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Electronics and Communication Engineering

Minor Project Report

on

ATTENDANCE MONITORING SYSTEM

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Semester: VI, 2020-2021

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HUBBALLI-580031
2020-21

SCHOOL OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

This is to certify that project entitled " **ATTENDANCE MONITORING SYSTEM** " is a bonafide work carried out by the student team of " **Manjushree U Kochrekar (01FE18BEC077), Smrithi Rane (01FE18BEC131), Aniketh Joshi (01FE18BEC022)**". The project report has been approved as it satisfies the requirements with respect to the Minor project work prescribed by the university curriculum for BE (VI semester) in School of Electronics and Communication Engineering of KLE Technological University for the academic year 2020-21.

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ACKNOWLEDGMENT

Our sincere gratitude to our guides; Dr. Saroja V Siddamal and Prof. Prashant V Achari. We would also like to thank our seniors, Ms. Akshata and Mr. Harsh for guiding us in the initial stages of this project.

-The project team

ABSTRACT

Although GPS is widely used for live-location based systems, it cannot be used for accurate indoor positioning and for that reason we make turn to Bluetooth, the perfect technology for indoor positioning. We will be using the the same technology to build what we call a smart attendance monitoring system. Here we make use of beacon technology using BLE and integrate it with various other systems like node-red and MQTT, to build a Bluetooth based automated attendance marking system, furthermore we've also tried to simulate the hardware using android development and hence tried to reduce the hardware as of now. Bluetooth signals from the student's device which simulates beacons are detected by the simulated-gateways and once the data is collected and formatted, it is sent to the node-red server where we process the data such as RSSI signals and the details of the student and the present or absent details. There are two user ends, student and the teacher. This project is concentrated upon helping teachers with managing the student attendance and class details.

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Chapter 1

Introduction

1.1 Motivation

Marking attendance is a tedious and time consuming process if done manually and hence in this automated era, we decided to work on a smart attendance system that would be user friendly and fast. We hence read many a research papers and tried to come up with the best system that would use low cost technology and already available softwares to connect various systems that would manage student attendance and class details effectively.

1.2 Objectives

- To design a dashboard at the server side that could store the data of every student registered.
- The dashboard must also take inputs from the user-end(admin) and store it in the database and give permissions to edit it.
- The dashboard must also register classes and show them in live sessions
- The anchor needed for sharing of data between the student device and the server must be simulated in android environment.
- The anchor must detect BLE signals from the device and compare it with the registered data base and then send a string data with credentials to the node-red server.
- The server must process the data and compare the data and if not present add the data to the server database and must mark present the student.

1.3 Literature survey

1.3.1 Reference Paper 1

[3] In this paper, The design for an Indoor Positioning System (IPS) has been realized using Bluetooth Low Energy technology. The motivation for this solution lies the in the recent real availability of such technology and the challenges related to it, in terms of fluctuation of RSSI. The objective of the system is to track the position of a device by means of BLE in indoor conditions. To do this, BLE modules are in fixed positions, while BLE SensorTags are in motion. The system works on the trilateration technique, and distance between estimated position and real position is defined as the error, which is minimized. To facilitate the trilateration, three receivers are installed in a room. The SensorTag CC2650 which acts as the beacon is an IoT device developed by Texas Instruments, which has sensors humidity, pressure, temperature, magnetometer, gyroscope and accelerometer. At every time interval, the SensorTag sends messages which are non-connectable advertisements. These advertisements are done through three different channels, with same counter ID for receiver to manage channel diversity. Raspberry Pi with sniffer devices are used as receivers, sniffers receive the messages sent by the three channels. Raspberry Pi runs a python script to control and interact with these sniffers and the data sent by the beacons. Computation of distance is carried out on the Raspberry Pi. Further in the paper, RSSI formulae are defined that consider the error estimated and minimization of the same. The system has channel diversity and combination of algorithms to achieve the best distance result using the RSSI values. It uses Weighted trilateration to estimate the area of intersections of the three signals. The paper has three different techniques to enhance the precision of BLE indoor positioning, using channel diversity, Kalman Filtering and Weighted Trilateration. The focus of the system throughout is to reduce the dispersion of the RSSI measurements inherent to such systems. Kalman Filtering is put in place to make up for unlikely or wrong values of RSSI. The paper claims to have the most balanced solution considering precision and cost as parameters.

