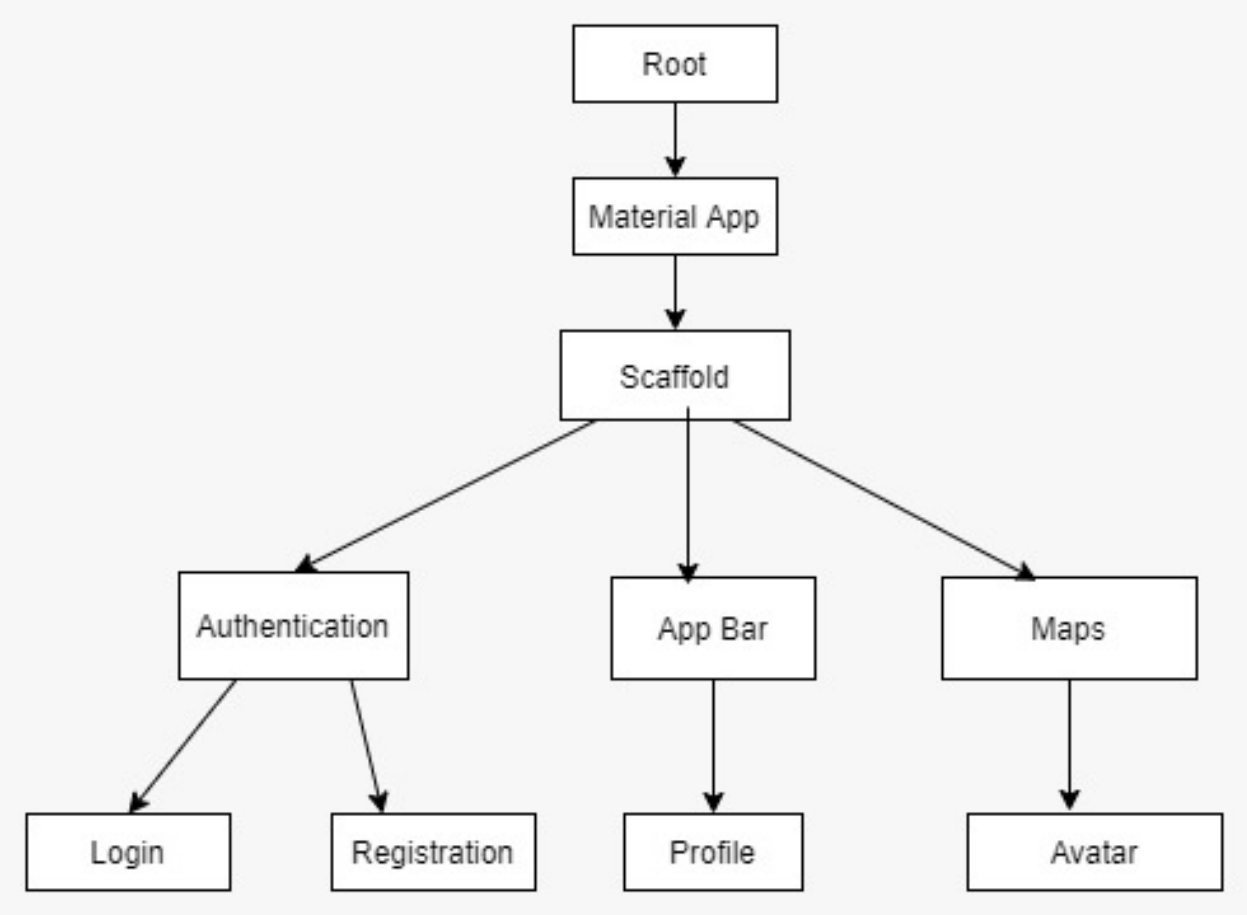


Figure 20: Widget tree

10 Operational Scenarios

10.1 Scenario 1

Alternative paths:

- User opens the application, then he logs in with his account, if doesn't has an account he can go and sign up, then he will be redirected to the homepage where he can find Alternative paths page which offers him other paths to walk through.

10.2 Scenario 2

Sending notifications:

- Admin logs in with his credentials, if he find many users in the same place, he can send them notifications in order to save the social distancing.

10.3 Scenario 3

Showing Crowded areas:

- User logs in with his credentials, he redirected to the homepage, by choosing Crowded areas tab, he can show the crowded places around him in order to avoid contacting many people.

10.4 Scenario 4

Edit profile:

- User logs in with his credentials, he can access only his profile and edit his data (phone number, email,..).

