Paradigm Environmental strategies (P) Ltd

EMBEDDED SYSTEM AND IOT

Duration: 15/01/2024 – 20/04/2024

A PROJECT REPORT

Submitted by

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CERTIFICATE

This is to certify that the internship report submitted along with the internship entitled **Embedded System and IOT** has been carried out by **Tirth Parmar** under my guidance in partial fulfillment for the degree of Bachelor of Engineering in Electronics and Communication, 8th Semester of Gujarat Technological University, Ahmedabad during the academic year 2023- 24.

Prajwal Pravinjith sir
Exernal Guide

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Koramangala 4th Block,
Bengaluru- 560 034.

DECLARATION

I hereby declare that the Internship report submitted along with the Internship Project entitled **Embedded System and IOT** submitted in partial fulfillment for the degree of Bachelor of Engineering in Electronics and Communication to Gujarat Technological University, Ahmedabad, is a bonafide record of original project work carried out by me at Paradigm Environmental strategies (P) Ltd, under the supervision of Prajwal Pravinjith sir and that no part of this report has been directly copied from any without providing due reference.

Name of the student Sign of student
Tirth Parmar

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to all those who have contributed to the completion of this project. Without their support, guidance, and encouragement, this endeavor would not have been possible.

First and foremost, we extend our heartfelt thanks to Paradigm Environmental strategies (P) Ltd for providing us with the opportunity to undertake this project. We are grateful for the resources, infrastructure, and assistance extended to us throughout the duration of this endeavor.

We also extend our appreciation to the entire team at Paradigm Environmental strategies (P) Ltd for their support and cooperation. Their collaboration and contributions have greatly enriched the project and facilitated its successful completion.

Additionally, we would like to thank Prajwal Pravinjith sir for their cooperation and assistance in providing necessary inputs and resources.

Last but not least, we express our gratitude to our families and friends for their unwavering support and understanding during the course of this project.

Thanking you
Tirth Parmar

ABSTRACT

This ESP32-based system integrates various sensors and modules to facilitate waste collection management. It includes functionalities such as GPS tracking, NFC tag detection, and weight measurement using load cells. The system utilizes an ESP32 microcontroller, TFT display, GPS module, NFC reader, and HX711 load cell amplifier. Upon initialization, the TFT display showcases a user interface representing the system's identity and status. The system then proceeds to establish a Wi-Fi connection for data transmission.

During operation, the system continuously reads GPS coordinates and NFC tags. Detected GPS coordinates and NFC tag IDs are utilized to identify collection locations and vehicles respectively. Weight measurements from the load cells determine the quantity of mixed waste collected. Collected data, including driver information, vehicle details, GPS coordinates, and waste weights, are formatted into an HTTP request. This request is sent to a Google Sheets API endpoint for storage and further processing.

Overall, this system provides an efficient and automated solution for waste collection monitoring, offering real-time insights into collection activities and waste quantities.

Table of Contents

About company

Ecoparadigm is a leading company specialised in implementing sustainable and eco-friendly development projects. With a unique mix of knowledge and experience, we work in close collaboration with the public and private sectors.

Since the conception of this company, we have gained extensive experience in capacity development, policy building, awareness raising, project implementation and consulting in the field of sustainable water and sanitation management.

The main motto of the company is to help customers on ways to optimise their utilisation of resources and conserve the environment.

Weekly report – 15Jan to 21Jan

- During this period of time I did things related to TFT SPI LCD Display, L89 modules, C programming and ESP 32 microcontroller.
- I studied about the L89 module and TFT SPI LCD Display.

L89 Module

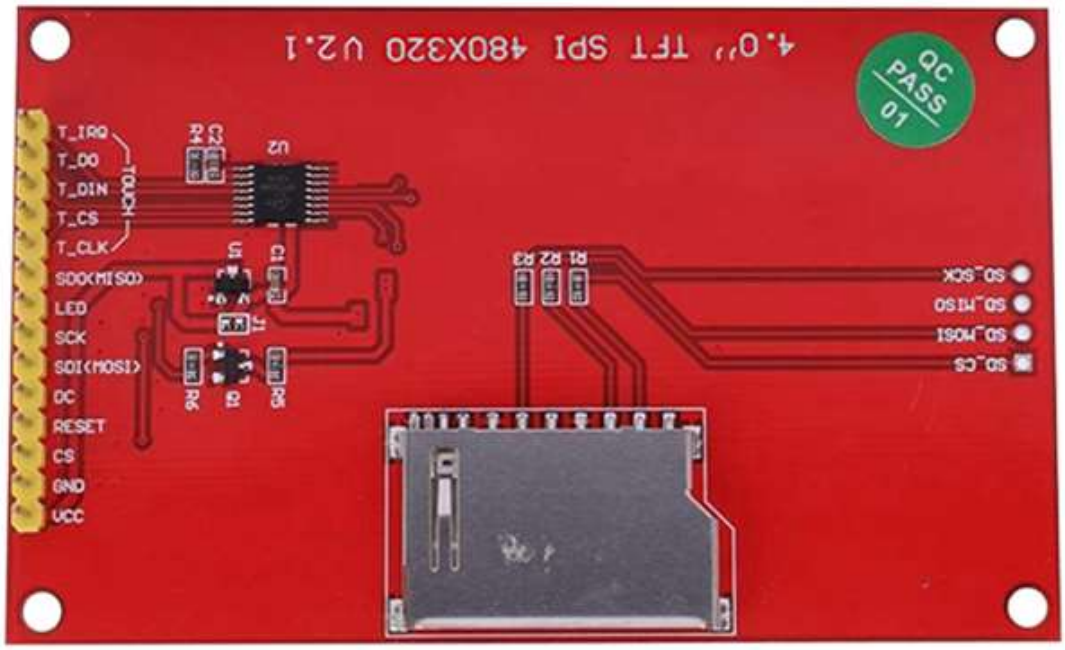
The L89 is a GPS module, specifically the Quectel L89-M2. It's a compact and highly integrated GPS receiver module that combines GPS, GLONASS, BeiDou, Galileo, and QZSS (Quasi-Zenith Satellite System) systems for accurate positioning.

Applications:

- Automotive Navigation: The L89 module is commonly used in automotive navigation systems for providing accurate positioning and navigation assistance to drivers.
- Asset Tracking: It's utilized in asset tracking systems where the real-time location of assets such as vehicles, containers, or packages needs to be monitored.
- Fleet Management: Fleet management systems utilize GPS modules like the L89 to track and manage vehicles, optimize routes, and improve operational efficiency.
- Personal Navigation Devices: It's also found in personal navigation devices such as handheld GPS units used for hiking, biking, or outdoor activities.

- IoT Devices: With its compact size and low power consumption, the L89 is suitable for integration into various Internet of Things (IoT) devices such as wearable fitness trackers, smartwatches, or asset tags.

TFT SPI LCD Display



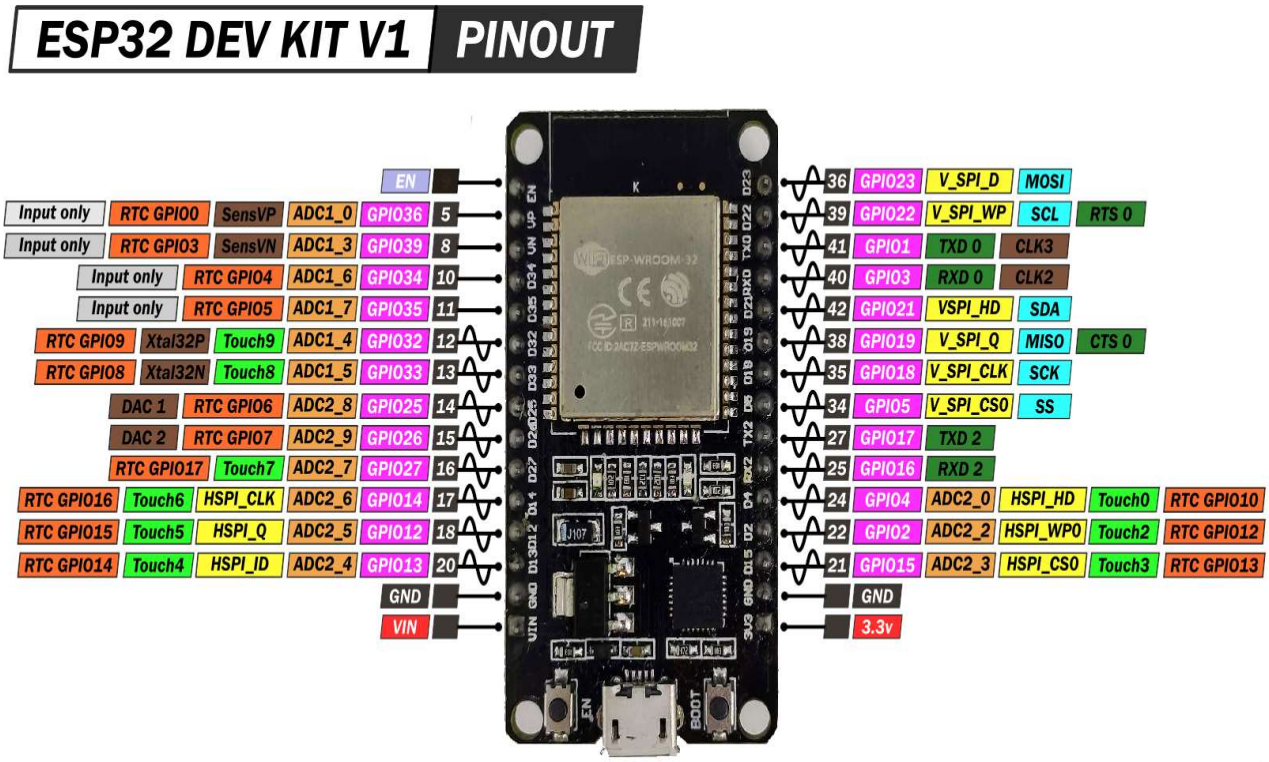
The ILI9488 TFT LCD Display is a type of thin-film transistor (TFT) liquid crystal display (LCD) that utilizes the ILI9488 display controller. Here are some detailed insights:

Technical Specifications:

- Controller: ILI9488
- Display Type: TFT LCD
- Resolution: Typically, 320x480 pixels
- Color Depth: 16-bit color (65,536 colors)
- Interface: Usually supports SPI (Serial Peripheral Interface) or MCU (Microcontroller Unit) interface
- Size: Various sizes available, commonly 3.5 inches

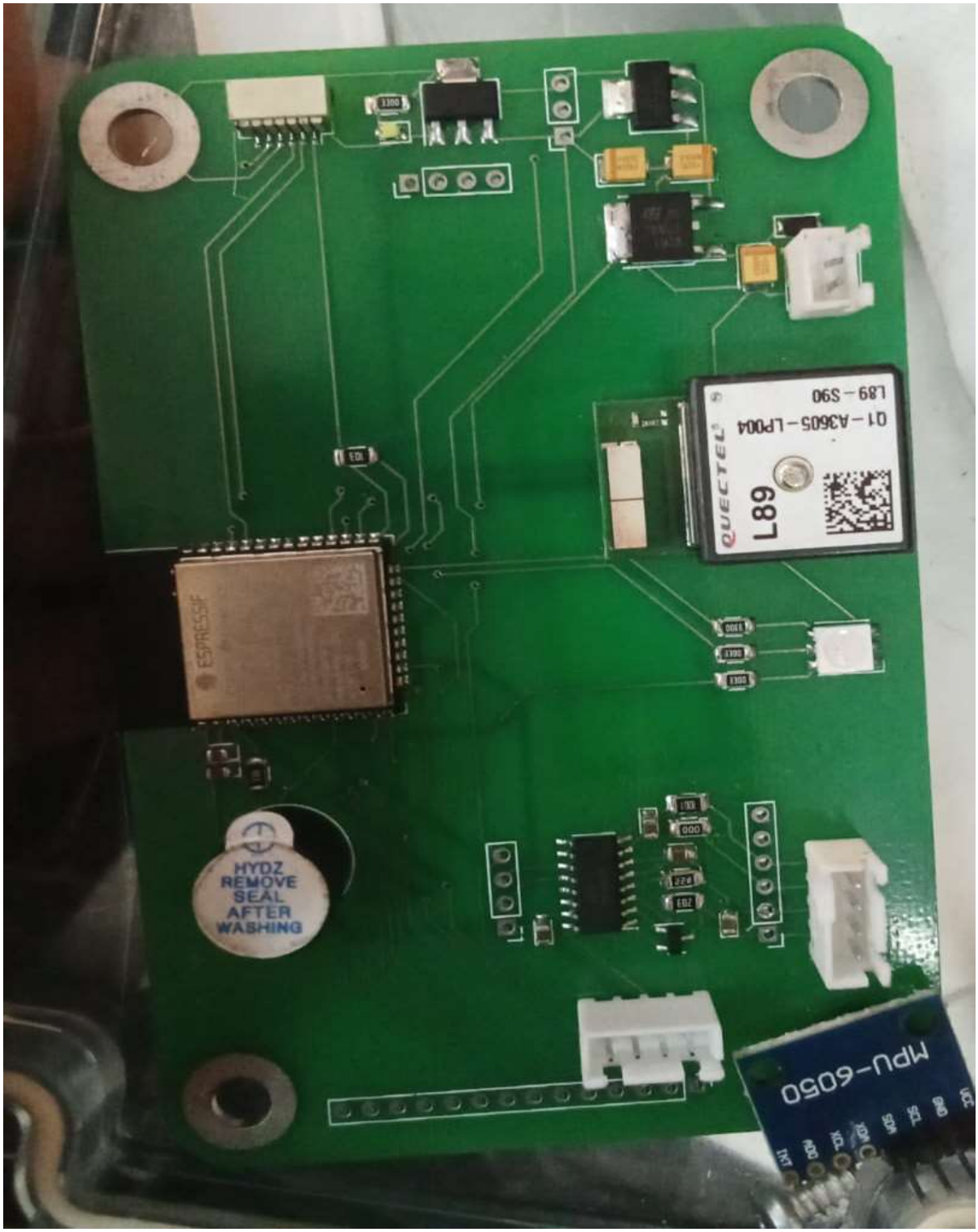
- I also learned about the esp32 microcontroller with their functionality, advantages, disadvantages, applications and specifications of esp32 board.

