Mid Term Presentation of BTP project

Real-time Battery Monitoring system using Machine Learning

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Introduction to Battery Monitoring System

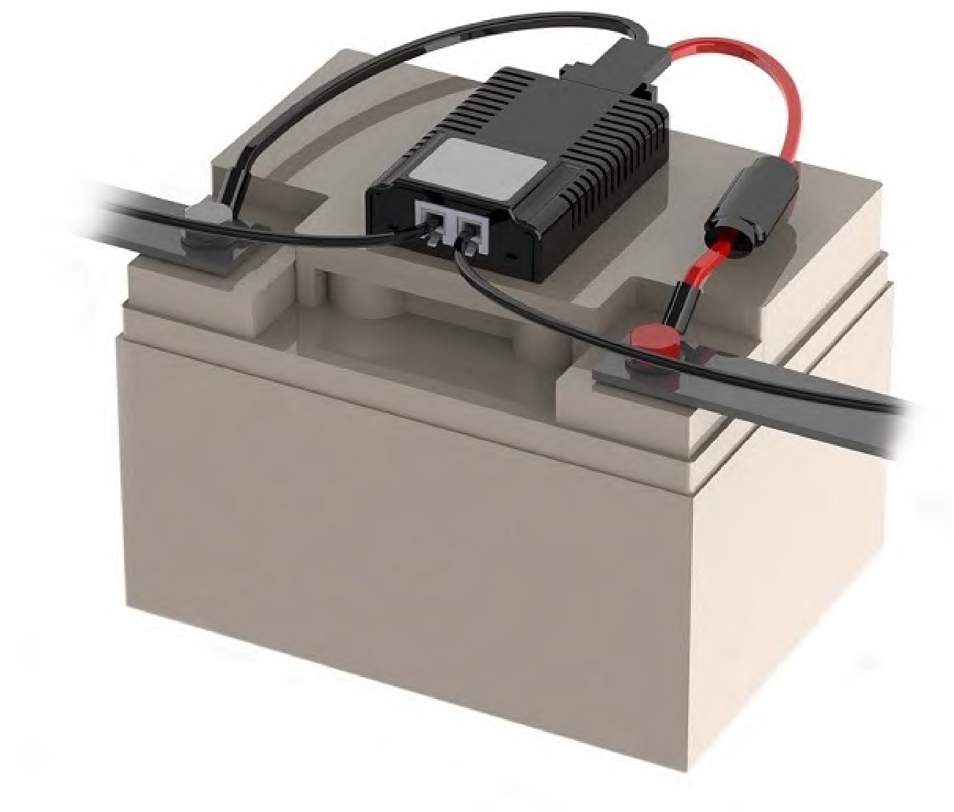
Purpose

- With the rise of electrification in various tech products, many countries are working towards optimizing the performance and safety of battery operated machines.

- Lithuim-ion battery is used widely. This wide usage is primarily because it is lighter, efficient, charge faster and have a longer lifespan than other.

- Practically, Li-ion batteries are susceptible to many conditions that can damage the battery pack.

- Thus a typical Battery Monitoring System (BMS) became a revolutionary component which has the capability to monitor and optimize various parameters like Current, Voltage, Temperature, concerned for the safety.



www.missioncriticalmagazine.com

Introduction to Battery Monitoring System

Functions

- The primary function of the BMS is to protect the battery cells from damage caused by being overcharged or over-discharged.
- But it has many more functionalities apart from protecting:

Sensing Functionalities

- Measures cell voltages
- Measure cell current
- Measure cell temperature

Functions

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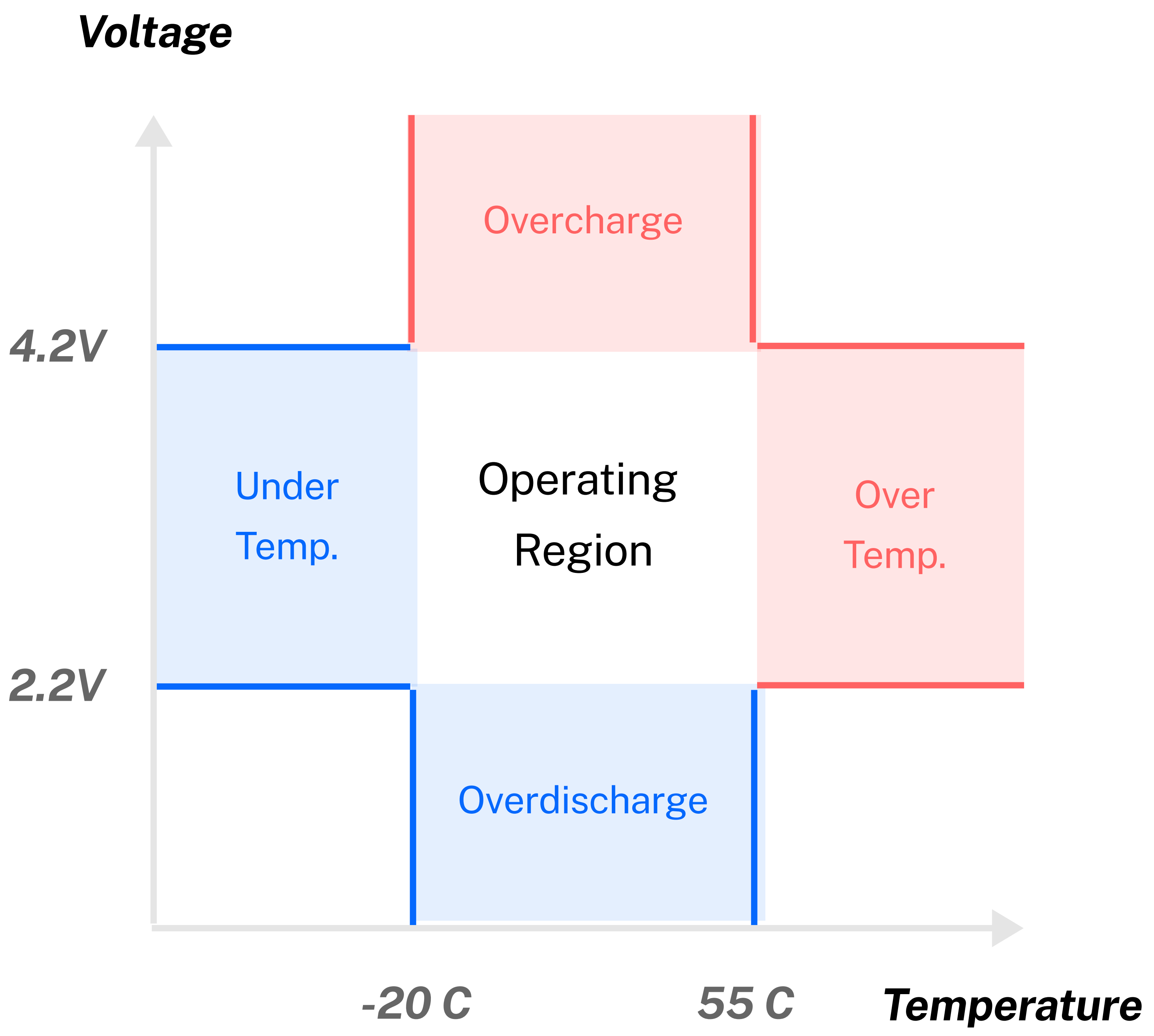
Protection Functionalities

- Over Voltage , Current & Temperature
- Short Circuits
- Disconnecting a cell if faulty



