Condition Monitoring of Battery in EV using IoT

B. TECH PROJECT

Submitted by

GROUP 10

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Condition Monitoring of Battery in EV using IoT

PROBLEM STATEMENT

Traditional monitoring methods may not offer real-time and comprehensive insights, posing safety risks and inefficient battery usage. Battery failure or degradation in EVs can lead to downtime, costly repairs, and reduced performance. Leveraging IoT for battery monitoring can provide real-time insights.

OBJECTIVES

1) To sense and obtain the real time values of the three variables of the battery :
   a) Voltage
   b) Current
   c) Temperature
2) To store the obtained values in Microsoft Azure Cloud storage.
3) To display the stored values on Power BI dashboard.

OUTLINE

1) Condition monitoring
2) Need of condition monitoring of battery in EV
3) Workflow
4) Components
5) Circuit diagram and connections
6) Cloud & interface
7) Conclusion
8) Timeline
9) References
10) Acknowledgement
11) Achievement

CONDITION MONITORING

The condition monitoring system gives an insight into the operating condition of the equipment being monitored thus the better prediction of preventive or emergency measures can be taken.

Condition Monitoring

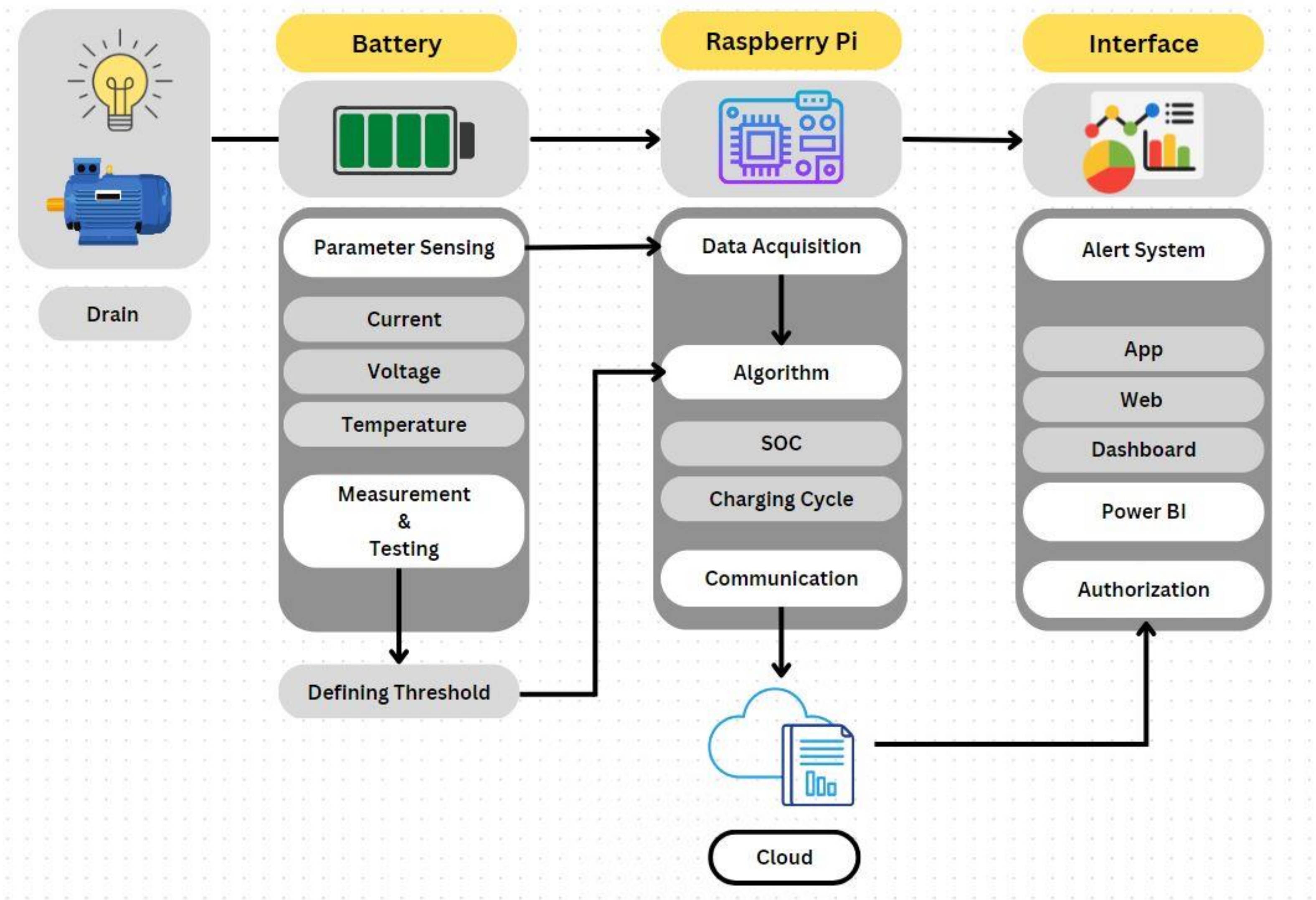
Safe Operation

Prevention of Unplanned Downtime

Cost Reduction

NEED OF CONDITION MONITORING OF BATTERY IN EV

WORKFLOW



Battery
Raspberry Pi
Interface
Drain
Parameter Sensing
Current
Voltage
Temperature
Measurement
&
Testing
Defining Threshold
Data Acquisition
Algorithm
SOC
Charging Cycle
Communication
Cloud
Alert System
App
Web
Dashboard
Power BI
Authorization

CIRCUIT DIAGRAM AND CONNECTIONS

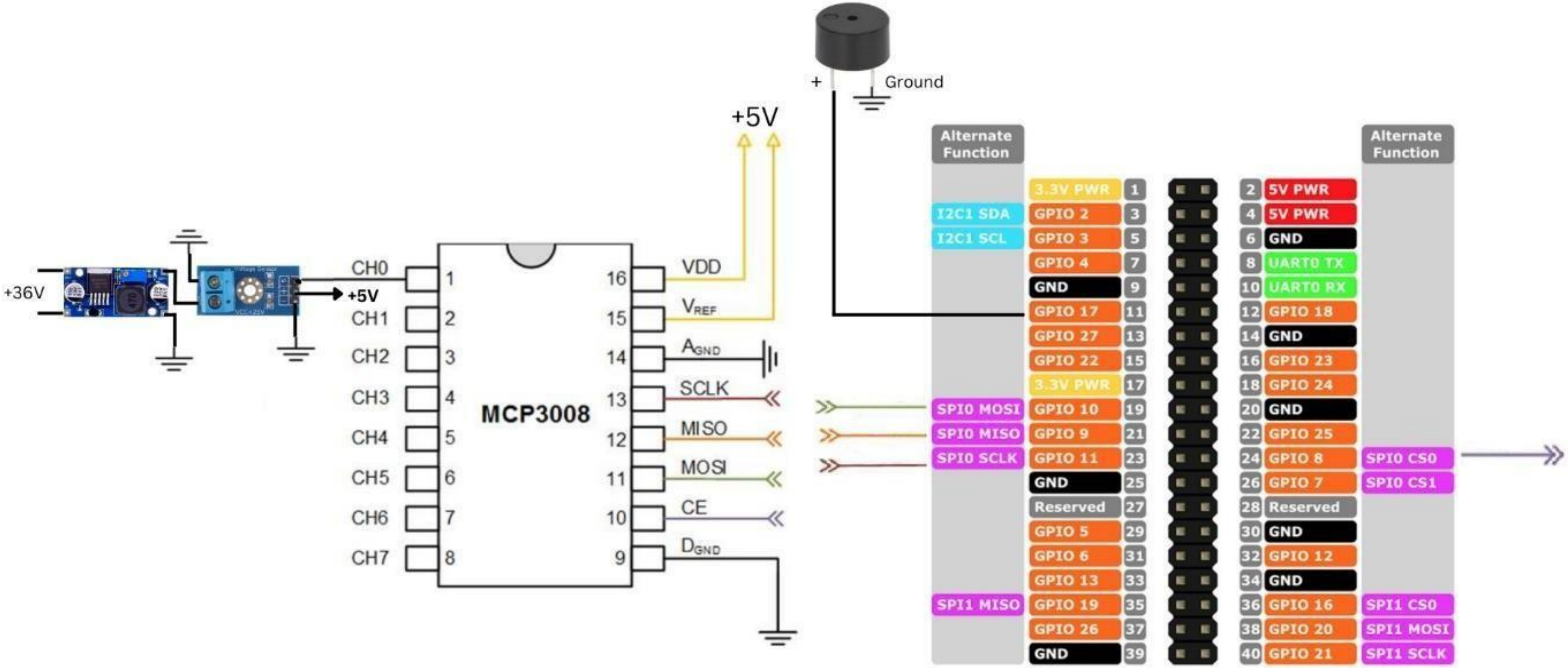


Fig.1 Circuit Diagram

CONTROLLER

- Raspberry Pi 3 (Model A+) acts as brain of our condition monitoring system.
- It provide platform for sensors, fetch the data and transform it as per our requirements.
- Key features :

✓ Compatible to Python
✓ Ethernet & Wi-Fi connectivity
✓ Interactive OS

- Raspberry Pi has 40 GPIO pins (Digital). Analog sensors communicate via MCP3008 (10 Bit, 8 Channel ADC).