ESP32

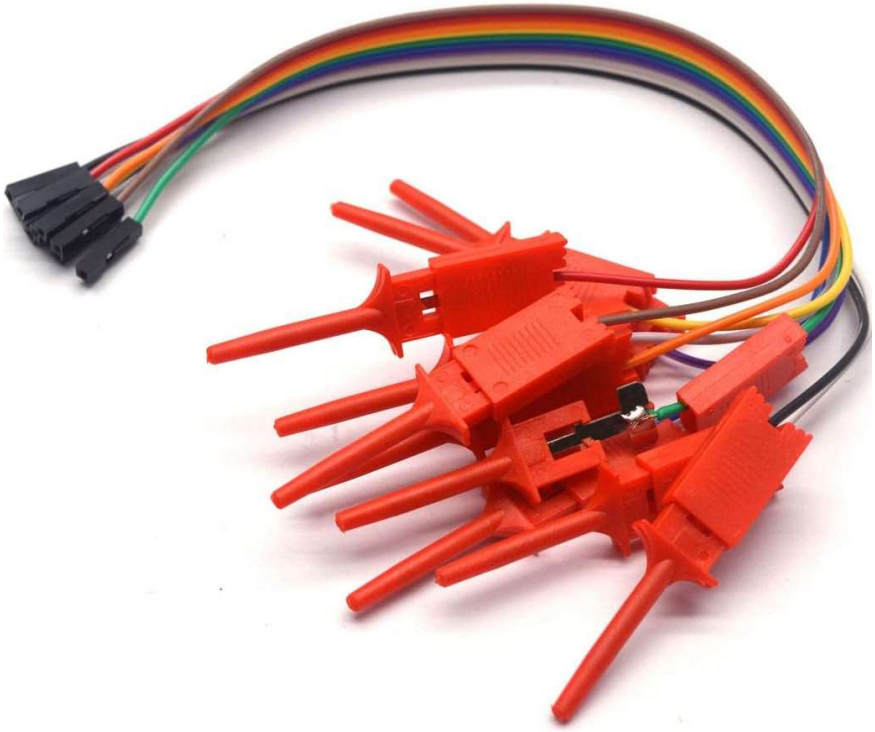


Weekly report – 22Jan to 28Jan

- During this period of time I learned the things related to SMD board and SEWAC board difference also learned about the different SOT (Small outline transistors) which works in SMD board as voltage regulator.

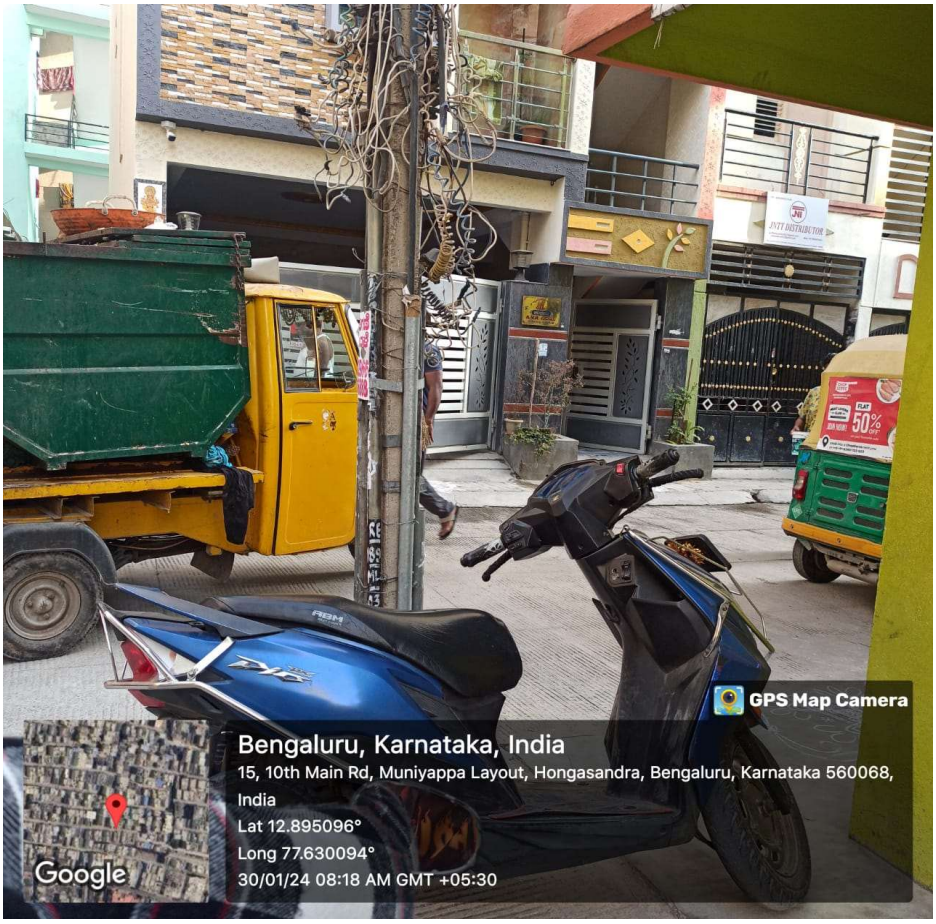


➢ I also learned about logic analyzer hook probe.



Weekly report – 29Jan to 4Feb

- In this week we went to hongasandra project site.
- During operation, the system continuously reads GPS coordinates and NFC tags. Detected GPS coordinates and NFC tag IDs are utilized to identify collection locations and vehicles respectively. Weight measurements from the load cells determine the quantity of mixed waste collected. Collected data, including driver information, vehicle details, GPS coordinates, and waste weights, are formatted into an HTTP request. This request is sent to a Google Sheets API endpoint for storage and further processing.


GPS Map Camera
Bengaluru, Karnataka, India
15, 10th Main Rd, Muniyappa Layout, Hongasandra, Bengaluru, Karnataka 560068, India
Lat 12.895096°
Long 77.630094°
30/01/24 08:18 AM GMT +05:30
Google

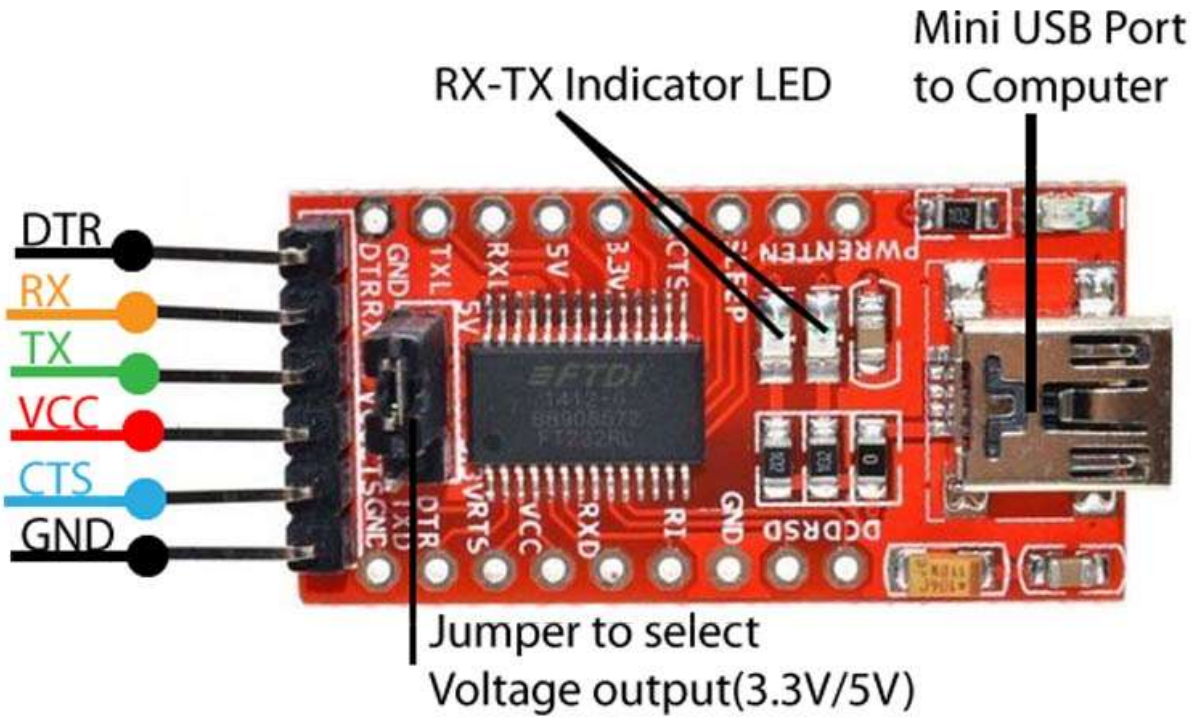

Google
Type
Degress
DMS
mist
Latitude
12.89541
12°53'43...
20.0 °C
Longitude
77.62795
77°37'40...


Google
Type
Degress
DMS
mist
Latitude
12.89541
12°53'43...
20.0 °C
Longitude
77.62795
77°37'40...

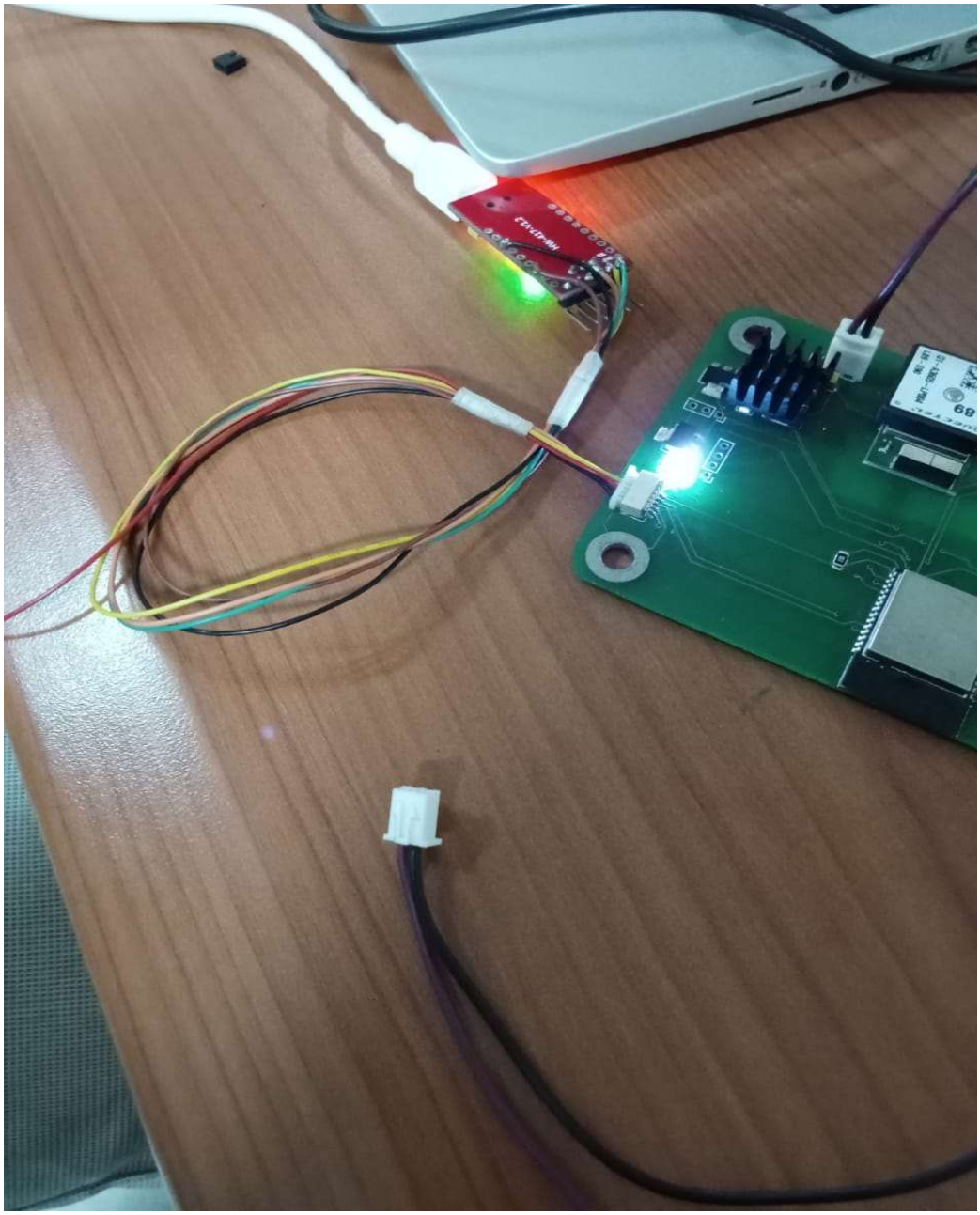

Tire Shop
Google
Type
Degress
DMS
Latitude
12.89297
12°53'34...
Longitude
77.61871
77°37'7"...
mist
20.0 °C

Weekly report – 5Feb to 11Feb

- During this week I learned about the FTDI USB to TTL converter.