11 Project Plan

Table 13: Project name time plan

Id	Task	Start Date	Number of Days	Team Member
1	Idea Discussion	7/15/2020	15	All
2	Idea Research	7/30/2020	30	All
3	Proposal Document	9/17/2020	36	Ziad, Ahmed
4	Implementation (10 %)	9/25/2020	10	Youssef, Mohamed
5	Proposal Evaluation	10/27/2020	1	All
6	Implementation	10/29/2020	22	Mohamed, Youssef
7	Collecting dataset	12/1/2020	20	All
8	SRS Writing	12/7/2020	20	Ziad, Ahmed
9	Work on GUI	12/8/2020	13	Ahmed, Youssef
10	Implementation	1/3/2021	18	Ziad, Mohamed
11	SDD Writing	1/29/2021	17	Ahmed, Ziad
12	Implementation	2/18/2021	63	All
13	System Prototype	4/25/2021	1	All
14	Implementation	4/26/2021	24	Mohamed, Youssef
15	Technical Evaluation	5/25/2021	1	All
16	Validating and Testing	5/26/2021	25	All
17	Final Thesis	6/25/2021	1	All

	Task	Assigned To	Start	End	days
	Project		7/15/20	6/29/21	246
1	Idea Discussion	ALL	7/15/20	8/4/20	15
2	Idea Research	ALL	7/30/20	9/9/20	30
3	Proposal Document	Ziad,Youssef	9/17/20	11/6/20	36
4	Implementation (10%)	Youssef,Mohamed	9/25/20	10/8/20	10
5	proposal Evaluation	ALL	10/27/20	10/27/20	1
6	Implementation	Mohamed,Youssef	10/29/20	12/1/20	22
7	Collecting dataset	ALL	12/1/20	12/29/20	20
8	SRS writing	Ziad,Ahmed	12/7/20	1/4/21	20
9	Work on GUI	Ahmed,Youssef	12/8/20	12/24/20	13
10	Implementation	Ziad,Mohamed	1/3/21	1/27/21	18
11	SDD writing	Ahmed,Ziad	1/29/21	2/22/21	17
12	Implementation	ALL	2/18/21	5/17/21	63
13	System Prototype	ALL	4/25/21	4/26/21	1
14	Implementation	Mohamed,Youssef	4/26/21	5/27/21	24
15	Technical Evaluation	ALL	5/25/21	5/25/21	1
16	Validating and Testing	ALL	5/26/21	6/29/21	25
17	Final Thesis	ALL	6/25/21	6/25/21	1

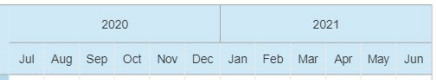


Figure 21: Project name GANTT Chart

12 Appendices

12.1 Definitions, Acronyms, Abbreviations

Abbreviations:

1. SRS: Software Requirement Specification
2. WiFi: Wireless Fidelity
3. OSELM: Online Sequential Extreme Learning Machine
4. RSSI: Received Signal Strength Indicator
5. RFID: Radio-frequency identification

