SMART TIMETABLE

Prepared by: TEAM DCD

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Table of content

Abstract

In this project, we are trying to address a common problem in most of the Sri Lankan schools. Usually in a school, some of the teachers get absent in almost every day. So, for the periods covered by those teachers, some other teachers should be assigned. But most of the schools this is don manually. Therefore, it takes a considerable time for this assigning process. And also, most of the times this message is passed to the corresponding teacher by the respective class monitor. Hence, it takes a considerable time for this process. But this is a waste of valuable time of thousands of students. In this report we to provide an IOT based solution for making this process very efficient compared to manual procedure. We can add this solution as a part of the smart classroom system too.

List of Figurers

Chapter 1

Chapter 2

Chapter 3

Chapter 4

Chapter 1 - Introduction

1.1 Overview

Still, most of the government schools mark the attendance of teachers manually. Usually, in almost-every day, some of them may be absent. So, some other teachers need to be assigned for the periods covered by those absent teachers. Another teacher is assigned to those periods who are present and doesn't have any other class in that timeslot. In most of the schools this is done manually, and it takes a considerable and variable amount of time in each day upon the number of absent teachers. When the updated is prepared, class monitors must go to the office and check whether there is any such period and inform the corresponding teacher or there's a dedicated person in some schools who passes the message to each such teachers.

This method has a lot of problems, and we have experienced them.

- In most of the times, class monitor must inform the corresponding teacher. Therefore first, he needs to find where the teacher is and normally this is done when the corresponding period starts. So, he may have to spend time from the period just for informing the teacher which is a waste of time of all the students in that class.
- If a teacher who has a class in the very first period got absent, there is a big problem. Because assigning another teacher may not have been completed by the time the period starts. As we mentioned above, since this process is done manually, a considerable amount of time may be gone from the first period, when the updated timetable is available. Also, some extra time will also be wasted until the message reaches the corresponding teachers.
- As described above, in most of the schools, teachers know whether they have assigned to some other classes in their free slots, only when the class monitors informed. Generally, class monitor informs this, after the corresponding period starts. So, they may have to go to that class instantly regardless of what they are doing at that time. So, there's an uncertainty in their minds when they are planning some activities in their free time.

To validate our problem, we conducted a small survey within the limited time that we were given. Through this survey we could know the opinion of both the students and teachers about the existing method for assigning teachers for free periods as well as their willingness to have a smart solution for this particular problem. The results are shown below.

1. Student Category

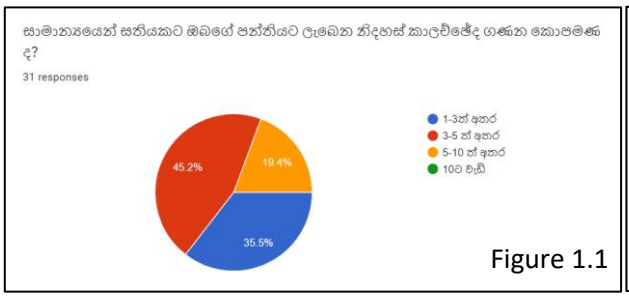
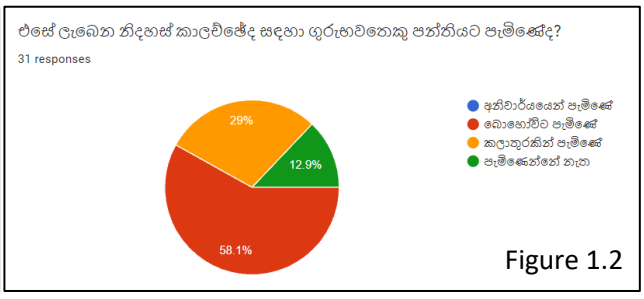


Figure 1.1



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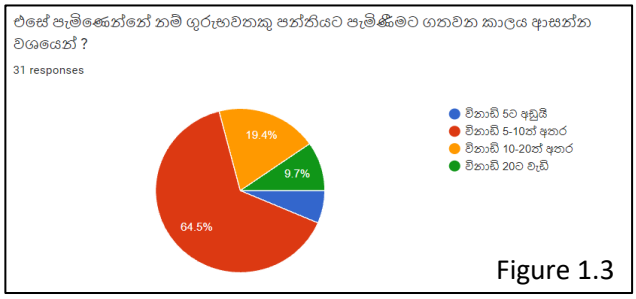

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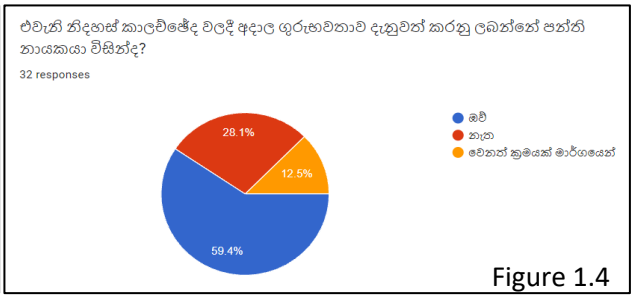


Figure 1.4

When we are looking at these results, it is obvious that a considerable amount of time taken for a teacher to arrive a class and majority has voted that class monitor passes the message to respective teachers. As we discussed under the problem definition, the reason for this waste of time is inefficiency of the existing method for assigning teachers for free periods.

2. Teachers Category

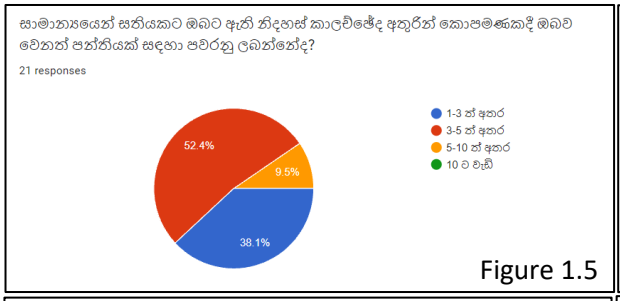


Figure 1.5

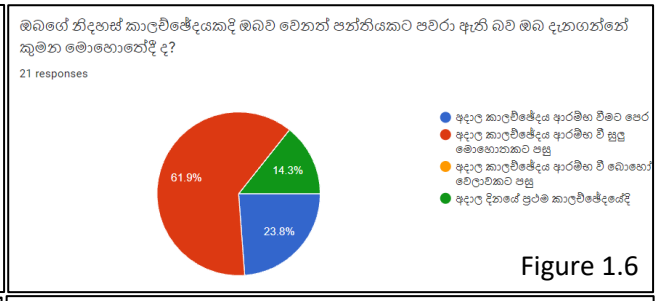
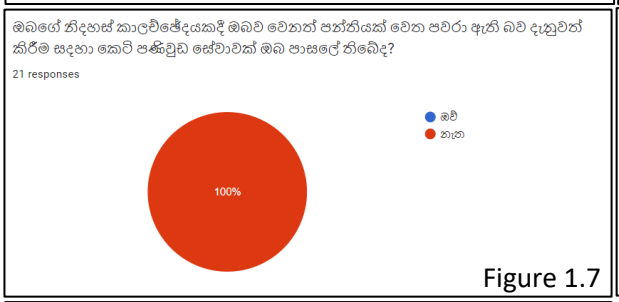


Figure 1.6



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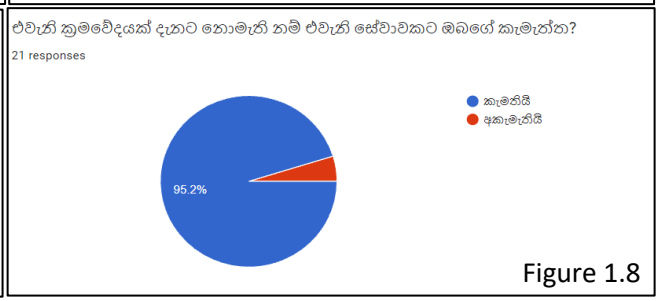

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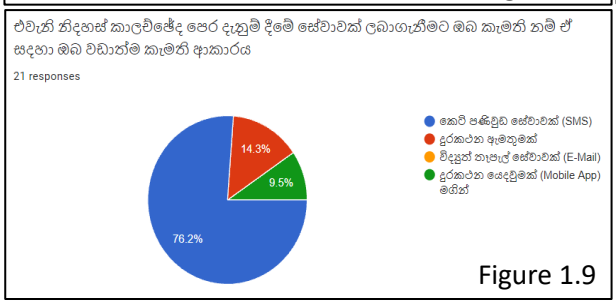


Figure 1.9

According to above results, in most of the schools the teachers are notified after the corresponding period has started. Also, it seems that, still no one have addressed this problem sufficiently to give a smart solution. According to figure almost every teacher like to have this kind of smart solution for this.