1.3.2 Reference Paper 2

This paper starts with talking about the rise in use of global navigation satellite systems to locate, navigate and have working location-based services for different applications. These signals from navigation satellite systems are not strong enough to be able to penetrate into buildings and provide location tracking in indoor environments. This lack of competence has created a motivation to research and develop an indoor positioning system that uses RF based wireless technology and operates on a smartphone.
The paper talks about Fingerprinting localization which is a technique used to obtain better accuracy in location tracking results and its incorporation into an indoor positioning system. Further it opens up on the challenges a practical implementation of IPS faces and solutions to the same, comparing performances with similar systems.
The paper mentions the choices of signal sources that can be incorporated such as WIFI and geomagnetic fields or BLE with ultra-wideband radio signal tags. However due to the indoor environment being complex, propagation in multiple pathways and shadowing effect on signals tends to be a common occurrence according to the author, which results in less accurate propagation time and time synchronization, affecting the wireless signal

measuring solution principles such as TOA (time of arrival), RSS (Received signal strength), TDOA (time difference of arrival) and AOA (angle of arrival).
Further the paper branches out and explores the wireless technologies used in IPS systems such as RFID/NFC, UWB, WSNs, Wi-Fi, BLE and offers a comparison between Wi-Fi and BLE. The key to locating and tracking a device is to make use of the signal the device to be tracked is broadcasting. The methods to signal measurement are many and all offer a considerate accuracy and precision. RSS, TOA, TDOA, AOA, CSI and RTT etc. However, for even better accuracy researchers often combine two or more principles and realize a design.
The paper throws light upon the parameter metrics of an IPS, accuracy and precision being the top of all, along with the complexity of the system in place, scalability and robustness for the environment where its going to be situated and cost of the system. These parameters are important as manipulating them gives a developer a workaround for the practical problems of an IPS such as complex indoor environments, instability of RSS and computational time.
The existing algorithms to achieve an IPS are Proximity based, Lateral/Angular (RSS, TOA and TDOA), Weighted Centroid Localization, Trilateration, Fingerprinting (Deterministic, Probabilistic) etc.
Finally, the paper explores on the ways of implementing Fingerprinting Localization using WIFI and BLE or ML based solutions. It justifies with performance metrics the accuracy of Fingerprinting being promising. However, it also addresses the drawback which is the requirement of offline training phase. But the authors firmly believe that there can be better solutions developed to achieve a near perfect IPS to offer LBS in difficult indoor environments. [6]

1.3.3 Reference Paper 3

This paper uses cloud-based identification system for location tracking. The device used in iBeacon by Apple. The iBeacon app on the user's mobile phone tracks the location of the iBeacon device.
The device transmits an id via Bluetooth to devices in the vicinity the app. The location is identified using latitude and longitude. The app uses the id and accesses information stored in databases online.
The setup comprises of supply, battery, a PIC microcontroller, EEPROM, ibeacon module, LCD display and UART cable. Power supply and rechargeable batteries are the input devices and the antenna is the output device that constantly transmit the identification number which provides address of the device
The ibeacon works at 3.3 voltage with the operating frequency of 2.4GHz. The ibeacon operation performance is based on the BLE technology that is Bluetooth Low energy. [5]

1.3.4 Reference Paper 4

This paper was one of the classic papers on the Bluetooth indoor positioning that we usually find online. It used the usual RSSI way of calculating the distance and Trilateration process for locating an object/asset and was integrated with Wi-Fi fingerprinting. They did however, care to mention in the abstract that they achieved an accuracy of 90% with 1.21 meters and that's why it was important for us to understand the various aspects of this paper. The paper gave a brief explanation as to why RFID is

not the way to go since we need a dedicated RFID reader which is only an extra hardware since at this point we're using Bluetooth which is easier. The experimental area was that of a typical Trilateration experiment set up and they basically made us e of Wi-Fi as a means of communication for the computation server since it was faster and that was how this paper achieved hence proposed. .[4]

1.3.5 Reference Paper 5

The paper started out with how WSNs (Wireless sensor networks) are very widely flourishing these days, especially in the fields of indoor localisation and tracking. The main idea of this paper was to present a detailed research of hybrid WSN tracking systems using the RSSI(Received Signal Strength Indicator) and inherital system functionalities. Most of this papers work was based on XBee series two module and its inherent functionalities.
However, the most important aspect was this paper was over the fact that they not only implemented the hybrid system proposed, but also the regular indoor localisation system using just the RSSI signals and a thorough comparison of both the methods was done and evaluated for accuracy. It was notably mentioned that results were tested for eight different locations for both the methods. In the end with average it was found that RSSI offered the error margin of 0.80 meters where as the hybrid system offered 0.60 meters of margin. as obvious the system not only gave better range but also an astounding accuracy. The working of hybrid modules was certainly something to be added in future scope of the project. [1]

1.3.6 Reference Paper 6

The paper talks in depth about the BLE technology and also about mesh network and how it can be used for indoor positioning systems. So at first in the introduction it was mentioned the various applications of indoor positioning systems and also new features in Bluetooth The main idea of this paper was to build an indoor localisation system for a working environment with employees ad one admin who oversees their movements. Using the RSSI values the distance calculation algorithm was applied and the result was tracked for various environments. to calculate the accurate position of the asset/object, algorithms such as trilateration and triangulation both were tested. So the result analysis of this paper was done using root mean square error method and optimal graphs were plotted. While various other papers explore Bluetooth on a general creamy layer, this particular thesis paper went in depth about the GAP, GATT and access profiles in Bluetooth, it also helped us learn in depth about Bluetooth and its architecture and the IP stack. There was also the use of kalman filter to address noise issues caused during signal transmission .[2]

1.4 Problem statement

To design a smart attendance system using node-red as server and simulate a beacon and gateway in the android environment, so that smart phones can replace the extra hardware used for BLE signal processing i.e, beacons and anchors. A server is set up on node-red to to process the data and mark the attendance of the student, hence the attendance monitoring system.

