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"iNav"-Indoor Positioning and Navigation System

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Received: 13 December 2017 Accepted: 2 January 2018 Published: 15 January 2018

Abstract

Getting a pin-point accurate location is a difficult task and prone to many errors, thus providing a wrong location. Existing GPS Based Location service has proved to be moderately reliable, but it is not the same when considering indoor wise location. Getting an indoor location inside a building is harder than ever since due the signal barriers and narrow range. In this article a system for Indoor Positioning and Navigating with customized maps is presented. This will make the users to get to know the location very quickly and easily. It will be more applicable for the Government Departments where it is difficult to find a proper location. The RSSI of the wireless access points will be used to triangulate the location.

Index terms— location, indoor positioning, access points, WIFI adapters, floor plan.

1 Introduction

inding a specific location inside of a large building is a tedious and time-wasting task to a person who has never been to the place before. The iNav will help the users to find the way in, way out and other sections or shops if it is a Shopping Complex, Government Departments and Institutions etc.... For an example if a person goes to Department of Immigration and Emigration of Sri Lanka to apply for a passport he/she will have to go from place to place spending all his time searching for the specific places he needs to go. If there is a way of getting indoor location that will ease his work and get the work done quickly.

Most of the people are having Smart Phones which comes with Android Operating System. The application is built to run on an android device. The location is being determined by using the Received Signal Strength Indicator (RSSI) of the wireless access points residing in the building.

Objectives of this research are follows, i.

To develop an algorithm to determine exact position of the device/user will be identified using a trilateration that uses the RSS of Wi-Fi access points. ii.

To develop an algorithm to draw the path to the intended destination from the current location or from a specific location as required. iii.

To develop an android application to determine the current location and provide voice navigation. This research has been organized as follows.

Author ?: e-mail: gowthamseafret@gmail.com Section 2 has provided the background through the Literature Review. Section 3 describes the Methodology of this System. The discussion of the developed system has described in Section 4. Section 5 contains results and discussion of this research. Finally, Conclusion is discussed in Section 6.

2 II.

3 Literature Review

With the technological advancements the need to use positioning systems is ever increasing. The most reliable and widely used positioning system is GPS (Global Positioning System). Even though it remains as the best suited method to Outdoor positioning, when it comes to Indoor positioning it lacks the accuracy due to its inability pass through the building materials. Therefore, throughout the years the researches are trying devise new means for indoor positioning which are both accurate and cost effective. Below are the Research works carried out for Indoor Positioning System.

Researches based on Indoor positioning using Visual Light Communication (VLC) has been an interesting field due to the accuracy of its positioning, license-free operation etc. There are several indoor positioning methods based on VLC like triangulation base on Received Signal Strength (RSS), fingerprint analysis, proximity and image positioning methods.

Bangjiang Lin and his team have proposed system for indoor positioning using Orthogonal Frequency Division Multiplexing Access (OFDMA) scheme. In the system they have proposed, they used three subcarriers with the maximum received signal intensity using three LEDs without the Inter Carrier Interference to locate the receiver's position. [1] A team lead by Silke Feldmann has proposed Bluetooth-based positioning system which uses the Radio Signal Strength Indicator (RSSI) to measure the distance between the sender and the receiver. They have used Least Square Estimation (LSE) to determine the approximate RSSI value and have devised a method to convert the RSSI value to a distance. Then using the triangulation method, which uses 3 or more signal emitters, to locate the device. [3] The area of Wi-Fi based positioning service has caught attention of many researchers. Main reason behind this is that the Wi-Fi is already available in almost every place including public areas and supported by Year 2018

"iNav"-Indoor Positioning and Navigation System many devices. Since the ability to use existing Wi-Fi access points to determine the position, the cost it takes to establish the system is low.