Therefore, we believe this is one of the most suitable problems to address in terms of IOT and such a solution will play a major role to minimize the wasting of time due to inefficient communication in Sri Lankas schools. [Link for this google forum of our survey has attached at the end of the report]

1.2 Objectives

- Identifying absent teachers quickly and soon after assigning the available teachers for the periods which should be covered by those teachers who are absent, using a computer system.
- Notifying the respective teachers that they have been assigned to some classes as soon as the system determines the updated timetable.
- Notifying the respective classes about the updated timetable.

With these, our main objective is to save the valuable time of students as well as teachers by improving the efficiency of inter-personal communication with the aid of IOT.

1.3 Methodology

As you could understand, this method is very inefficient and a waste of time of hundreds of students and teachers. Therefore, we have come up with a solution for this based on IOT, which has a significant impact on all the problems that we have above. The following facts collectively describe our complete solution. But in this stage, we are specially addressing how to deliver the message for teachers saying that what are the time slots they have been assigned for those classes quickly and for the respective classes using an IOT based system. Our solution is as follows.

- Introducing an automated attendance marking system based on fingerprints. As mentioned above, this is not a main concern in this stage. And also, our solution can be applied to schools where there's already have or even doesn't have an automated attendance marking system.
- A system that assigns teachers for the periods of absent teachers automatically within a very small amount of time compared with manual procedure.
- An IOT based system which automatically sends the message to respective teachers as soon as the above step is completed.
- An IOT based system that sends the updated time slots with the names of the assigned teachers for the respective classes.

Steps 3 & 4 are our major concerns in this stage. Hence, we assume that we have a digital copy of attendance of teachers. But we implement a simplified version of step 2 as well. The following figure shows a functional block diagram of our solution.

First, we get a digital copy of the attendance of teachers and the data will be sent to a raspberry pi. Those data will be fed into a computer program which identifies the absent teachers quickly and assigning some other teachers to those periods automatically. Once this is completed, we have the updated timetable for whole school. The program takes a very small time to prepare the updated timetable, compared to manual method. Then by the server LoRa node, which is connected to Raspberry Pi, gets the updated timetables of classes one by one and transmit it to corresponding

classroom. By the time the receiver LoRa node at each classroom is turned ON and they are waiting for data. One such transmission does takes not more than 10 seconds. So, our system is capable of updating all the devices in the school within few minutes. So, class monitors no longer required to pass the message to teachers, and teachers do not have to wait until they received the message from a class monitor or some other person.

Using the MQTT broker, we send the updated timetable data determined by Raspberry Pi to the node red flow. Then using Twilio Messaging Service, we send the updated timetable to corresponding teachers as an SMS.

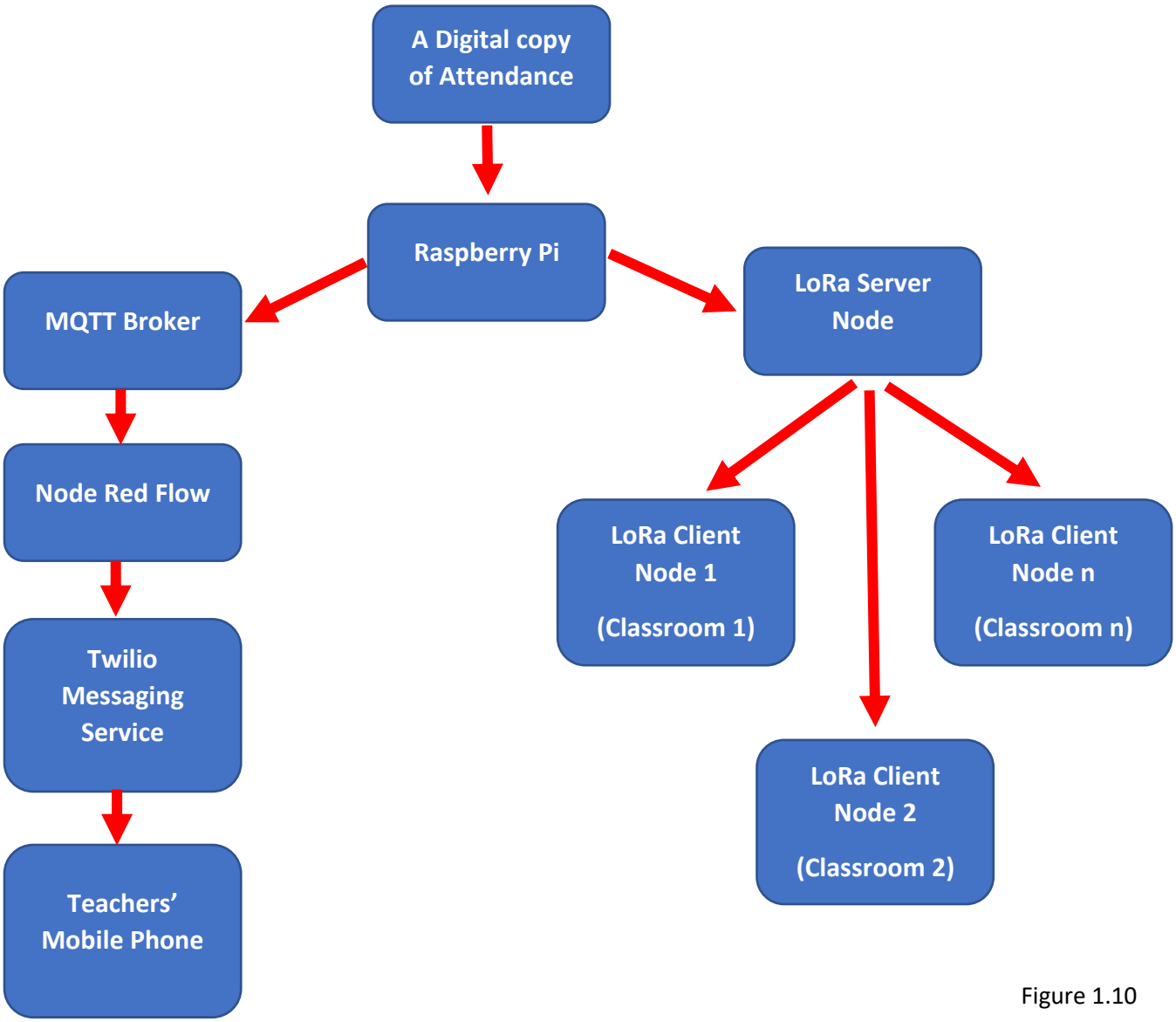


Figure 1.10

Chapter 2 – Hardware Design

2.1 Introduction

- Basically, our solution is consisting of two endpoints. They are the server device and client devices. The server device is located at the main office in the school. The client devices are to be installed in classrooms. In this section we discuss our hardware design phase under communication technology used, micro controllers and device overview, power sources and PCB design.
- We considered several design decisions under this phase. They are,
    - The device at classrooms should be able to drive using batteries, therefore, it should be a low power device. Hence, we need to select technologies and components precisely. Also, there should be a mechanism to automatically turn OFF the client devices when its purpose has been served.
    - We need a communication technology which has a high range, low bandwidth, and low power.
    - The server node should have a controller with relatively high computational power and a relatively high memory since it has to run the computer program to assign teachers and send the updated timetable to each and every class.