12.2 Supportive Documents

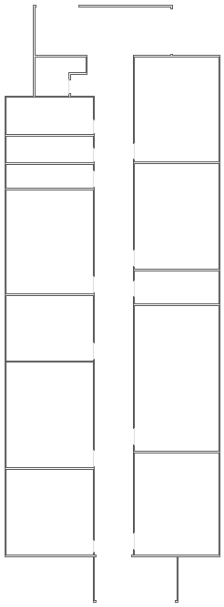


Figure 22: Autocad Corridor 1

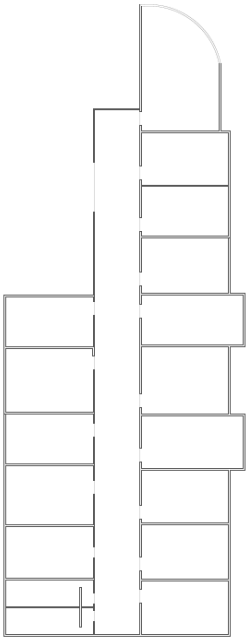


Figure 23: Autocad Corridor 2

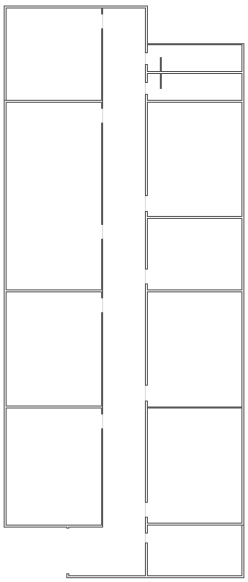


Figure 24: Autocad Corridor 3

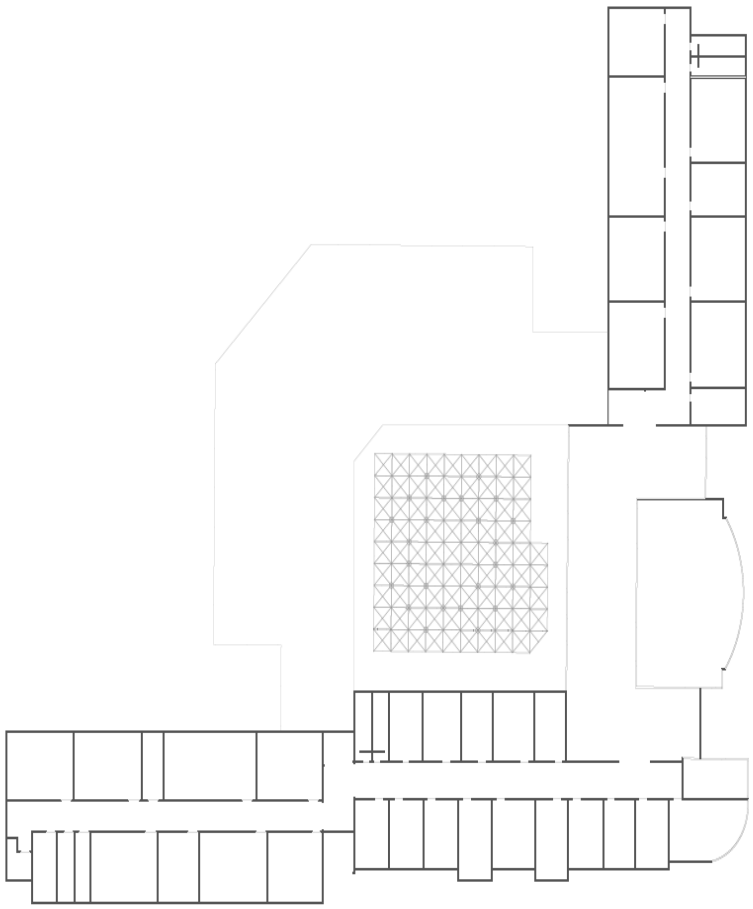


Figure 25: Autocad floor

References

[1] H. Zou, H. Jiang, X. Lu, et al. “An online sequential extreme learning machine approach to WiFi based indoor positioning”. In: *2014 IEEE World Forum on Internet of Things (WF-IoT)*. 2014, pp. 111–116. DOI: 10.1109/WF-IoT.2014.6803130.

[2] Sahil Puri. *Indoor Positioning System using Bluetooth*. International Journal of Engineering Research, 1May 2015. ISBN: 2319-6890)(online),2347-5013(print).

[3] Faisal Baig, Saira Beg, and Muhammad Fahad Khan. “Zigbee based home appliances controlling through spoken commands using handheld devices”. In: *International Journal of Smart Home* 7.1 (2013), pp. 19–26.

[4] Claude Caron, Daniel Chamberland-Tremblay, Cédric Lapierre, et al. “Indoor Positioning”. In: *Encyclopedia of GIS*. Ed. by Shashi Shekhar, Hui Xiong, and Xun Zhou. Cham: Springer International Publishing, 2015, pp. 1–9. ISBN: 978-3-319-23519-6. DOI: 10.1007/978-3-319-23519-6_626-2. URL: https://doi.org/10.1007/978-3-319-23519-6_626-2.

[5] Zhixin Yang, Pengbo Zhang, and Lei Chen. “RFID-enabled indoor positioning method for a real-time manufacturing execution system using OS-ELM”. In: *Neurocomputing* 174 (2016), pp. 121–133.

[6] Joaquín Torres-Sospedra, Oscar Belmonte Fernández, Raul Montoliu, et al. “How Feasible Is WiFi Fingerprint-Based Indoor Positioning for In-Home Monitoring?” In: Sept. 2016, pp. 68–75. DOI: 10.1109/IE.2016.19.

[7] A. H. Lashkari, B. Parhizkar, and M. N. A. Ngan. “WIFI-Based Indoor Positioning System”. In: *2010 Second International Conference on Computer and Network Technology*. 2010, pp. 76–78. DOI: 10.1109/ICCNT.2010.33.

