# A REPORT

# ON

# Electric Vehicle Telematics Module

**By**


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***Prepared in the partial fulfillment of the***
Practice School III Course

**AT**

**Interwork Software Solutions Pvt Ltd, Noida**

**A Practice School III Station of**

## BML MUNJAL UNIVERSITY

**(May, 2021)**

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# CERTIFICATE

**This is to certify that Practice School Project of Sontu Narendra Gautam titled Electric Vehicle Telematics Module to the best of my knowledge is a record of bonafide work carried out by him under my guidance and/or supervision. The contents embodied in this report, to the best of my knowledge have not been submitted anywhere else in any form for the award of any other degree or diploma. Indebtedness to other works/publications has been duly acknowledged at relevant places. The project work was carried during Jan 2021 to June 2021 in Interwork Software Solutions Pvt Ltd.**

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# BML MUNJAL UNIVERSITY
# PRACTICE SCHOOL – III
# JOINING REPORT

**Date: 15/01/2021**

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The internship opportunity I had with Interwork Software Solutions Pvt. Ltd was a phenomenal chance for learning and expert development. Accordingly, I see myself as truly lucky to have been offered the chance to be a part of it. I'm additionally happy for the opportunity to cooperate with such countless astounding individuals and experts who guided me through my internship period.

I want to take this opportunity to offer my heartfelt gratitude to Mr. Vishnu Panda, Interwork's Chief Executive Officer, who greeted me warmly and led and supported me throughout my internship, and arrange all necessary facilities to make the internship experience more enjoyable.

I want to offer my thanks to Mr. Akanshu Pratap Singh, General Manager Engineering and Architecture, who, despite being very occupied with his duties, set aside the effort to tune in, give fundamental exhortation and direction.

Finally, I would like to thank Prof. Hemant Gupta for being my Faculty Mentor and helping me successfully undertake all the necessary tasks and provide all the required inform to ensure the timely completion of the program.

# ABSTRACT

In an increasingly digital world, it is pretty evident that the EV industry is on the boom. The introduction of a telematics system to the business will provide valuable data for consumers or fleet managers to monitor. Telematics is a term "any use of telecommunications in combination with information and communication technology. It is the process of sending, receiving, and storing data about remote objects, such as vehicles, using telecommunication devices".

This report titled " Electric Vehicle Telematics Module " covers the complete operation and study of the EV telematics module and battery management system which is a part of Interwork’s upcoming Fleet Management project. The main objective of the report is to study the various equipment's provided for building the hardware and the process underneath it. Also, some essential ideas and facts which were learned in due course are added in this project report.

This Telematics module operates by capturing vehicle location data through a GPS compliant system mounted in the vehicle, transmitting data collected over secure cellular networks, and presenting and visualizing vehicle location and driver data using a web-based software interface. Through collecting vehicle location and operation data and converting it into market insight, this Telematics device can perform a variety of tasks.

# TABLE OF CONTENTS

# 1. Organization’s business sector

Interwork is a new age software solutions company dedicated to assisting businesses throughout the world on their digital transformation journey. Changing factors such as government rules, company rules, geopolitical conditions, and others are forcing today's businesses to be more adaptable and flexible, and to change the way they do business on a regular basis. With a lot more prominent related and open worldwide economy, organizations are carrying out new strategies to remain applicable and in front of the rivalry, and computerized change is one such methodology that nobody can overlook in this day and age.

Interwork's deep domain knowledge in key industry verticals such as Automotive & Urban Mobility, Aerospace & Defense, Healthcare & Life Sciences, Energy & Utilities has aided enterprises in resolving key business challenges such as process re-engineering, enhancing collaboration between internal and external stakeholders, and bringing transparency and trust to transactions and assure transaction and data security.

# 2. Overview of the organization

New age Start Up in Product, Solutions and Services. Focusing on emerging technologies clubbed with deep domain expertise. Domain focused are Automotive & Urban Mobility, Energy & Utilities, Healthcare & Lifesciences, Aerospace and Defense.

Many of Interwork’s products and solutions are industry first, Registered with Govt. Agencies & programs like MSME, IEC, Startupindia etc, it is DPIIT Recognized and already have patent filed for ElektriVo.

### 2.1 Products and Solutions

i. Innovative solutions built on Blockchain
ii. SeeREAL- Drug Track & Trace
iii. ElektriVo M- Smart Supply Chain Solution for Electric Vehicle Manufacturers
iv. ElectriVo I- Smart Charging Battery Swapping & Billing Platform

### 2.2 Services

i. Blockchain - Private & Public Blockchain, DAPPs, Smart Contracts.
ii. IoT- Telematics, BMS, Fleet Management
iii. DevOps-End to End DevOps- AWS, Azure, GCP.
iv. Data & Analytics- Data Management, BI, Big Data
v. Application Development- Cloud Native, Web & Mobile
vi. Security-IDAM, VAPT, Digital Foot Printing

# 3. Plan of internship

My job role here is IoT and Embedded intern, the ultimate goal of the internship is to develop an electric vehicle telematics module that has multiple peripherals for different purposes. The telematics design, hardware, sources, and development need to be figured out in the process. The internship program began on January 15th, 2021, and will tentatively end on June 10th, 2021, completing 18 weeks or 90 days of work at the office.

The first fortnight of the internship was dedicated to research about Battery Management System (BMS), BMS working, batteries, hardware, and types of BMS available in the market. First, I studied extensive documentation to learn about the key aspects of Battery Management System and various types of battery chemistries. Next, I understood the working of BMS and wireless BMS, their differences, and the communication protocols used. Finally, based on my mentor's advice, I started making documentation on BMS.

In the second fortnight, I delved deep into familiarizing myself with various features of the wBMS like SmartMesh Networking, CAN bus, Bluetooth, and Micro-controller connectivity. Next, I have performed research on the client offered Smart Lamp project and gave out my suggestions. By the end of this week, I have interfaced the Bluetooth module to the MC development board and was able to write the code.

In the third fortnight, I have performed another research on the Autonomous robot project and I made several recommendations. Later in the week, we had a BMS discussion with a client. Next, I have integrated the GPS module with the MC development board. Finally, I was introduced to the Telematics project by my mentor, and I have done my research on the telematics product.

In the fourth fortnight, after involving myself entirely in the product, I have submitted the hardware components required to develop the Telematics module. After the approval, I have received hardware at my house. I started working on and implementing various modules.

The consecutive few weeks were spent interfacing hardware or fixing bugs by identifying the loopholes in the code, having meetings with my mentor, understanding the problem areas, and coming up with a solution.

The final fortnight of April was when I had responsibility to identify and evaluate the errors persisting in the code and making changes required in the hardware. By the end of April, I played a significant role as a IoT and Embedded engineer in the team. With this, I will complete the internship period assigned by the university but I’ll be working for them for two more months to help them in this project, and all the deliverables will be achieved, making Practice School 3 a success.

# 4. Introduction

Since the invention of the steam-powered automobile, the automotive industry has gone a long way. Continuous industrialization, as well as rising disposable incomes around the world, have generated a massive market for the business. Electronic devices are becoming more prevalent in automotive systems, accounting for around 25-35 percent of a vehicle's overall production cost, depending on the model. The role of embedded systems in vehicle performance and quality is becoming increasingly important. Telematics for automotive safety and road safety are made possible through wireless vehicle safety communications. We require an electronic sub-system in a vehicle to exchange safety information, such as road dangers and vehicle positions and speeds, through short-range radio links. Due to time-to-market constraints, the time and effort required to design and develop hardware and software in automotive applications is growing at an exponential rate.

By introducing a telematics module in an EV, the companies can achieve;

- Driving Patterns – These can be monitored to ensure that each driver is adhering to the highest possible safety and fuel efficiency standards. It will also reveal reckless or risky drivers.
- Traffic and Congestion – By being mindful of traffic delays and congestion, fleet controllers can provide customers with alerts on delays while staying on schedule.
- Geofencing – This ensures that fleet drivers stay within designated areas and routes that have been chosen for their performance. The fleet controller will be notified if a driver deviates from the route and will be able to contact the driver.
- Servicing and Maintenance – Knowing the exact mileage and use of your fleet vehicles allows you to schedule your servicing and general upkeep.
- Telematics Mapping – This helps you to re-enact a driver's movements and driving as though you were the one behind the wheel, noticing speed, braking, and idling habits.