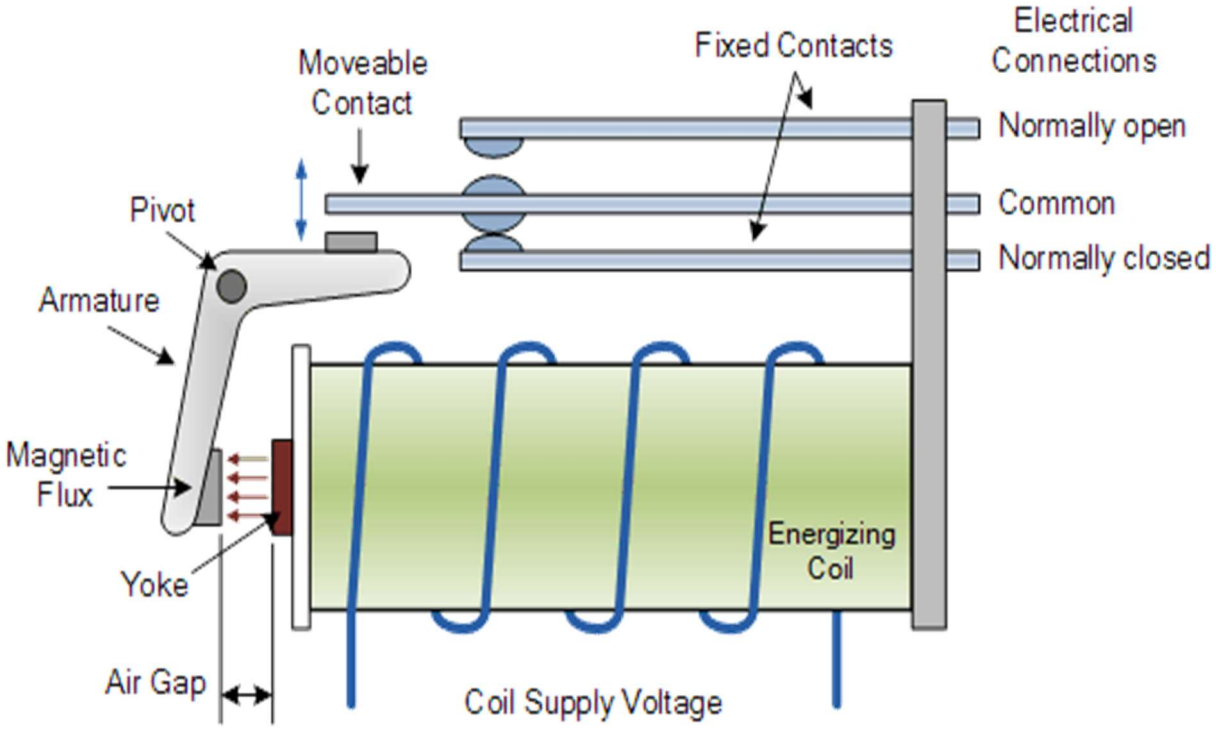


- Then I interfaced the TTL converter with SMD board for locations in terms of lat and long.
- For locations I tried with SMPS board and TTL converter.

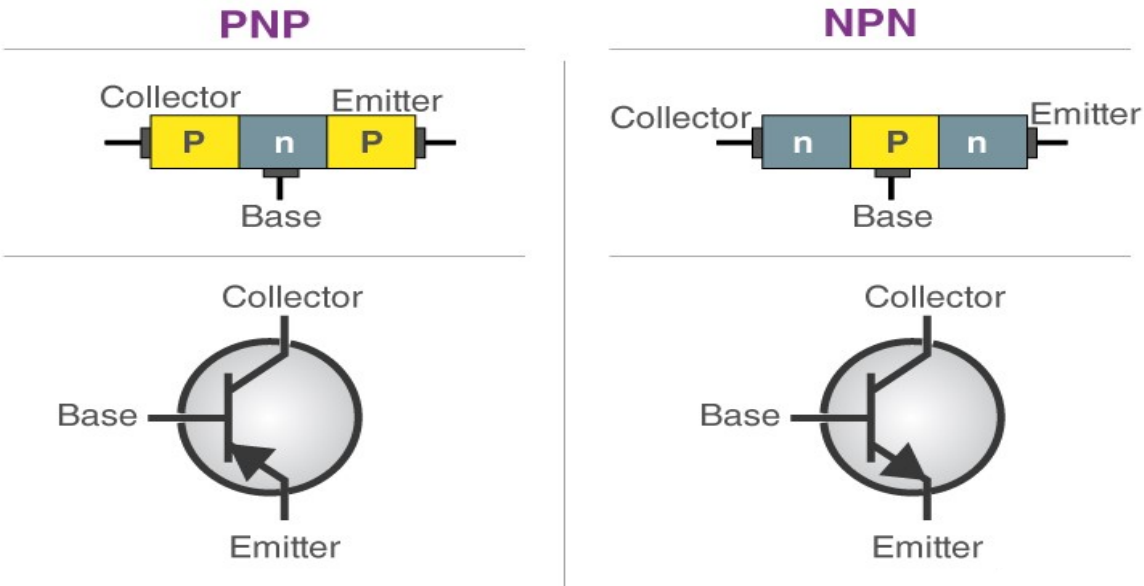


Weekly report – 12Feb to 18Feb

- During this week I made one presentation related to switching devices and I learned where this switching devices are useful.
- **Relay**

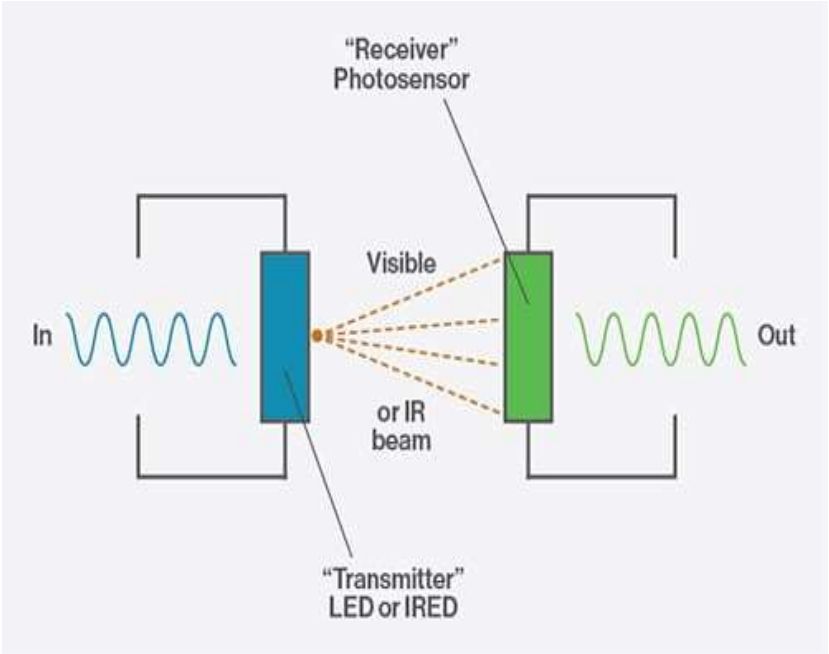


- **Transistor**



- **Vacuum tubes**

- **Optocoupler**



Weekly report – 19Feb to 25Feb

- In this week I made presentations on AC to DC converter.

- **Rectifier**

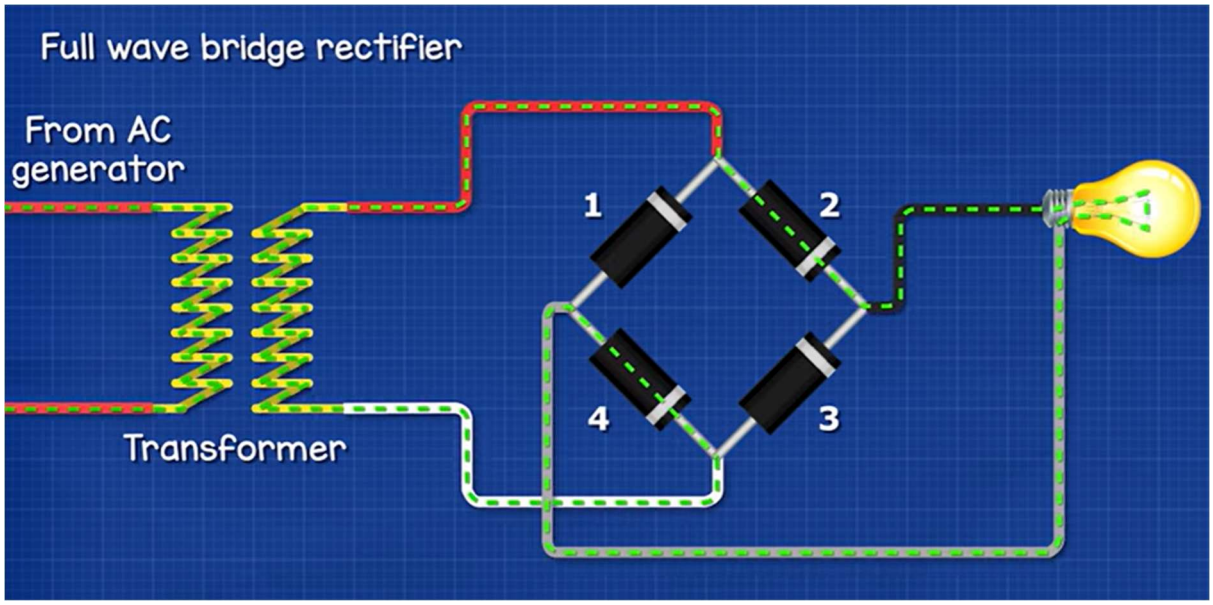
  Diode: Lets current flow in one direction.

  Transformer: Steps down or up voltage.

  Capacitor: Smooths out the rectified waveform.

  Resistor: Limits current or provides discharge path for capacitor.

  Inductor: Stores energy and smooths current flow.



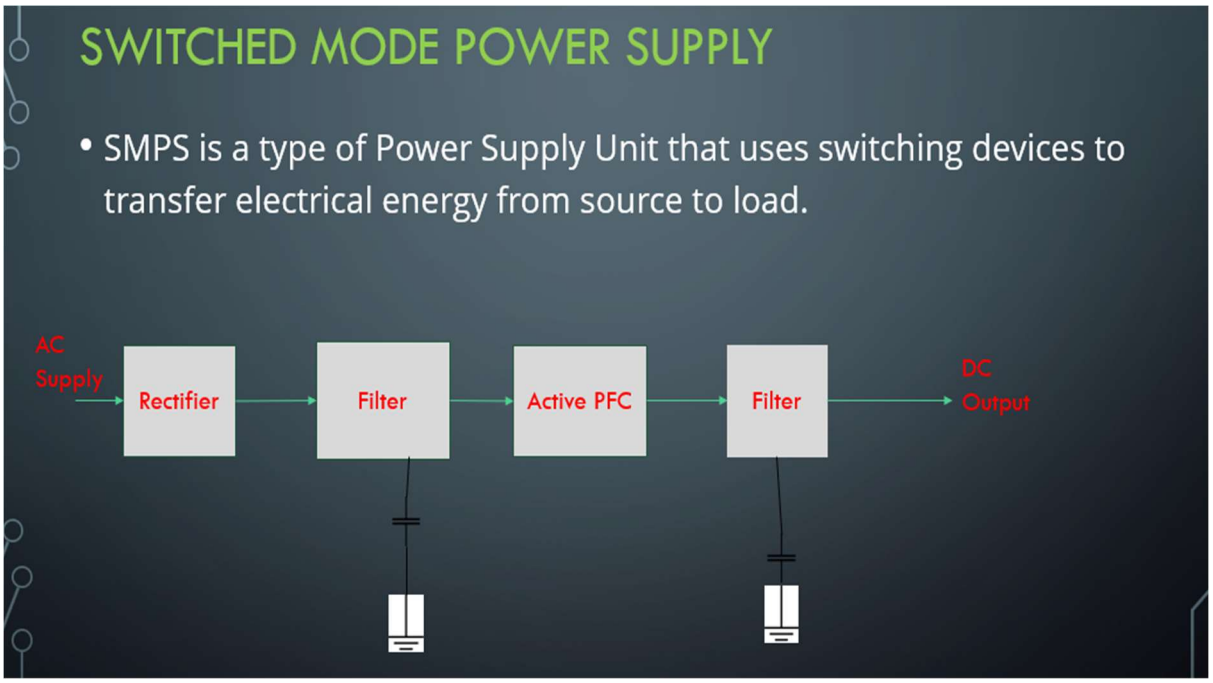
- **Switched-Mode Power Supply (SMPS):**

  Switching Transistor: Rapidly switches to control output voltage.

  Transformer: Steps voltage up or down efficiently.

  Capacitor: Filters output voltage ripple.

  Inductor: Stores energy and smooths current flow.