2.2 Communication Technology

- To establish data communication between server device and client devices, we need to use a communication device. As mentioned above, we need a high range, low bandwidth, and low power solution. The mostly used IOT communication technologies with above properties are ZigBee, NB-IOT and Lora. We have chosen Lora due to the advantages listed below,
    - Long range – Can be connected devices up to 10 miles
    - Low power consumption
    - It uses license free sub gigahertz radio frequency bands (433MHz, 868MHz)
    - Data encryption methods
    - Bidirectional communication
    - Ease of use and availability in the market.

So, we used LoRa module (SX1278) with an antenna to establish data communication between server and client devices.

Figure 2.1

2.3 Microcontrollers Selection

- As we mentioned above the server device should have a considerably higher computational power and a memory. Therefore, microcontrollers like Arduino or STM32 may not be sufficient. Hence, we have decided to use a Raspberry Pi as our server device.
- For client devices we do not need a high computational power. Also, it should be low power as well. Therefore, we decided to select SMD version of Atmega328P microcontroller for client devices.

2.4 Client Devices PCB design and Component Selection

- The higher-level view of our client devices circuit is shown below.

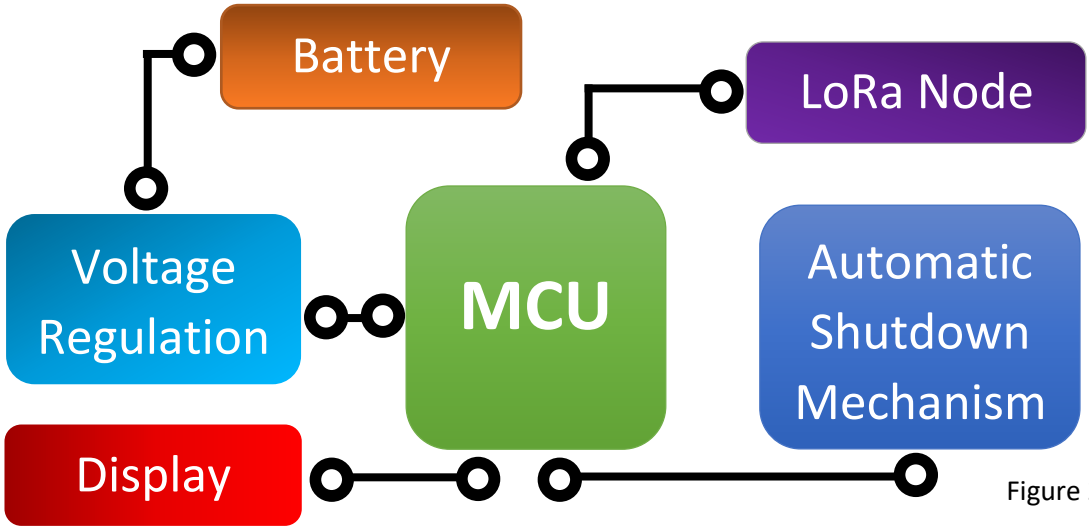


Figure 2.2

- When it comes to battery, we decided to use AA batteries by considering several options. We considered mainly the cost, how long it can drive our device without replacing or recharging, rechargeable or not, and physical size. Since we design our circuit such that it uses a low power, we do not need a battery with very high capacity. Also, rechargeability is not required due to it can be operated with four AA batteries for a long time. By using AA-batteries we can reduce the cost a lot at the same time achieving a longer lifetime.
- When selecting voltage regulators, we considered what is the required maximum current needed for driving the load and minimum input voltage that should be supplied in order to have a regulated output. Since we are using AA-batteries, a single battery has a voltage difference of 1.5V. Since we need to provide 5V to Atmega328P microcontroller, we have to use at least 4 batteries in series. Therefore, we have to select a 5V regulator which has a minimum input voltage below 6V. Therefore, we selected low dropout voltage regulators; HT7550 as the 5V regulator and HT7536 as the 3.6V regulator, which has a minimum input voltage of 5.5V. 5V is required for microcontroller and LCD while 3.6V is required for LoRa module. The

maximum output current of these regulators is 100mA. But our load does require a maximum current less than 100mA.

- As the display we will be using a 20x4 LCD character display. It should be enough for our application because in general no classes may have more than 4 different free periods in a given day.
- We implement an automatic shutdown mechanism as well. It is required because after some time past the message receives, the students are aware of their free periods in that day. So, there is no need of displaying it throughout the day. So, we implement our device s.t it automatically shutdowns after a given time-period.

- We used Altium Designer 2021 for Schematic and PCB. Schematic diagram is shown below.