Introduction to Battery Monitoring System

Functions

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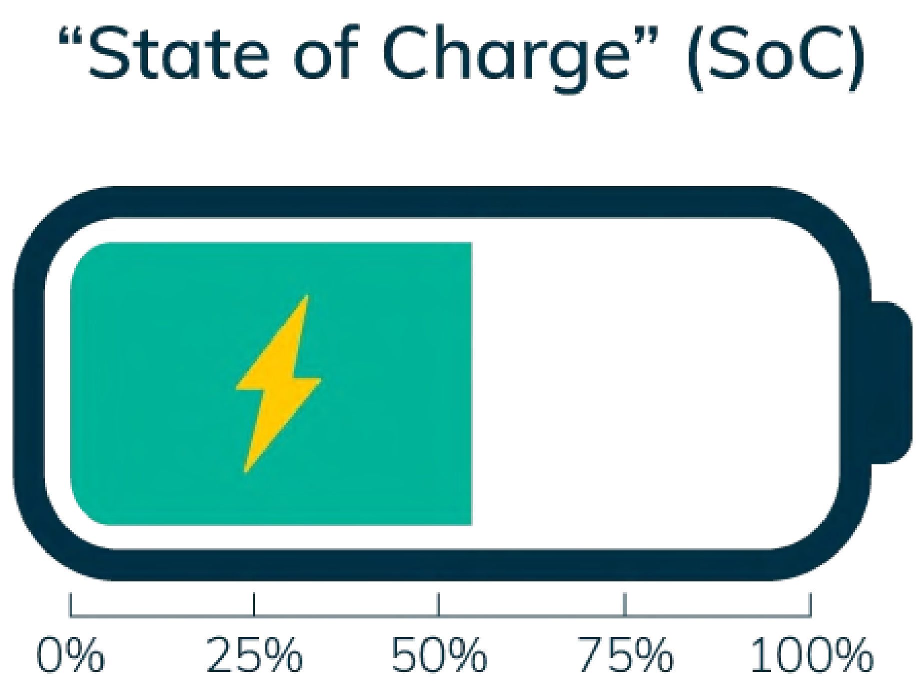
Estimation

State of Charge (SOC)

- It is the level of charge of a battery relative to its capacity of charge.



www.evgo.com

Functions

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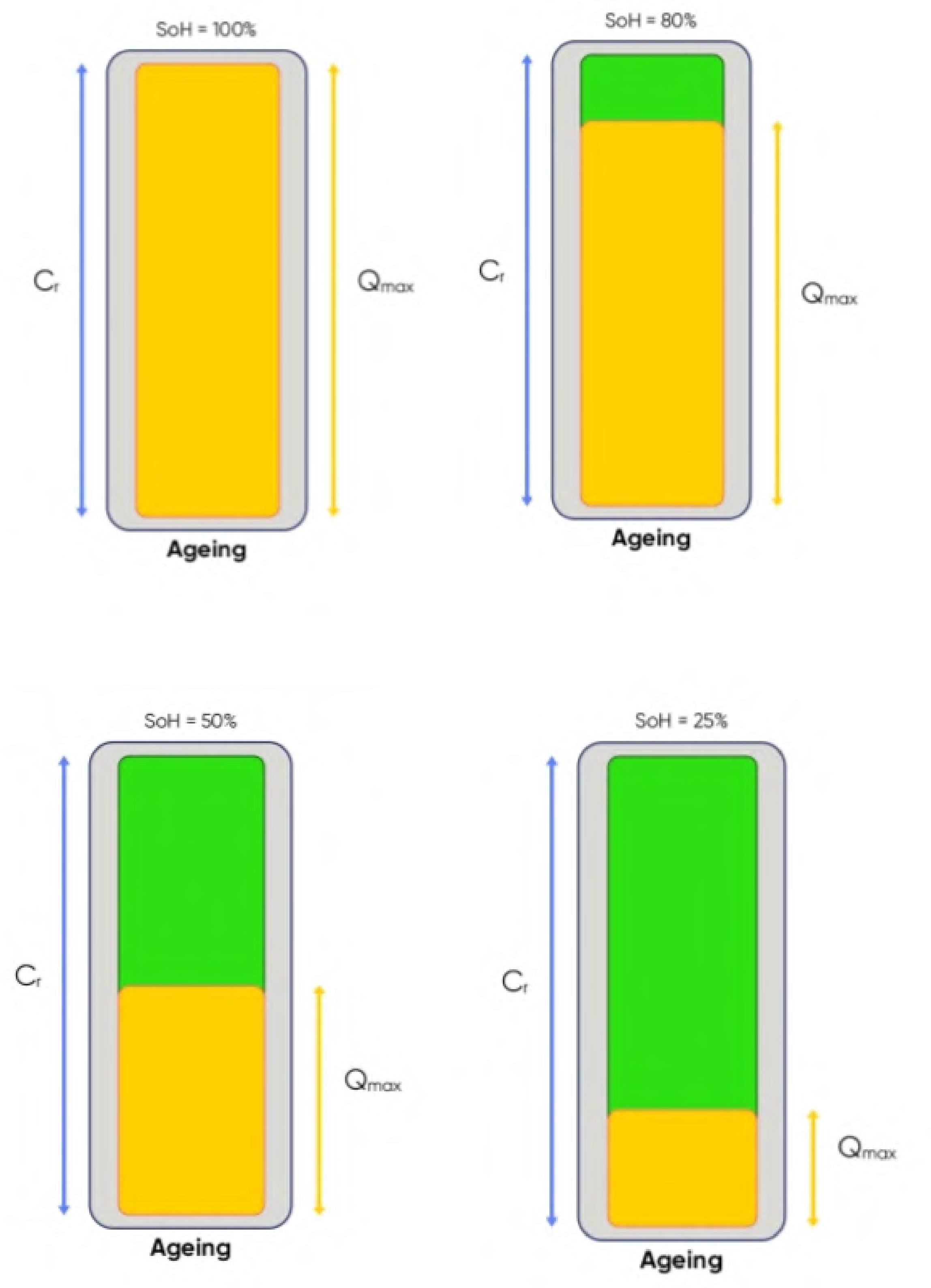