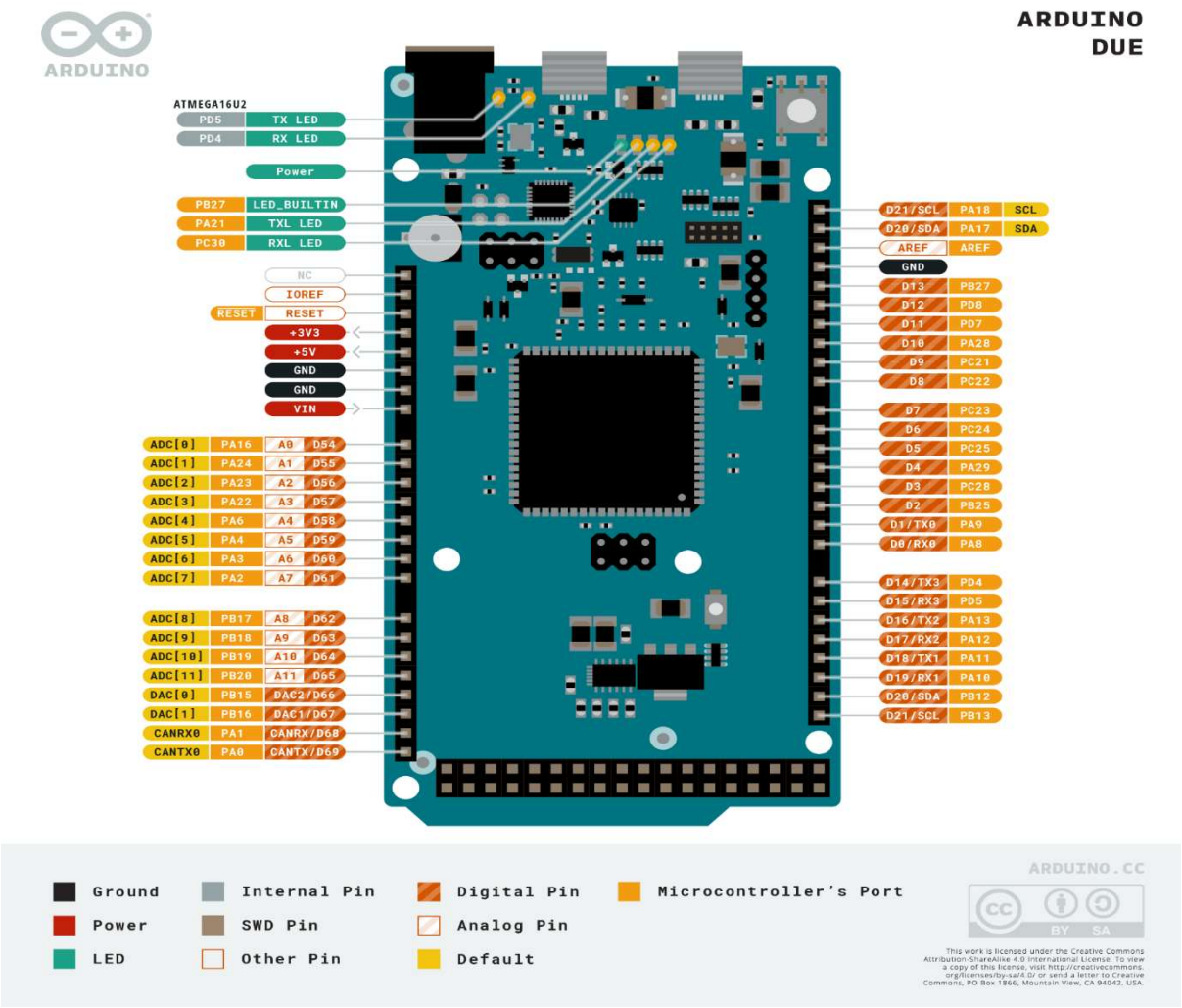
- During this week I also learned about what is buck boost converter

A buck-boost converter is a type of DC-DC converter that can step up (boost) or step down (buck) an input voltage to provide a stable output voltage, regardless of whether the input voltage is higher or lower than the desired output voltage.

Buck-boost converters are essential DC-DC converters used to regulate voltage in various electronic systems and devices. Their ability to step up or step down the input voltage to provide a stable output voltage makes them valuable components in applications ranging from portable electronics to renewable energy systems.

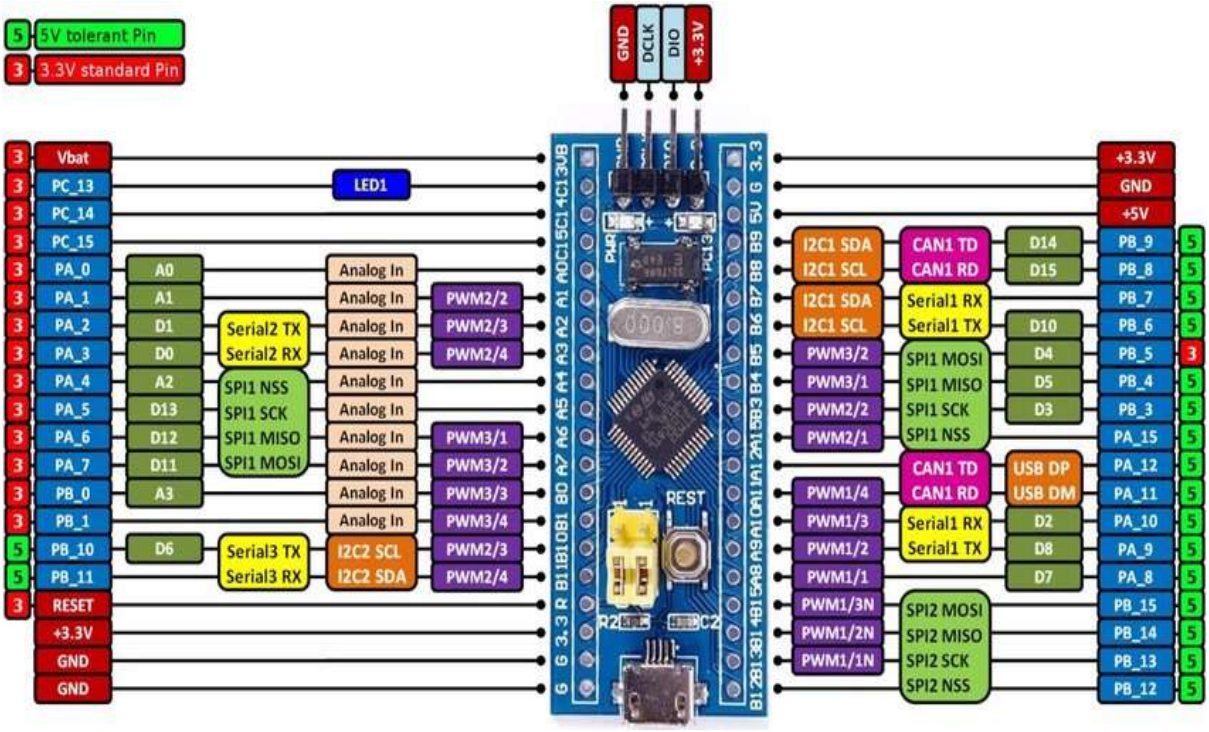
Weekly report – 26Feb to 3Mar

➢ Arduino due



The Arduino Due is a microcontroller board based on the Atmel SAM3X8E ARM Cortex-M3 CPU. It offers 54 digital I/O pins, 12 analog inputs, and 2 DAC outputs, making it suitable for a wide range of projects. With a clock speed of 84 MHz and 512 KB of flash memory, it's powerful for complex tasks. It has native USB connectivity, facilitating communication with computers and other devices. Its 3.3V operating voltage makes it compatible with a variety of sensors and modules. The Due is ideal for applications requiring higher processing power and connectivity.

- **STM32**



- During this period I connected TFT SPI LCD Display with stm32 and I got the dry, wet and mixed garbage value but using the wifi.

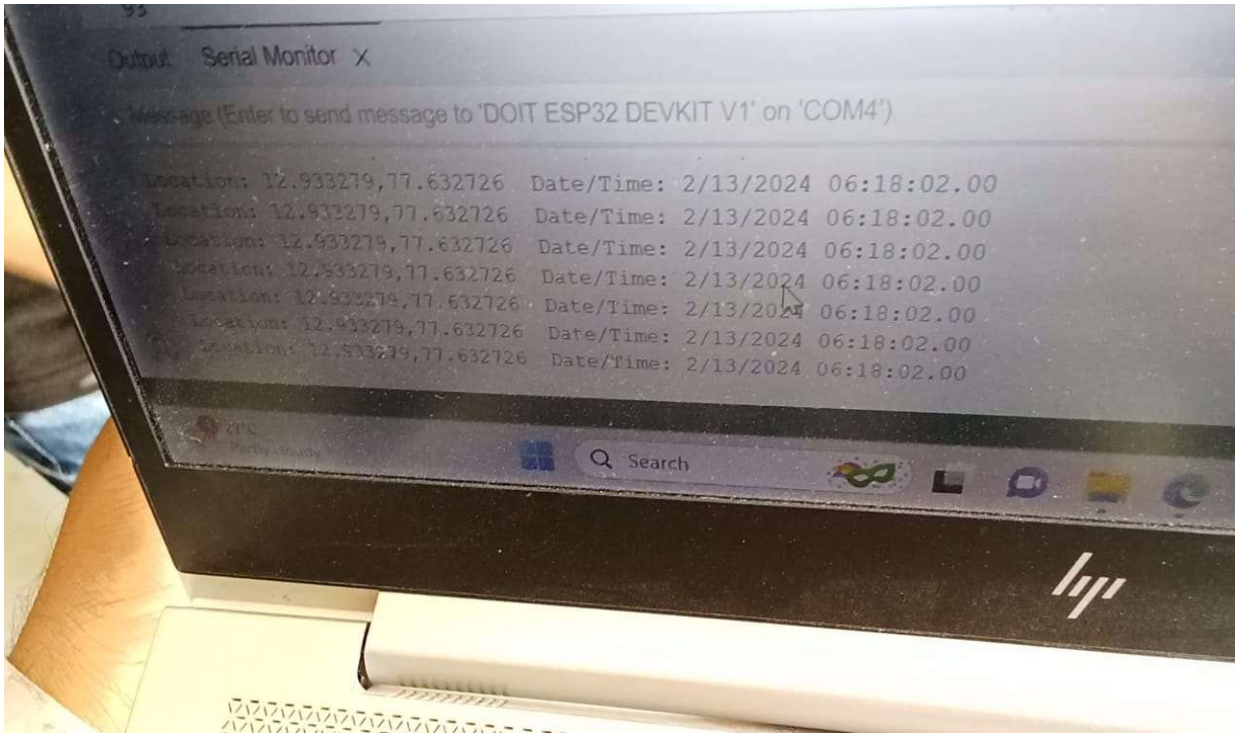
Weekly report – 4Mar to 10Mar

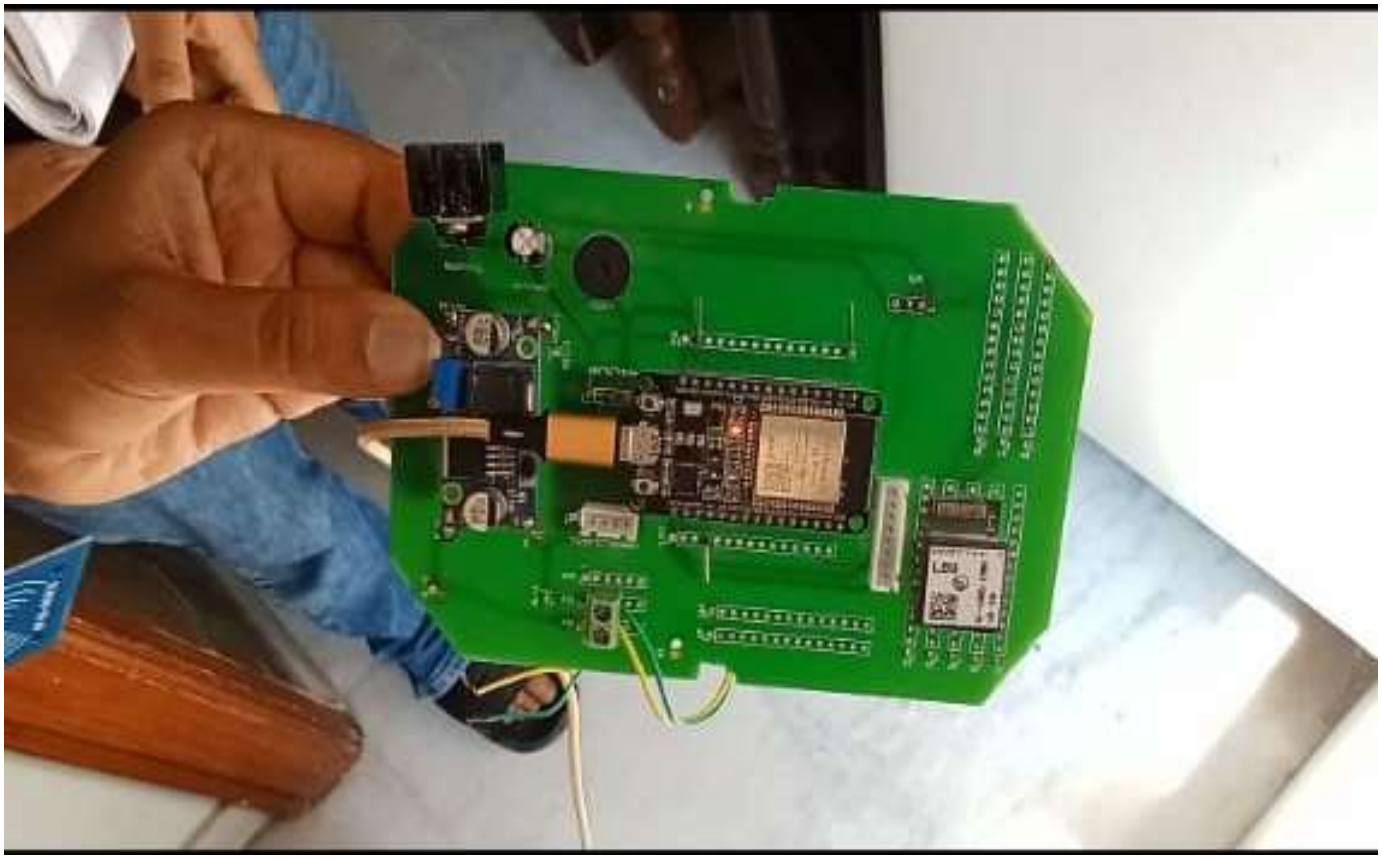
- During this time I gave presentations on digital communication protocols that includes the UART, USART, SPI, I2C, I2S, CAN, TWAI, RS232. I learned the different protocol utility with different devices.