The system proposed by Qiyue Li and his team uses Received Signal Strength (RSS) and Radio Frequency Fingerprinting in order to determine the position of a device. First the system gets the RSS data from neighboring Access Points (3 or more) to get an approximate location. Then through the collaboration between the location derived from the RSS and the fingerprint map, the system provides the user with an accurate location of the device. [4] When it comes to using wireless local positioning systems, the main drawback faced was the path loss. Where the wireless signal accuracy drops due to varies obstacles in the transmission path like concrete structures, brick structures and other various materials which reflect or refract the wireless signal. R. F. Safna and her team have studied the previous Wireless pathloss models and developed a new optimized Wireless pathloss model to determining the placement of the Access Points. They have identified four factors which plays a major role in indoor coverage footprint. They are shadowing, wall attenuation factor, floor attenuation factor and the employed frequency band. The team have selected JTC (Joint technical committee) indoor path loss model as the base model to the optimization of wireless access point placement. [5] The quality of wireless signal can be varied due to the hardware facts such as transmission power, frequency, temperature and humidity. To test these theories varies researches have been done.

A team lead by Kenneth Bannister studied the effects of temperature on wireless signal strength. They have used two sensor nodes for this experiment and have connected them using a coaxial cable and a sequence of attenuators with nominal value of 60dB to reduce noise and signal variability. The tests were performed by using one as a control node and putting the other inside a chamber where you can change the temperature. After the experiment they have concluded that temperature has a negative effect on Signal Strength and that when the temperature increases the Signal Strength decreases linearly up to 8dB at 65°C. [6] Dolphin system consist of distributed wireless sensor nodes which are capable of sending and receiving RF and ultrasonic signals. These nodes are attached to various indoor objects. In this system, all objects in the system have capability of sending and receiving ultrasonic and radio signals to measure distance between two objects with only a few manually preconfigured objects as reference stations. All other locations of objects are gradually determined based on a recursive positioning algorithm. The RF function is used for time synchronization and message exchange among nodes. There are two main advantages in this mechanism. First, the system requires only a few (minimum three) nodes to determine all position of nodes. Second, nodes can determine their position even if the nodes cannot receive ultrasound from reference nodes directly. In the DOLPHIN system, there are two types of nodes: a reference node, which is a fixed node located to previously measured position, and a normal node which location is determined by the algorithm. Each node has a unique ID for RF communication, a node list for node selection, and a position table for position calculation. [7] The below Table 1 shows list of similar research products/research areas referred in understand the availability of similar systems.

4 Methodology

The development of the iNavhas be done based on the Prototype methodology. Prototype is a working model of software with some limited functionality. The prototype does not always hold the exact logic used in the actual software application and is an extra effort to be considered under effort estimation.

5 a) Planning

This is the initial phase of the SDLC which determines the feasibility of the project. It involves creating of a set of plans to help guide your team through the execution and closure phases of the project.

In our Project we have gathered the required information from the User how the System should work, and we planned accordingly. GPS will not be accurate inside location and we found an alternative solution to

6 b) Analysis

A research has been carried out to study about the factors related to indoor positioning system in various buildings. Population for this data gathering is Customers. Questionnaire has been taken as Data gathering method. Questionnaire were carried out to the sample size of 50 people based on non-probability sampling.

Based on the data gathered for this project below have been found out.

? Age Group between 20-25 requires this System to get implemented in large building as it will make their visit easier. ? Most of the people are getting the help from the people who are working at the buildings to get navigation direction. ? People like to have a way of navigating them to the shops easily in this Application.

Based on the data gathering we have decided to add following functions in our project.? Voice Navigation ? Rate Shops ? Locate a friend c) Design

This phase will explain how the system will operate with the relevant Hardware and Software using diagrams. This will include High Level Architecture Diagram, Use Case and Class Diagram. The System is designed and finalized in this phase with all the requirements. High Level Diagram for this System is shown below. The RSS is measured from the mobile device and will be send to the local server through the use of mobile data with its WiFi adapter's MAC address and a time stamp. This combine with the data from the humidity and the temperature sensors will be sent to the local server with the MAC address of the mobile device. Then the server will determine the position of the mobile device and send it to the device via internet.

7 d) Implementation

Android Studio will be used for development of the Application. Android SDK version 27 will be used. Java will also be used for the coding purpose instead of using Kotlin. We will be using Amazon Web Services to get the data from the Database for Positioning. Access Points will be used to find the location of the user and Arduino will be used to calculate the temperature and humidity.