www.biologic.net

Estimation

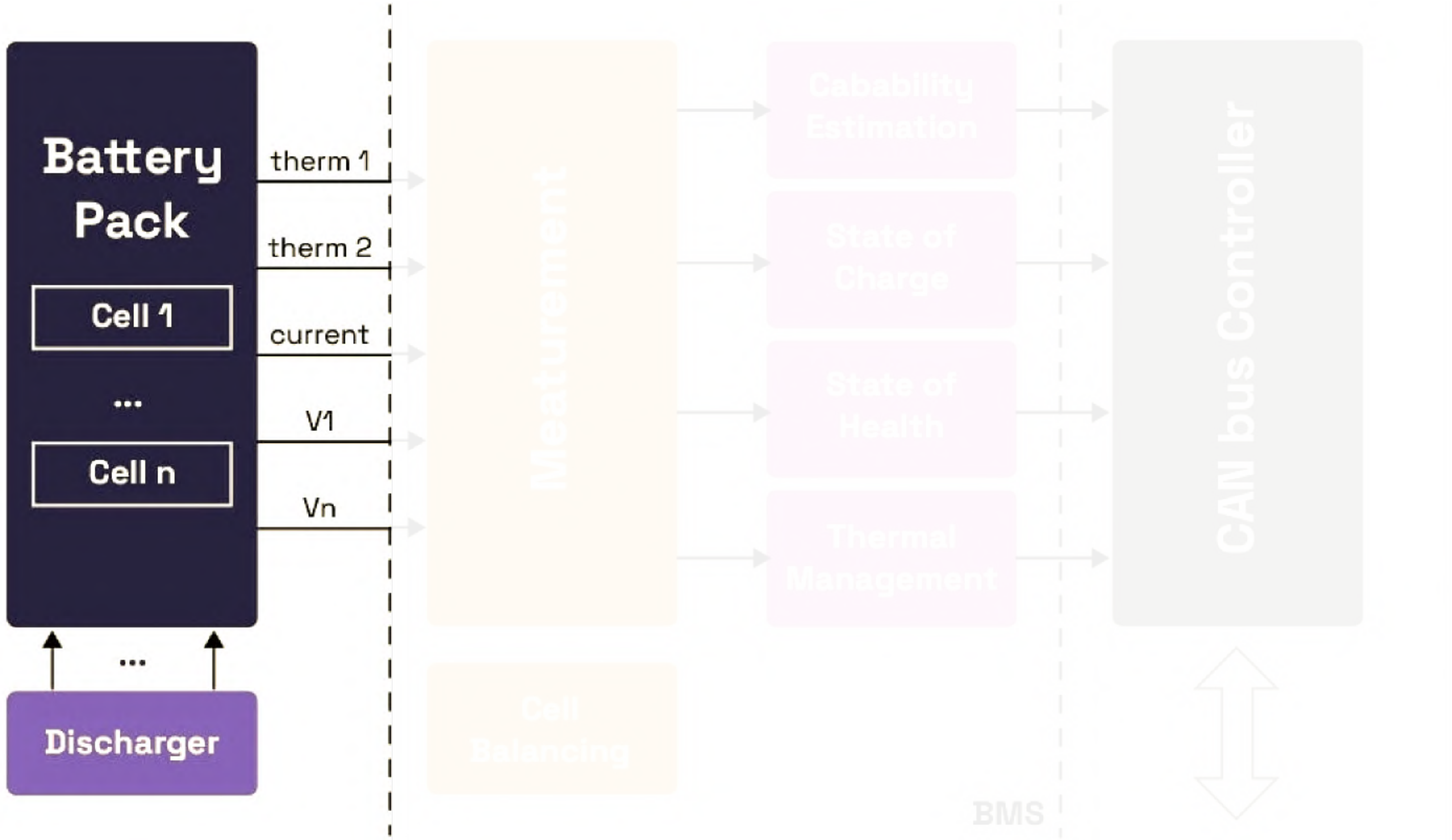
State of Health (SOH)

- It is the measure of a performance of a battery considering the difference of the maximum capacity currently in use to the maximum capacity of a fresh battery.

Introduction to Battery Monitoring System

Working

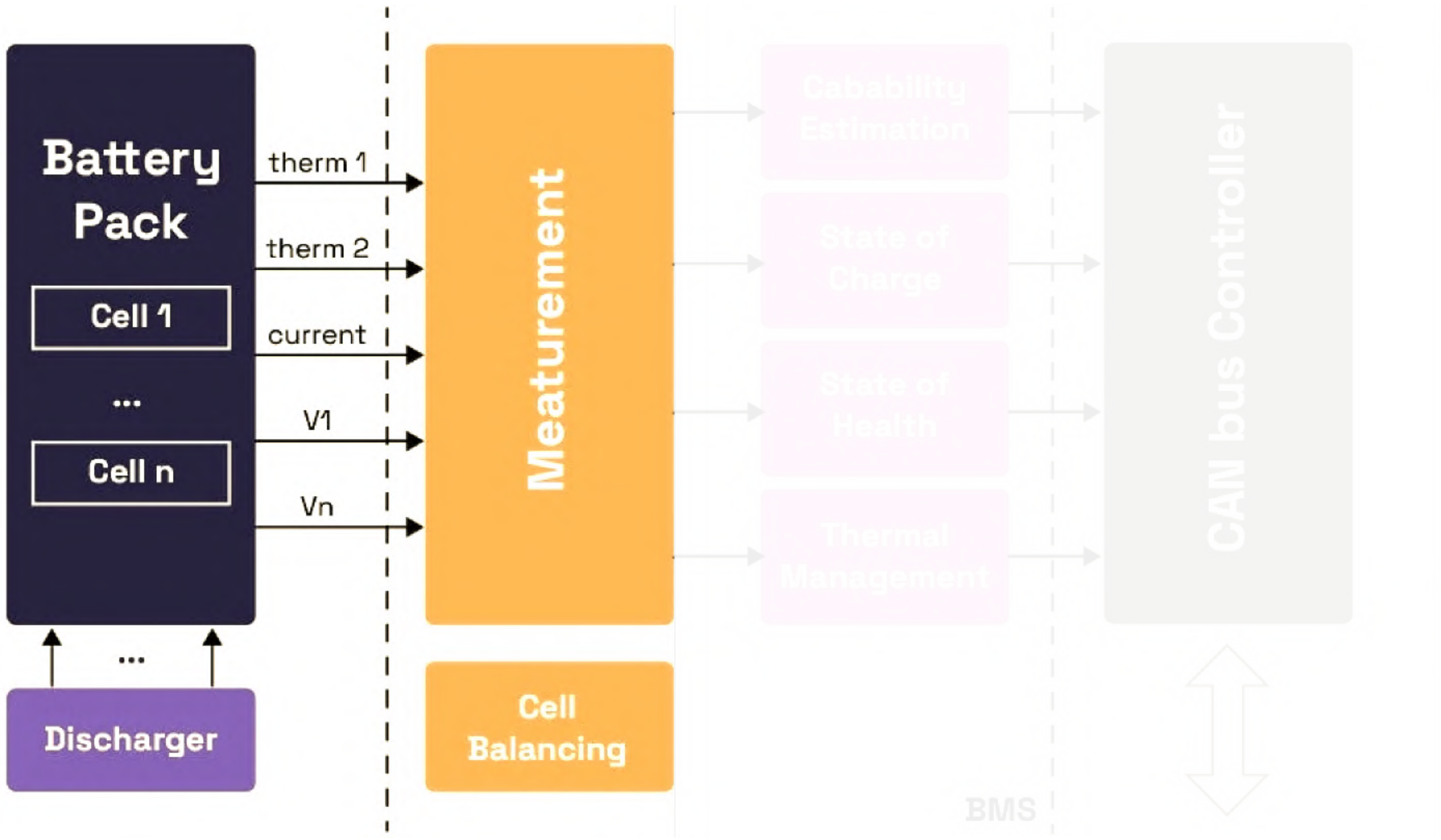
1. BMS gets the data from various sensors