Parameters	UART	USART	SPI	I2C	I2S	CAN	RS232
Speed	slower	Fast than UART	fastest	Slower than SPI	Faster than I2C	moderate	slowest
Complexity	simple	moderate	Most complex	Less complex than I2C	More complex than I2S	Moderate	Simple
Number of wires	2	4	4	2	3	2	9(4)
Duplex	Full duplex	Half/Full duplex	Full duplex	Half duplex	Full duplex	Half duplex	Full duplex
Communication type	Serial communication	Serial communication	Serial communication	Serial communication	Serial communication	Serial communication with multi-master capability.	Serial communication
Applications	In telecommunications, GPS modules, personal computers, Sim cards	embedded systems, communication between microcontrollers and peripherals.	Touchscreen, video game controller, RTC, SD Card, Temperature and Pressure sensors	Ports, LCD displays, LED driver, Motor controllers	Connecting digital audio devices, audio codec to play audio, connecting digital audio devices together	Automotive (passenger vehicles, trucks, buses), Elevator and escalators, Electronic equipment for aviation and navigation	serial communication between computers and peripherals.
Baud rate	Can support a range of baud rates	Can support high baud rates	Can support high baud rates	up to 400 kbps (standard mode) or 3.4 Mbps (high-speed mode).	Can vary depending on the audio application.	Standard baud rates range from 10 kbps to 1 Mbps	up to 115,200bps
Cost	Low	Higher than UART	Higher than UART and I2C	Higher than UART	Higher than UART,I2C	Higher than SPI	Moderate
Synchronous/Asynchronous	Asynchronous	Both	Synchronous	Synchronous	Synchronous	Synchronous	Asynchronous

Weekly report –11Mar to 17Mar

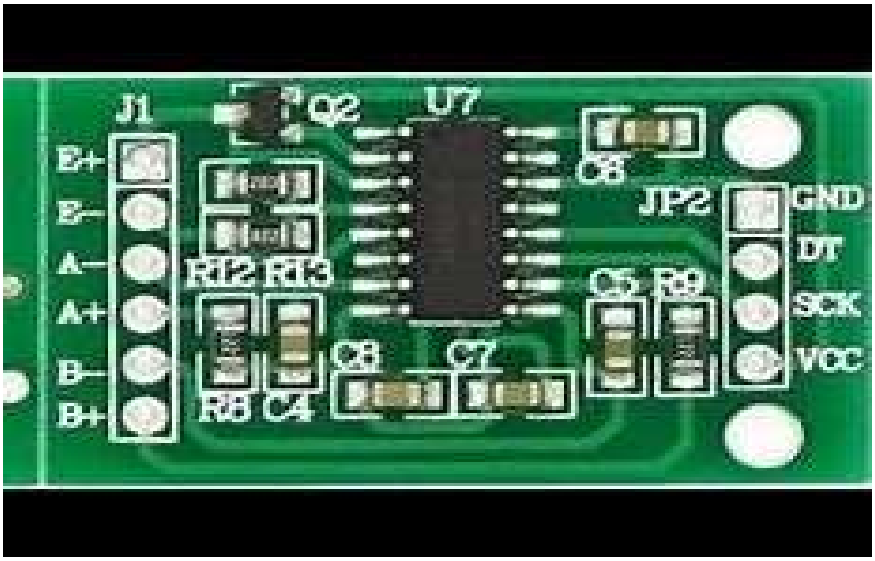
- During this time we connected the esp32 with gps module and we got the locations in terms of lat and long. Here we applied the esp32 to SEWAC board where SEWAC board contains the L89 module and when we placed L89 in open sky view then we got location data easily.
- I also tried this thing with NEO-6M Module by individually and it is worked perfectly.
- The NEO-6M module is a type of GPS (Global Positioning System) module that helps devices determine their location by receiving signals from satellites. The ESP32, on the other hand, is a powerful microcontroller commonly used in IoT (Internet of Things) projects. When we connect a NEO-6M module to an ESP32,we are essentially allowing the ESP32 to communicate with the GPS module and use the location data it provides.



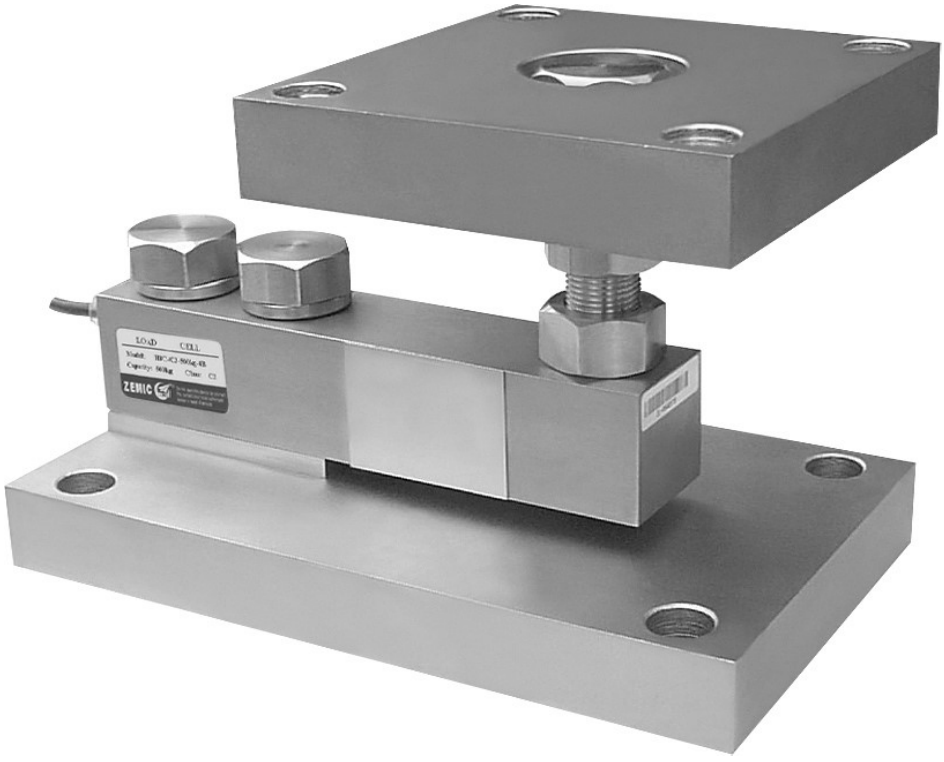


Weekly report –18Mar to 24Mar

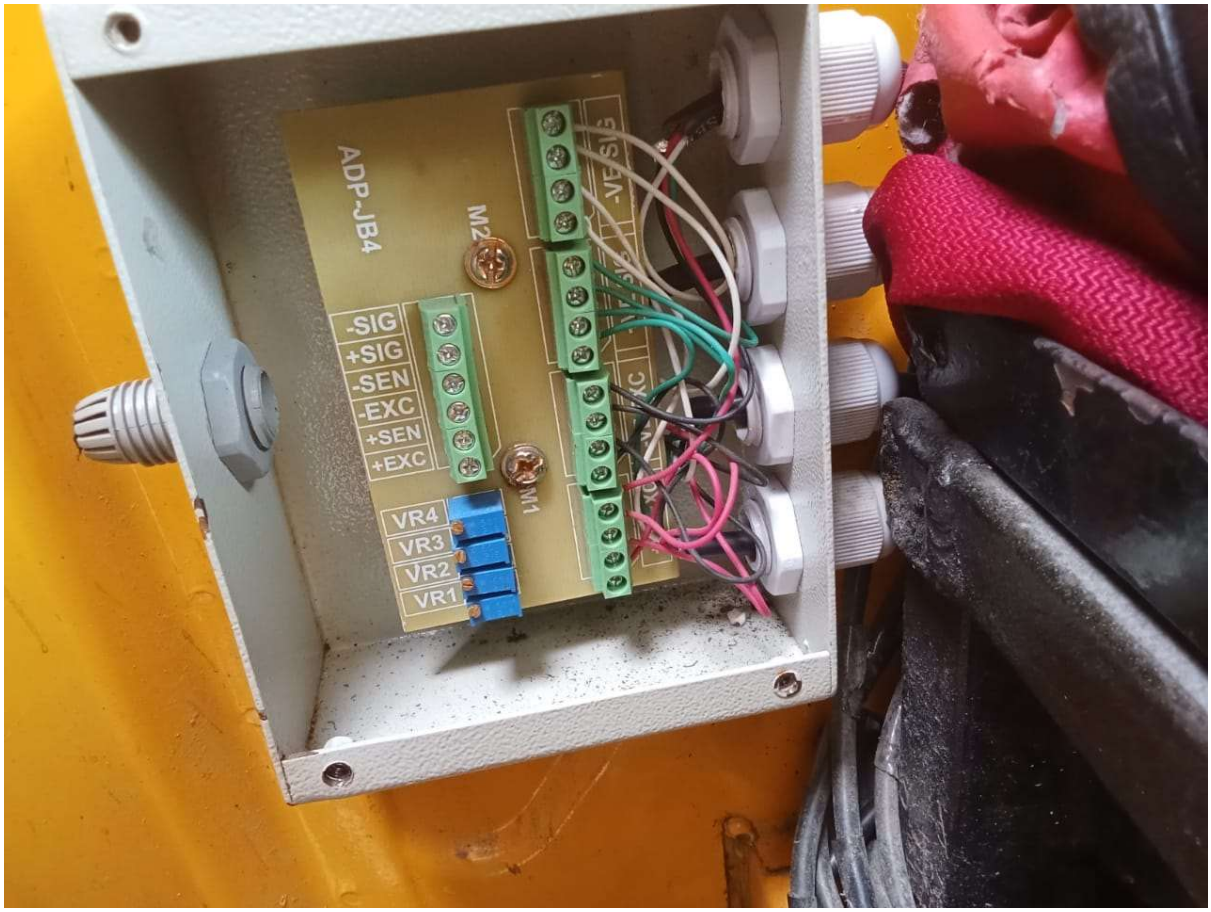
- During this time I made connections using the hx711 IC where hx711 IC is used as analog to digital converter of weight.



- Here GND, DT, SCK, VCC is connected with loadcells and E+, E-, A-, A+ is connected with weight transmitter board.
- Our loadcell