1.5 Organization of the report

- Chapter 2 gives details about the system that we have designed and the various functional blocks and flow diagrams that we have used in the project. It starts on from small general block diagram and then a separate block diagram for each of the general blocks and explores all the aspects of the system.
- Chapter 3 deals with the implementation aspect of the project hence all related achievements in the form of the hardware and software are here mentioned and snapshots of the system/software that was built has been shown in this section
- Chapter 4 the crucial part of the project and hence talks about the results and observations derived from the project and experiments. Ways to optimise the system have also been briefed in the same.
- Further the conclusion and application of the project has been briefed in the last chapter 5

Chapter 2

System design

2.1 Functional block diagram

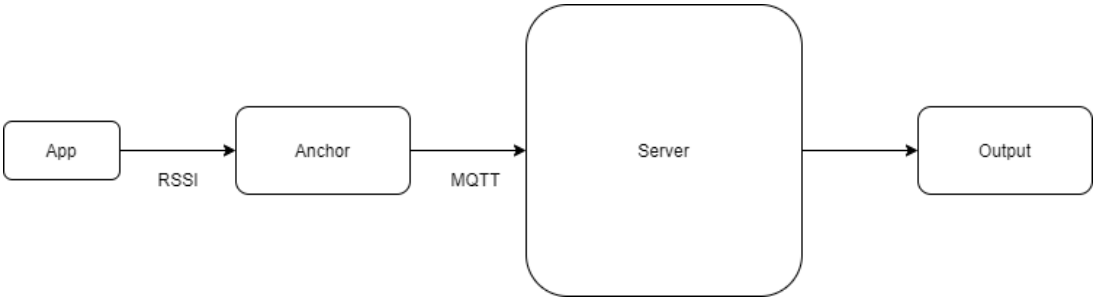


Figure 2.1: General Flow

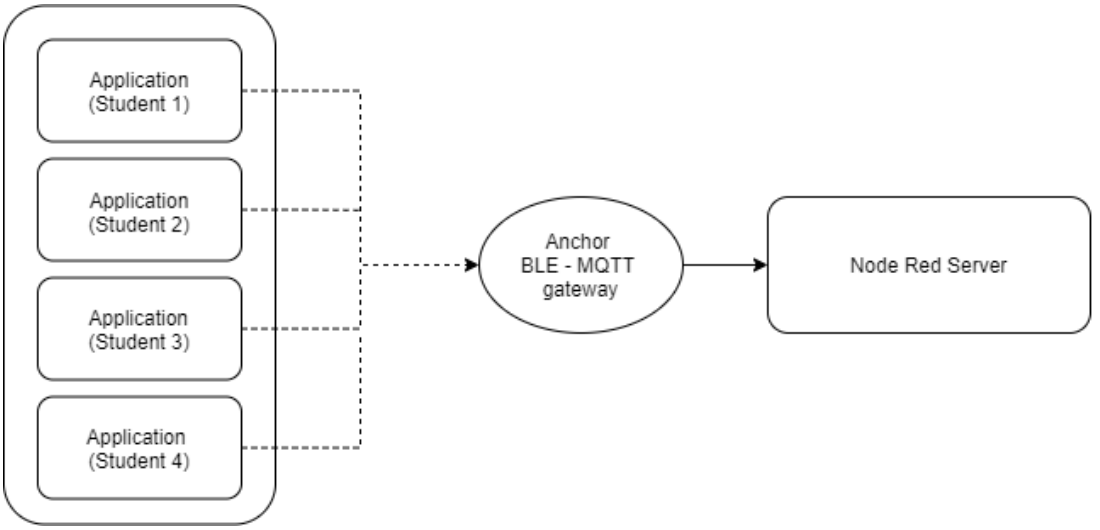


Figure 2.2: Detailed Flow

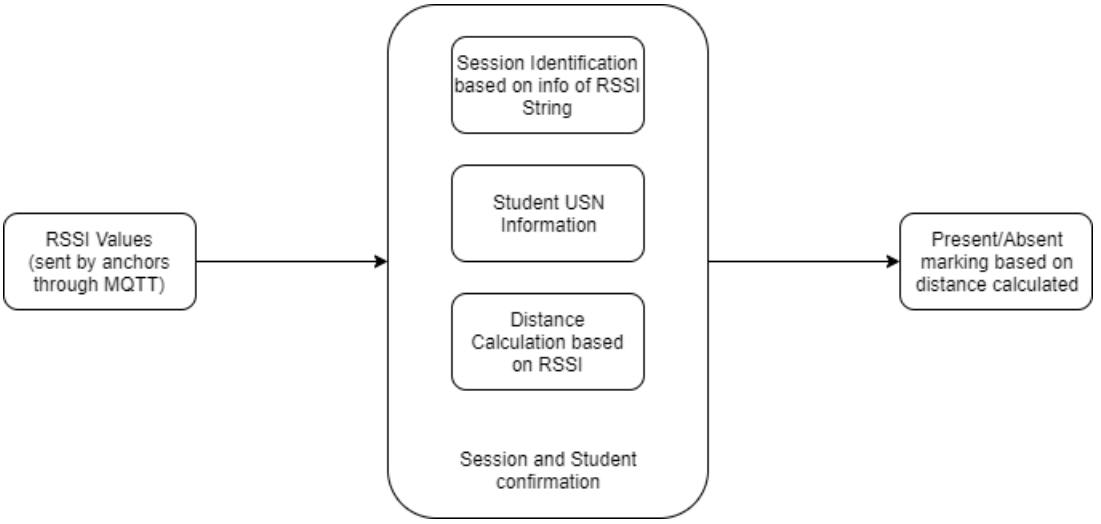


Figure 2.3: Node Red Back-End Process

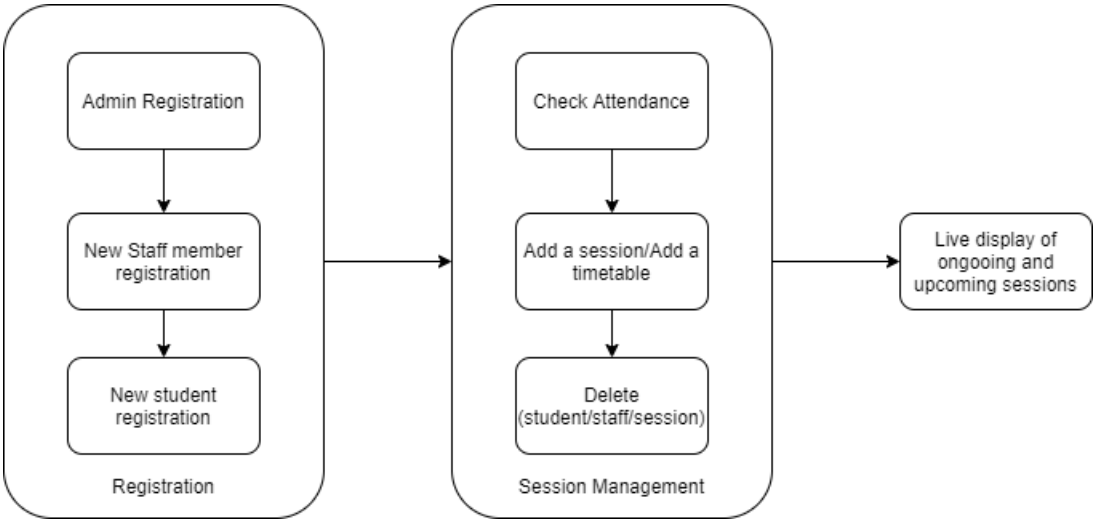


Figure 2.4: UI Features

2.2 Final design

The teacher and the student user-end looks as follows.