Introduction to Battery Monitoring System

Working

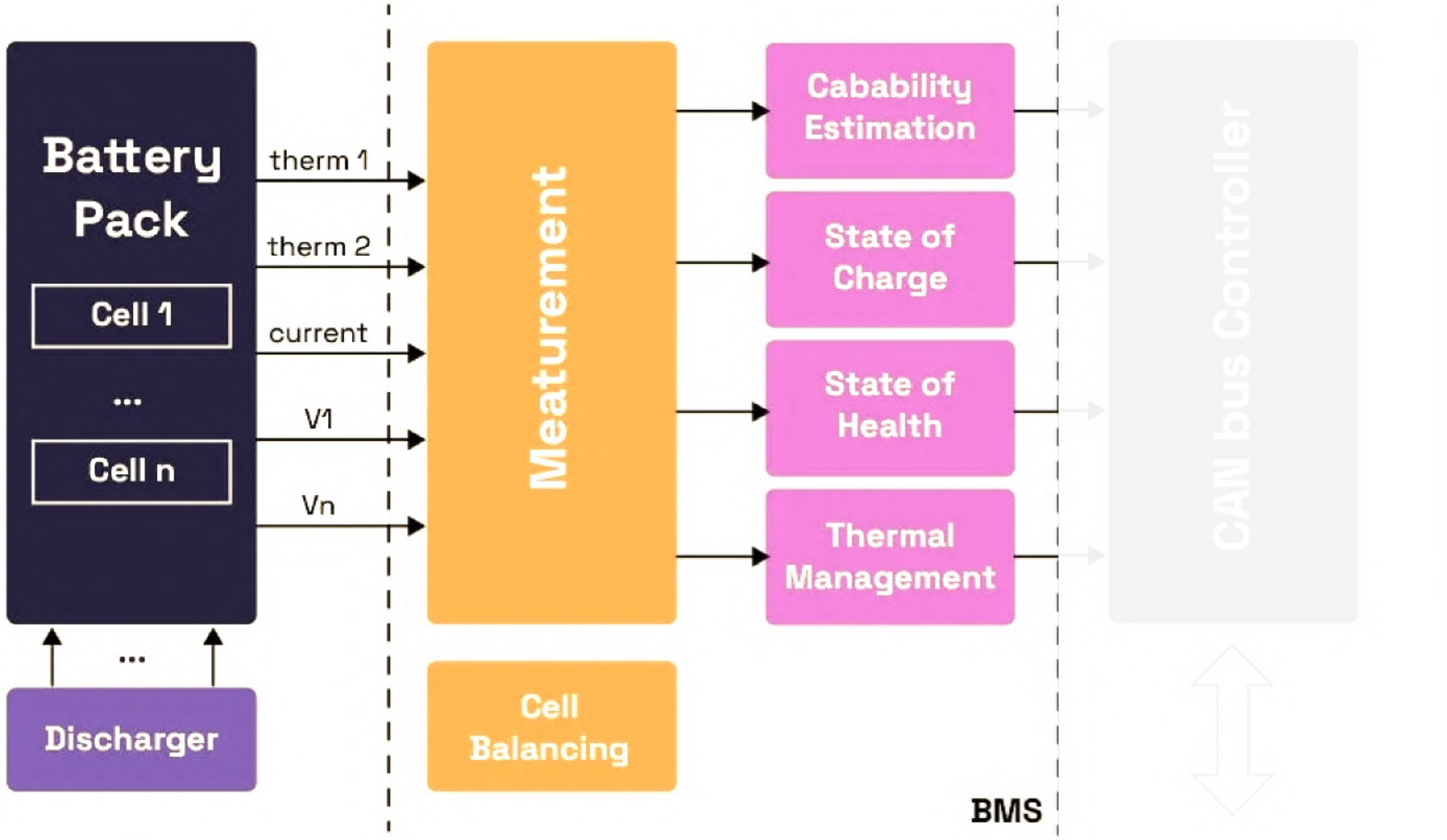
1. BMS gets the data from various sensors
2. Measuring with the help of a Microcontroller unit



Introduction to Battery Monitoring System

Working

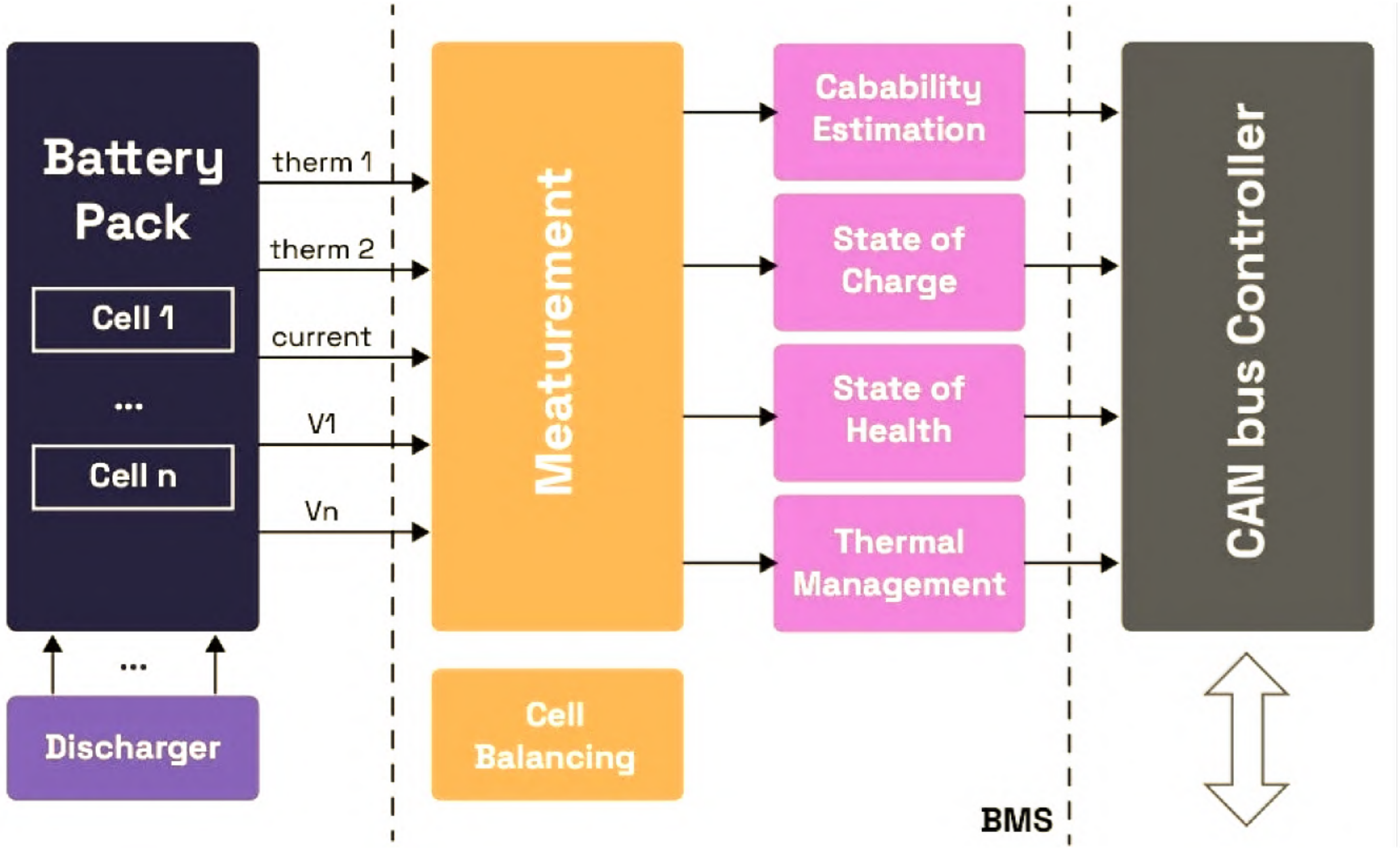
1. BMS gets the data from various sensors
2. Measuring with the help of a Microcontroller unit
3. Estimation of State of Charge, State of Health, Thermal Status with various algorithms



Introduction to Battery Monitoring System

Working

1. BMS gets the data from various sensors
2. Measuring with the help of a Microcontroller unit
3. Estimation of State of Charge, State of Health, Thermal Status with various algorithms
4. Data sent through Control Area Network of that system to perform require actions



