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Automated Battery Management System for E Vehicles

Muthukumar.R[1], Jansirani.K [2], Senthamizhan.V[3], Sujithra.N[4]
[1]Associate Professor, Department of EEE, Erode Sengunthar Engineering College, Erode, Tamilnadu, India.
[2]Student, Department of EEE, Erode Sengunthar Engineering College, Erode, Tamilnadu, India.
[3]Student, Department of EEE, Erode Sengunthar Engineering College, Erode, Tamilnadu, India.
[4]Student, Department of EEE, Erode Sengunthar Engineering College, Erode, Tamilnadu, India.

Abstract-The Electric Vehicles (EV) Battery Management System (BMS) is a crucial part of EVs because it does important tasks like controlling charging and discharging, state detection, fault diagnosis and warning, data recording and analysis, etc. Nonetheless, new battery types are continually developing due to the quick advances in electrochemistry and materials related to batteries. An essential component for any system is the battery, which requires perfect maintenance to ensure optimal performance. It is now crucial to maintain the health of batteries in today's technologically advanced culture. In a fuel-cell/batteryhybrid system, fuel cells, lithium-ion batteries, and related dc/dc converters are all included. Utilising energy management systems allows power sources (such as fuel cells and lithium-ion batteries) to be allocated according to demand. The state-machine approach is suggested due to the EV's limited compute capability and its simplicity in engineering implementation. Battery lifespan as well as efficiency can be significantly increased with the use of EB Power, AC/DC, and DC/DC converters for battery management. Furthermore, precise battery condition tracking and management are made possible by the combination of parts like PT/CT sensors, ADC converters, and PIC controllers. The use of an LCD screen and LM35 sensor improves accessibility for users, and the integration of IoT technology enables remote control and data collection and processing. Battery control is now an effective instrument for extending battery life and enhancing overall device performance due to its cutting-edge capabilities.

Keywords- IoT, Sensors, Battery monitoring, adafruit, PIC Controller.

II. INTRODUCTION

The last few years have seen a rapid development of unmanned aerial vehicles (EVs) because of their numerous applications. EVs are employed in a wide range of fields, including military, healthcare, agriculture, and surveillance. EVs are categorised according to their weight, autonomy level, and altitude [1]. Because of industry demand and technological advancements, EVs are now widely used. Specifically,battery-operated EVs have gained popularity. Unmanned aerial vehicles, or EVs, that run on electricity are now the new face of green aviation [2,3]. The roll axis stability for targeting and sensing can be enhanced by using the control bandwidth that the motor has available. Electric propulsion systems are typically more dependable than those based on traditional internal combustion engines (ICEs) because they typically have fewer moving parts. But just like ground vehicles, battery-powered electric EVs have trouble estimating how much charge is left, so most of their flight plans are extremely cautious[4]. ICE- based powertrains

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typically have metered fuel delivery and operate in narrow RPM ranges. This makes itpossible to predict remaining use time or travel distance with a reasonable degree of accuracy.

In contrast, batteries lose capacity over time and with use. Capacity fade is influenced by a number of variables, including ambient storage temperatures and the battery's initial state of charge (SOC).

Furthermore, other factors like battery health and the imposed discharge or load profile affect a battery's usable charge for a given discharge profile in addition to the battery's starting state of charge. This is due to the fact that terminal voltage determines the battery shut-off criteria in the majority of battery-powered propulsion systems. This voltage has a highly nonlinear relationship with the battery's SOC, which is further complicated by a sudden drop in terminal voltage as the battery's SOC approaches empty.