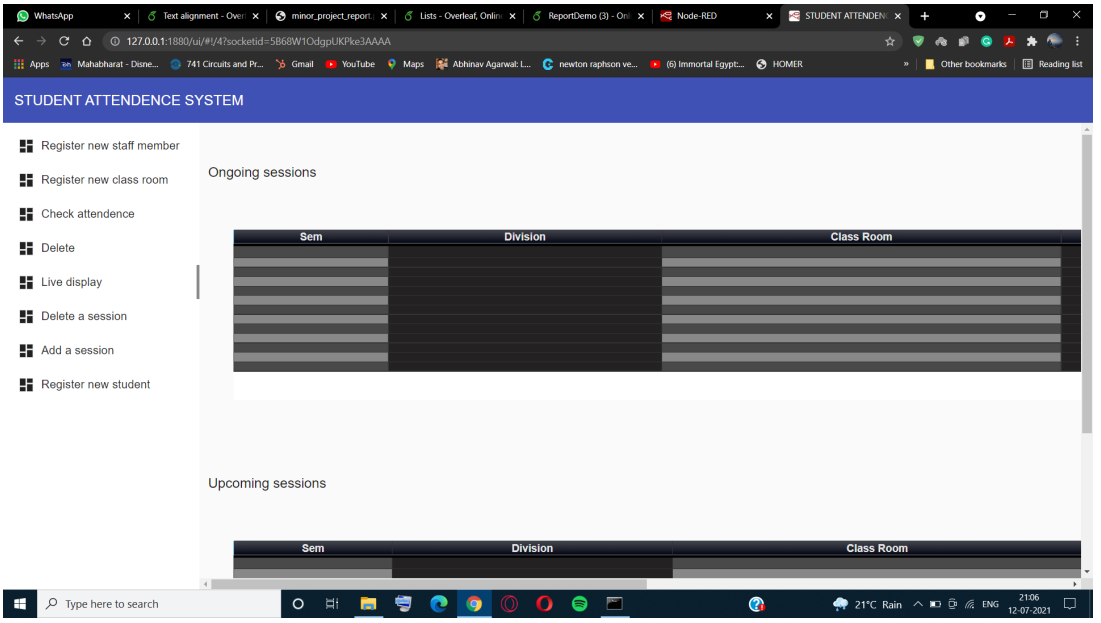


Figure 2.5: live and upcoming sessions

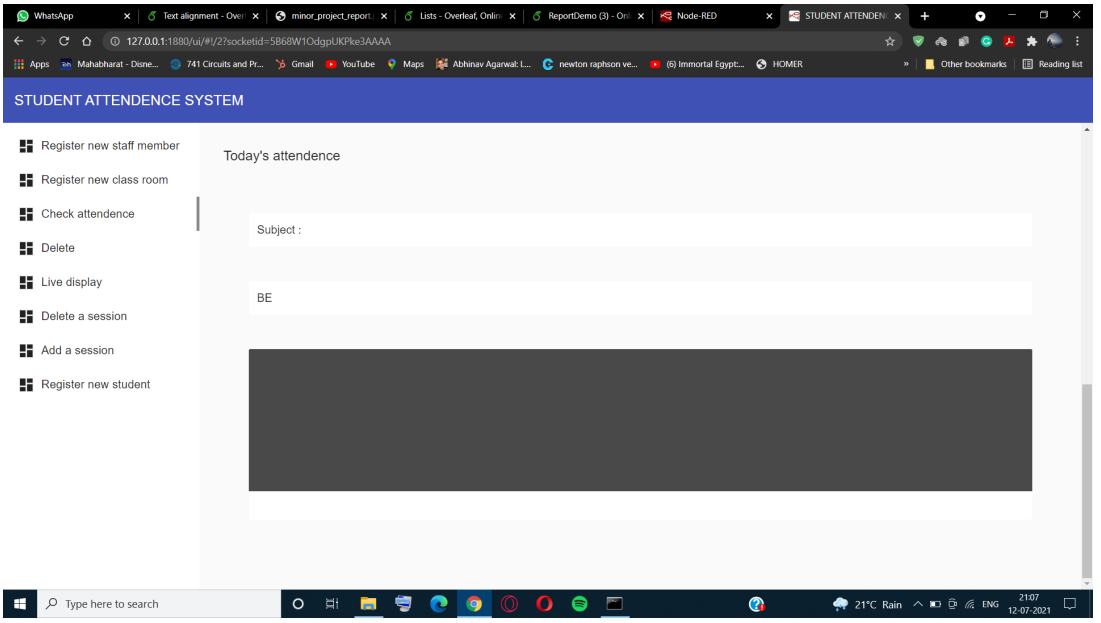


Figure 2.6: attendance

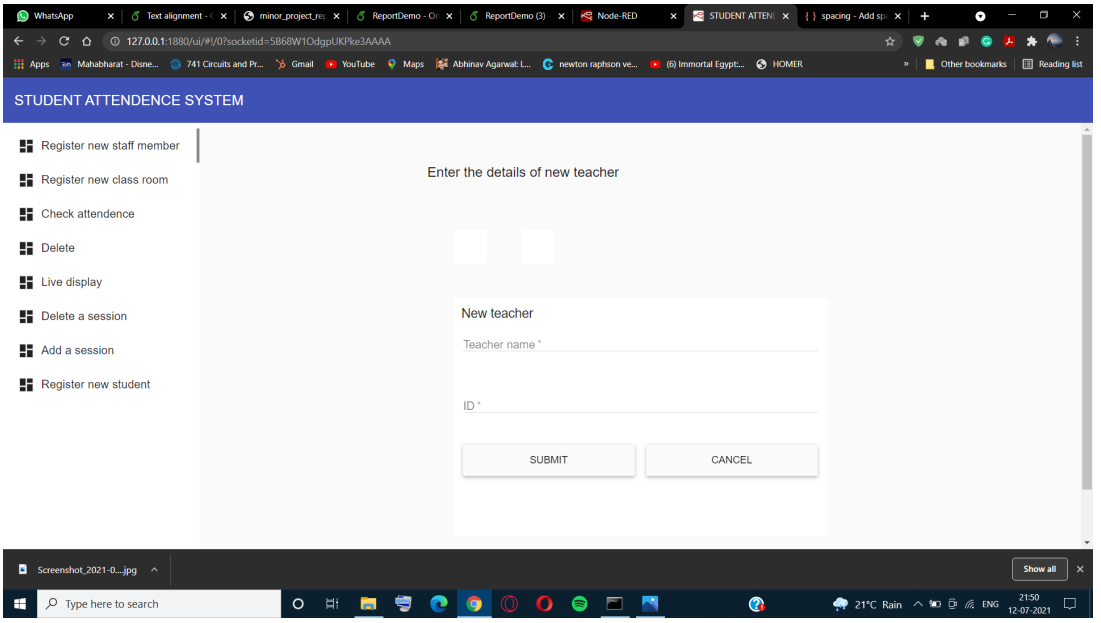


Figure 2.7: add teacher