8 e) Testing

This phase focus on identifying the system defects and fixing them to provide the system with a better quality, performance and accuracy. Performing tests during the early steps of SDLC reduces risks. Testing that to be performed is discussed below.

IV. User registration interface for android user. User needs to enter Name, Username which will be used to login to the application then email address and password. When user selects the Locate friend option from the home interface, user will be taken to locate friend interface. User can locate whoever in the specific floor if the friend is online in the system and that friend is added to the list. By entering the name of the friend, he/she will be located in the floor map.

9 Results and Discussions a) Login Screen

10 c) Home Screen

11 Discussion

"iNav" allows the user to locate themselves in a particular building with high accuracy, then using that information they can get the navigation path to a desired location in the building. The application also allows the user to locate other users from the friend list within the same building. Additionally, "iNav" also allows its users to view ratings of the shops inside the building, read reviews and give them as well. The system will be accessible at any given time therefore the users can use its functions anytime they desire.

The major challenges faced by research and development team during the development period are listed below ? Build or adjusting algorithms to achieve accurate results ? Learning new technologies ? Retrieving answers from logical questions.

The system was originally planned to include a build owner interface, where it allows the building owners to add the blueprints of their buildings and get the locations to place the Access Points in the most feasible and accurate way. But the time constraints of the project, amount of research involved in the topic and lack of knowledge in the field led the team to remove this interface completely.

And originally the location was to be derived from three methods Received Signal Strength measurements (RSS. Because of the different processing capabilities of the end devices, it causes the application to have different reaction times in different end devices which cannot be generalized into a constant value or set of values. Due to this reason the team decided to devoid from using this method completely.

12 VI.

13 Conclusion

iNavhas been developed with the main objective to give current position of the users and navigation to their desired Destination inside the same floor inside the building. This system will help them to locate where they are and where their friends are inside the same floor. Using Username of their friends or Mobile Numbers, friend can

be located if he is in the same floor. Shop Ratings will be developed to get reviews from the users for the shops which is in the same floor. This will enable for a user to view the Reviews of a shop before visiting them. Voice Navigation will also be developed for the navigation purpose. User can give Start Location and End Location, once those are given user can select Voice Navigation to navigate them using Voice. Paths will be drawn from the place where user is. An Android Application will be developed using Java with compatible for Android Version 5.1(KitKat) or above. And it can be downloaded from Play Store for free of charge.

14 VII.

15 Limitation

The main intention of developing this system is to introduce a Positioning and Navigation System is to provide solution to customers visiting large building from loitering here and there. This mobile application is currently focusing on one floor for the navigation and positioning. If the number of simultaneous users get increased the signal strength that the end devices receive will be reduced, which in turn can lead to possible decrease in accuracy. And if the user is having an android mobile which is lesser than the required Android Version it will not be supported. User should also be able to connect to internet using their Mobile Data. For that they should be having enough data in their mobile. If they don't have enough data in their mobile to get connected our servers, they will not be able to use our application. Application will not work on the users' mobile if their mobiles are having any problems related to WIFI signals.