Because of their high energy density and low self-discharge rate, lithium-based batteries are the primary power source for EV. Nevertheless, EV batteries deteriorate over time. Numerous problems, suchas flight delays, forced crashes, and lost connections, could result from this. As a result, battery malfunctions or low battery levels may prevent EVs from operating reliably [6,7]. As a result, EV batterydegradation can be expensive. For EVs to operate effectively, a dependable battery management system (BMS) is necessary[8]. Therefore, the BMS should permit battery monitoring by giving precise SoC and state-of-health (SoH) data in order to guarantee the coherent operation of EVs. As a result, the battery's lifespan is increased and unintended consequences from EVs operating without supervision are prevented. The concept of Battery Management Systems (BMS) has gained popularity due to the extensive use of Libatteries[9,10]. The primary goals of these systems are to optimise the use of the energy contained in the batteries and give the craft operator access to real-time diagnostic data. The BMS needs to use the battery's SOC information in order to complete these tasks.Battery-powered electric EVs struggle to estimate the remaining charge because the real value of SOC is not known with absolute certainty[11,12]. Because of this, the majority of flight plans have extremely conservative durations, which implies that they are even shorter than what the battery could tolerate. Improved BMS is required to deliver higher efficiency. The functioning system, efficiency, and battery life, including the charging and discharging manage, must all be monitored by the battery tracking system, which is a component of the BMS[13]. The components of a battery tracking system include instruments that measure variables including temperature, current flow,and battery voltage. These variables are able to analyzed to determine the battery's SOC and state of health[14-17].

The efficiency of the battery depends on its SOC and temperature. The BMS for a system has tracking metrics including current, voltage, and temperature in addition to calculates battery properties like SOC[18,19]. The battery's SOC indicates the maximum amount of power it can store or the amount of charge it now has. If the amount of charge is determined properly, then isn't a danger of charging excessively the battery[20]. Over charging may lead to gas emissions, notably those of hydrogen, oxygen, and hydrogen sulfide. A sulphuric acid electrolytic aqueous solution is evaporated to produce them . These gasses must be recognized immediately because it is

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flammable. If it send out a signal that alerts the user,the battery should not be overcharged in order to prevent any risks. Therefore, the BMS uses various control techniques, including solid control algorithms, meta-heuristic algorithms, adaptive control, etc. toregulate the temperature inside the battery and the current under limitations. This is going to have the direct effect of keeping the environment clean and green. Additionally, the lifespan of the batteries needsto be extended. IoT enables the storage of these data points in the cloud, making them accessible at any time on any mobile device and retrievable for future research [21–23].

The Internet of Things (IoT), which connects everyday objects and enables them to gather and exchange data, has completely changed the way we work and live. This technology makes it feasible to design and build a remote battery monitoring and control device[24]. The modern world places a premium on the efficient and effective management of energy resources, especially batteries. Batteries are essential for running everything from portable electronics to household appliances. Consequently, there is a great chance to manage energy resources more effectively with the design of a remote battery monitoring and control device that makes use of IoT technology. However, manual checks are a common part of traditionalbattery monitoring and control methods, which can be laborious and error-prone. The development of automated systems for remote battery monitoring and control using Internet of Things technology is becoming more popular as a solution to this problem. IoT and battery monitoring are becoming more andmore important in energy management, especially in remote areas where power supply dependability is a concern[25]. By ensuring that devices are functioning correctly and lowering the chance of failure, this information can then be used to improve the safety and wellbeing of people living in the home. The management of battery power has gained significance in the design of portable devices. Batteries are being utilised in a greater variety of devices and are getting more powerful as technology develops, from smartphones and laptops to electric cars and renewable energy sources. The creation of an Internet of Things-based remote battery monitoring device could yield useful data regarding battery performance, facilitating enhanced power management and extended battery life. Due to this, battery power management systems and the Internet of Things are becoming increasingly important in both the energy and power markets. As a result, creative solutions for enhancing the power market have been developed.

The primary device utilized here is a PIC Controller, and an IoT-based battery tracking system is implemented to allow readers to examine the battery's state from any location using the adafruit app. Thereare the following sections in this paper: proposed work is covered in Section 2. The paper is concluded in Section 4 after discussing the results in Section 4, which calculates the battery parameters.

III. PROPOSED SYSTEM

Figure 1 depicts the architectural layout of the proposed system. The voltage sensor initially establishes the lithium-ion battery's needed voltage level for the system to operate. A PIC controller receives the voltage level data from the battery for analysis. The information processed is transmitted wirelessly through the adafruit app to the battery monitor user interface in a PC, as

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depicted in the figure.