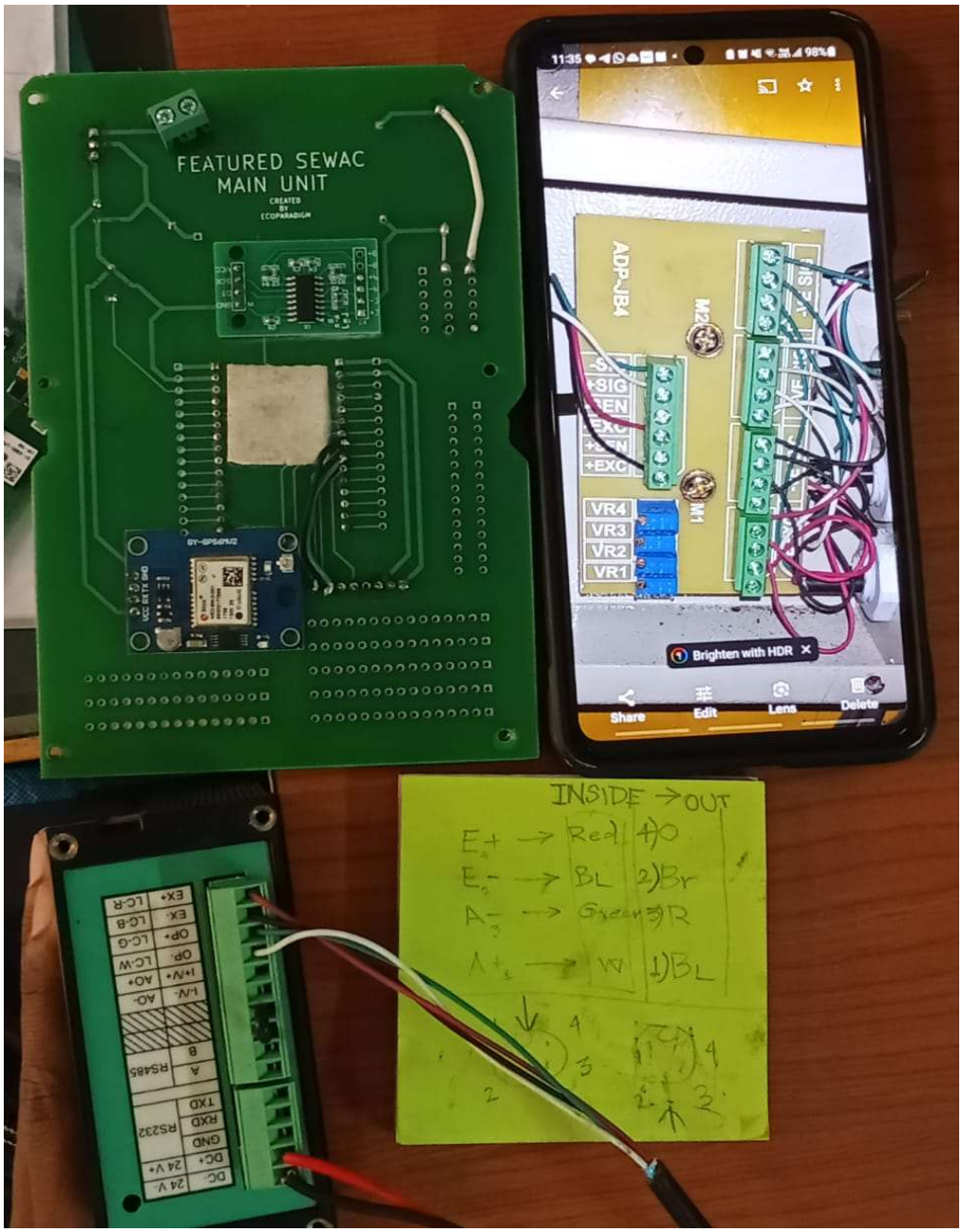


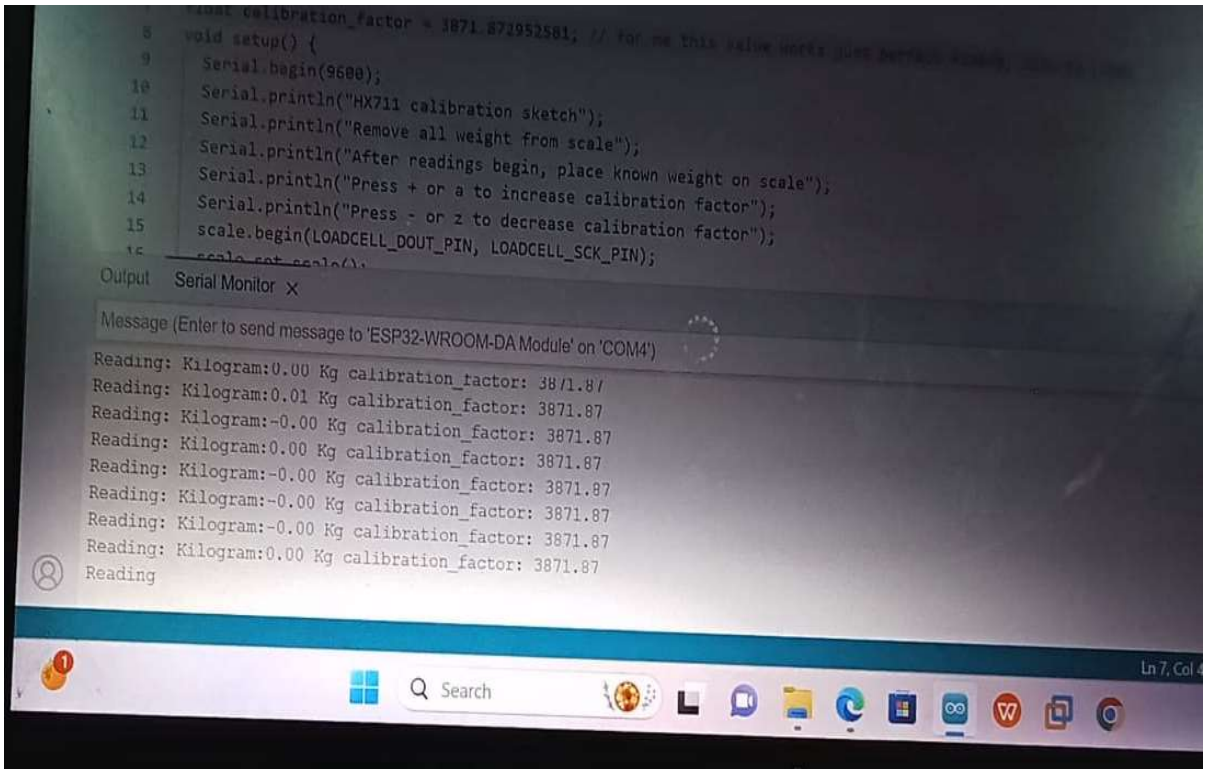
- Our weight transmitter



Weekly report –25Mar to 31Mar

- In this time period we made connections successfully between hx711, loadcell and weight transmitter and our weight calculation is perfect using the calibration factor. This all devices connected with SEWAC unit.




void setup() {
Serial.begin(9600);
Serial.println("HX711 calibration sketch");
Serial.println("Remove all weight from scale");
Serial.println("After readings begin, place known weight on scale");
Serial.println("Press + or a to increase calibration factor");
Serial.println("Press - or z to decrease calibration factor");
scale.begin(LOADCELL_DOUT_PIN, LOADCELL_SCK_PIN);
Output
Serial Monitor
Message (Enter to send message to 'ESP32-WROOM-DA Module' on 'COM4')
Reading: Kilogram:0.00 Kg calibration_factor: 3871.87
Reading: Kilogram:0.01 Kg calibration_factor: 3871.87
Reading: Kilogram:-0.00 Kg calibration_factor: 3871.87
Reading: Kilogram:0.00 Kg calibration_factor: 3871.87
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Reading
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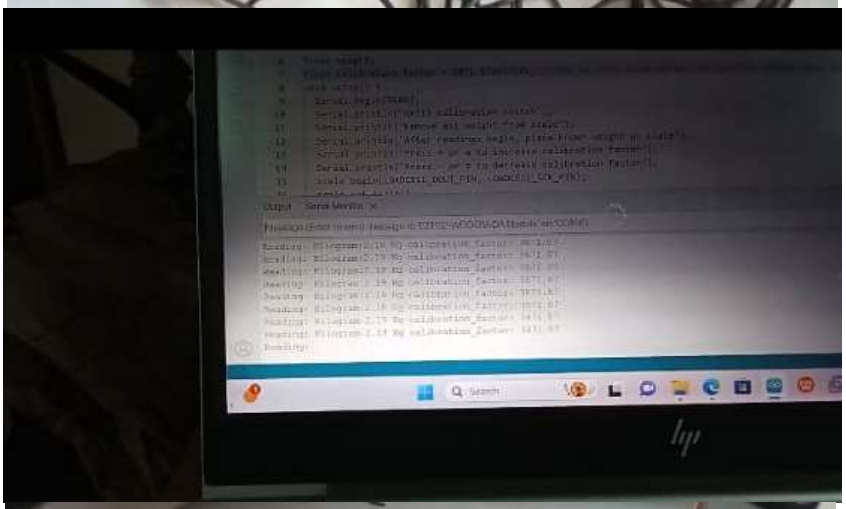
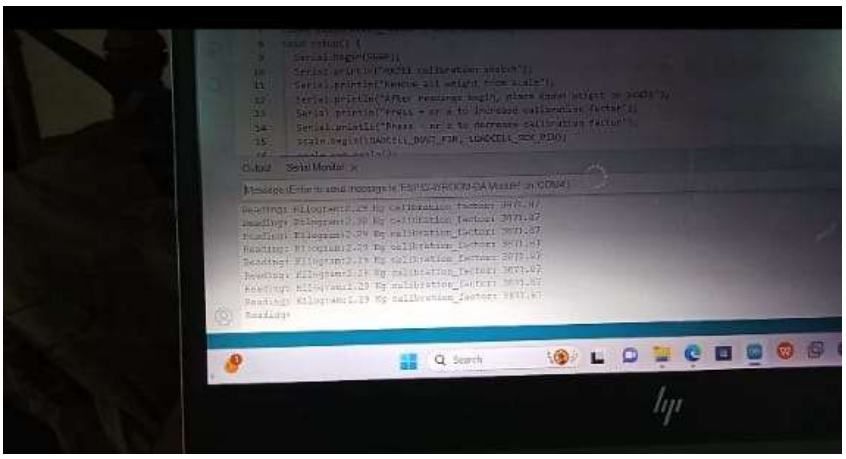
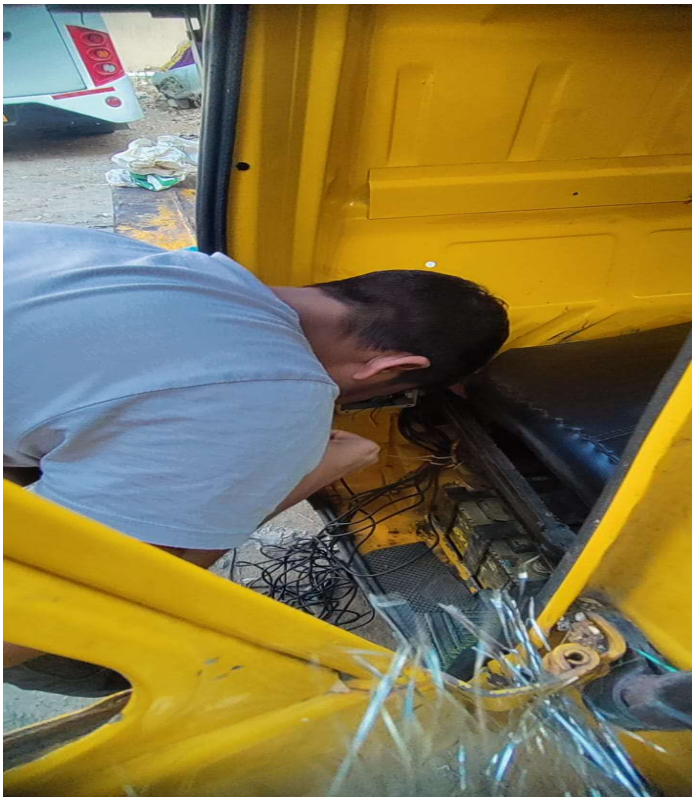
Ln 7, Col