16 VIII.

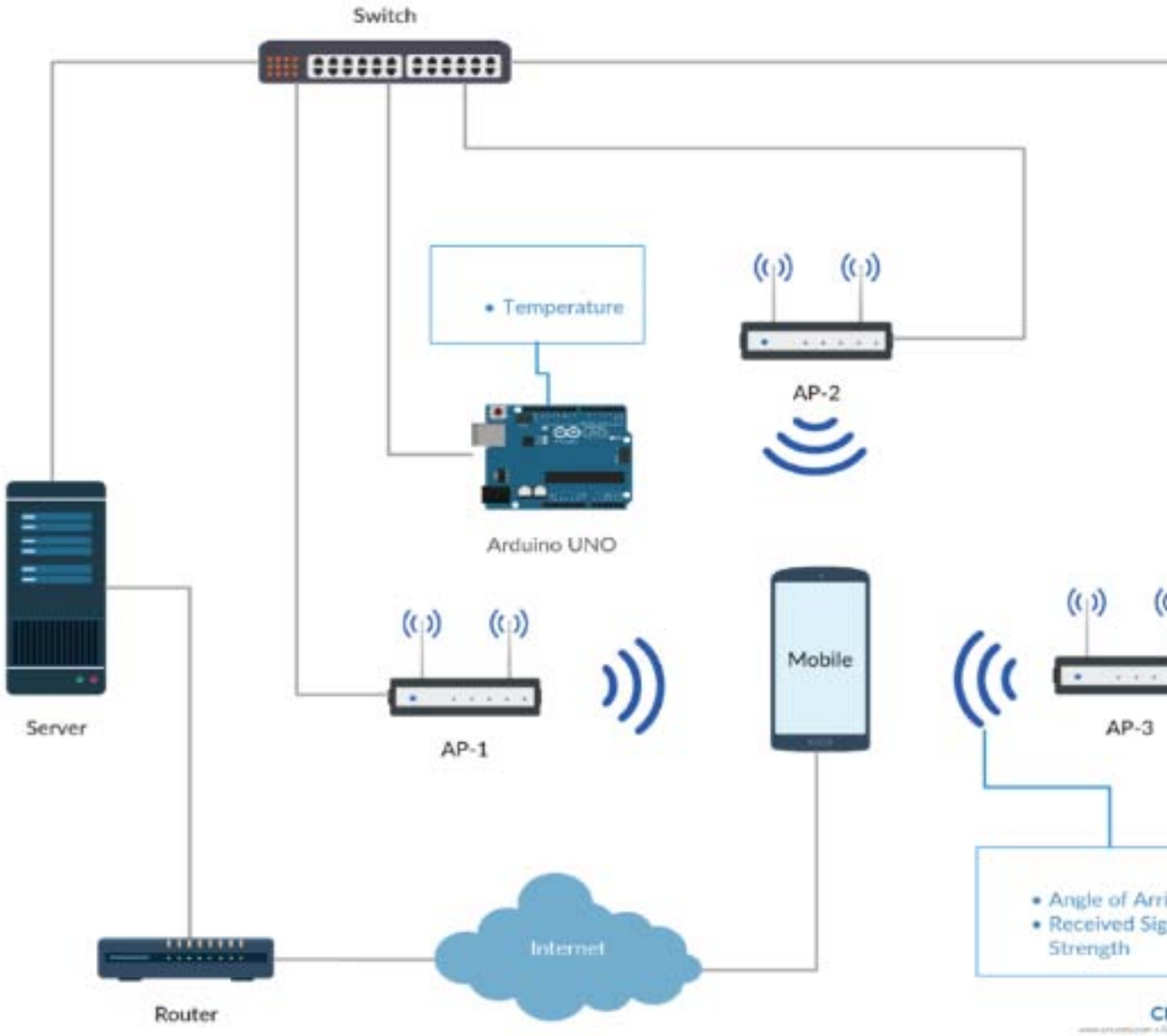
17 Future work

The recommendations for any parties who are interested in developing this system further are, ? The research group should make their users to access the Application in anywhere in the building. All the locations should be defined for the relevant building floors. ? Make the Application compatible with iOS.

? Make the Application which will be supporting to newer versions of the AndroidOS. ? Make the application run with a variety of language options. ? Adding Time of Flight to increase the accuracy of the positioning service. ? Add means to get building blueprints from the user and give the locations to place the Access Point. ? Add Augmented Reality to the Application so user can have a different view of the map and easy to view the paths to their destination.