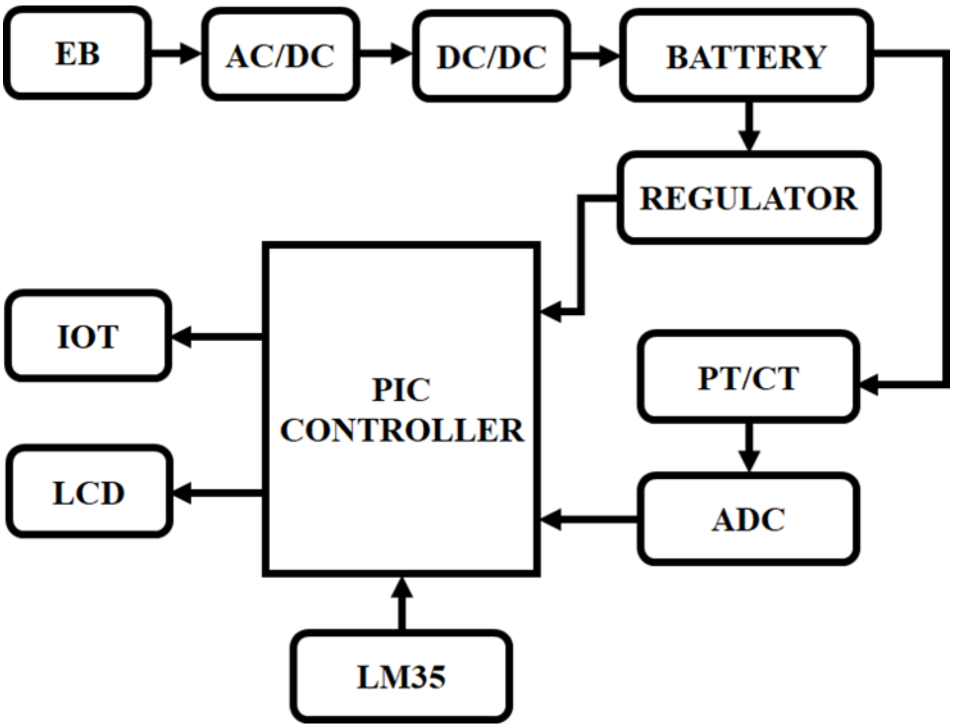

Figure 1. Proposed System

The suggested approach makes use of managing batteries to improve battery health in a society that ismore and more reliant on technology. The precise tracking and oversight of the battery's condition is made possible by the integration of parts like PT/CT sensors, ADC converters, and PIC controllers. The user's ability to get battery data is improved by the inclusion of an LM35 sensor and LCD display. Analysis of data in real time and remote administration are made feasible for better battery life with the introduction of IoT technologies. The suggested system successfully improves battery life and performance for greaterdevice effectiveness by incorporating EB Power, AC/DC, and DC/DC converters. When the transfer of data succeeds, the computer's battery tracking application will provide the most recent battery status information. If the power source generates low voltage, the user receives a warning message. In along with checking the voltages of the battery packs, the online BMS may communicate with a BMS to acquire battery information. The following sections discuss the system's detailed design.

III.PROPOSED SYSTEM MODELLING

This paper describes the construction of an BMS using the PIC16F877A. The PIC16F877A, an 8-bit microcontroller with 8 Kbytes of ROM for programme memory, is the primary controller for the main proposed control card. The following lists the individual components of the intended hardware, which is an LCD display based on the PIC16F877A microcontroller.

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- PIC 16F877A microcontroller
- LM35 temperature sensor
- Liquid Crystal Display (LCD)

I. PIC CONTROLLER

A microcontroller is a type of system used in embedded applications. Processor, memory, and programmable input/output are all included in this system, depending on how the application is being used. The author intends to use a microcontroller of the PIC 16F877A type for this project. This device has an analogue to digital converter with 8 bits and 8 channels that can measure voltage and current. The five I/O ports on this 40-pin device are appropriate for the author's project, which calls for an LCD and temperature sensor. This microcontroller can also serve as the foundation for a battery management system. Below is a 40-pin microcontroller shown in Figure 2.