## 4.1 Problem Statement

The usage of telematics in connected cars and fleet management is necessary, the idea of connected cars is gaining traction, and almost all of the major automakers are considering it as the next big thing that will help them develop their businesses. They're looking at how Internet of Things solutions will aid in the optimization of the car's processes, internal functions, maintenance, and passenger experience.

Design and Development of a complete automotive Telematics System that reads data from a GPS, BMS, Accelerometer, and gyroscope and transmits it through GSM and ESP32 module which interprets it and relays it in an effective and easy to use graphical user interface (GUI). The vehicle unit generates data, which is then transferred to the back-end systems. This communication occurs through the telematics module installed in the vehicle.

This report presents a framework for development of telematics module, with the following objectives: 1) to propose a unified hardware and software framework for the development of work, 2) to define a structured development method focused on test management and 3) to evaluate creation of an electronic module for telematic application to assess the efficacy of the proposed method.

## 4.2 Literature Survey

In recent times, electric vehicle technology has evolved and began to have an impact on the automobile industry. In previous research in the field of EV telematics, the features were less and had primarily focused on the location and battery of the vehicle. Most of the previous works in this field were dedicated to determining the optimum location. Value, proficiency, and time factors and the impact of late designing plan changes, the impacts of an inventory network arrangement, interaction and item complexity, and the level of oddity have all been examined in past examinations. The significant difference between the existing modem EV telematics and our product is that the existing ones show a lack of quality and efficiency. Our product is focused on comprehensive research and is designed for manufacturers who want to handle telematics information in the best way possible. Our customer-centric approach to EV adoption and growth has the potential to be a game-changer.

# 5. Methodology

## 5.1 Architecture

The three basic blocks of an electric vehicle telematics solution are as follows:

- Control Unit of the Telematics (TCU)
- A Telematics Cloud Server
- Web app and Mobile-App at the front end.

The TCU, is the telematics gadget's focal component, speaks with the in-vehicle organization (through Control Area Network Bus) and the telematics cloud worker.

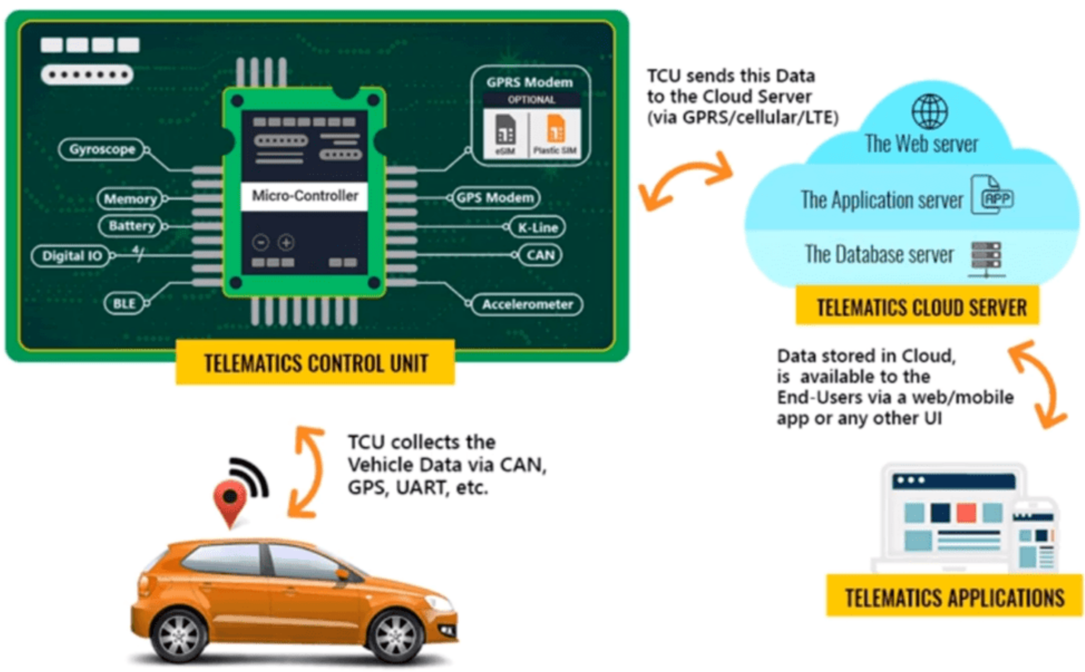


*Figure 1: Telematics Architecture*

The Telematics Control Unit gathers essential data like diagnostics, ongoing vehicle position, and speed and imparts it to a cloud worker in a predefined bundled design by means of a remote organization like GPRS or cellular.

## 5.2 Module

The TCU is the core of a telematics framework, dealing with assignments including gathering vehicle information through CAN-BUS port, overseeing information procured by means of various correspondence interfaces like CAN, GPS, UART, GUI, Memory, and battery the executives. And furthermore, deals with the Telematics Cloud Server's two-way correspondence.

The following components make up the core framework of a Telematics Control Unit hardware architecture:

- The vehicle's latitude and longitude are tracked using a Global Positioning System module (GPS).
- A CPU is a computer processor that can manage memory and process data. In commercially available telematics systems, microcontrollers or microprocessors are employed to manage various processes that occur within the TCU.
- All communication with the vehicle's electronic control systems is controlled by a CAN Bus module. A telematics framework can utilize the K/Line transport to alarm the client of burglary or give far off locking and opening of the vehicle.
- A memory unit is essential for conserving information in the event of a network outage or for preserving vehicle data for later use. Advanced telematics functions such as speech recognition can also be provided by this memory module. Flash and dynamic random-access memory are two of the most utilized memory types in a vehicle telematics framework.
- Modules that assist a variety of communication methods, such as LTE, cellular, and Wi-Fi.

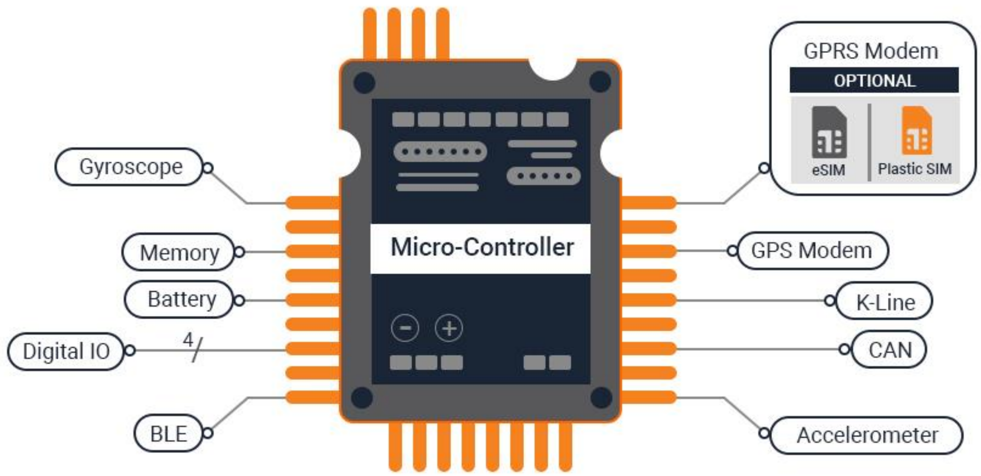


*Figure 2: Telematics Control Unit*

- A GPRS module associates with the web and, at times, permits voice correspondence with far off gadgets. A sim card, e-sim card, or plastic sim card is typically included with the GPRS module, notwithstanding the GPRS modem, to allow association with far off gadgets over the phone organization.
- A General-Purpose Input/Output Interface (GPIO) is utilized to associate lights and buttons. There are simple and computerized I/O interfaces accessible.
- Acceleration, Harsh Braking, and Cornering Speed are all recorded by the gyroscope and accelerometer module.

## 5.3 Components

Hardware used for the development of telematics module are

**5.3.1. STM32 Dev board:** STMicroelectronics' STM32F103C8T6 Development Board is an ARM Cortex-M3 Microcontroller. The STM32F103C8T6 is a high-performance 32-bit microcontroller that easily beats the Arduino UNO.