[8] Ju-Hyeon Seong and Dong-Hoan Seo. “Real-time recursive fingerprint radio map creation algorithm combining Wi-Fi and geomagnetism”. In: *Sensors* 18.10 (2018), p. 3390.

[9] Sunmin Lee, Jinah Kim, and Nammee Moon. “Random forest and WiFi fingerprint-based indoor location recognition system using smart watch”. In: *Human-centric Computing and Information Sciences* 9.1 (2019), p. 6.

[10] Sunmin Lee and Nammee Moon. “An Indoor Positioning System Using RSSI and BSSID”. In: *Advances in Computer Science and Ubiquitous Computing*. Springer, 2017, pp. 1031–1036.

[11] Qing Yang, Shijue Zheng, Ming Liu, et al. “Research on Wi-Fi indoor positioning in a smart exhibition hall based on received signal strength indication”. In: *EURASIP Journal on Wireless Communications and Networking* 2019.1 (2019), p. 275.

[12] Xingbin Ge and Zhiyi Qu. “Optimization WIFI indoor positioning KNN algorithm location-based fingerprint”. In: *2016 7th IEEE International Conference on Software Engineering and Service Science (ICSESS)*. IEEE. 2016, pp. 135–137.

[13] Rohan Reddy Tirumalareddy. “BLE Beacon Based Indoor Positioning System in an Office Building using Machine Learning”. In: (2020).

[14] Hung-Huan Liu. “The quick radio fingerprint collection method for a WiFi-based indoor positioning system”. In: *Mobile Networks and Applications* 22.1 (2017), pp. 61–71.

[15] Z. Ma, S. Poslad, J. Bigham, et al. “A BLE RSSI ranking based indoor positioning system for generic smartphones”. In: *2017 Wireless Telecommunications Symposium (WTS)*. 2017, pp. 1–8. DOI: 10.1109/WTS.2017.7943542.

[16] Shaomeng Chen, Haiyong Luo, Qu Wang, et al. “A Bluetooth Localization Algorithm Based on Map Path Calibration and Time Series Filtering”. In: *China Satellite Navigation Conference*. Springer. 2018, pp. 355–371.

[17] infsoft. *https://apps.apple.com/eg/app/infsoft-maps/id1199931726*. 2017.

[18] infsoft. *https://www.infsoft.com/software/developers-integration/software-development-kit-sdk*. 2020.

[19] J. C. Aguilar Herrera, P. G. Plöger, A. Hinkenjann, et al. “Pedestrian indoor positioning using smartphone multi-sensing, radio beacons, user positions probability map and IndoorOSM floor plan representation”. In: *2014 International Conference on Indoor Positioning and Indoor Navigation (IPIN)*. 2014, pp. 636–645. DOI: 10.1109/IPIN.2014.7275538.

[20] MapWize. *https://play.google.com/store/apps/details?id=io.mapwize.app*. 2018.

[21] Barandi Sapta Widartono. "Indoor Positioning System (IPS) for Guiding the Location Inventory Goods in Buildings". In: *Sumatra Journal of Disaster, Geography and Geography Education* 4.1 (2020), pp. 95–99.

[22] COVIDSafe. *https://play.google.com/store/apps/details?id=au.gov.health.covidsafe*. 26 April 2020.

[23] David Watts. "COVIDSafe, Australia's Digital Contact Tracing App: The Legal Issues". In: *Australia's Digital Contact Tracing App: The Legal Issues (May 2, 2020)* (2020).

[24] CovidWise. *https://play.google.com/store/apps/details?id=gov.vdh.exposurenotification*. 28 August 2020.

[25] D Skoll, JC Miller, and LA Saxon. "COVID-19 testing and infection surveillance: Is a combined digital contact tracing and mass testing solution feasible in the United States?" In: *Cardiovascular Digital Health Journal* (2020).

[26] Croudless. *https://play.google.com/store/apps/details?id=com.quarantined*. 10 June 2020.

[27] Martin Adam, Dominick Werner, Charlotte Wendt, et al. "Containing COVID-19 through physical distancing: the impact of real-time crowding information". In: *European Journal of Information Systems* (2020), pp. 1–13.

[28] Steerpath. *https://play.google.com/store/apps/details?id=com.steerpath.demohl=en3*. 2020.

[29] Steerpath. *https://steerpath.com/smart-campus*. 2019.

[30] Juhani Lavonen. "Developing a Web Application for Indoor Map Data Management". In: (2018).