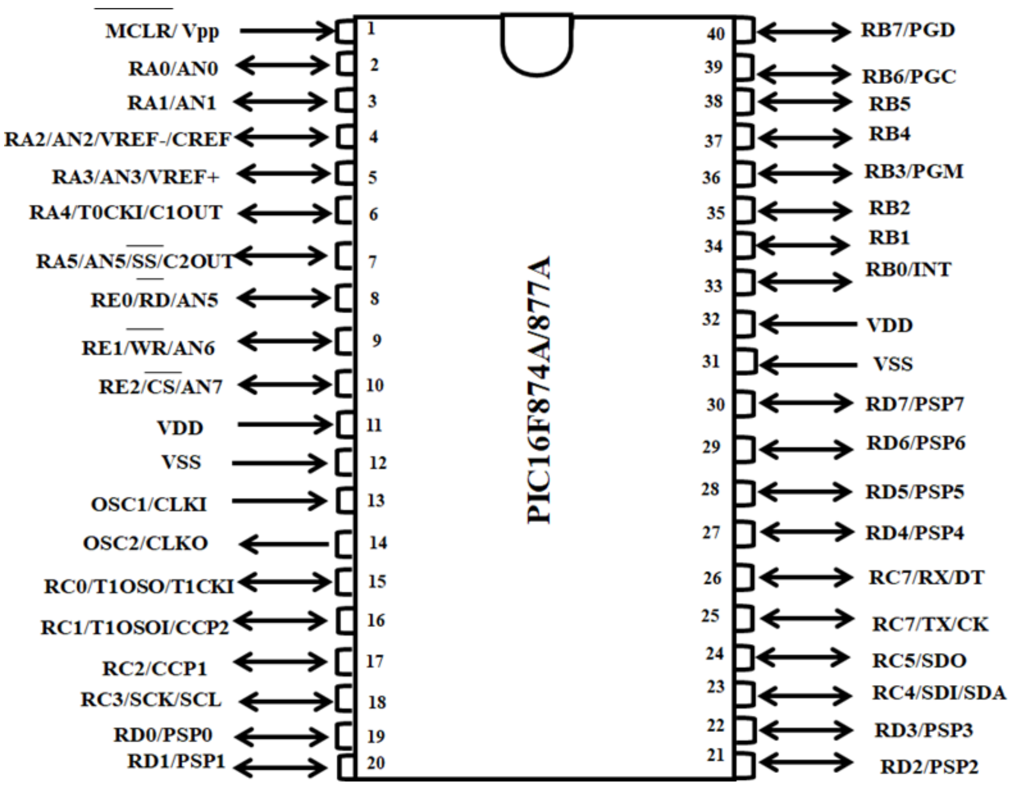

Figure 2. Pin diagram of PIC 16F877A

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The IC known as the PIC (Peripheral Interface Controller) was created to manage peripheral devices,thereby reducing the workload on the primary CPU. The brain serves as the primary CPU in a machine, while the autonomic nervous system serves as the PIC in a human. The MIKRO C programme was used to develop and debug the PIC source code. As seen in Figure 6, the load control unit controls the PIC16F877A's ADC input to manage the load's power consumption. The analogue voltage from the potentiometer was read by the ADC input across the PIC16F877A's output at a duty cycle of 10w and a scale of 10mV.