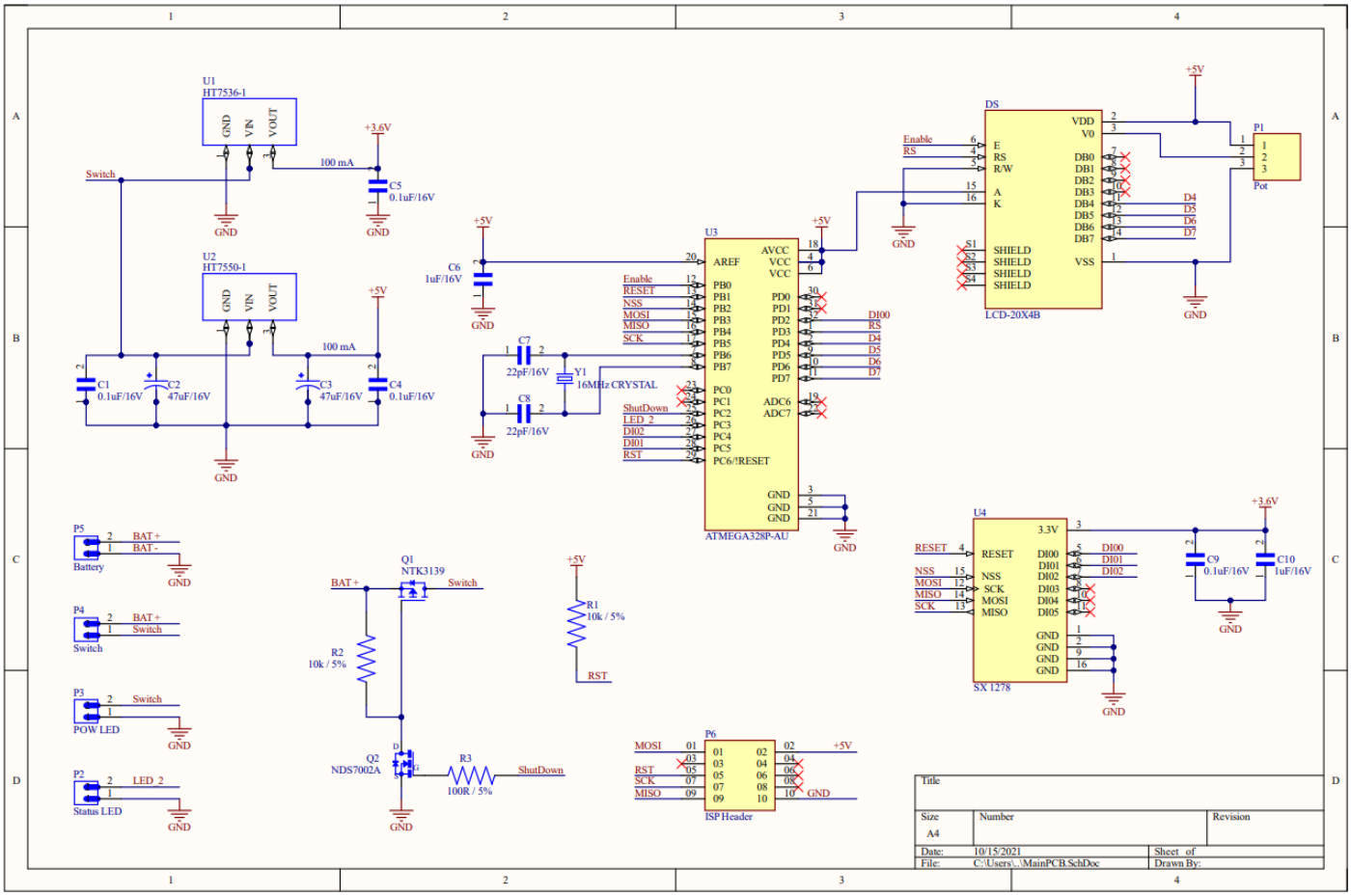


Figure 2.3

- Our PCB design is shown below.