Introduction to Battery Monitoring System

Applications

Electric Vehicles

On Board Battery Charger

Autonomous Vehicle

Multicopters and Drones

Service Robots

Power Tools

Wearables

Home Appliances

Smart Audio

Wireless Charging

Literature Reviews

Sr.No	Paper Title	Authors	Summary
1.	A Guide to Lithium Polymer Batteries for Drones *Article - Tyro Robotics*	Lauren Nagel	• How to read the specifications of a Li-Po Battery Pack • Understandin C-Rate, Maximum Capacity, Supply Voltage
3.	Battery Management System Hardware Concepts: An Overview *Applied Sciences MDPI (Page 2-14)*	Markus Lelie Thomas Braun Marcus Knips Hannes Nordmann Florian Ringbeck Hendrik Zappen Dirk Uwe Sauer	• Existing concepts in a BMS System • Different topologies of current BMS System of different companies
4.	Design a Battery Monitoring System for Lead-Acid Battery *International Journal of Creative Research Thoughts (IJCRT) (Page 308 - 310)*	Niraj Agarwal Phulchand Saraswati Ashish Malik Yogesh Bateshwar	• How to use current sensor and temperature sensor to measure SOC

Literature Reviews

Sr.No	Paper Title	Authors	Summary
4.	Battery Management Systems: Accurate State-of-Charge Indication for Battery-Powered Applications *ISBN 978-1-4020-6944-4*	P. P. L. Regtien H. J. Bergveld Dmitry Danilov Valer Pop	• Detail study and drawbacks between different methods like Coulomb Counting, Voltage Acquisition to determine the State of Charge
5.	Machine Learning Approaches in Battery Management Systems: State of the Art *IEEE Explore (Page 63-64)*	Reza Ardeshiri Bharat Balagopal Amro Alsabbagh Chengbin Ma Mo-Yuen Chow	• Comprehensive study of different Neural Network approaches in the estimation of SOC and Remaining Useful Life of a battery
6.	Predicting the Current and Future State of Batteries using Data-Driven Machine Learning *Nature Machine Intelligence*	Man-Fai Ng Jin Zhao Qingyu Yan Gareth J. Conduit Zhi Wei Seh	• Advantages of data driven models and challenges in current models
7.	Overview of Machine Learning Methods for Lithium-Ion Battery Remaining Useful Lifetime Prediction *Electronics*	Siyu Jin Xin Sui Xinrong Huang Shunli Wang Remus Teodorescu Daniel-Ioan Stroe	• Review of different ML Algorithms and to find the best and accurate one

Problem Statement

- Currently, battery monitoring system rely mostly on measurement of current and voltage and ultimately SOC through hardware systems.
- These methods neglect to consider temperature of surroundings as a parameter, which are pretty critical in understanding the true runtime of the battery
- Current algorithms (such as Coulomb Counting, Voltage Method) suffer from Hysterisis — a condition where there is a delay in the output of a system —causing a certain error in measurements
- Battery aging effects are not taken seriously which effects the accuracy

Objectives

- In this age of Artificial Intelligence, there are very few BMS systems based on Machine Learning

- One of the best solution to overcome the challenges aforementioned is to use data driven approach in order to be efficient and accurate.

- To study different machine learning approach and to find the best approach.

- To bring into account the effect of battery temperature in order to get the optimum result.