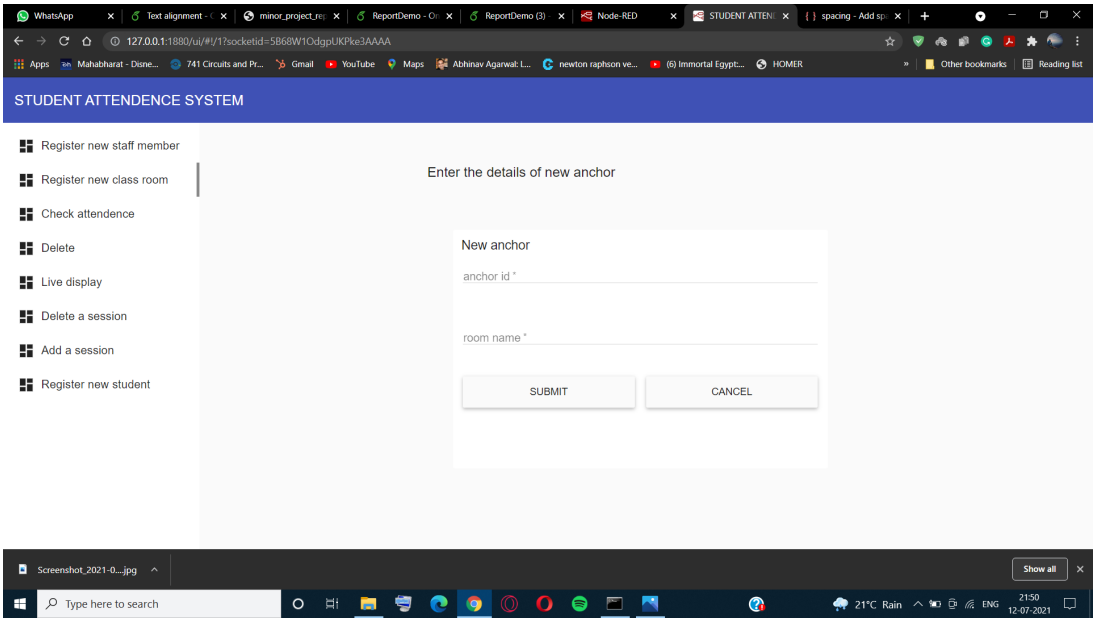


Figure 2.8: remove student or class

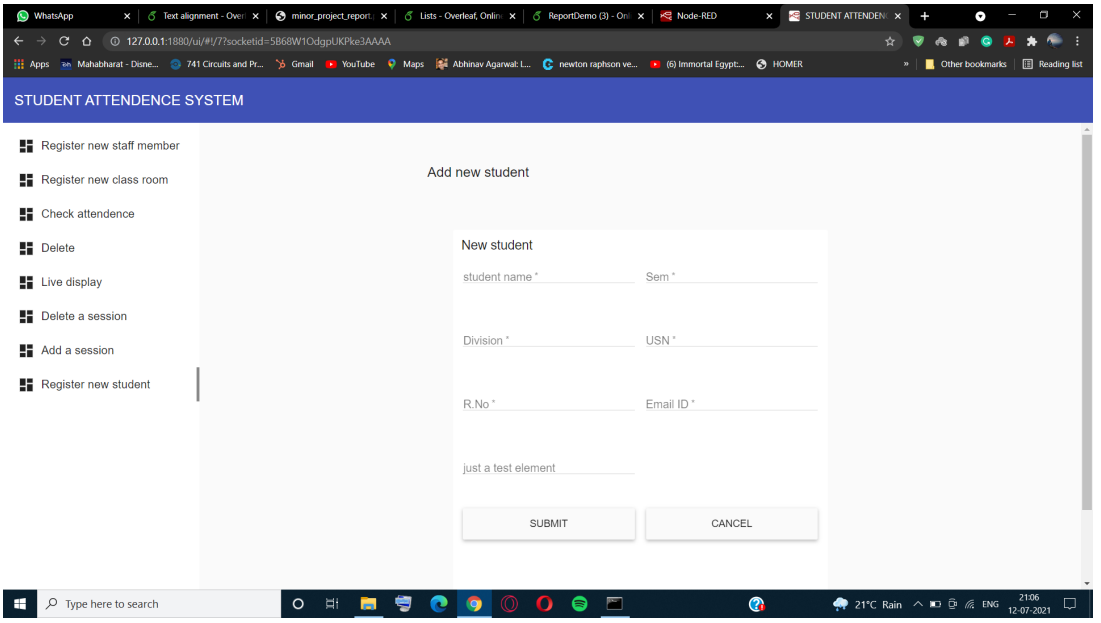


Figure 2.9: add student

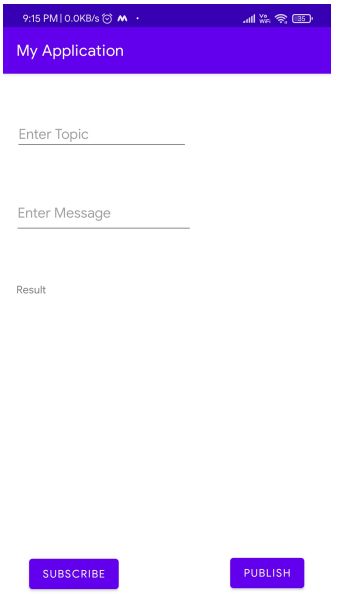


Figure 2.10: MQTT functionality

Chapter 3

Implementation details