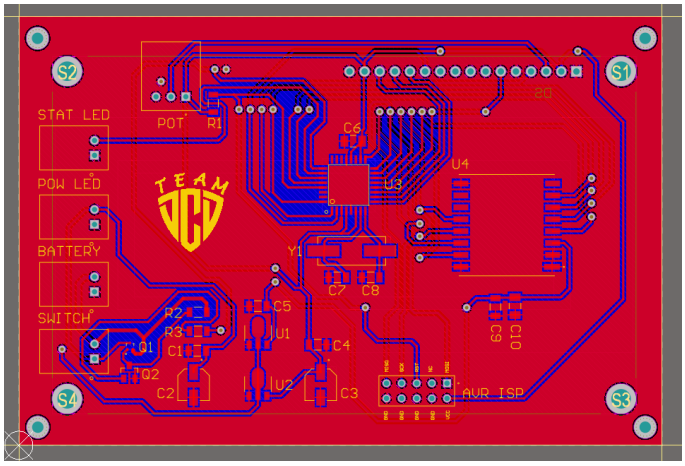


Figure 2.4 Top Layer

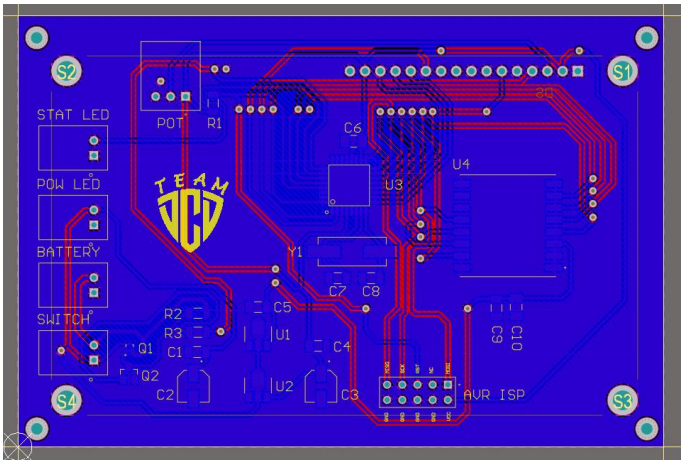


Figure 2.5 Bottom Layer

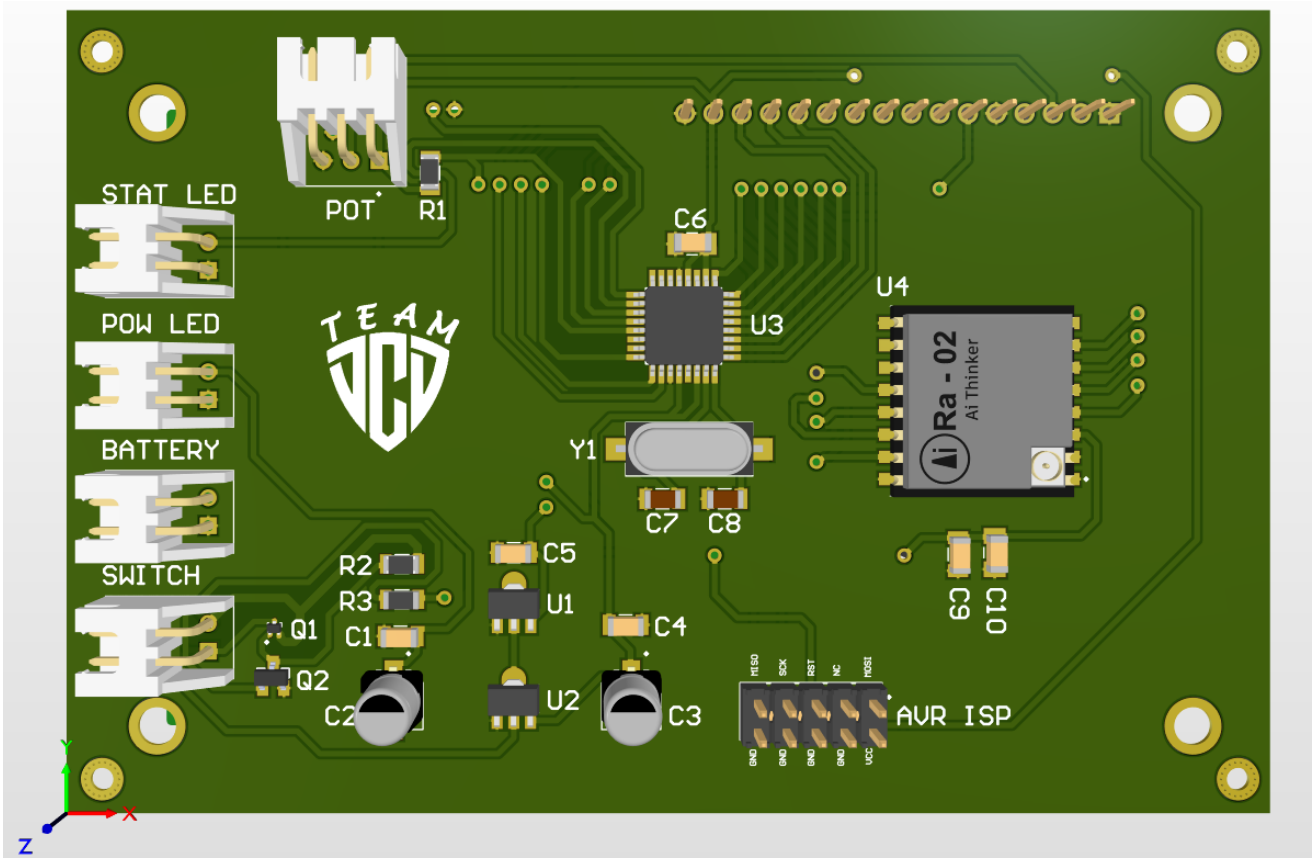


Figure 2.6 3D - Top View

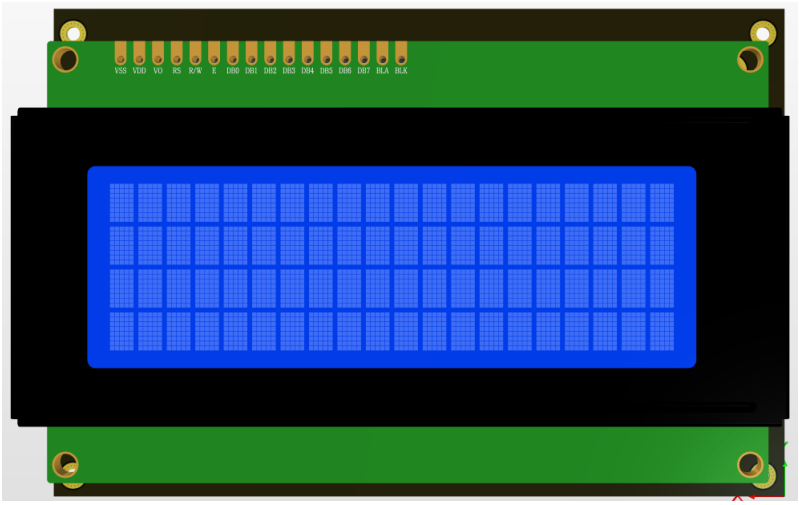


Figure 2.7 3D – Bottom View

Chapter 3 – Mechanical Design

Mainly the mechanical design part of our project is designing the enclosure for the device that places in classrooms. We used SolidWorks 2020 software as the mechanical design software. As the initial step of our mechanical design, we came up with few design considerations.

1. The device should be very much user friendly, and appearance should be good enough, because one of the students may have to operate it daily.
2. The device should be small enough to be kept on a table.
3. The indications by the device should be clearly visible.
4. Since our device is battery driven, replacing the batteries should be easily done.
5. Weight of the device should be small.

Keeping these in mind we began our design process. There are mainly two parts of our enclosure. The front side of the enclosure and battery holder.

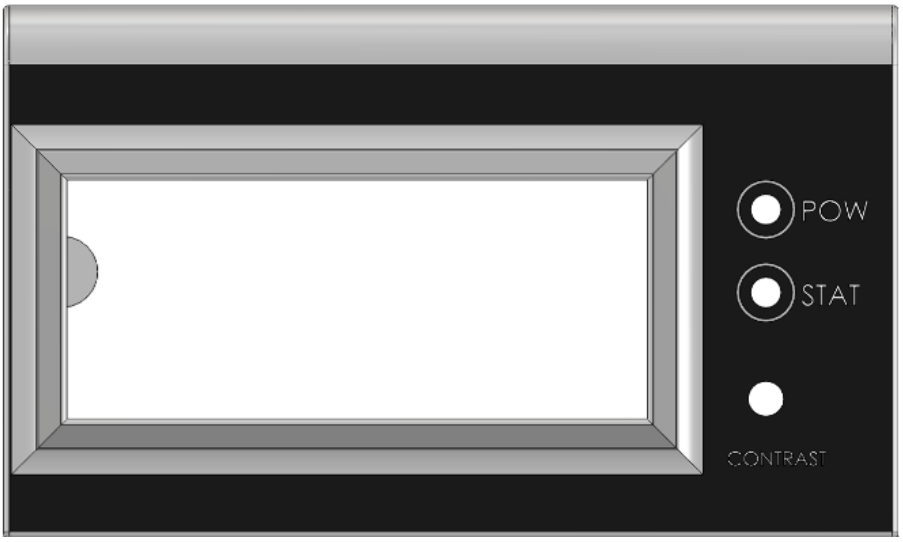


Figure 3.1

Figure 3.2

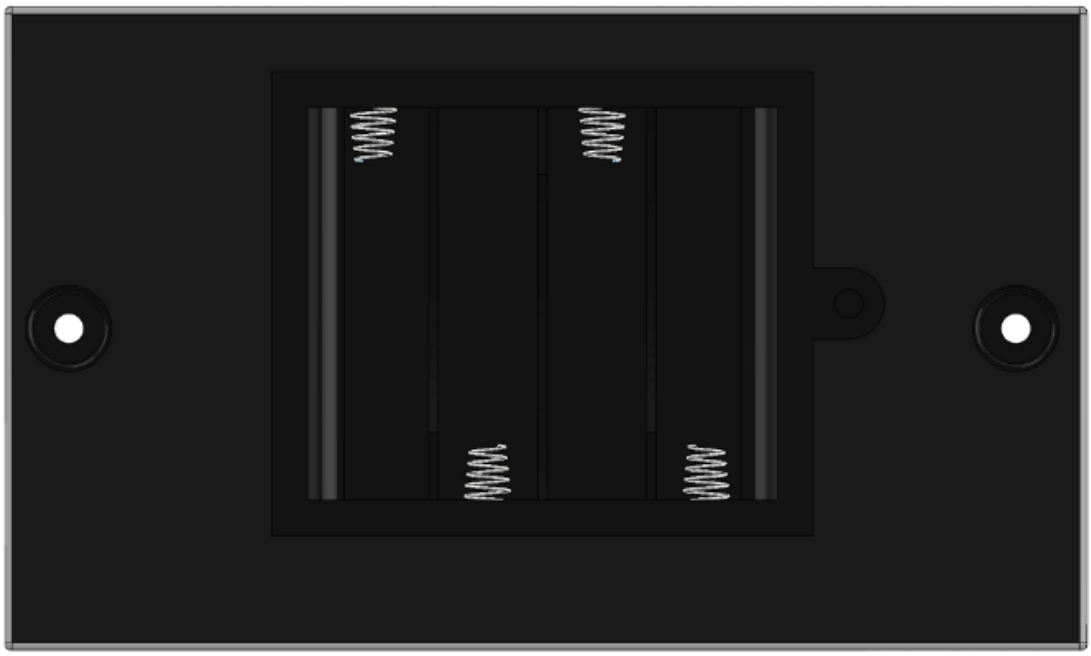
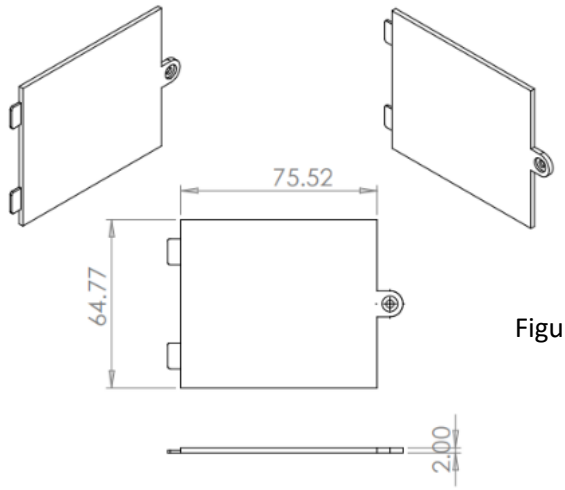


Figure 3.3

Figure 3.4



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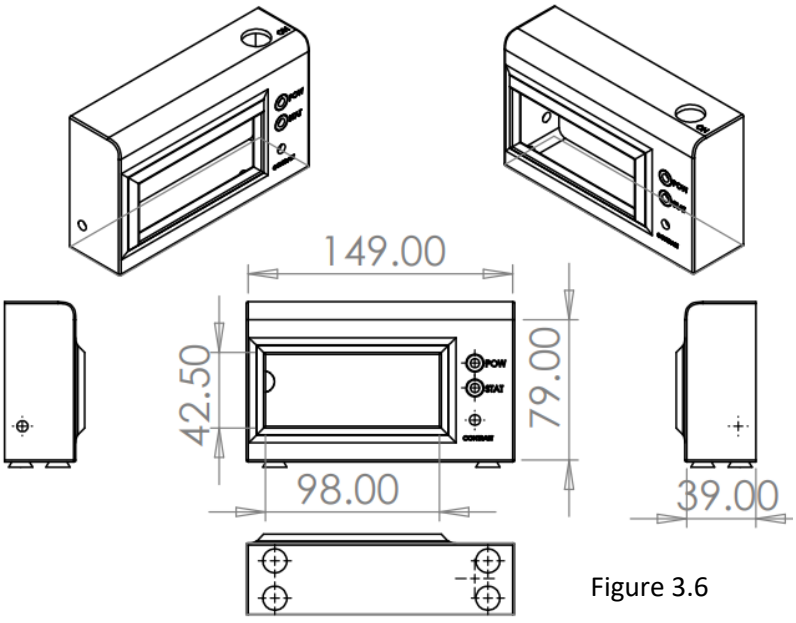