Fig.2 Raspberry Pi 3 (Model A+)

COMPONENTS

MCP3008 A/D Converter:

- Analog to digital converter
- 8 input channels
- SPI serial interface

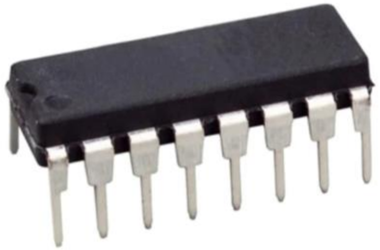


Fig.3 MCP3008 A/D Converter

Fig.4 Voltage Detection Sensor

Voltage Detection Sensor Module:

The Voltage Sensor Module (25 V) allows to give the analog input to the microcontroller via ADC to monitor voltage.

COMPONENTS

LM2596HVS DC-DC buck converter:

It is DC-to-DC converter (buck converter) module with an input voltage range of 4.5 volts to 50 volts and an output of 3 volts to 40 volts.

Fig.5 DC-DC Buck Converter

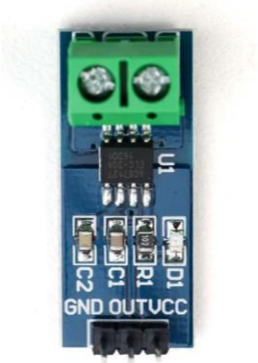


Fig.6 Current Sensor ACS712

Current Sensor ACS712:

It is current sensor module which operates on 5V supply. It is used for both AC and DC currents. Two Current sensors are used :

1) Current sensor for Charging : 5A Range,185 mV/A output sensitivity
2) Current sensor for Discharging : 30A Range,66 mV/A output sensitivity

COMPONENTS

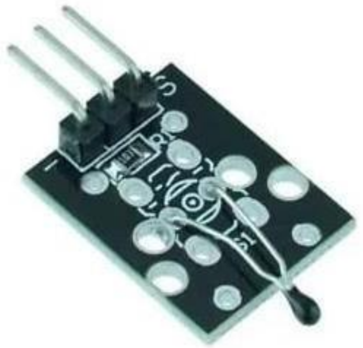


Fig 7. Analog temperature module

Analog temperature module:

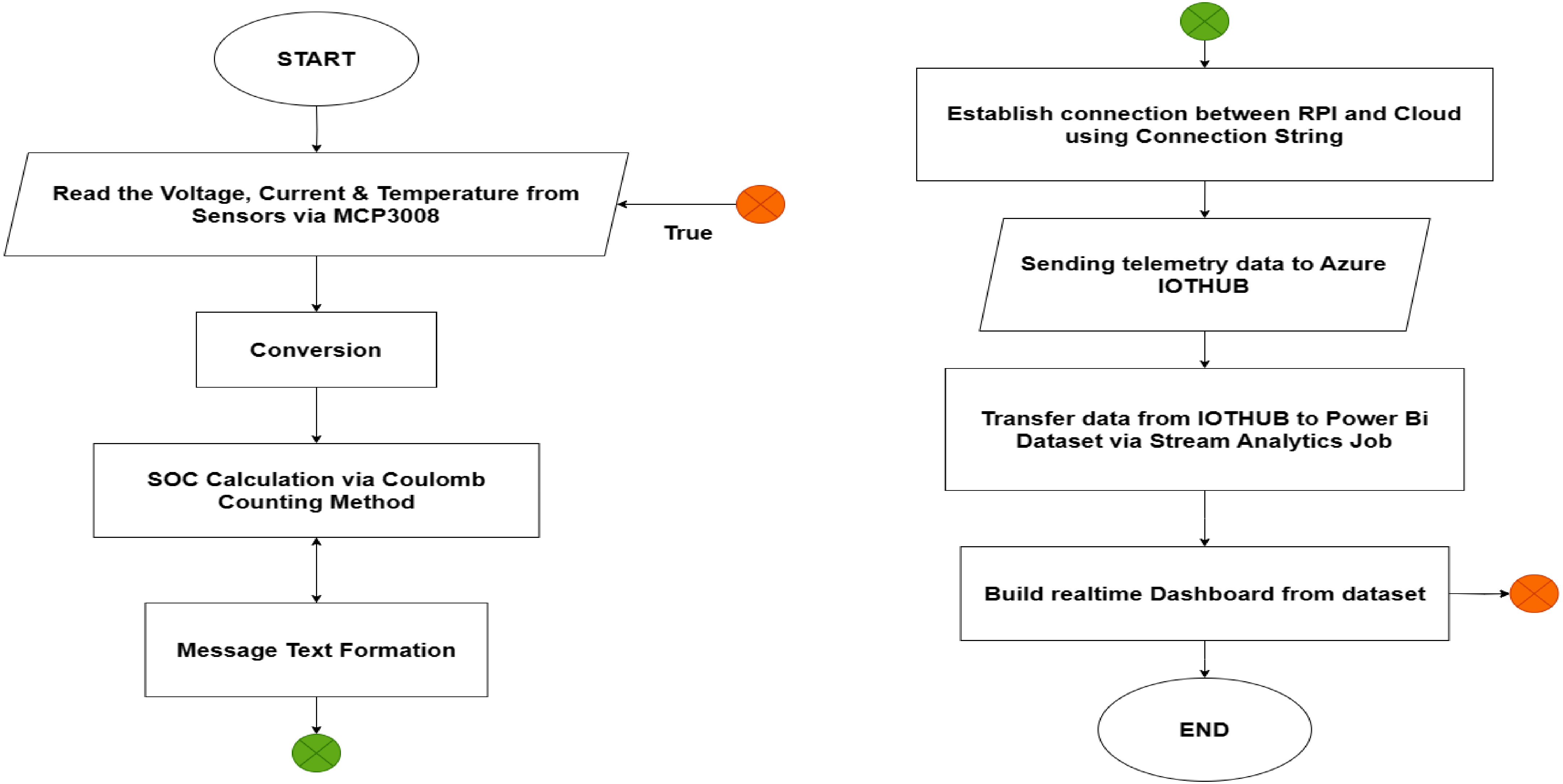
The Analog Temperature Module is based on a thermistor (NTC), which senses the changes in the ambient temperature in real time by changing resistance in response to changes in temperature.

5V Active Electromagnetic Buzzer:

This is a 5V active electromagnetic buzzer. It is PCB mountable. It uses a coil element to produce an audible tone and runs on a 5V supply.

Fig 8. Buzzer

FLOWCHART :



START
Read the Voltage, Current & Temperature from Sensors via MCP3008
True
Conversion
SOC Calculation via Coulomb Counting Method
Message Text Formation
Establish connection between RPI and Cloud using Connection String
Sending telemetry data to Azure IOTHUB
Transfer data from IOTHUB to Power Bi Dataset via Stream Analytics Job
Build realtime Dashboard from dataset
END

SOC CALCULATION

SOC calculation is done by Coulomb Counting method.