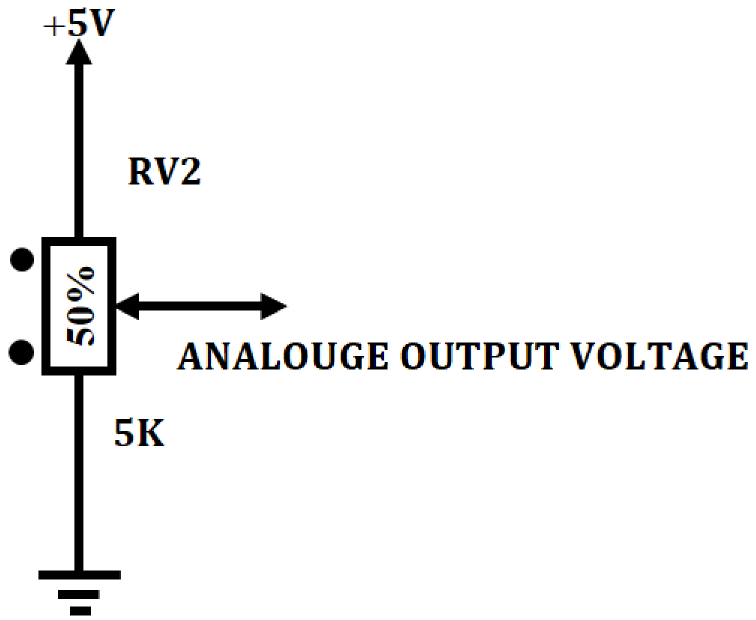

Figure 3. Load Controller

The PIC (Peripheral Interface Controller) is an integrated circuit designed to manage peripheral devices, thereby reducing the workload on the primary CPU. The brain serves as the primary CPU in a machine, while the autonomic nervous system serves as the PIC in a human. Similar to the CPU, the PIC is software-controlled and has calculation and memory functions. The maximum clock operating frequency of a PIC is approximately 4MHz, and its memory capacity (used to write programmes) ranges from 1K to 4K words, depending on the type. With a few exceptions, the majority of the PIC16F877A microcontroller IC's design values were taken from the data sheet. This microcontroller is the main component of the control unit.

PIC 16F877A, a programmable interrupt controller to improve response time and reduce computing difficulty, the entire system is fitted with a sophisticated microprocessor. Any switching that is actuated is detected using PIC 16F877A. This PIC produces sensations and audio noises. Whenever this microcontroller is turned on, the application that exists in its memory is run. One integrated circuit has a single collection of information. A processing core, memories, and configurable input/output peripherals make up the PIC, a compact computer. The PIC has a MicroC programming code loaded on it, making it a crucial component of the suggested solution. Due to the On-chip ADC in the PIC 16F877A, the microprocessor directly converts the analog signals that the sensors acquire into digital signals. Comparingthis architecture to those that use an

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additional a microcontroller ADC, memory, I/O devices, and additional attributes like inexpensive price and small dimensions, it is beneficial. The PIC is powered by a +5V power supply. If the PIC's input voltage is higher than +5V, a voltage regulator (L7805) can be used to keep it there. The PIC won't work without a crystal oscillator, that is used for running the code. As an immediate computing component, the PIC uses a high speed oscillation. The PIC16F877A is a microcontroller with eight bits and with 40 pins. Of these, 2 pins are utilized for Vcc, 2 pins are utilized for ground, 2 pins are employed for crystal oscillators, 1 pin is utilized for reset, and the remaining pinshave been utilized as I/O pins.

II. LM35 SENSOR

The embedded temperature sensor LM35 is produced by National Semiconductor. It operates more linearly and with more precision. At normal temperatures, the voltage at the output of the LM35 linear proportionate Celsius thermometer may deliver an ordinary accuracy of 1/4°C of ambient temperature eliminating requiring for extra calibrating or fine-tuning. Temperature sensors of the LM35DZ-92 type in plastic packaging were utilized in the test.