Existing Systems	Fingerprinting	Positioning using RSS	Trilateration Technique
1. Angle of Arrival Estimation using WiFi and Smartphones	No	No	No
2. Indoor WiFi Localization on mobile devices	Yes	Yes	Yes
3. Quuppa's HAIP system	No	No	No
4. Apple's WiFiSLAM	Yes	Yes	Yes
5. Wi-Fi Compass for Indoor Passive Positioning with Decimeter Accuracy	No	No	Yes
6. RSS-Based Indoor Positioning Based on Multi-Dimensional Kernel Modeling and Weighted Average Tracking	Yes	Yes	No
Our System (INPS)	**No**	**Yes**	**Yes**

Figure 1:

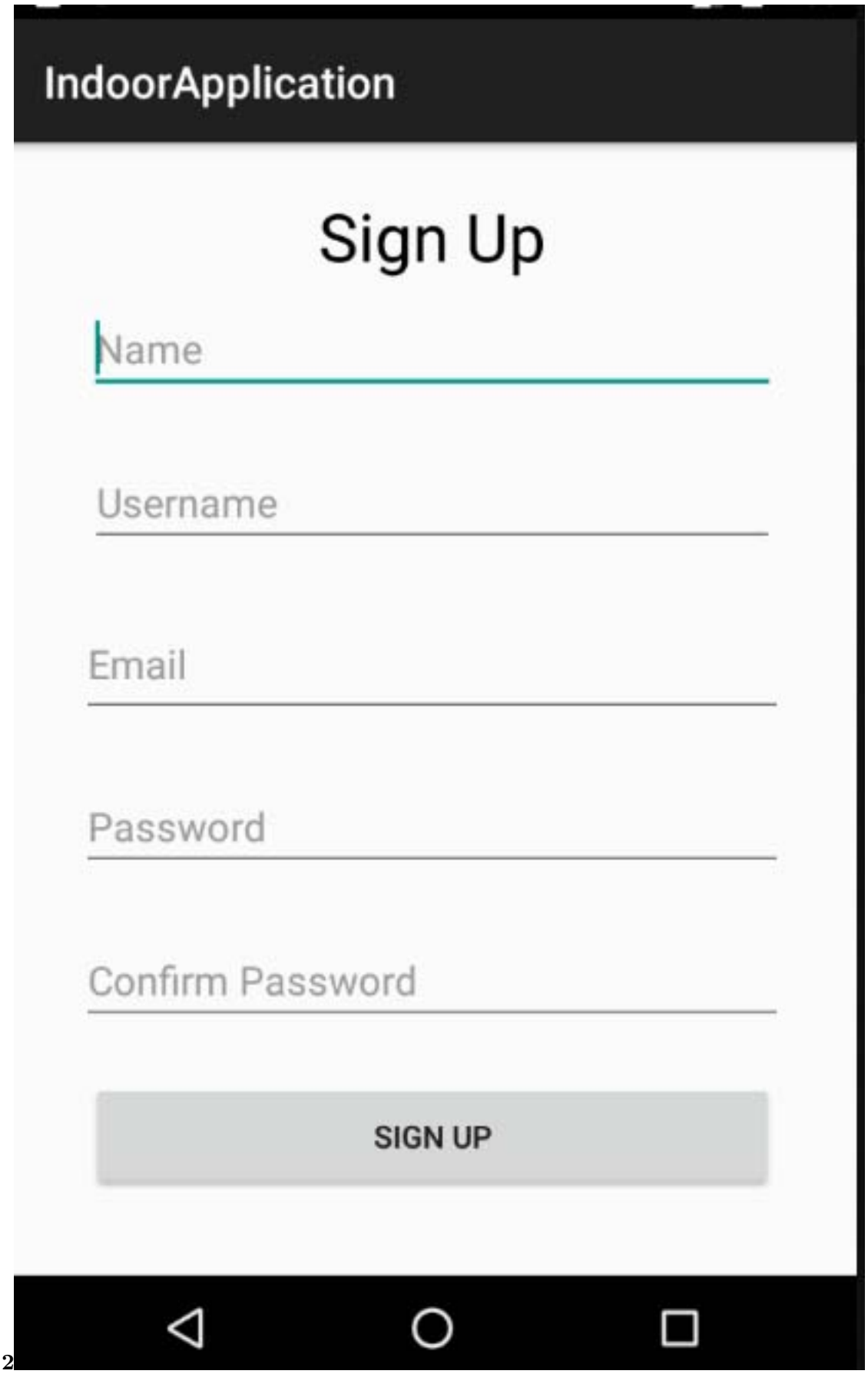


1

Figure 2: Figure 1 :