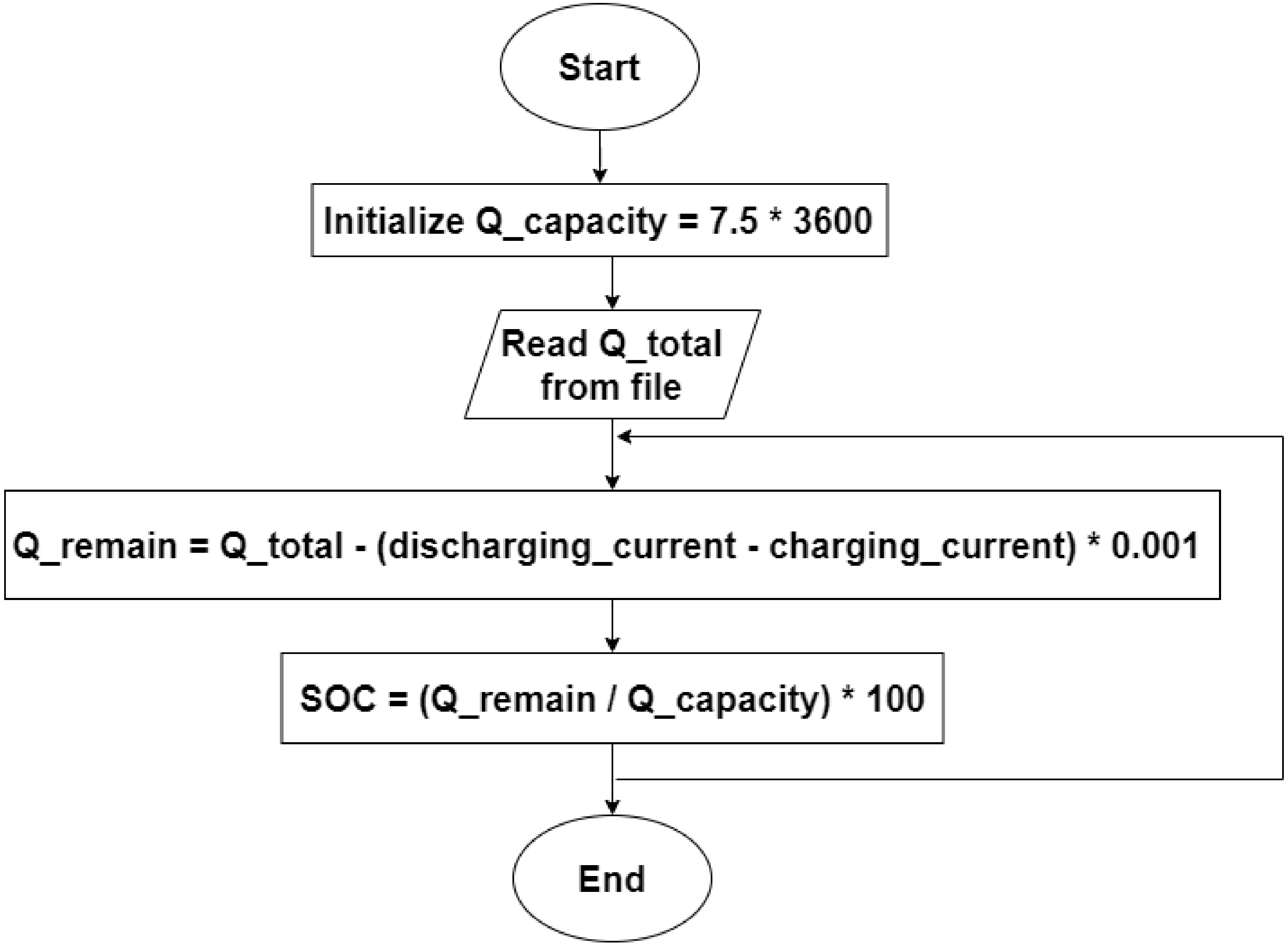
Certain assumptions are made like the effects of temperature are neglected and Current is considered constant for 1 msec.

The Coulomb Counting method measures the discharging current of a battery and summation of the discharging current over time is done in order to estimate SOC, as the current we are getting is discrete.

$$\boxed{Q\_remain = Q\_total - \sum I\_discharging}$$

$$\boxed{\%\ soc = \frac{Q\_remain}{Q\_total}}$$

FLOWCHART OF SOC CALCULATION

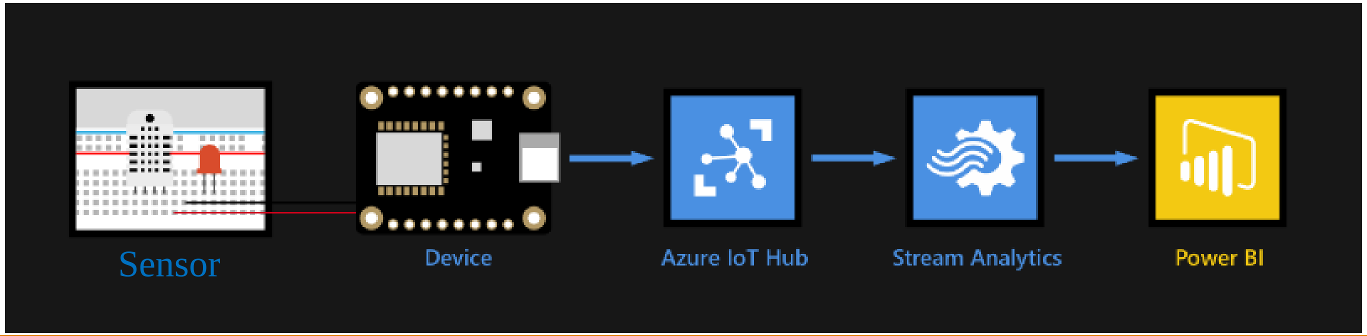


CLOUD AND INTERFACE

- **Microsoft Azure** provides cloud services & Power BI is User Interface.
- Azure is “Pay as you Go” service model & student gets $100 credit for development & Learning purpose.
- We use two SaaS services in our project :

  IoT HUB : To established connection between RPi & Cloud.