Methodology

1. To make a BMS Hardware system to get a real time current, voltage data

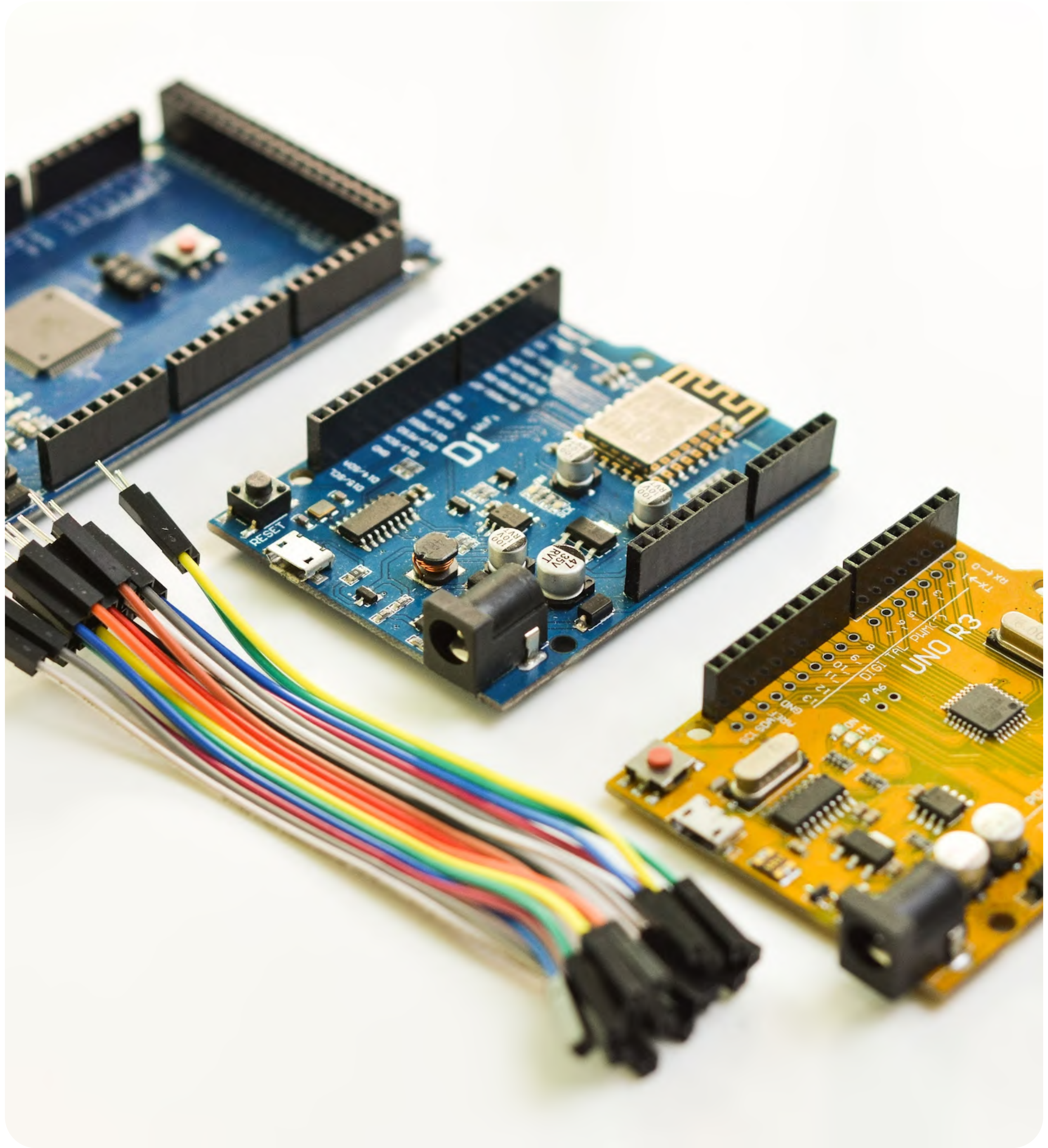


Image credit - Unsplash.com

Methodology

1. To make a BMS Hardware system to get a real time current, voltage data

2. Testing the hardware system

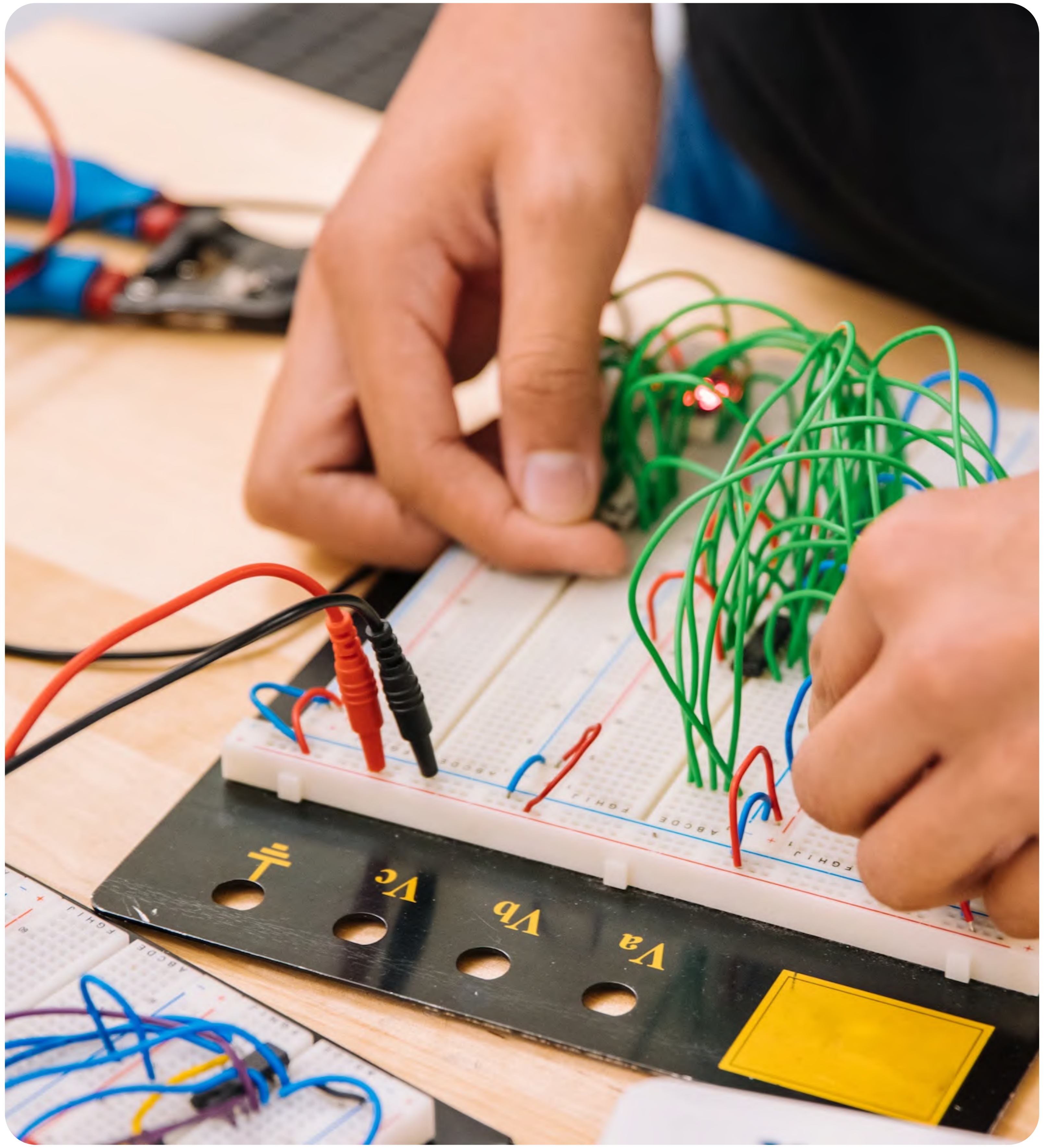


Image credit - Unsplash.com

Methodology

1. To make a BMS Hardware system to get a real time current, voltage data

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2. Testing the hardware system

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3. Select a Machine Learning Algorithm with necessary requirements