*Figure 3: STM32 Blue Pill*

We can also program this board using the Arduino IDE (with a few tweaks and an external programmer, such as a USB to U(S)ART converter) as a bonus. The following are the specifications of the MCU used in the blue pill board:

a) Memory includes 64 kilobytes of Flash memory and 20 kilobytes of SRAM memory.
b) 32 pins available with external interrupt ability
c) Three 16-bit Timers, One 16-bit Pulse Width Modulator Timer
d) Pulse Width Modulator Pins – 15
e) 10 Channels of 12-bit Analog to Digital Converter
f) Two I2C peripherals
g) Three USART Peripherals with hardware control
h) Two SPI Peripherals
i) Other Peripherals – USB 2.0, CAN 2.0 (CTx, CRx)

**Pin Description:**

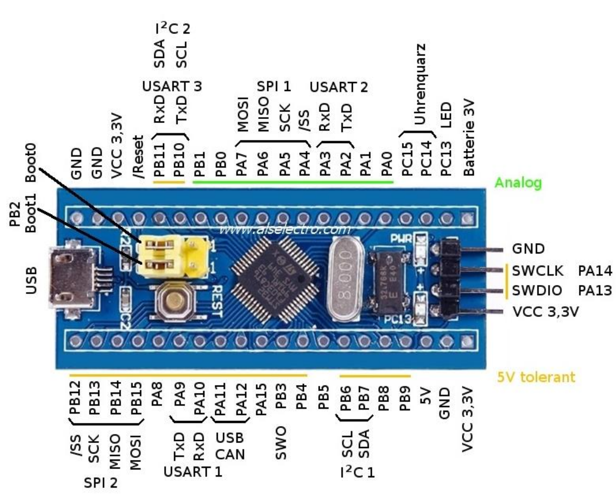


*Figure 4: Pin description of STM32 Blue Pill*

**5.3.2. SIM900A GSM/GPRS Module:** SIM900A Modem is viable with any GSM network administrator SIM card and has its own extraordinary telephone number, very much like a phone.

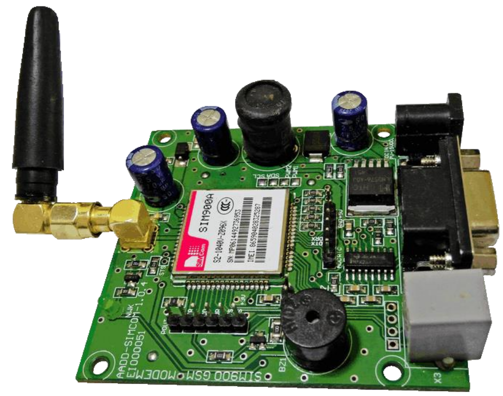

*Figure 5: SIM900A GPRS/GSM*

The SIM900A GSM/GPRS modem is a fitting and-play modem with a RS232 chronic connector. This current modem's RS232 association can be utilized to impart and foster inserted applications. SMS control, information move, controller, and logging are instances of uses that can be made.. The SIM900 supports voice calls, SMS, Data/Fax, GPRS, and other features. AT instructions are used by the SIM900A modem to operate with supported functionality.

**Pin Description:**

a) Power Supply 3.3V to 6 V
b) **Ground:** 0V or Gnd
c) **TX:** Data is serially transmitted.
d) **RX:** Data is serially received.
e) **Power Requirement:** This board requires external power supply of ~12V and can draw up to ~2A of current at its peak.
f) **Indicators:** It has two LED indicators as,
ON: It shows that the module is getting power supply and is switched on.
NET: When the module is communicating with the radio network, this network LED blinks.

**AT Commands:** AT commands are commands that operate a modem. ATtention is abbreviated as AT. The letters "AT" or "at" begin each command line. As a result, AT commands are used to refer to modem commands.

| Mode | Command |
|---|---|
| Making SIM900 in text mode | AT+CMGF=1\r |
| SMS to a particular phone number | AT+CMGS=phone_number |
| Read the 1st SMS from the inbox of phone | AT+CMGR=1\r |
| Read the 2nd SMS from the inbox | AT+CMGR=2\r |
| Read all SMS | AT+CMGR=ALL\r |
| Call to a particular phone number | ATDP+ phone_number |
| Hang up | ATH |
| Receive a call | ATA |

**5.3. GPS Module:** The GPS collector module's yield is in NMEA string design (National Marine Electronics Association). Of course, it yields sequentially on the Tx pin at a 9600 Baud rate.

*Figure 6: Neo 6M GPS*

Longitude, latitude, altitude, time, and other parameters are separated by commas in this National Marine Electronics Association string output from a GPS receiver. Each string begins with the character "$" and ends with the carriage return/line feed sequence.

**Pin description:**

a) Power Supply 3.3 to 6 V
b) **GND:** 0V or Ground
**c)** **TX:** Serially transmits data that includes information such as location, time, and so on.
d) **RX:** Receive data in a serial format. It is essential while configuring the GPS module.

**5.3.4. MPU6050 (Gyroscope + Accelerometer + Temperature) Sensor Module:** The MPU6050 sensor module is an across-the-board six-axis movement GPS beacon. It contains a three-axis gyro, a three-axis pivot accelerometer, and a Digital Motion Processor in a little bundle. It additionally accompanies an on-chip temperature sensor. It utilizes an I2C interface to speak with the microcontrollers.

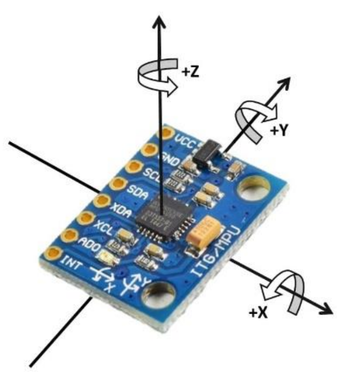


*Figure 7: MPU6050 (Accelerometer & Gyroscope)*

It has an Auxiliary I2C bus for interfacing with sensors such a 3-axis magnetometer and a pressure sensor, among other things. If the three-axis magnetometer is attached to an additional I2C line, the MPU6050 may be able to provide entire 9-axis Motion Fusion output.

**Three-Axis Gyro:** MEMS technology is used in the MPU6050, which is a three-axis gyroscope. As indicated in the picture below, it's used to detect rotational velocity along the X, Y, and Z axes.

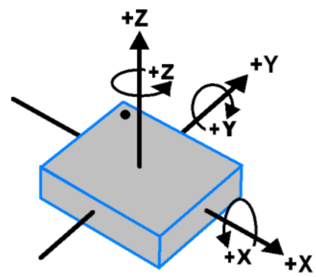


*Figure 8: Gyroscope axis description*

a) The Coriolis Effect produces a vibration that is sensed by a MEM within MPU6050 when the sensors are rotated around any of the sensing axes.
b) A voltage corresponding to the angular rate is obtained by amplifying, demodulating, and filtering the signal.
c) To sample each axis, this voltage is converted using a 16-bit Analog to Digital Converter.
d) The output ranges are +/- 250, +/- 500, and +/- 1000, 2000.
e) In degrees per second, the angular velocity along each axis is measured.

**Three-Axis Accelerometer:** The MPU6050, a three-axis accelerometer, makes use of MEM technology. As shown in the picture below, it is used to detect angle of tilt or inclination along the three axes.

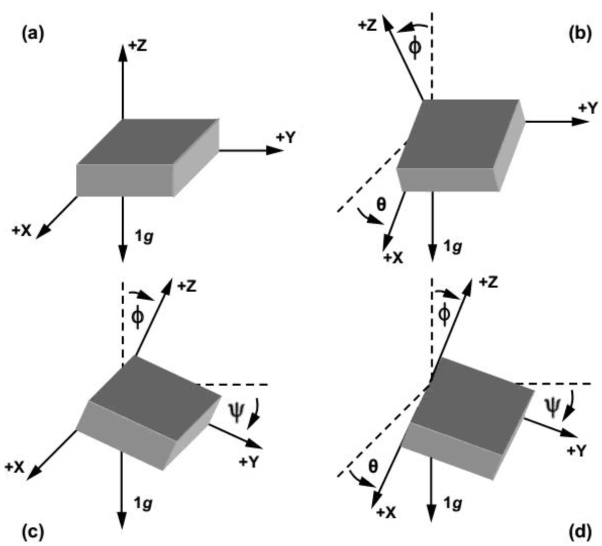


*Figure 9: Accelerometer axis description*

a) Acceleration along the axes causes the movable mass to be deflected.
b) The differential capacitor is unbalanced as a result of the moving plate (mass) displacement, resulting in sensor output. The amplitude of the output is proportional to the acceleration.
c) The output is digitized using a 16-bit Analog to Digital Converter.
d) Acceleration ranges are +/- 2g, +/- 4g, +/- 8g, and +/- 16g.
e) It is calculated in gravitational force (g) units.