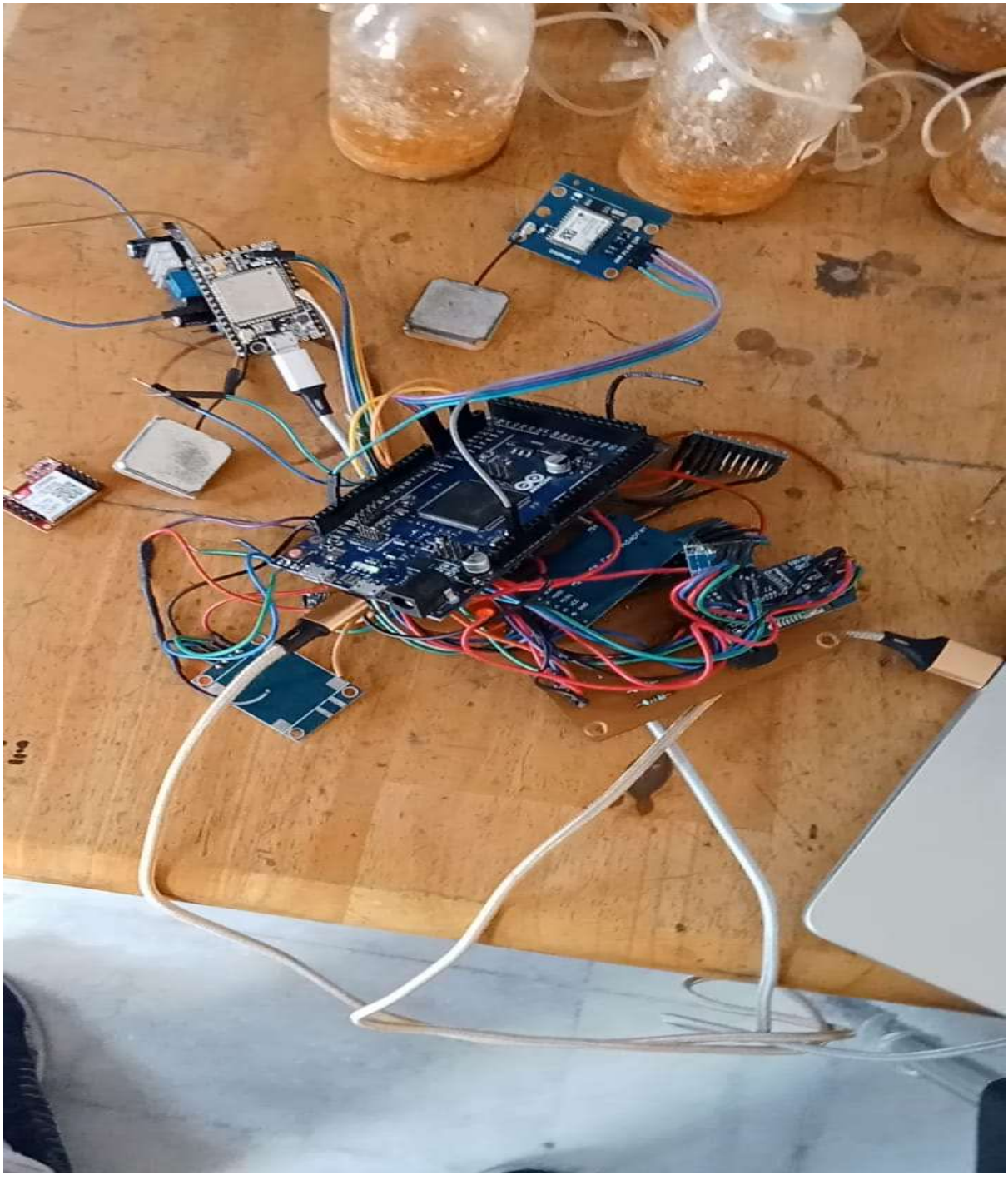
Weekly report –1Apr to 7Apr

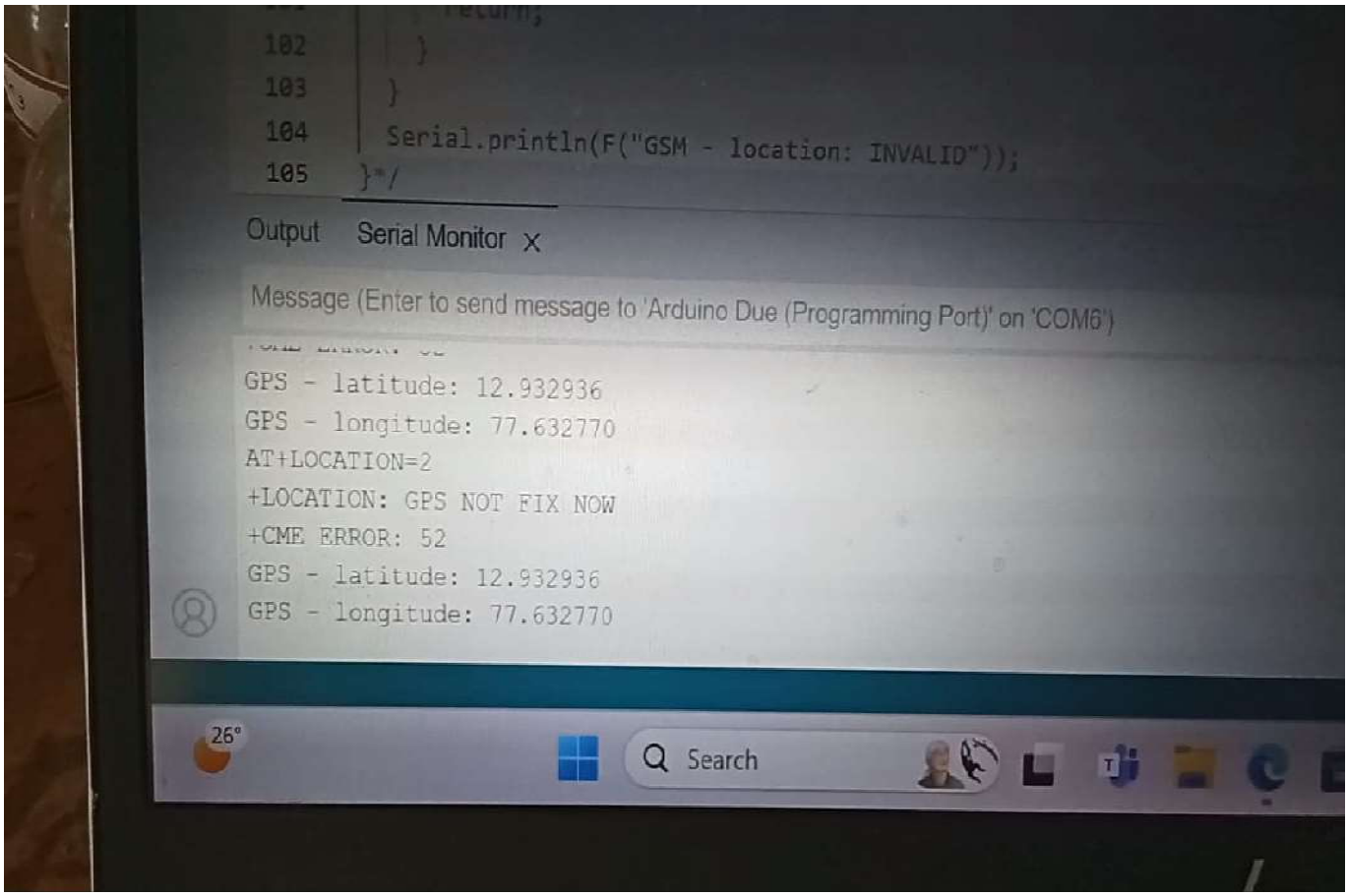
- During that time me and my office colleagues are visited hongasandra again for calculating the weight using loadcells where 4 loadcells are fitted on garbage van. We applied with 2 different code 1st one which is example code of hx711 IC and 2nd one is our own project code both are worked on that day perfectly.
- We also made some of the corrections with weight transmitter and our SEWAC board is worked.



Weekly report –7Apr to 14Apr

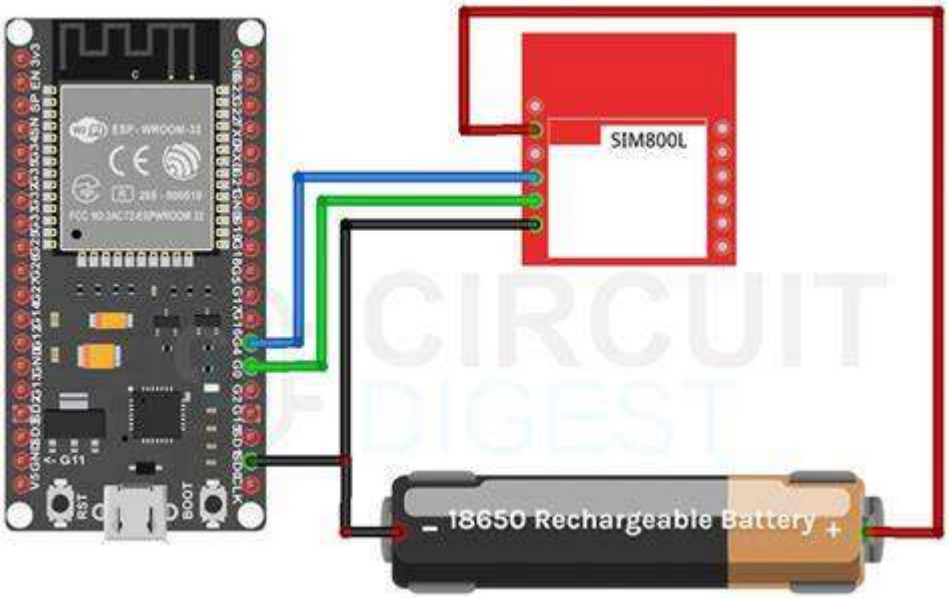
- During that time I tried with GPS and GSM both together for locations and I got locations using GPS. For GPS I used the NEO-6M Module and for GSM I tried with 2 modules 1st is A9g and 2nd is SIM800L but I only got GPS is not fix now in default case using GSM.
- Here I used the Arduino due as microcontroller because the Arduino due has more UART options and I wanted to try GPS and GSM both together.




}
}
Serial.println(F("GSM - location: INVALID"));
}*/
Output
Serial Monitor
Message (Enter to send message to 'Arduino Due (Programming Port)' on 'COM6')
GPS - latitude: 12.932936
GPS - longitude: 77.632770
AT+LOCATION=2
+LOCATION: GPS NOT FIX NOW
+CME ERROR: 52
GPS - latitude: 12.932936
GPS - longitude: 77.632770
26°
Search

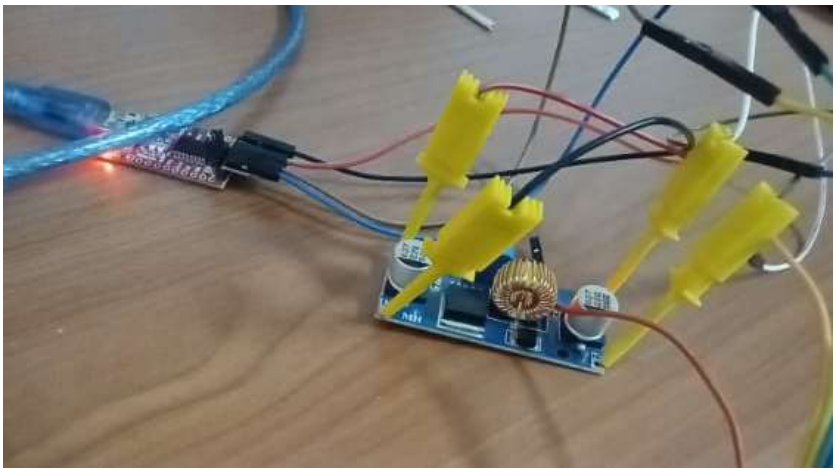
Weekly report –15Apr to 21Apr

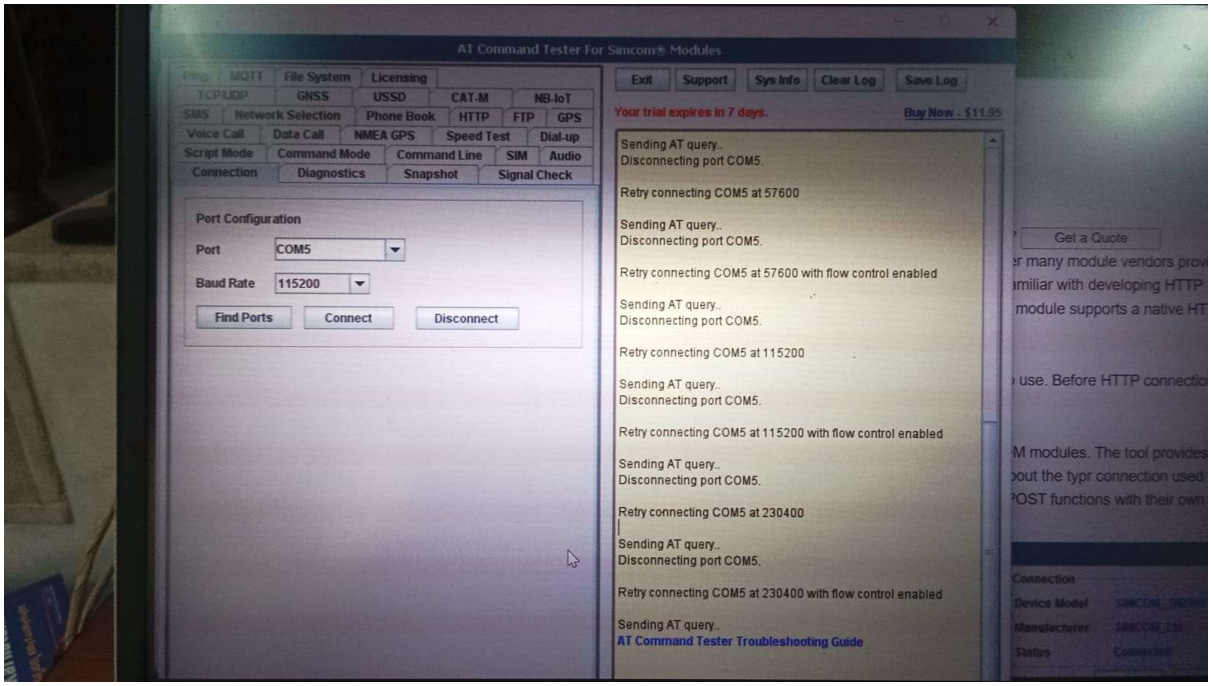
- After trying with wifi I want to try this SEWAC project without wifi so tried with AT+HTTP at commands with using the A9G and SIM800L Module.
- In A9G except AT+LOCATION and AT+HTTP all at commands are worked. I also tried with SIM800L so some of the AT+HTTP related at commands are worked and some of the at commands are not worked.
- Here I tried Both the microcontroller boards ESP32 and Arduino due.



Weekly report –22Apr to 28Apr

- During this period I tested the at commands using the at command tester software. Where I tried HTTP at commands and MQTT at commands using GET and POST request with SIM800L.
- I also tried others at commands using the TTL converter with using the ESP32 as microcontroller.