2

Figure 3: Figure 2 :

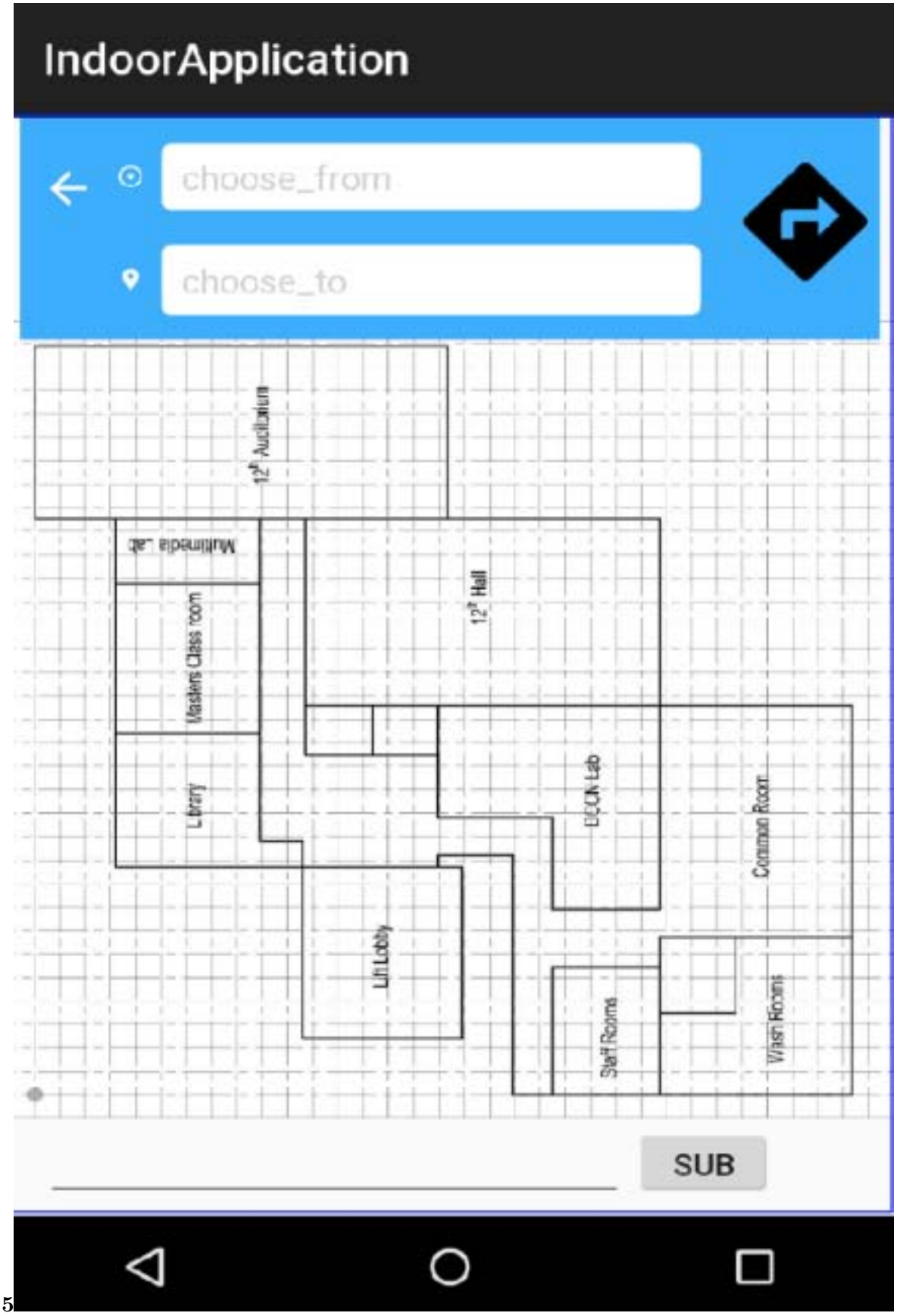


2

Figure 4: Figure 2 :

3

Figure 5: Figure 3 :