**Pin Description:** MPU6050 contains 8 operating pins,

a) **INT** is Interrupt pin.

**b) AD0:** I2C slave address LSB pin. This is the device's seven-bit slave address's 0th bit. When VCC is connected, the slave address switches and it is interpreted as logic one.

**c) Auxiliary Serial Clock (XCL):** I2C-enabled sensors are connected to the MPU6050's SCL pin through this pin.

d) **XDA:** Auxiliary serial data pin is used to link the MPU6050 to other I2C-empowered sensors.

e) Serial Clock pin (**SCL**).

f) Serial Data pin (**SDA**).

g) **GND:** 0V

h) **VCC:** +5V DC supply.

**5.3.5. Arduino Uno:** Arduino Uno is a MCU development board made by Arduino.cc, an open-source integrated circuit technology platform built on the Atmega328 AVR microprocessor.

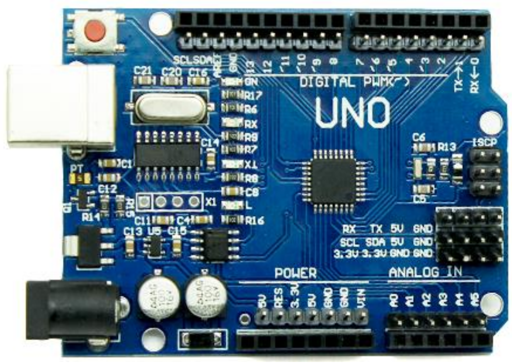


*Figure 10:Arduino Uno*

**Pin Description:**

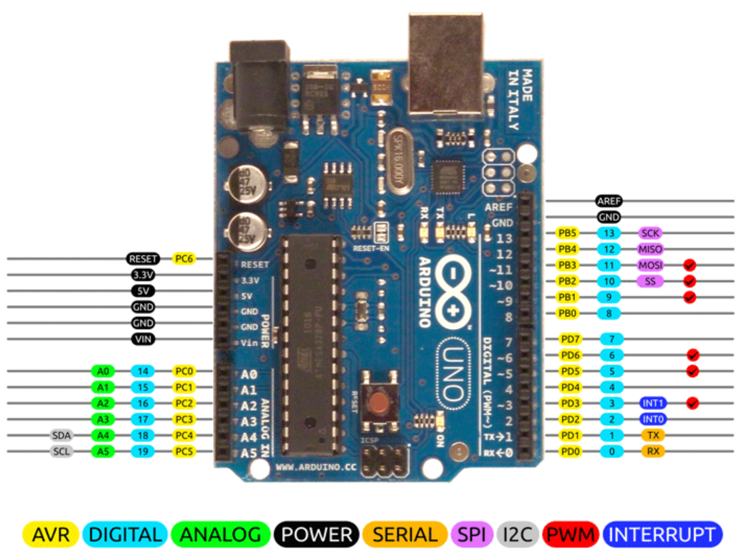


*Figure 11: Arduino Uno pin description*

**a) VCC:** 5V& 3.3 V

b) **Ground:** 0V
c) **Analog Pin:** Only 6 pins
d) **GPIOs:** 14 pins
e) **UART, SPI, I2C:** One set of each available.

The bootloader on the ATmega328 on the Uno is pre-programmed, permitting the client to assign new code to the MCU without the utilization of an outside equipment software engineer. In contrast to prior sheets, the Arduino Uno doesn't utilize the FTDI USB-Serial. On this board, the Atmega16U2 is utilized as a USB-to-chronic converter. The Arduino Uno is just utilized for testing in this project.

**5.3.6. ESP8266 Wi-Fi Module:** The ESP8266 Wi-Fi Module is an independent SOC with an inbuilt TCP/IP convention stack that can give admittance to Wi-Fi network to any microcontroller. The ESP8266 may either have an application or offloading all Wi-Fi network usefulness to a different application processor.

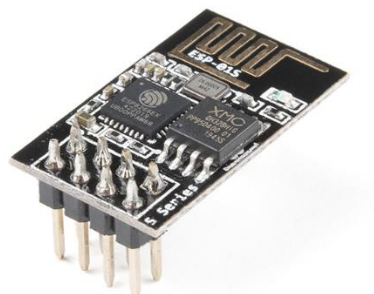


*Figure 12: ESP8266 Wi-Fi Module*

**Pin Description:**

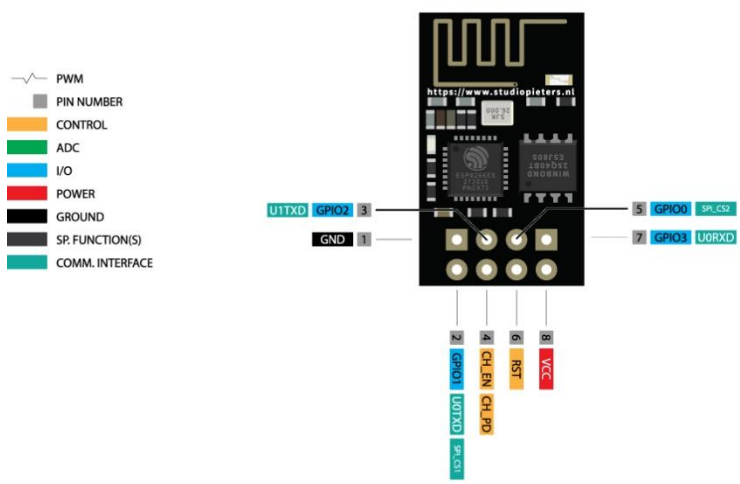


*Figure 13: ESP8266 pin description*

a) **VCC:** 5V
b) **Ground:** 0V
c) **GPIO:** Four pins

d) **Enable:** When the EN pin is set HIGH, the ESP8266 chip is empowered. At the point when the chip is set LOW, it utilizes a minimal measure of force conceivable.
e) **RST pin:** Reset

With ample processing and storage on board, this module can connect to sensors and other application-specific devices through its GPIO with little development and load during runtime.

**5.3.7. FTDI CP2102 Module:** The CP2102 Bridge is used in this SiLabs USB2.0 to TTL UART Converter module. This module works with PC's that don't have a standard serial port. This module on your computer generates a virtual COM port that can handle a variety of serial connection Baud Rates through USB.

*Figure 14:FTDI CP2102 Module*

**Pin Description:**

a) **TX:** TX Output Transmit
b) **RX:** Input Receive
c) **GND:** 0V
d) **3V3:** Power supply
e) **5V:** Optional power supply
f) **DTR/RST:** Optional pin for reset.

We must use a setup file to install the driver, which will automatically install the necessary driver files for Windows 10. After the driver has been installed, plug the module into any USB port on your laptop. Finally, a new COM port is available to the laptop. Data I/O at the TTL level is a feature that makes it more convenient. As a result, you won't need to use MAX232 chips to develop an RS232 to TTL converter.

**5.3.8. ST-Link Programmer:** The ST-LINK/V2 is an in-circuit debugger and software engineer for the STM8 and STM32 microcontroller families. The single wire interface module (SWIM) and JTAG/sequential wire troubleshooting interfaces are utilized to speak with any STM8 or STM32 microcontroller on an application board.

*Figure 15: STLink Programmer*

The debugger associates with the ST Visual Develop or ST Visual Program programming for STM8 projects, and it interfaces with the Atollic®, IARTM, Keil®, or TASKING incorporated advancement conditions for STM32 applications utilizing a USB max throttle interface.