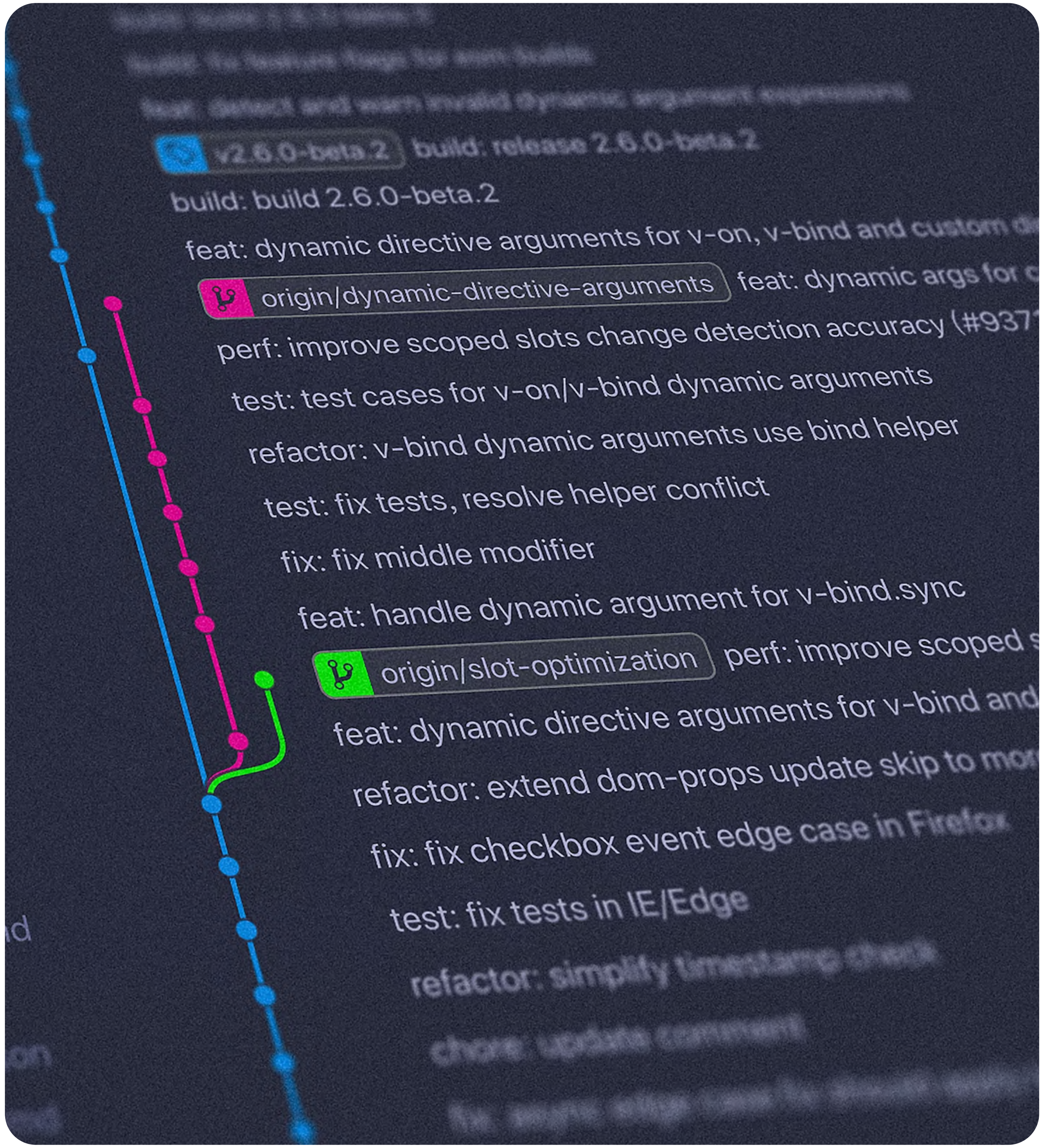


Image credit - Unsplash.com

Methodology

1. To make a BMS Hardware system to get a real time current, voltage data

2. Testing the hardware system

3. Select a Machine Learning Algorithm with necessary requirements

4. Train the model with a specific data set

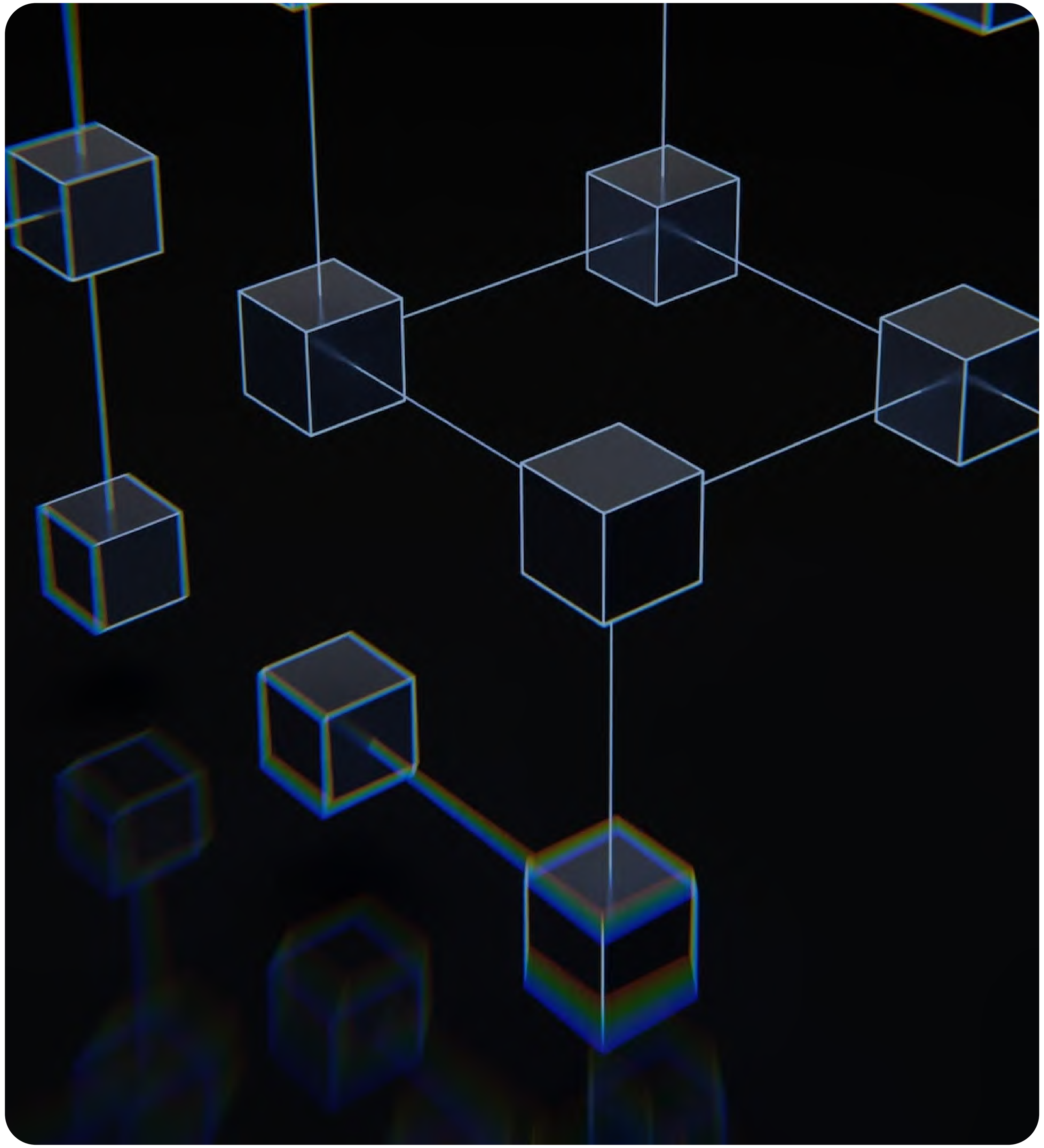


Image credit - Unsplash.com

Methodology

1. To make a BMS Hardware system to get a real time current, voltage data

2. Testing the hardware system

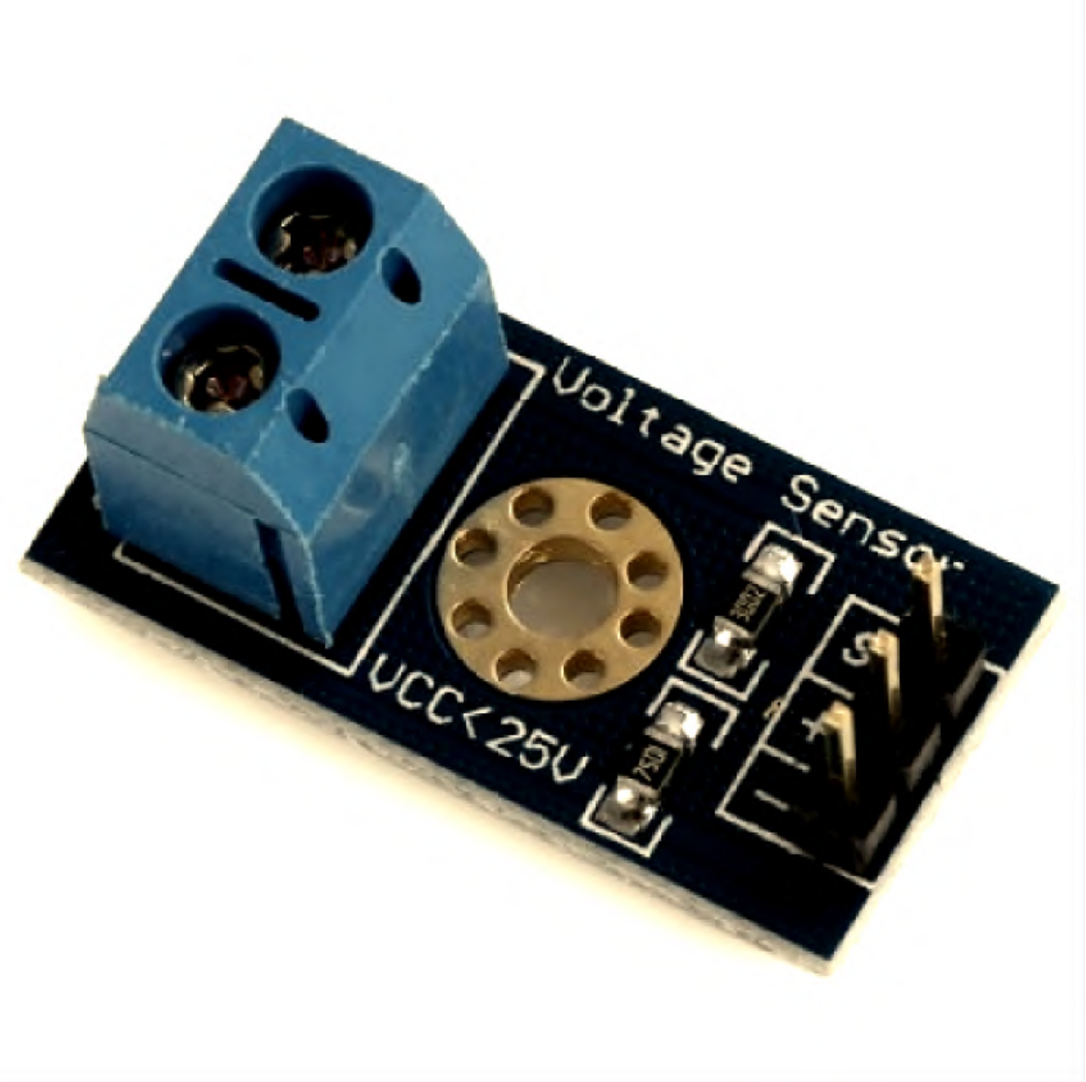
3. Select a Machine Learning Algorithm with necessary requirements