Figure 3.6

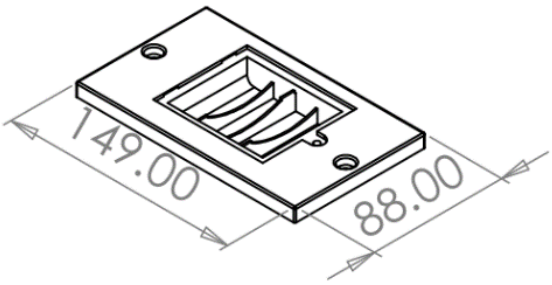


Figure 3.7

Figure 3.8

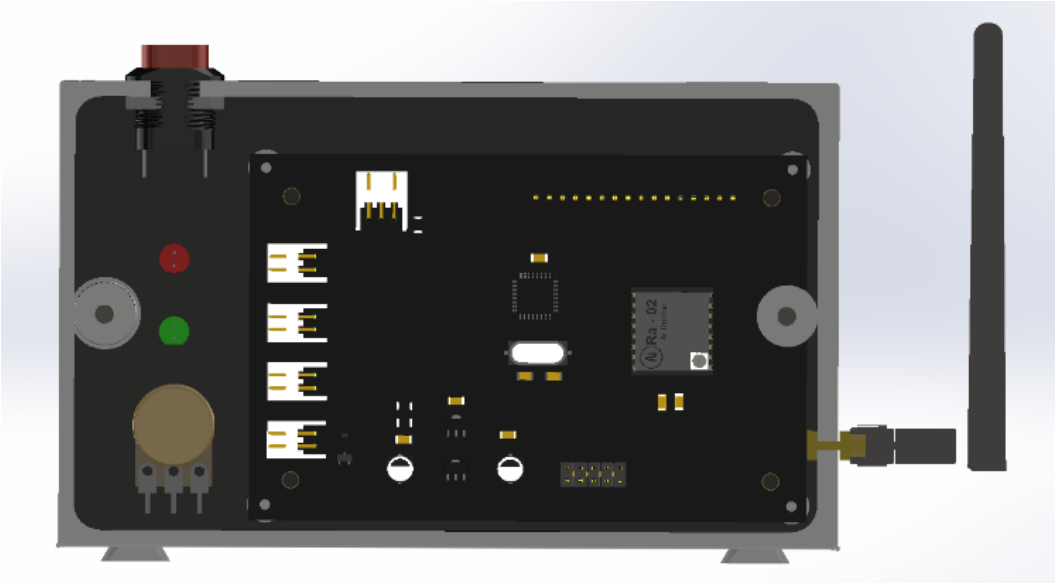


Figure 3.9

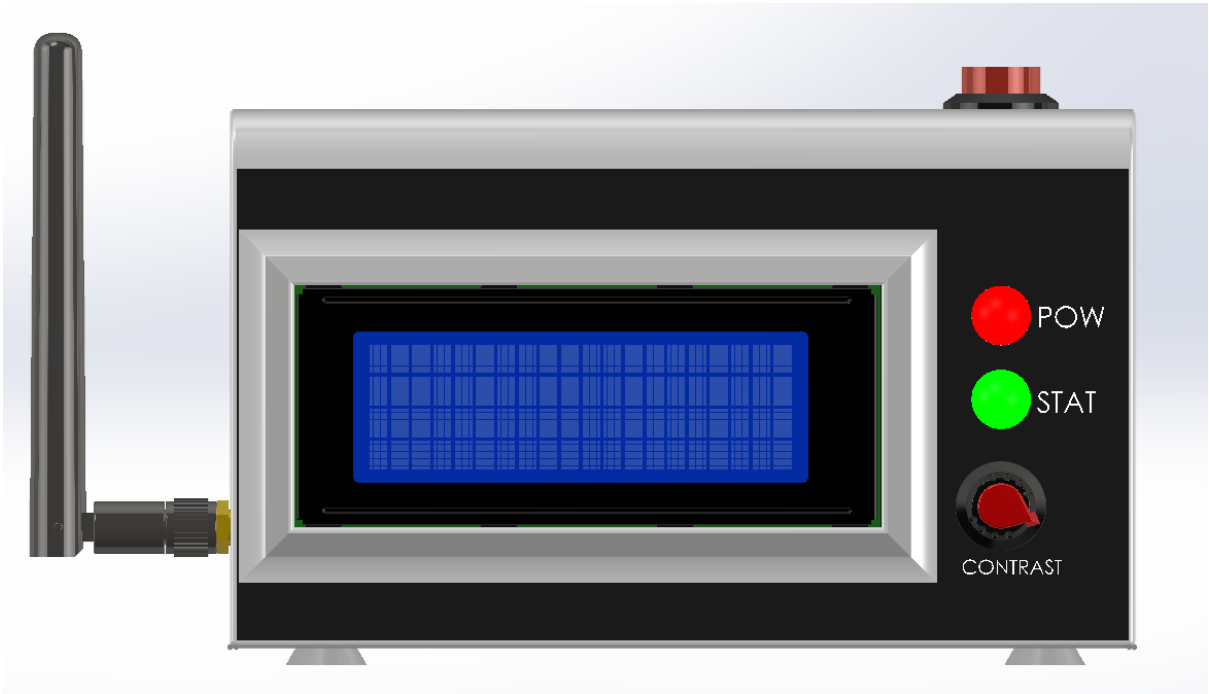


Figure 3.10

Chapter 4 – Software

4.1 Introduction

- In this project, we used many software tools as we had to work on various topics. In this section we are going to explain what those are and the tasks we achieved using those. As we mentioned above, in main four parts of this project, we are mainly looking at the IOT and the communication through networks. Main software that we used in this project are, Node-Red, MQTT, and Python.

4.2 Python

- We used this programming language to assign the available teachers to the periods that should be covered by those who were absent. We used files containing the information of each class and each teacher in the school in the same folder. Then we used python to publish the information that made in the Raspberry-Pi (the output) to the MQTT topic.

4.3 MQTT

- In our project we used MQTT to communicate between the device and Node-Red flow. As we are using Raspberry-Pi to collect data of absent teachers and timetables, we have to send the messages to the assigned teachers and each class. We used MQTT broker to the inter connection of this process.

4.4 Node-Red

- We used Node-Red to connect the messenger service with the Raspberry-Pi. We send the message as Jason object to the Node-Red flow and then edit them with the relevant order in the flow. Then we had used Twilio SMS pallet to send the message to the relevant teacher.