5

Figure 6: Figure 5 :

6

Figure 7: Figure 6 :

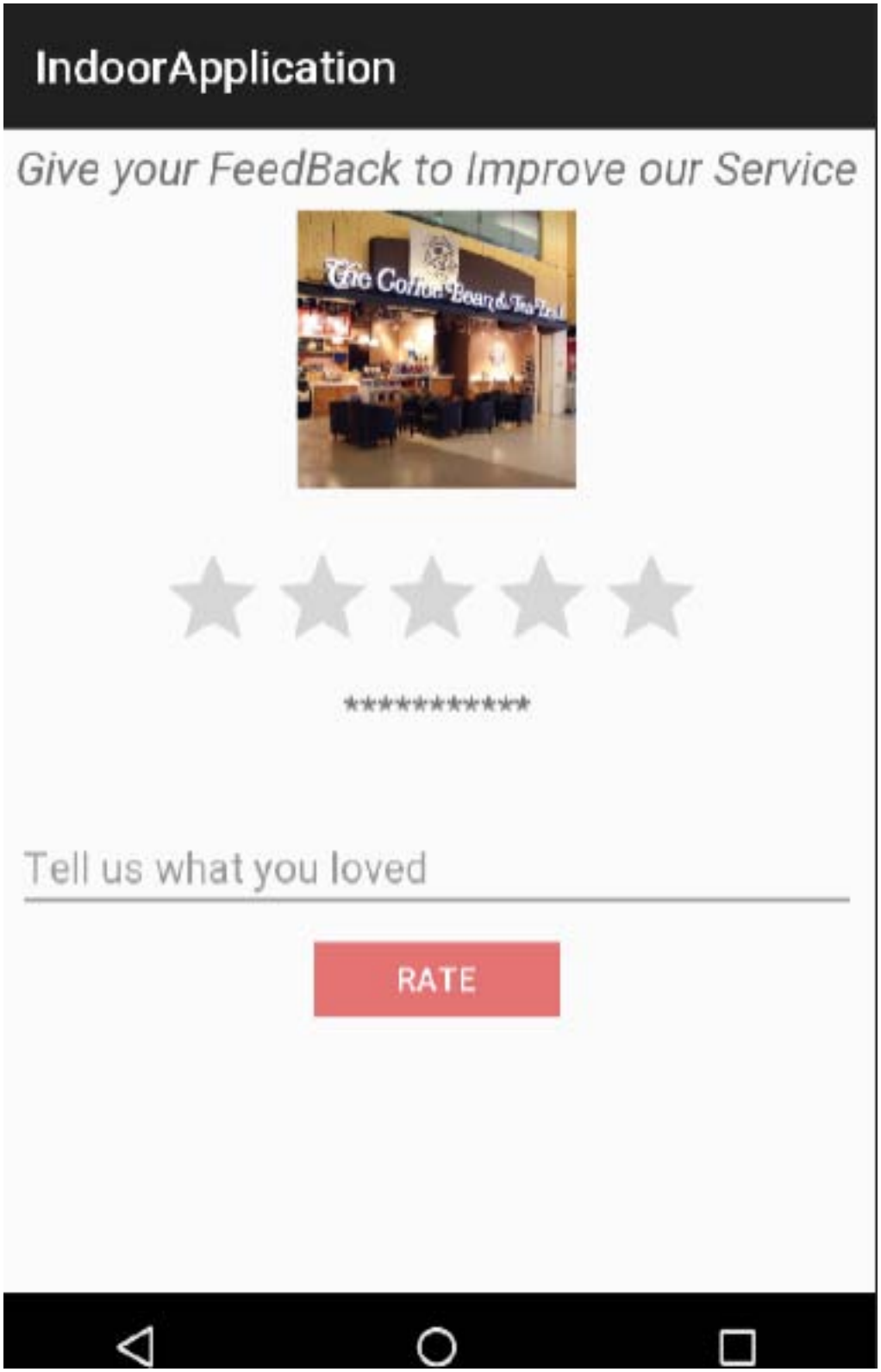


Figure 8:

1

Figure 9: Table 1 :

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