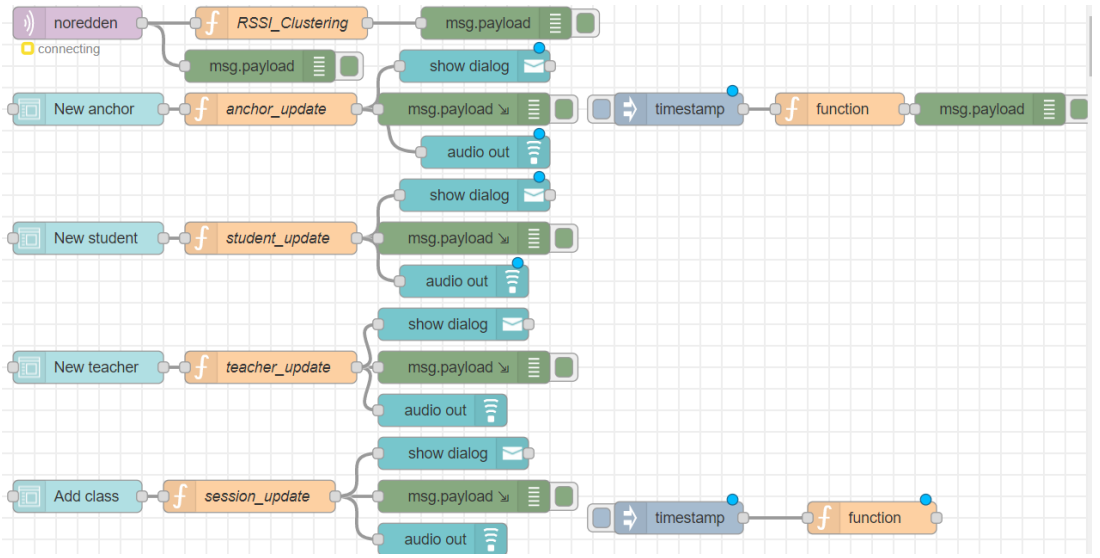
3.1 Specifications and system architecture

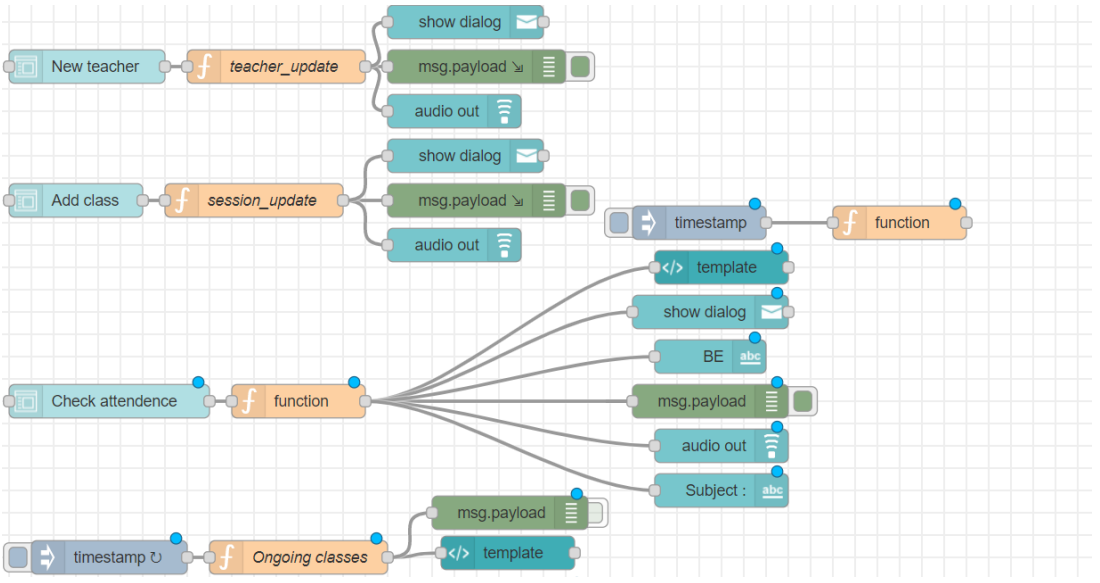
- The server and dashboard are built with node-red.
- The anchor and beacons are android simulated