4. Train the model with a specific data set

5. Validate the model and implement on the system

Image credit - Unsplash.com

Hardware Requirements



Source - Robu.in

Voltage Sensor

- Wide Voltage input range: DC 0-25 V
- Resistive Voltage Divider principle
- Resolution of 0.00489V

Hardware Requirements

Source - Robu.in

Current Sensor - ACS712

- Supply Voltage: 4.5V~5.5V DC
- Measure Current Range: 30A
- Low-noise analog signal path
- Output voltage proportional to DC current
- Nearly zero magnetic hysteresis

Hardware Requirements

Source - Robu.in

Battery - Lemon 1800mAh 3S 25C/50C Lithium Polymer

- Maximum Capacity 1800mAh
- Voltage 11.1 Volt
- Suitable for the required application

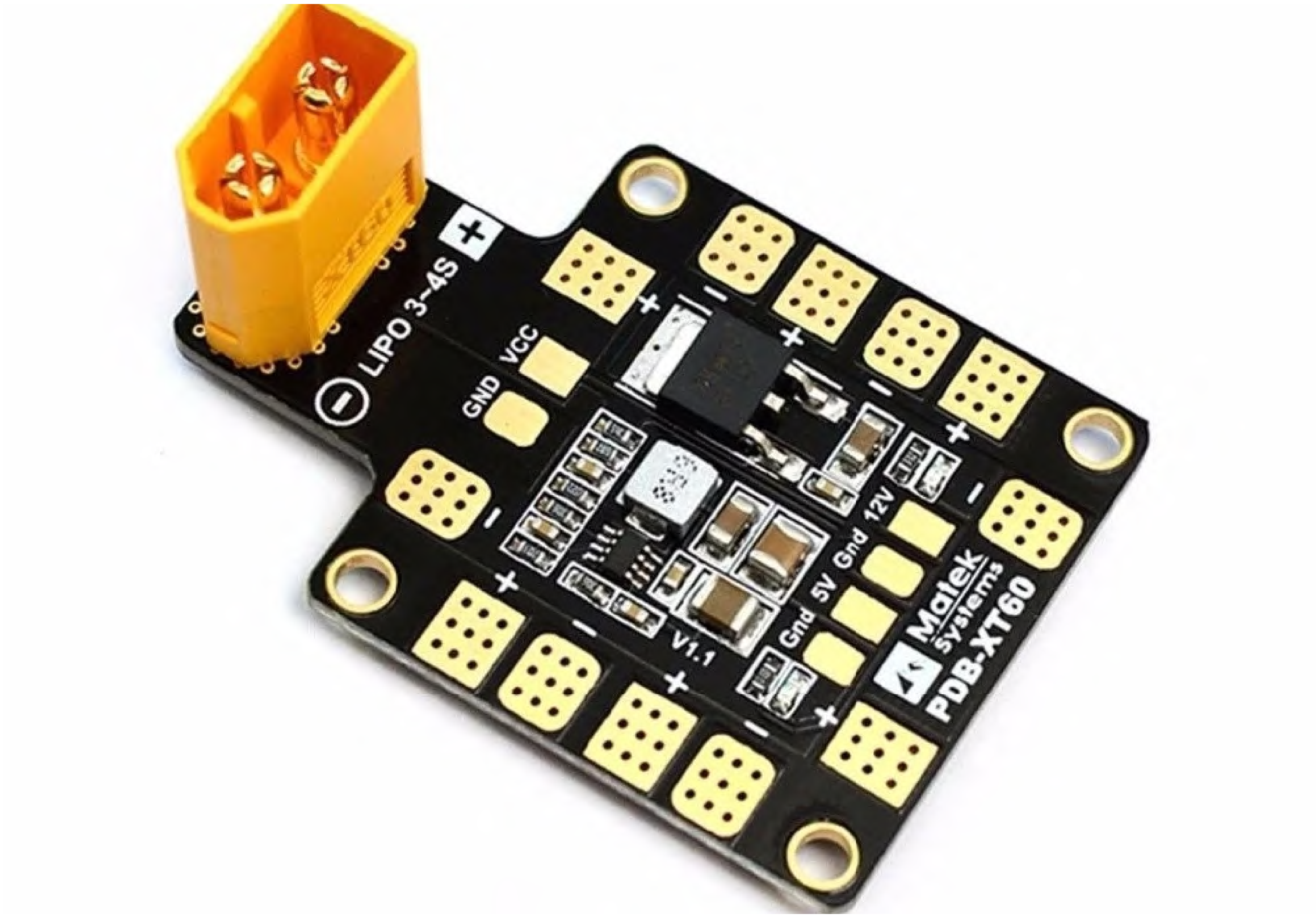
Hardware Requirements

Source - Robu.in

Micro-processor - Raspberry Pi 4 Model B 4GB Ram

- Used for onboard computation
- Better data processing

Hardware Requirements



Source - Robu.in

Power Distribution Board - PDB-XT60

- Regulated 5V and 12V outputs
- 6 pairs of connections
- Used for distributing the required amount of power to other elements of the system

Timeline

Mid Sem 7th Semester

- Understand the working of a monitoring system and identify the problem statement
- Choose necessary sensors and hardware required for data acquisition

End Sem 7th Semester

- Understand machine learning algorithm and its working
- Select the best algorithm

Mid Sem 8th Semester

- Training and Implementing the selected algorithm with the data set

End Sem 8th Semester

- Integrate hardware and machine learning to get the desired result of a battery driven device

References

1. Lauren Nagel - A Guide to Lithium Polymer Batteries for Drones - *Article - Tyro Robotics*
2. Markus Lelie; Thomas Braun; Marcus Knips; Hannes Nordmann; Florian Ringbeck; Hendrik Zappen; Dirk Uwe Sauer - Battery Management System Hardware Concepts: An Overview - *Applied Sciences MDPI*
3. Niraj Agarwal; Phulchand Saraswati; Ashish Malik; Yogesh Bateshwar - Design a Battery Monitoring System for Lead-Acid Battery - *International Journal of Creative Research Thoughts (IJCRT)*
4. P. P. L. Regtien; H. J. Bergveld; Dmitry Danilov; Valer Pop - Battery Management Systems: Accurate State-of-Charge Indication for Battery-Powered Applications - *ISBN: 978-1-4020-6944-4*
5. Reza Ardeshiri; Bharat Balagopal; Amro Alsabbagh; Chengbin Ma; Mo-Yuen Chow - Machine Learning Approaches in Battery Management Systems: State of the Art - *IEEE Explore*
6. Man-Fai Ng ; Jin Zhao ; Qingyu Yan ; Gareth J. Conduit ; Zhi Wei Seh - Predicting the Current and Future State of Batteries using Data-Driven Machine Learning - *Nature Machine Intelligence*
7. Siyu Jin; Xin Sui ; Xinrong Huang ; Shunli Wang ; Remus Teodorescu ; Daniel-Ioan Stroe - Overview of Machine Learning Methods for Lithium-Ion Battery Remaining Useful Lifetime Prediction - *Electronics*
8. Applications - Infeon Technologies

Thank you