  Stream Analytics Job : Streaming data from Hub to Power BI endpoints.
- Azure comes with robust framework & security provided by Microsoft.
- **Power BI** is a Visualization tool by Microsoft which helps to create lucrative Dashboards. It provides Website along with Android application to create interactive dashboard.



DASHBOARD

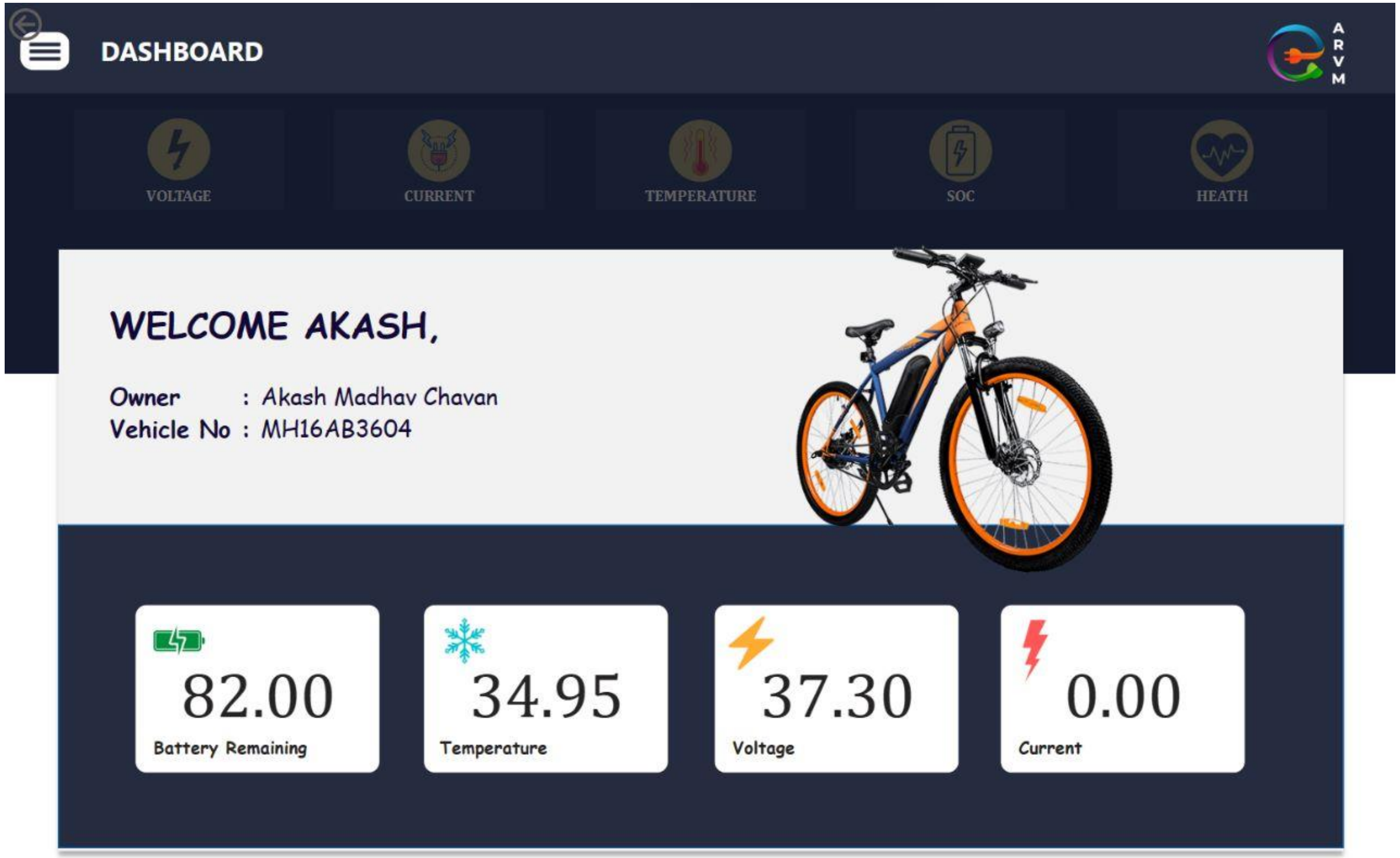


Fig.10 Web Version

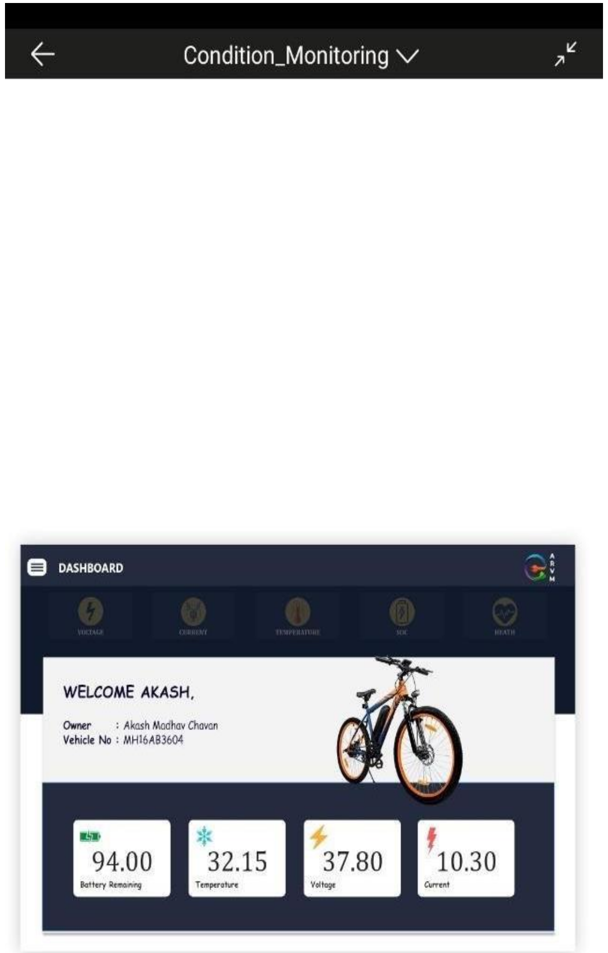


Fig.11 Mobile Version

E-CYCLE & ITS SPECIFICATIONS

Fig.9 Electric Cycle

Specifications of E-cycle :

1. Average speed = 25 km/hr.
2. Peak speed = 30 km/hr.
3. In single charging cycle, distance covered is 27 to 30 km.
4. Cycle takes approximately 2 hours for charging.

E-CYCLE CONVERSION KIT COMPONENTS

Fig.12 Motor

It is 36V, 250W High Power BLDC (Brushless DC) Motor.

Fig.13 Battery

It is 36V Lithium -ion Battery. Its capacity is 7.5 Ah .