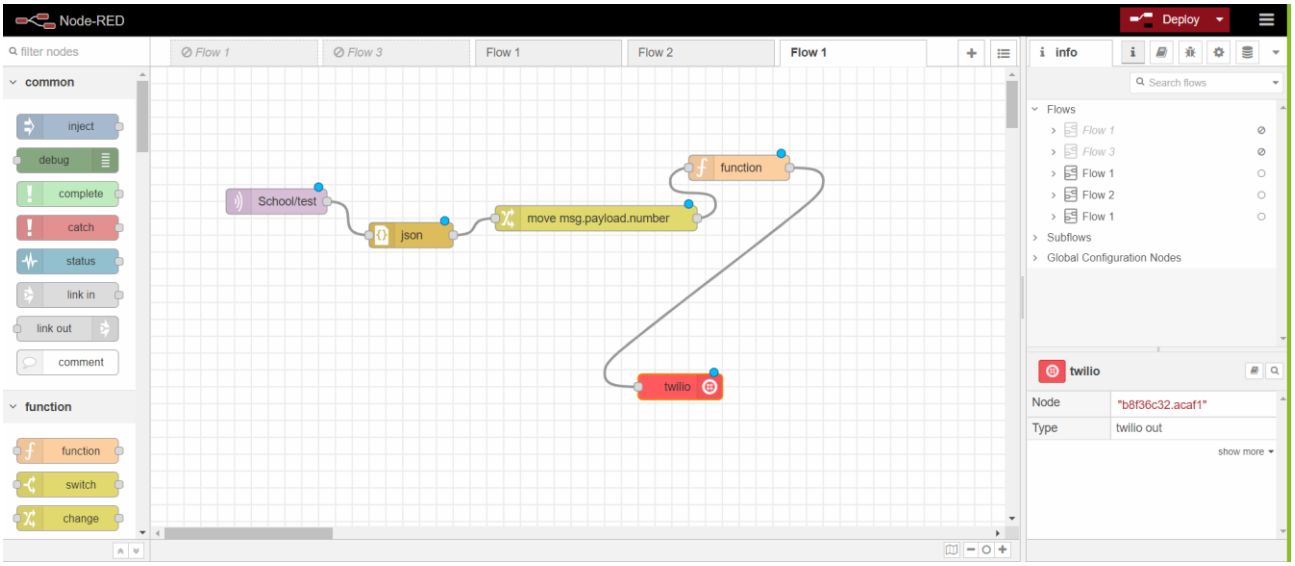


Figure 4.1

Chapter 5 – Conclusion

We designed a system for automatically assigning teachers to the periods covered by absent teachers. Then we developed an IOT based system to deliver the updated timetables to respective teachers. Finally, we developed an IOT based system to deliver the updated timetable to respective classes as well. Using this method, we could eliminate almost every bottleneck in the current manual system and our system takes few minutes to complete the whole task even for a large school. So, we believe using this method in practice will definitely save the valuable time of thousands of students and teachers and also make their lives easier.

Chapter 6 - Risk and Challenges

- We are using LoRa module as the communication technology. Since the TX & RX data rate of LoRa is quite low, for larger packets may take a considerable time.
- One student from each class should turn on the device everyday on time. If any class failed to do so, they wouldn't get updated timetable for that day.
- If we apply this for a huge school with large number of classes, multiple server devices or gateway devices would be needed to communicate with classes within a small amount of time.

Chapter 7 – References

[1] The most useful references were three workshops conducted by you.

[2] https://www.youtube.com/user/goengineer

[3] https://www.youtube.com/watch?v=GY2XUxGwqDg&list=RDCMUCWLoHp3WJG_ats8waVCu7Mw&start_radio=1&rv=GY2XUxGwqDg&t=0

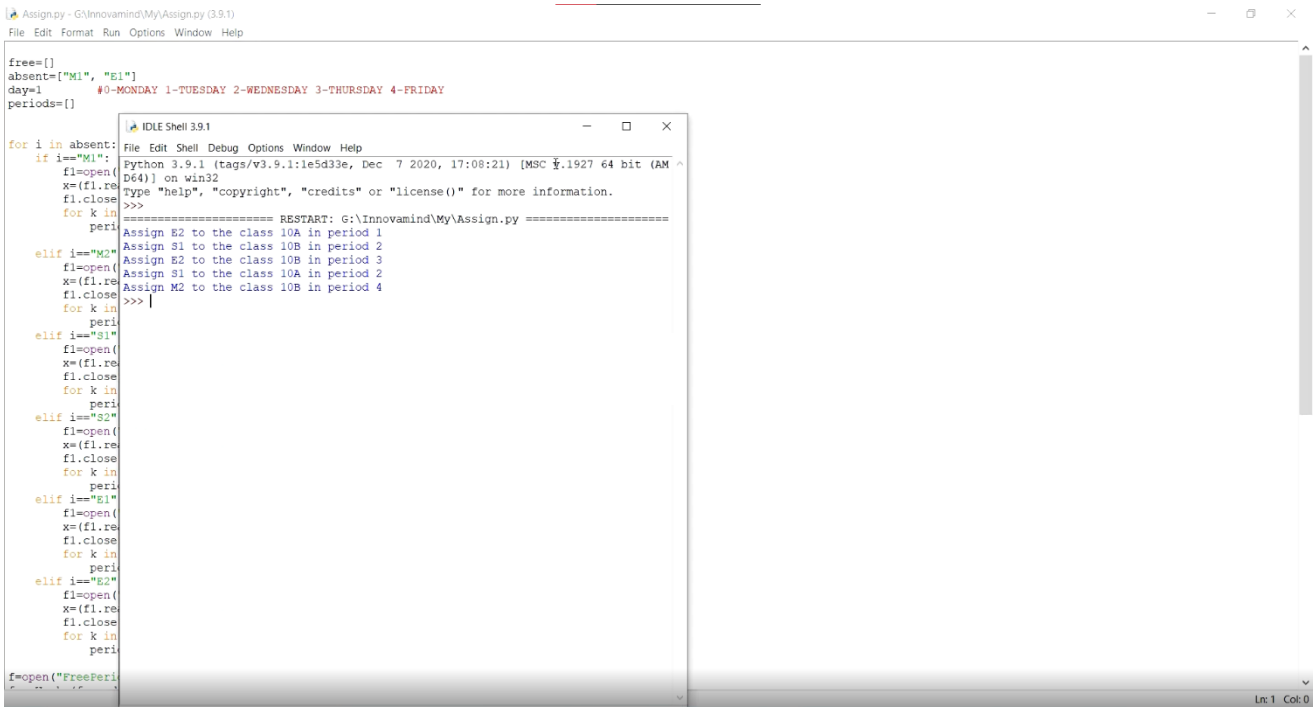
[4] https://circuitdigest.com/microcontroller-projects/arduino-lora-sx1278-interfacing-tutorial