AT Command Tester For Simcom® Modules
Ping
MQTT
File System
Licensing
TCP/UDP
GNSS
USSD
CAT-M
NB-IoT
SMS
Network Selection
Phone Book
HTTP
FTP
GPS
Voice Call
Data Call
NMEA GPS
Speed Test
Dial-up
Script Mode
Command Mode
Command Line
SIM
Audio
Connection
Diagnostics
Snapshot
Signal Check
Port Configuration
Port
COM5
Baud Rate
115200
Find Ports
Connect
Disconnect
Exit
Support
Sys Info
Clear Log
Save Log
Your trial expires in 7 days.
Buy Now - $11.95
Sending AT query..
Disconnecting port COM5.
Retry connecting COM5 at 57600
Sending AT query..
Disconnecting port COM5.
Retry connecting COM5 at 57600 with flow control enabled
Sending AT query..
Disconnecting port COM5.
Retry connecting COM5 at 115200
Sending AT query..
Disconnecting port COM5.
Retry connecting COM5 at 115200 with flow control enabled
Sending AT query..
Disconnecting port COM5.
Retry connecting COM5 at 230400
Sending AT query..
Disconnecting port COM5.
Retry connecting COM5 at 230400 with flow control enabled
Sending AT query..
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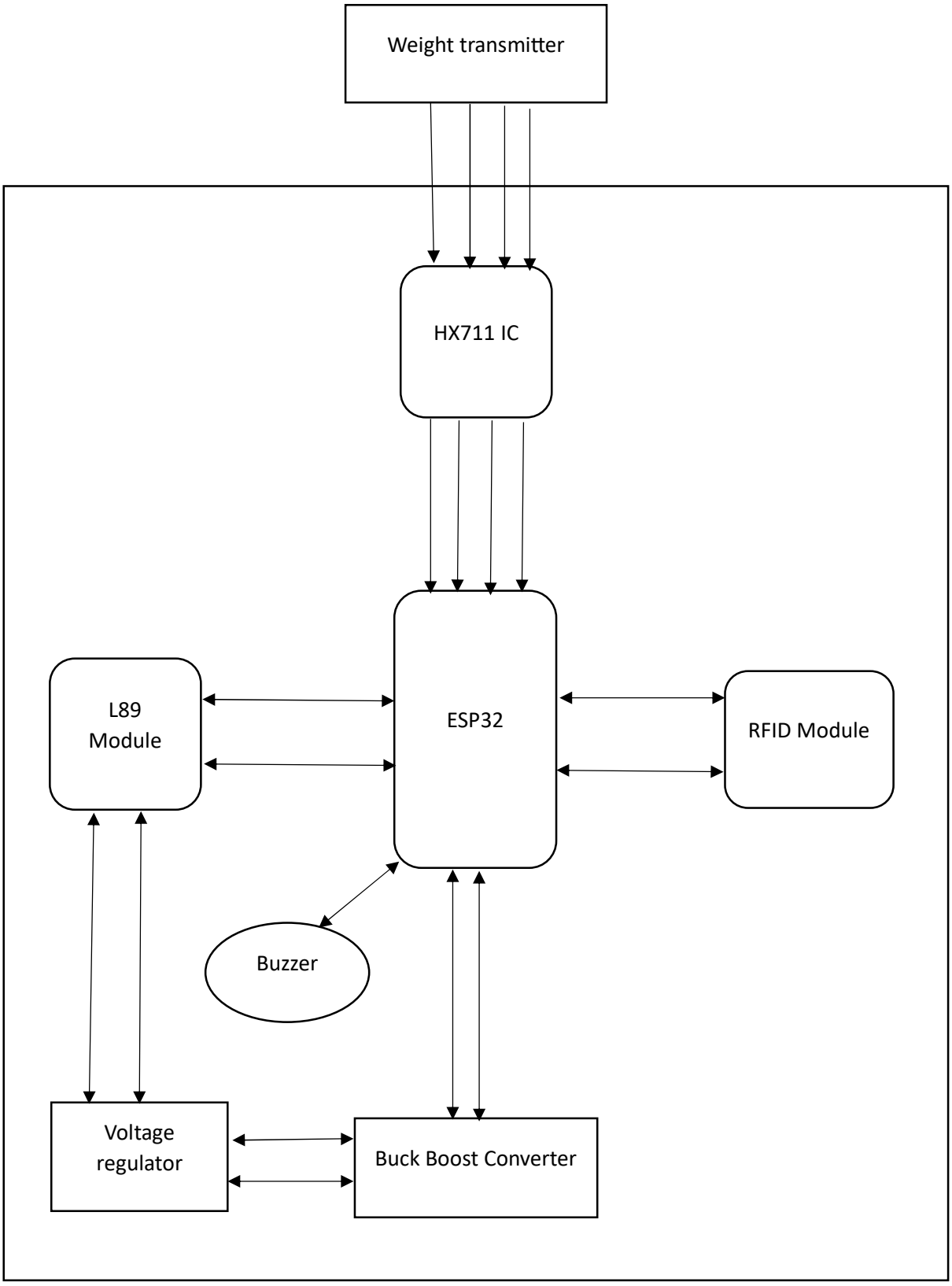
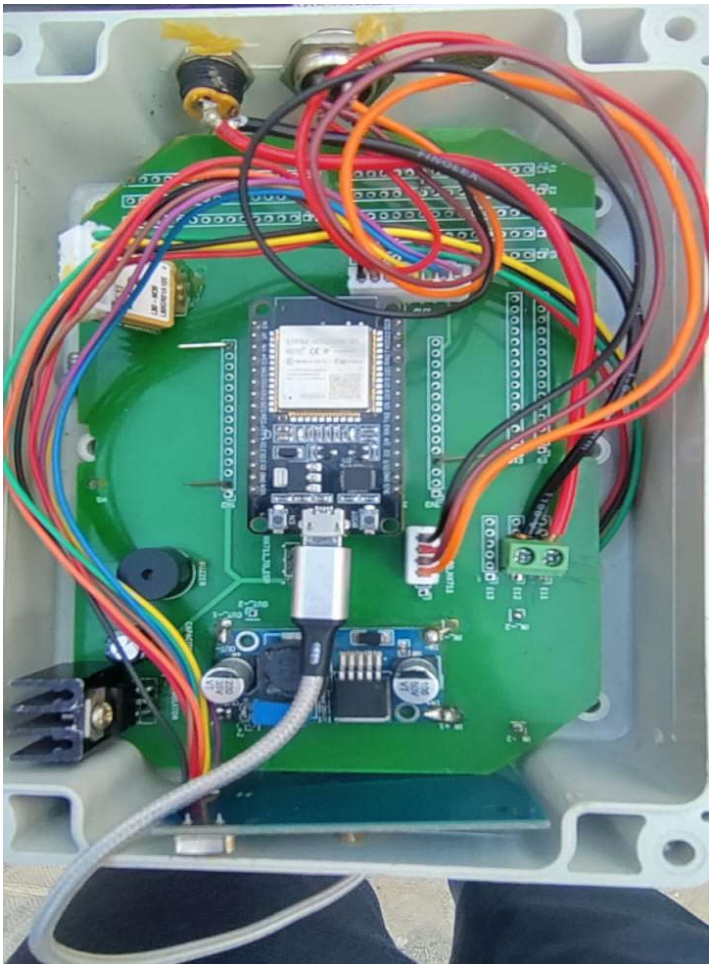
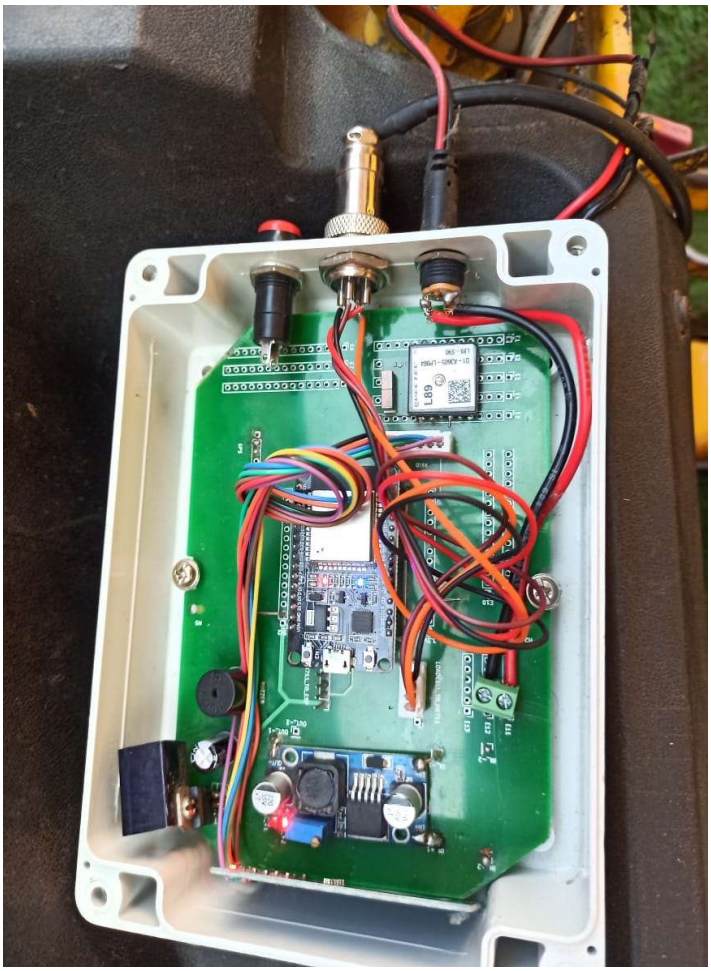
Final work

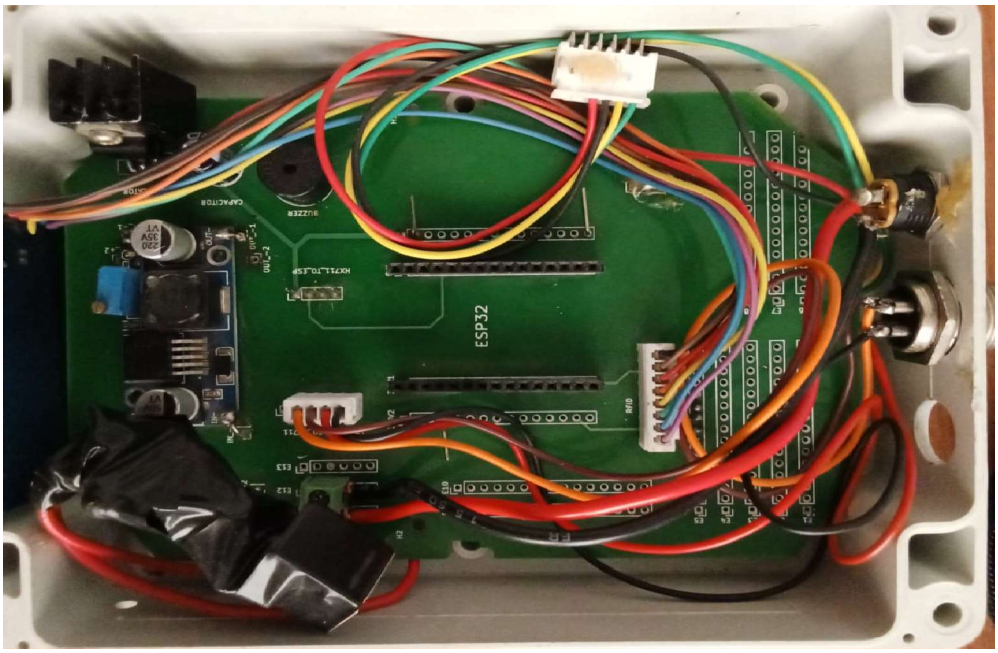
SEWAC Block Diagram



Project board:







Explanation:

This ESP32-based system integrates various sensors and modules to facilitate waste collection management. It includes functionalities such as GPS tracking, NFC tag detection, and weight measurement using load cells. The system utilizes an ESP32 microcontroller, TFT display, GPS module, NFC reader, and HX711 load cell amplifier. Upon initialization, the TFT display showcases a user interface representing the system's identity and status. The system then proceeds to establish a Wi-Fi connection for data transmission.

During operation, the system continuously reads GPS coordinates and NFC tags. Detected GPS coordinates and NFC tag IDs are utilized to identify collection locations and vehicles respectively. Weight measurements from the load cells determine the quantity of mixed waste collected. Collected data, including driver information, vehicle details, GPS coordinates, and waste weights, are formatted into an HTTP request. This request is sent to a Google Sheets API endpoint for storage and further processing.

Overall, this system provides an efficient and automated solution for waste collection monitoring, offering real-time insights into collection activities and waste quantities.

Conclusion

The project aims to create an IoT-based waste management system that tracks waste collection activities, including the types and weights of waste collected at various locations. It provides real-time monitoring and data logging capabilities, allowing for better management and analysis of waste collection operations. Possible future enhancements could include features such as real-time notifications, route optimization based on collected data, and integration with larger waste management systems.

Advantages

The described ESP32-based waste collection management system offers several advantages:

Efficiency: By automating the waste collection process, the system reduces manual effort and potential errors associated with traditional methods. This efficiency translates into cost savings and improved resource utilization.

Real-time Monitoring: The integration of GPS tracking enables real-time monitoring of collection activities. Supervisors can track the location of collection vehicles and ensure efficient routing, leading to optimized schedules and reduced fuel consumption.

Accuracy: The use of NFC tags and GPS coordinates ensures accurate identification of collection locations and vehicles. This accuracy minimizes the risk of errors in data recording and enhances the reliability of collected information.

Data Insights: Collected data, including GPS coordinates, NFC tag IDs, and waste weights, provide valuable insights into waste collection operations. Analyzing this data allows for optimization of collection routes, identification of high-volume collection areas, and better resource allocation.

Integration with Google Sheets: Sending data to a Google Sheets API endpoint enables seamless storage and further processing of collected information. This integration simplifies data management and facilitates analysis using familiar spreadsheet tools.

Scalability: The modular design of the system allows for easy integration of additional sensors or functionalities to meet evolving requirements. This scalability ensures that the system can adapt to changing needs and accommodate future enhancements.

Environmental Impact: By optimizing waste collection routes and improving operational efficiency, the system helps reduce fuel consumption and greenhouse gas emissions associated with waste collection activities. This contributes to environmental sustainability goals.

Future requirements

Predictive Analytics: Implementing predictive analytics algorithms to forecast waste generation patterns based on historical data. This could help optimize collection routes and schedules, reducing costs and improving efficiency.

Fault Detection and Maintenance: Integrating sensors for detecting system faults or component failures, and implementing remote monitoring capabilities for proactive maintenance. This would help prevent downtime and ensure the system operates smoothly.

Mobile Application: Developing a mobile application for waste collection personnel to view route information, update collection statuses, and report issues in real-time. This would improve communication and coordination among team members.

Environmental Impact Assessment: Incorporating features to assess the environmental impact of waste collection activities, such as calculating carbon emissions or estimating landfill usage. This could support sustainability initiatives and help reduce the ecological footprint of waste management operations.

User Feedback and Satisfaction Tracking: Incorporating mechanisms for collecting feedback from stakeholders, such as residents and waste collection personnel, to monitor satisfaction levels and identify areas for improvement.