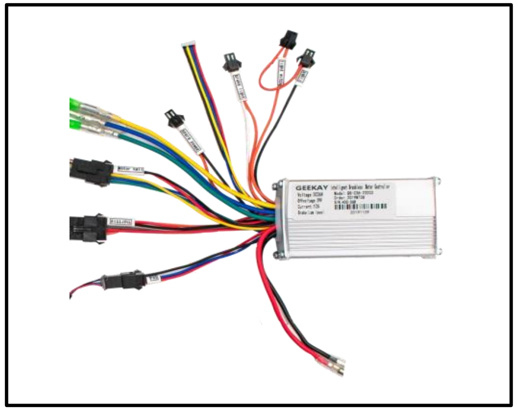


Fig.14 Motor Controller

Fig.15 Throttle

CONCLUSION

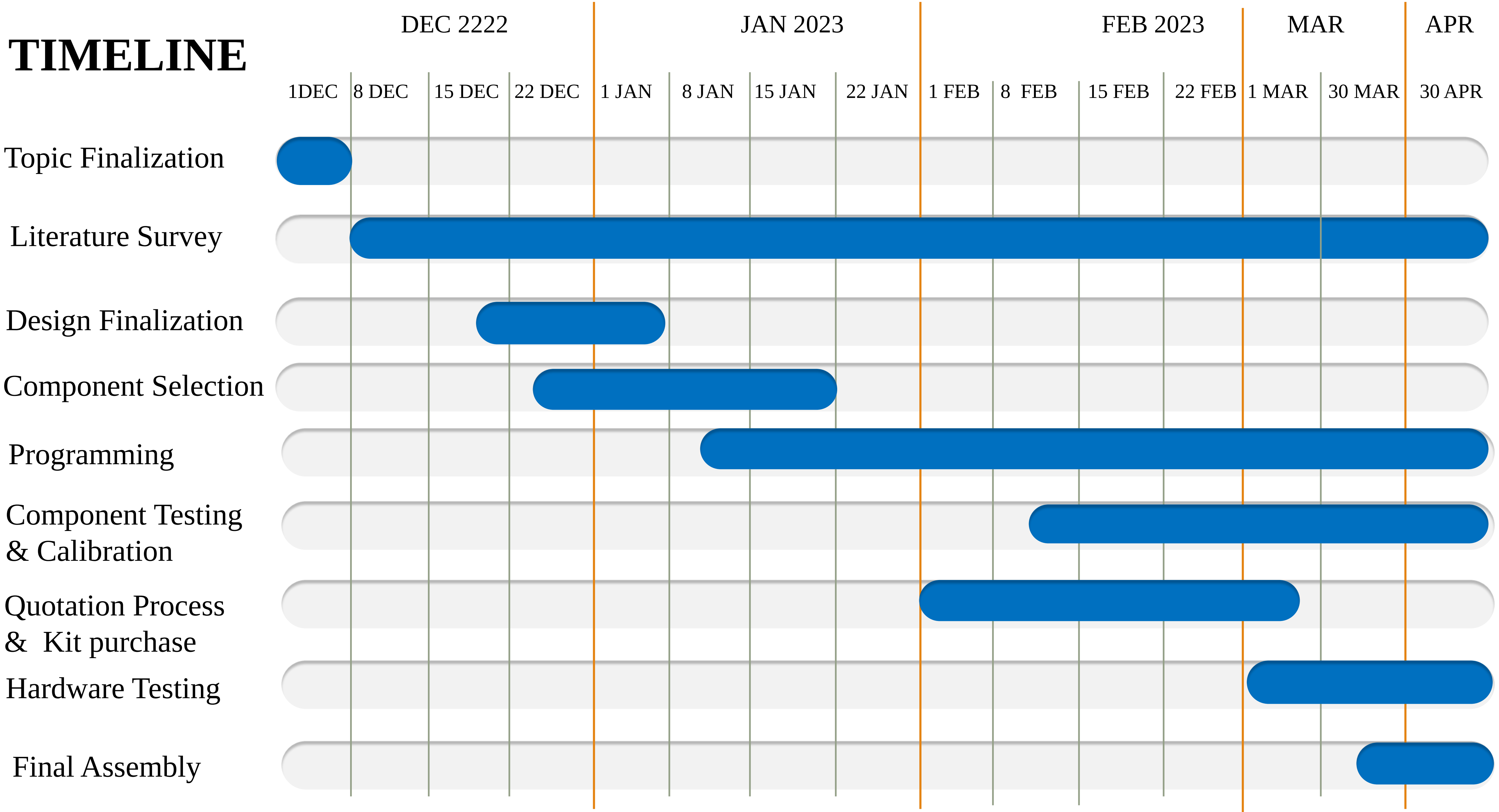
Battery condition monitoring using IoT offers a promising approach for ensuring safe and cost-effective use of vehicles.

The proposed battery monitoring system demonstrates :

- Excellent capabilities in terms of data transmission
- Easy installation
- Efficiently collect and display vital battery parameters such as voltage, current, temperature and SOC on a Power BI dashboard
- Data accessible to users through a mobile application at any time and from anywhere
- Enhances convenience and accessibility

The battery monitoring system plays a crucial role in supporting users and manufacturers in future vehicle maintenance.

TIMELINE


DEC 2222
JAN 2023
FEB 2023
MAR
APR
1DEC
8 DEC
15 DEC
22 DEC
1 JAN
8 JAN
15 JAN
22 JAN
1 FEB
8 FEB
15 FEB
22 FEB
1 MAR
30 MAR
30 APR
Topic Finalization
Literature Survey
Design Finalization
Component Selection
Programming
Component Testing & Calibration
Quotation Process & Kit purchase
Hardware Testing
Final Assembly

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ACHIEVEMENT

THANK YOU!!