Some Important links regarding our report

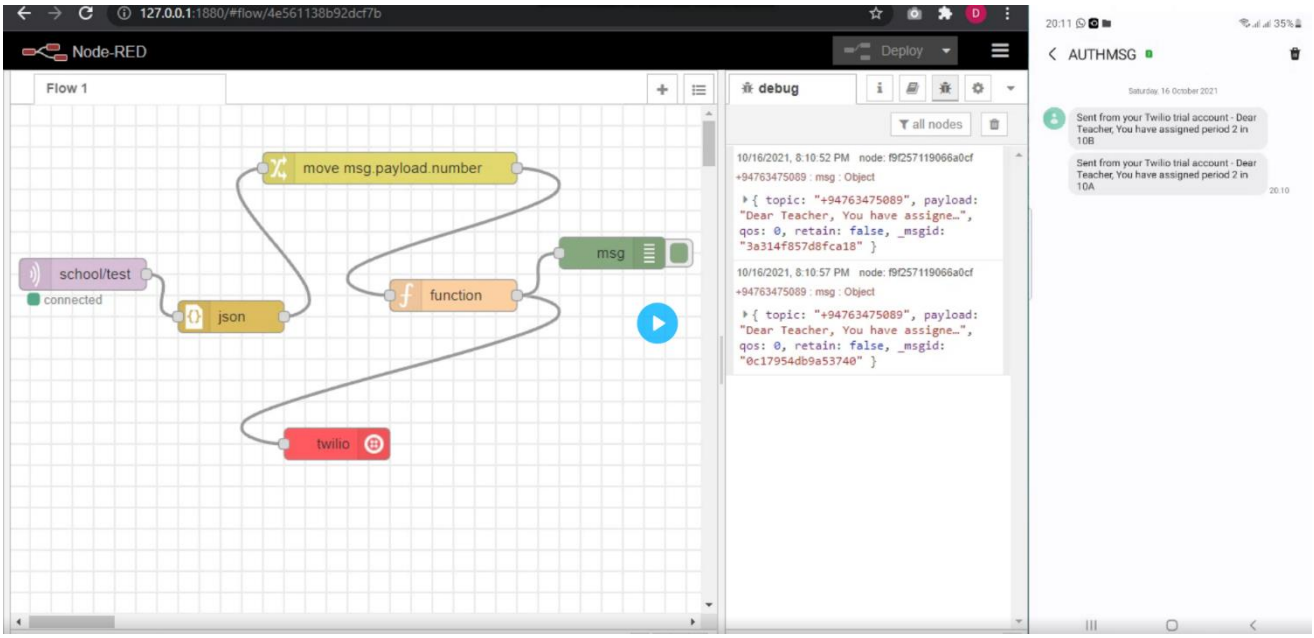
[1] Survey Questioner we conducted: https://docs.google.com/forms/d/e/1FAIpQLScbyzKIUICTFlGDa_QOVAgpR4-KvVMBk-5j_qRhm3lDJszhrA/viewform?usp=sf_link

[2] Google Drive link to our submission Zip file

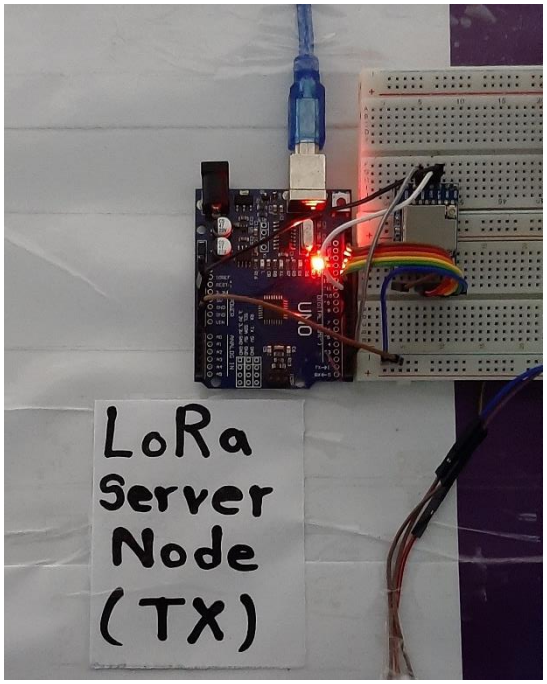
Chapter 8 – Project Demonstration

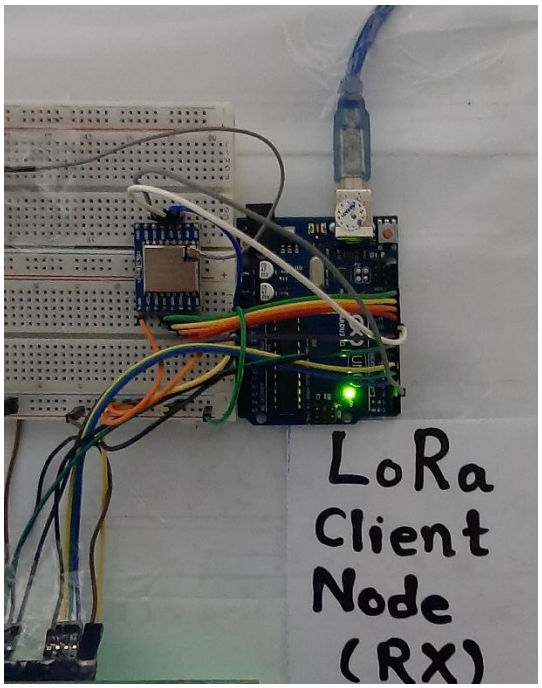


- This figure shows the output of our python program that has been used for assigning teachers to classes automatically when the attendance of teachers is given as input. We used a limited number of classes and teachers in this demonstration.

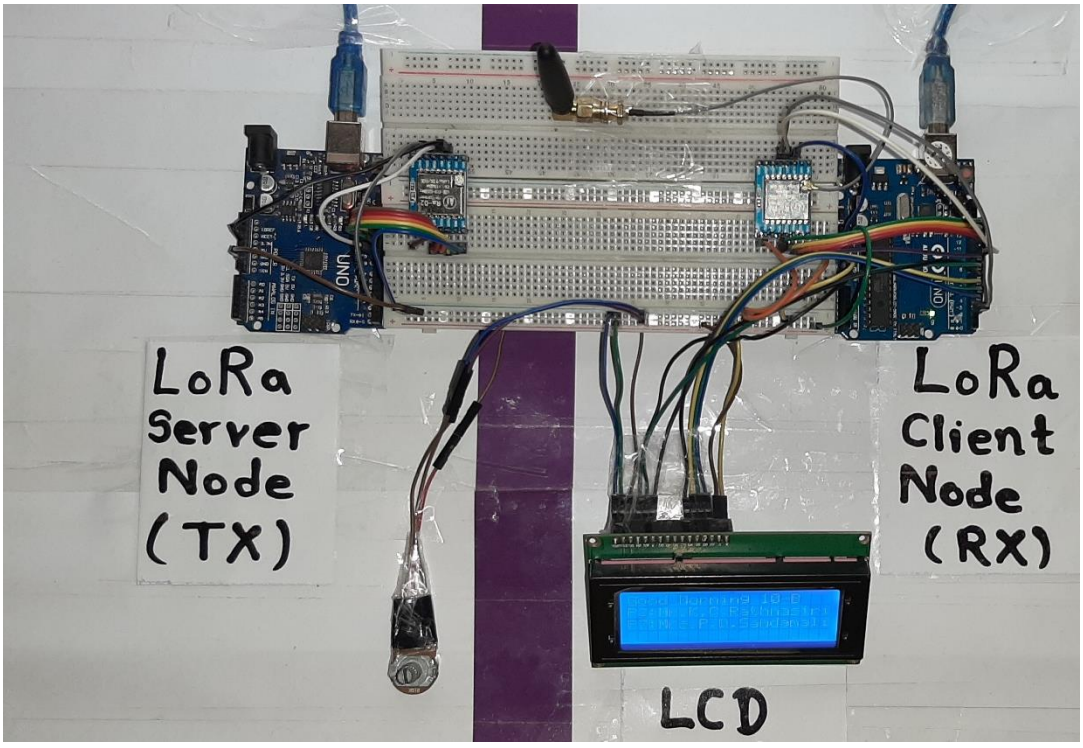


- This figure shows the final output of Node red flow, and the message has been delivered to the mobile phone of respective teacher.
- The following figures shows our hardware demonstration. We implemented the server node and one of the client nodes (one classroom) for this demonstration. We used Arduino as the server device because it is difficult to have a Raspberry Pi at the moment. Here we send the updated timetable from LoRa server node to the LoRa client node, then the client node decodes that message and show it on LCD display.


LoRa
Server
Node
(TX)


LoRa
Client
Node
(RX)


Good Morning 10-B
P2:Mr.K.C.Rathnasiri
P7:Mrs.P.D.Sandamali
LCD


LoRa
Server
Node
(TX)
LoRa
Client
Node
(RX)
LCD