**5.3.9. Bread board, Jumper wires and Soldering kit:** Soldering is a method of joining two or more metal objects by melting them together and then pouring a filler metal into the connection. It's utilized to create a long-term link between electronic components.

Soldering requires a variety of soldering instruments, including a soldering iron, an iron stand, a de-soldering pump, solder wire, de-soldering wire, and a solder wire tube, among others.

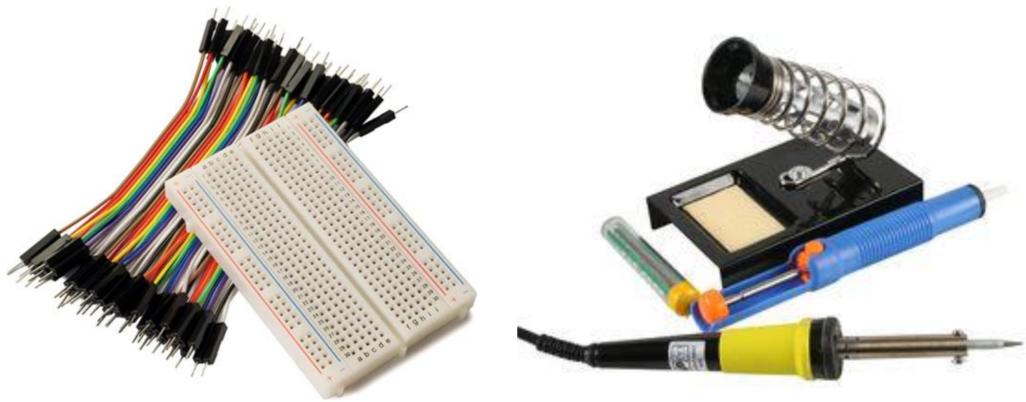

*Figure 16: Breadboard, Jumper wires and Soldering Kit*

The motivation behind the breadboard and jumpers is to make fast electrical associations between segments like ESP8266, MUC, capacitors, and so on so you can test your circuit before for all time fastening it together.

## 5.4 Working

As, we are building a telematics prototype, we have used STM32 which is quite powerful and popular board supported by Arduino IDE. To program it you need one is USB to TTL converter, the connections are shown below.

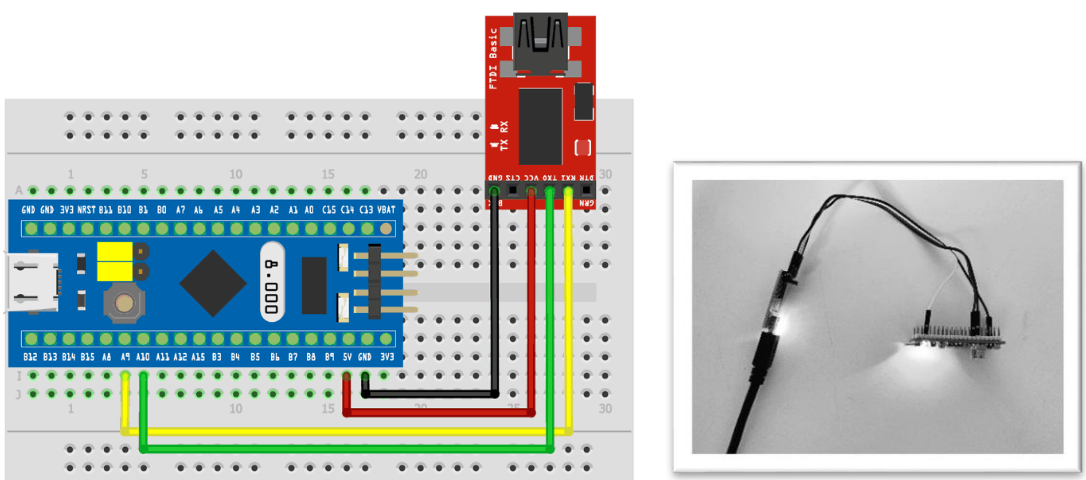

*Figure 17: FTDI with STM32 Bule Pill connections*

| FTDI | STM32 |
|---|---|
| VCC | 5V |
| Tx | A10 |
| Rx | A9 |
| GND | GND |

The VCC pin to the FTDI board is associated with the power supply's STM32 5V pin. The Gnd is associated with the Gnd of the STM32 microcontroller. The Rx and Tx pins of the FTDI board are associated with the STM32's A9 and A10 pins, individually. The STM32 MCU's Tx pin is A9, while the Rx pin is A10.

### 5.4.1 Preparing the IDE for STM32

Followed the means beneath to download and arrangement the Arduino IDE for utilization with the STM 32 Development board.

- ✓ Step 1: Installed the Arduino IDE.
- ✓ Step 2: I opened and downloaded the appropriate packages for the STM32 board after installing the Arduino IDE. This was accomplished by going to File -> Preferences.
- ✓ Step 3: By selecting Preferences, you'll be sent to the dialog box shown below. Paste the link into the extra Boards Manager URL text box LINK and click OK.

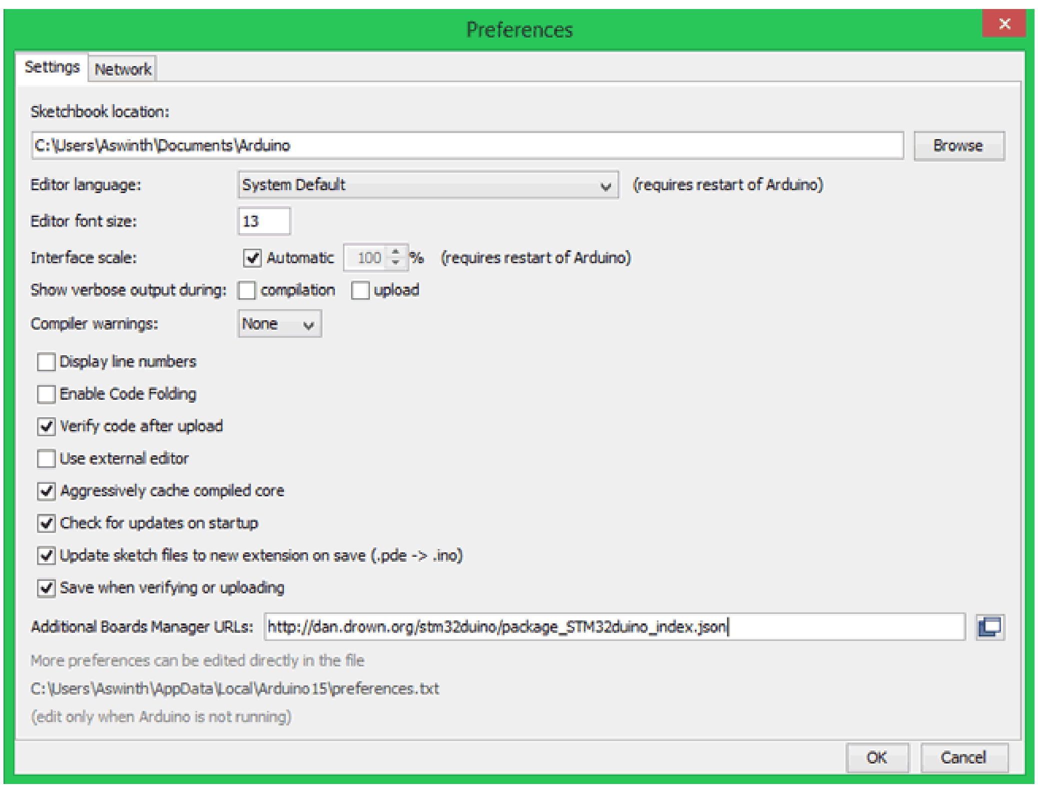


*Figure 18: Preference Settings in IDE*

- ✓ Step 4: I went to Tool -> Boards -> Board Manager to manage my boards. Searched for "STM32F1" in the Boards manager dialogue box and installed the package.

- ✓ Step 5: The installation is finished once the package has been downloaded. We can find the Generic STM32F103C series by going back to Tools and scrolling down as shown below. Select 64kFlah as the version, 72MHz as the CPU speed, and Serial as the upload mode.