3.2 Algorithm

1. Set a PC as a server.
2. Configure the anchors to the server and the Wi-Fi network to send data to the server. Here we use MQTT based communication system.
3. Program the beacon/tag(android device) with Eddystone protocol.(any third party app for the current purpose)
4. Install the anchors inside the building appropriately to cover the entire area.
5. Make sure the android devices are well within the signal detecting area and are transmitting BLE signals and are registered.
6. The signals are received continuously by the anchors and the data packets are sent to the node-red server. to the server through Wi-Fi.
7. Node-red is used to process the received data packets.
8. Extract RSSI value,Anchor ID and the Beacon ID from the data packets and compute
9. Mark the attendance of the student as required

3.3 Flowchart





Chapter 4

Results and discussions

4.1 Result Analysis

Input description	Expected output	Actual output
Anchor Registration	Registration window will appear in that Window we will be given an option to add Anchor as per MAC ID (unique identifier) checks this with global Anchors present in that locality and confirms Registration	Works as per the expected output requirements
Notify based on correct details.	On successful Registration the user shall be notified with the message that the Anchor has successfully registered.	Works as per the expected output requirements
Notify based on incorrect or same details.	If there is a repetition of Anchor ID while registration the user shall be notified with the message that the following Anchor id is already registered. On incorrect details the user shall be notified with the message to provide correct details.	Works as per the expected output requirements
Beacon Registration.	A registration window will appear ask for beacon id for registration if the id is unique it confirms registration.	Works as per the expected output requirements

Notify on correct details.	On successful registration the new device (student to be marked) gets registered.	Works as per the expected output requirements
Notify on incorrect details or same details.	If the mentioned id already registered the user shall be notified with the message that student is already registered.	Works as per the expected output requirements
Individual Status	A window will appear in that there is a provision to provide Registered Id's of the Asset to be tracked if the id is valid then status of the student will be displayed with audio output describing when user has entered the room with the logged time and Date	Works as per the expected output requirements
Notify on incorrect details	The message will be popped to the user saying Please enter valid Id (Asset) to be tracked.	Works as per the expected output requirements
Working of the anchor app	The application must detect the signals from a nearby device and extract the details from the device and bind into a string or buffer data and send it to the node-red server for further processing through MQTT.	The application currently only detects the signals and the mqtt aspect of it needs to be worked on.

4.2 Discussion on optimization

- The process of optimisation of this project started from the beginning itself, The whole idea was to test the system in a complete hardware devoid environment except for smart phones. Since the only hardware that was extremely necessary in the system was the anchor which was supposed to be configured in a way that detected data from the student device and send the formatted data to the node-red server in the form of a string. We tried to simulate the anchor functionalities in an android environment and test it. This stage of optimisation is still going on.

- Another way to optimise the system would be by optimising the code, currently we are using the most optimised code and the stages of optimising went from making a robust indoor positioning algorithm to removing its functionalities like trilateration and triangulation because we were making using of only one center-to-the-class anchor which was unique to that particular class. We made use of the distance calculating equation using RSSI and worked our way up the algorithm to modify it for an attendance based system.

- Another optimisation method would be by moving to cloud based storage from local storage options. The obvious issue with local data is that it is subject to loss at the hands of the user and in order to access the data one must have access to the device, but if we move to cloud storage such as AWS, google cloud, it is easy to maintain the data and access it easily. We can also add authentication to this data and keep a track of huge about of data this way. Currently we are working with different clouds and trying to find the best one to integrate it with.

Chapter 5

Conclusions and future scope

5.1 Conclusion

Attendance monitoring system is modeled using android simulated hardware i.e.. anchor and the beacon, the system basically took signal inputs and based on that as it went through various blocks of the system such as anchors, node-red server for further processing. Date and Time of entry and exit of the student is logged,hence also marking the attendance of the system..

5.2 Future scope

The attendance monitoring system is an modified application of the indoor monitoring system, It not only uses less hardware but also works efficiently. The future scope for this project would be to implement in a large scale network of classrooms. We can create one main server that handles all the database and extend its capabilities to much more than just attendance marking. The near future scope would be to test the system in a small environment and add functionalities of cloud based systems to store the data.

5.2.1 Application in the societal context

In a classroom of over 50 students, marking attendance not only uses a lot of time but is also a tough business since proxy attendance is the obvious issue. Hence marking attendance is a tedious and time consuming process if done manually and hence in this automated era, we decided to work on a smart attendance system that would be user friendly and fast. We hence tried to come up with the best system that would use low cost technology and already available softwares to connect various systems that would manage student attendance and class details effectively.

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