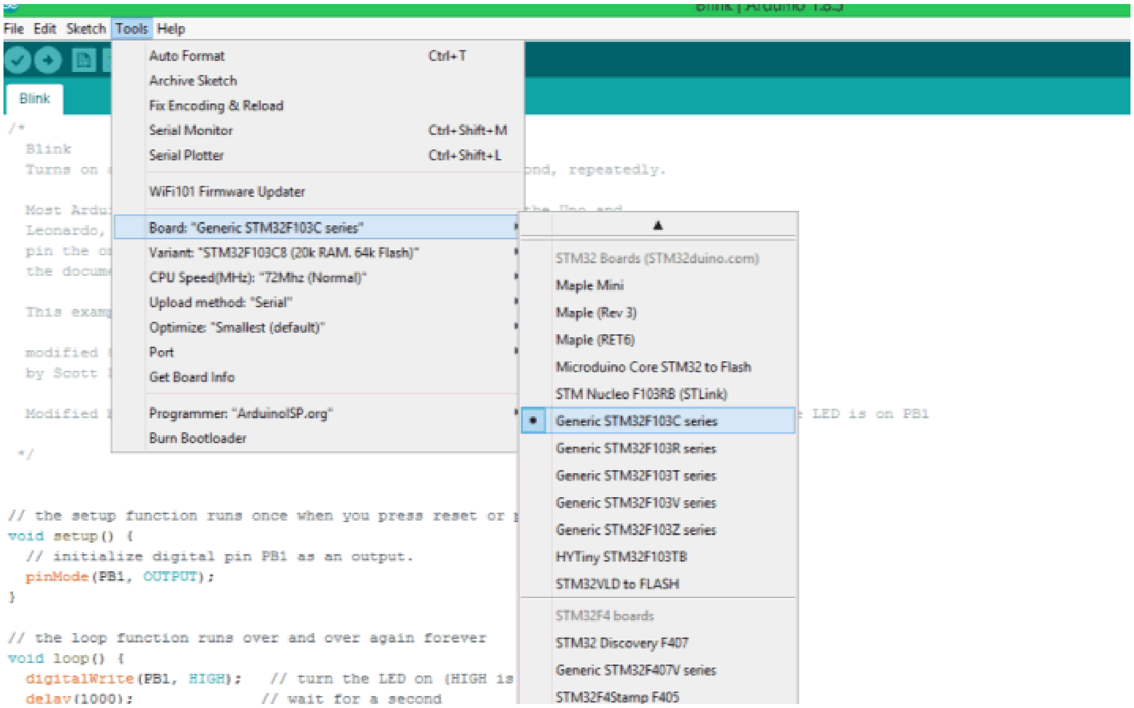


*Figure 19: Tool Settings and board selection*

- ✓ Step 6: Before uploading any program, the STM32 Board must be set into programming mode, which I accomplished by setting the boot 0 jumper to the lower position. The positions of the jumpers for Programming and Operating modes are indicated below.

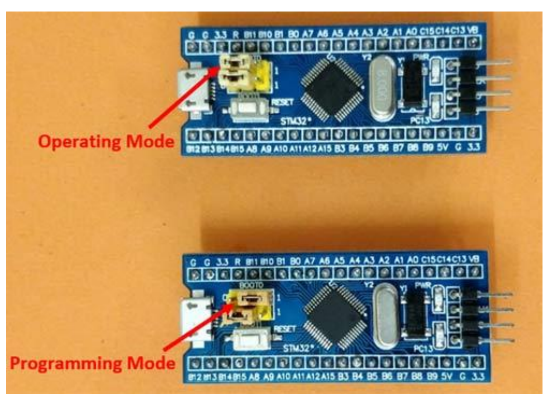


*Figure 20: Boot loading Operation*

To upload the software, I previously changed the boot 0 jumper to programming mode, and afterward tapped the Reset button. When I tapped the reset button, the board enters programming mode, and the green LED glows, flagging that the board is prepared for transfer.

### 5.4.2 Setup and Soldering

As the pins don't come pre-soldered to hardware, I have soldered pins for GPS, STM32 Blue pill and MPU6050(Accelerometer and Gyroscope) sensor.

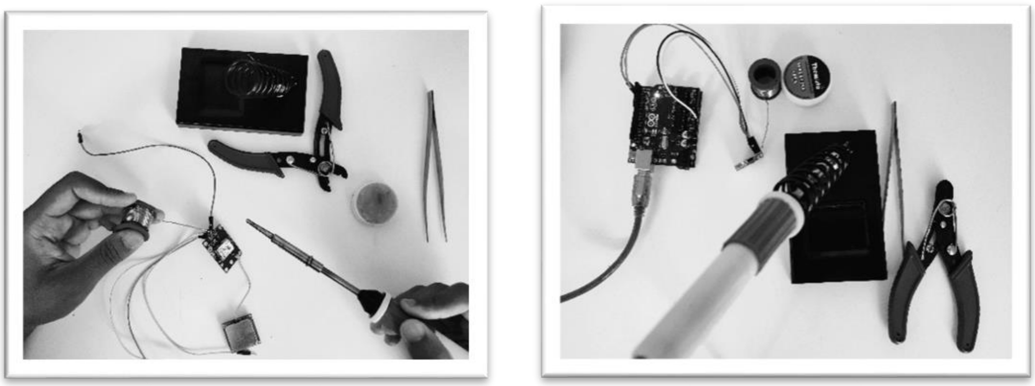

*Figure 21: Soldering and Soldering setup*

Soldering is a technique for connecting at least two things by dissolving and embeddings a filler metal (weld) into the joint, with the filler metal liquefying at a lower temperature than the abutting metal.

### 5.4.3 Peripheral Interfacing

GPS uses UART communication and uses the Tx and Rx pins to transmit and receive data. The GPS Tx pin is linked to the STM32 Rx pin, and the GPS Rx pin is linked to the STM32 blue pill Tx pin.

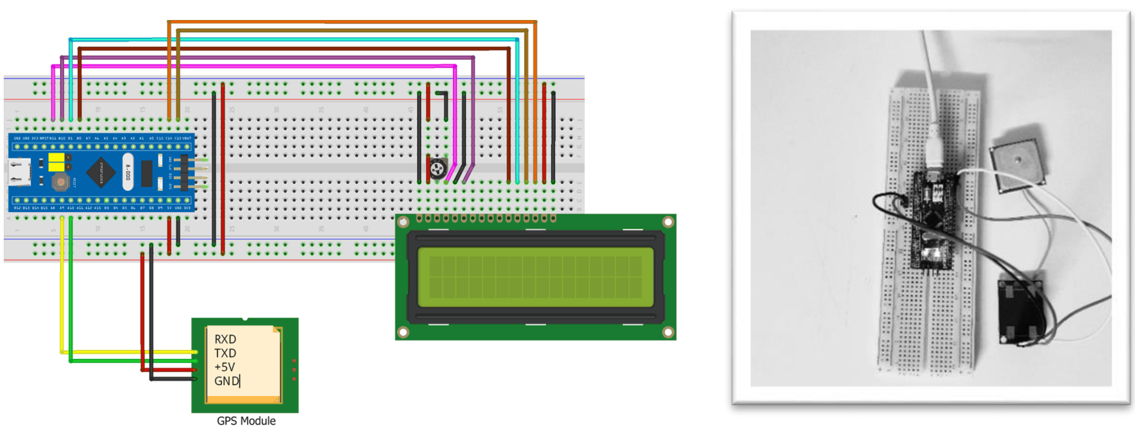


*Figure 22: GPS integration with STM32 Bule Pill*

| GPS | STM32 |
|---|---|
| VCC | 3.3V |
| Tx | PA3 |
| Rx | PA2 |
| GND | GND |

The GSM module SIM900 communicates through UART and uses the Tx and Rx pins to transmit and receive data. The GSM Tx pin is linked to the STM32 Rx pin, and the GSM Rx pin is linked to the STM32 blue pill Tx pin.

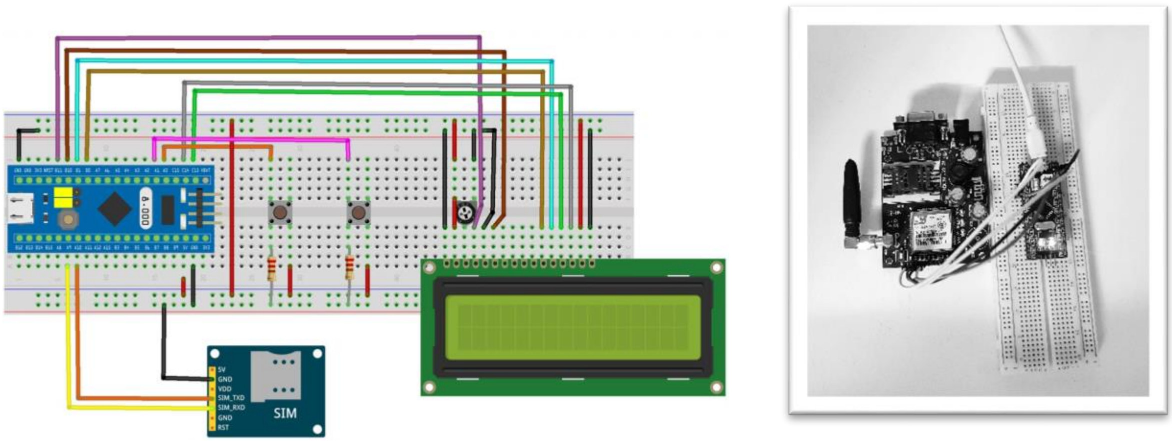


*Figure 23: SIM900A GSM integration with STM32 Blue Pill*

The SIM900A GSM module is powered by a 12V DC Power Adapter. The SIM900A is compatible with the 4G network, and AT-commands are used to access GSM Module capabilities such as transmitting and receiving voice calls and text messages.

| **SIM900A** | **STM32** |
|---|---|
| VCC | 5V |
| Tx | PA10 |
| Rx | PA9 |
| GND | GND |

MPU5060 employs Serial Clock (SCL) and Serial Data (SDA) pins for I2C connection. MPU6050's SCL pin is linked to STM32's SCL pin, while MPU6050's SDA pin is linked to STM32's SDA pin.

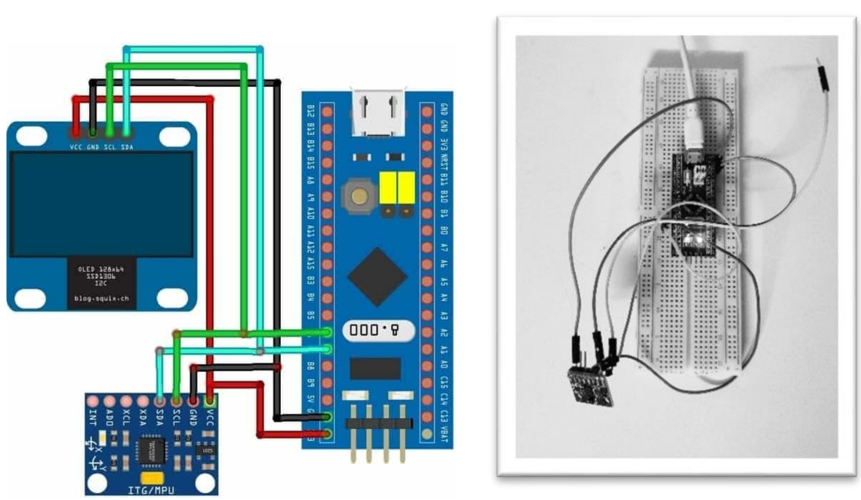


*Figure 24: MPU6050 integration with STM32 Blue pill*

| MPU6050 | STM32 |
|---|---|
| VCC | 5V |
| SDA | PB7 |
| SCL | PB6 |
| GND | GND |

The ESP8266 Wi-Fi module communicates via UART and uses the Tx and Rx pins to transmit and receive data. The Rx pin of the STM32 is linked to the Tx pin of the ESP8266, and the Rx pin of the ESP8266 is linked to the Tx pin of the STM32 blue pill.

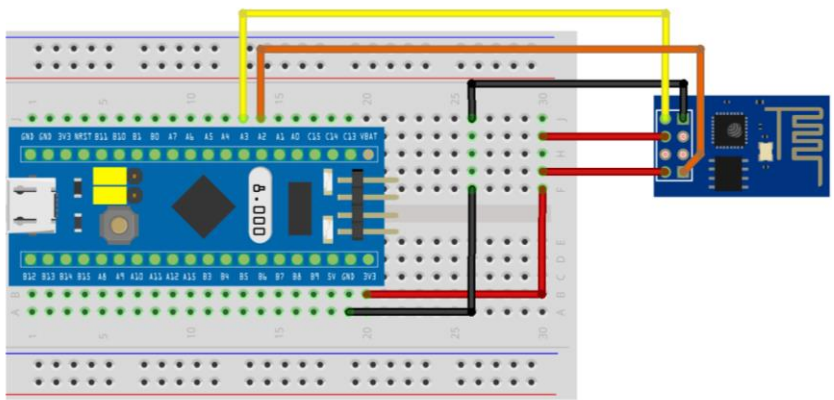

*Figure 25: ESP8266 Wi-Fi module integration with STM32 Blue Pill*

| ESP8266 | STM32 |
|---|---|
| VCC | 5V |
| Rx | PB10 |
| Tx | PB11 |
| CH_PD | 3.3V |
| GND | GND |

The STM32 with different peripherals like GSM, GPS, ESP8266, Accelerometer and Gyroscope connectivity is shown below.

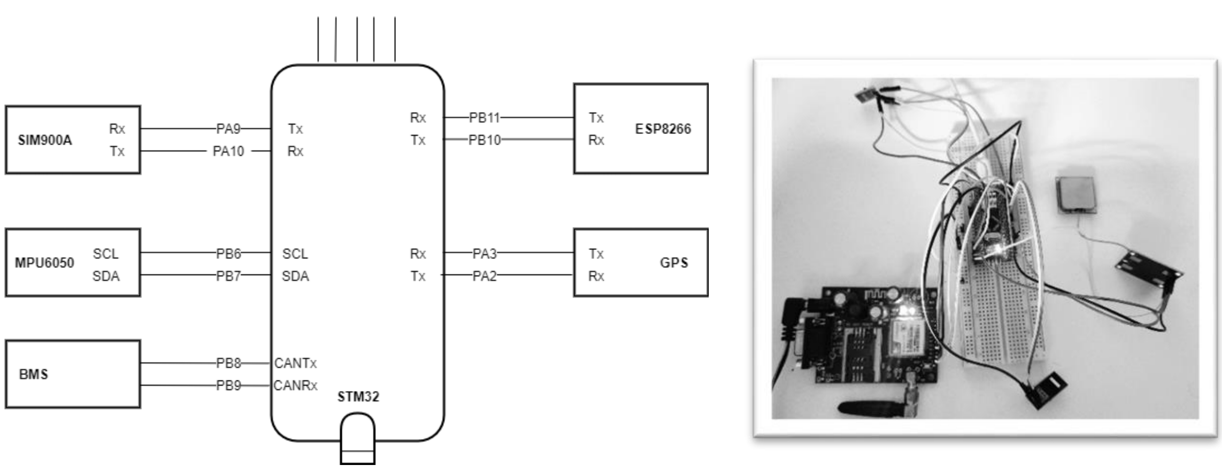


*Figure 26: STM32 Blue Pill integration with peripherals*

# 6. Results

After successful integration of the modules, I have achieved two things so far,

- Electric Vehicle Tracking
- Electric Vehicle Stability (Driver Behaviour)

1] Electric Vehicle Tracking

STM32 (TCU) connected to GPS and GSM, I was able to send the electric vehicle location over cellular network to the authorised owner or fleet manager.

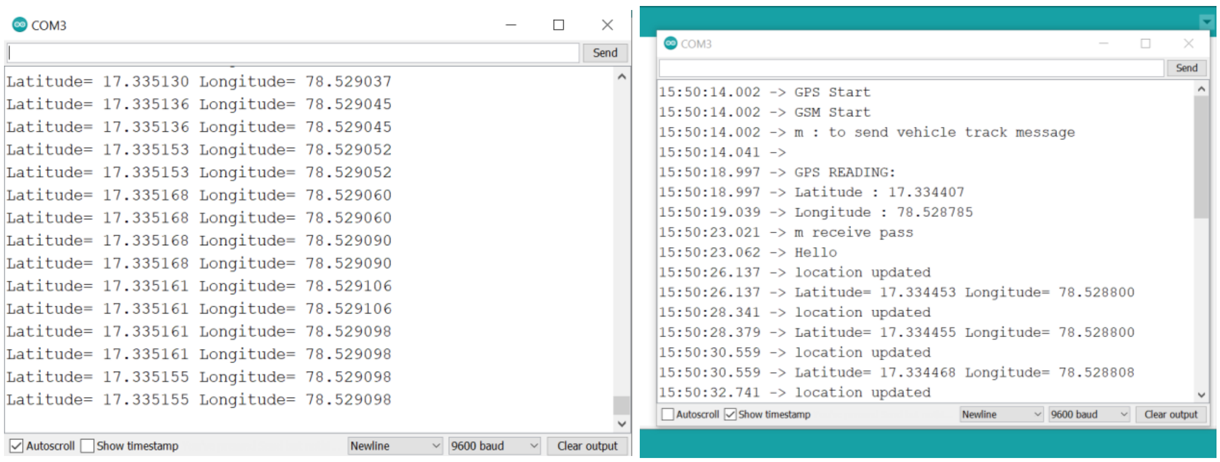


*Figure 27: Serial Monitor after TCU with GPS, GSM*

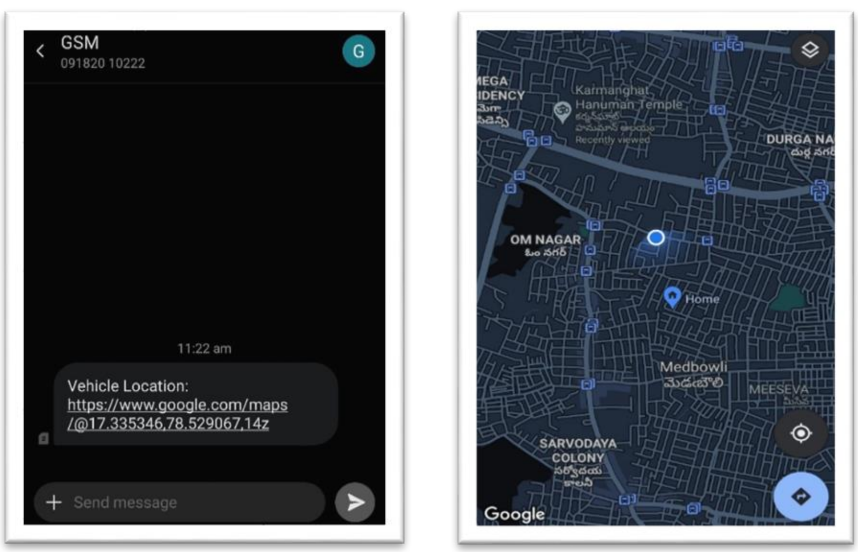


*Figure 28: Message received through cellular network and location of the EV*

The future work of this is, I'll be making a web server and creating a dashboard where the owner or the fleet manager can track the vehicle continuously.

2] Electric Vehicle Stability (Driver Behaviour)

STM32 (TCU) connected to MPU6050 (Accelerometer and Gyroscope), I have simulated the vehicle stability in a 3D simulator and was able to capture the axis values of the accelerometer and gyroscope.

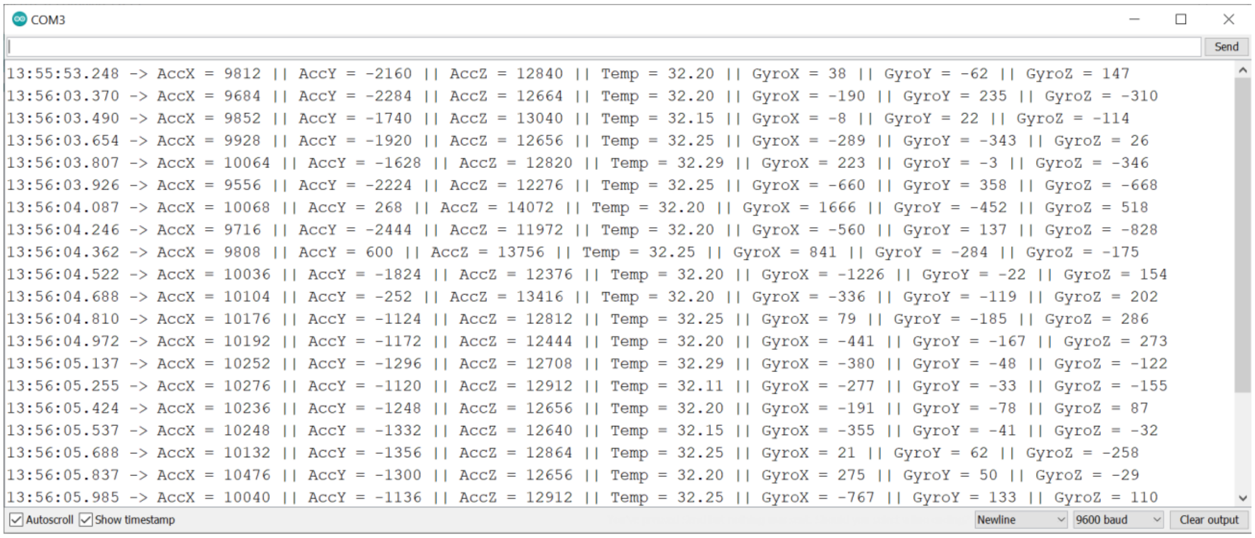


*Figure 29: Serial Monitor after TCU with Accelerometer and Gyroscope*

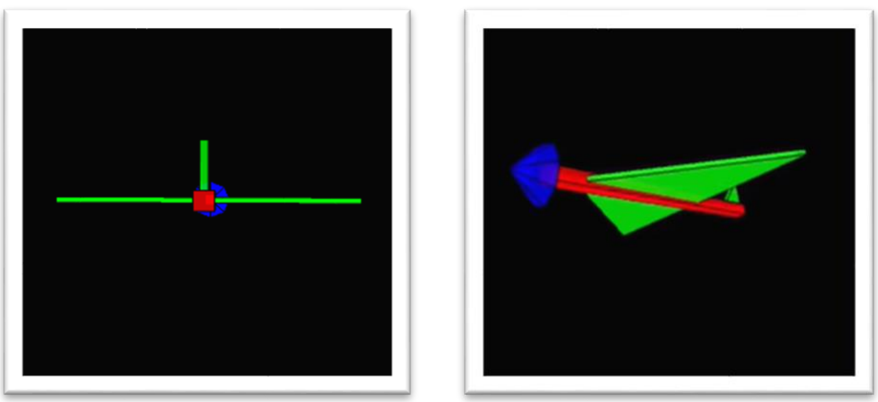

*Figure 30: 3D Simulation of Vehicle integrated with MPU6050 Module*

The future work of this is, I'll be making a web server and creating a dashboard where the owner or the fleet manager can check the vehicle stability and after certain calculations, we can also predict driver behaviour.

# 7. Conclusions

India is one of the major automobile manufacturers in the world. The demand for the automobile sector in the country is the reason for the increase in the competition in the industry. Every automobile company thrives on providing best-in-class technology in their vehicles at an economical price to attract customers.

EVS are known for their economic usage. It won't be long in a country like India before EVs take over the traditional gas-run vehicles. Drivers everywhere benefit from car telematics for a variety of reasons. This technology prevents individuals from being lost, makes it simple to get roadside assistance, and captures data that may be utilized in a variety of ways. Telematics is a type of technology that combines navigation, safety, security, and communication into a single device that fits in the dashboard of a vehicle.

Major Benefits of this EV Telematics Module achieved till now

- Vehicle Tracking
- Vehicle Stability (Driver Behaviour)

Working on this project at Interwork Software Solutions Pvt. Ltd. was highly beneficial to me. I learned a great deal about working in the corporate space and how real-time projects are executed in practical nature. I realized that it is not an individual effort, instead, it is a team effort in which many people are responsible for their tasks. I am very grateful for this opportunity provided to me by BML Munjal University in Practice School 3.

# 8. References


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