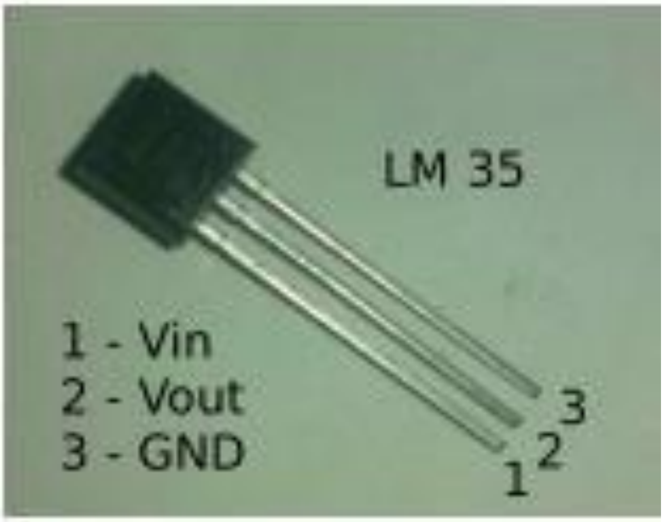

Figure 4. LM35 temperature sensor

The only step that is required for functioning with the fewest number of components is placing a voltage (5V) to the input voltage and grounding connections. The voltage at the output port will then produce a voltage proportionate to heat at a ratio of 10 mV/C (referenced to ground). Yet, for the purposeto obtain accurate and repeatable voltage measurements, it needed to link an artificial resistance load to the LM35 sensor's output wire and grounding because of the multiplexed function of the DAQ. Further measures were taken to electronically separate the connectors while preserving the most direct contact as possible with the sensor's enclosure and the concrete that surrounds it because the LM35 sensor wasn't precisely meant to be incorporated into concrete. The objective is to prevent electrical contact with the mortar while maintaining the thermal contact. To

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prevent a short of electricity, heat shrunk tubings were positioned around the three connections. The optical sensors were subsequently coated with urethane in order to protect the electrical connections from liquid. Lastly, heat shrink tubing was used to enclose the entire terminal and a section of the casing. A concrete mold 30.5 cm height and 15.2 cm in diameter built of steel, identical to the one was utilized for the testing setup in the research facility stage of this work. At the exact center of the dampness, two sensors for temperature were fixed to a circular steel bar. The container is subsequently filled with concrete as the temperature is kept under control. Additional temperature sensor was used to keep track of the ambient temperature for comparison.

III. PT/CT SENSORS

Using a uniform current transformer, or CT, the power system's flow of electricity is reduced. Whenever an enormous quantity of current runs across any device, this is utilized to determine the current. Since every device imposes a limitation on the amount of current it's able to measurement, a clamp meteris not suitable in this situation. Due to this, there only exists one instrument—known as a current transformer—that can be utilized for measuring a huge quantity of current. If you've ever used a clamp meter for measuring current, the thing on top of the clamp meter is known as a CT, or current transformer. We refer to the proportion of the current transformer as the CT ratio. As we are all aware, CT operates bylowering the current; therefore, a ratio, that we refer to as the CT ratio, is printed on it to let us understand the amount of current this CT will offer us by lowering the amount of current. By lowering our CT, we can determine the amount of power we're carrying with the use of the CT Ratio. Potential Transformer is the entirety of PT. We are now discussing the role of CT. Nowadays, PT still functions, but with electricity. By reducing the high voltage, PT provides us with a low voltage at the output. Large lines for transmissionemploy PT. This is due the high-voltage line for transmission uses higher voltages. It is aware of the fact that are unable to employ any thermometer to detect voltages of 33 kV or 220 kV. So employing PT this time as well as shifting from high to low voltage. But using the use of PT to quantify this output. The ratio, known as the PT ratio, is printed on it in the same manner as the CT par ratio. Whereas PT is employed for measuring voltage, CT is utilized to detect current. Although PT is connected in addition, CT is linked in series. The PT limit extends to 110V, whereas the CT ratio limit is 1 to 5A. The output variable of the CT is connected to the ammeter, and the output from the PT is connected to the voltmeter.

IV. ADC CONVERTER

The external environment can be accessed using microprocessor-controlled electronics, Arduinos, Raspberry Pis, and other such electronic instruments by using ADC, or ADCs. Many electronic devices communicate with the environment by detecting analog signals from such transducer because in real life, analog inputs have constantly fluctuating information from many sources and devices that may track temperature, noise, and illumination or motion.

Digital circuits and in the contrary, function with digital warnings, which only consist of two distinct states, a logic "1" or a logic "0", whereas analogue signals can be continuous and offer an endlessnumber of distinct voltage levels. ADC are ICs that may switch among the two distinct fields of constantlyshifting analogue impulses and discontinuous digital signals as a result.

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An ADC captures an analogue level at an exact moment and generates an electronic output that corresponds to this voltage, in theory. The A/D converter's image width determines how many binary digits, or bits, are utilised to show an analogue voltage state.

V. LCD

Materials used in liquid crystal displays combine the qualities of crystals and liquids. The transparentelectrodes that define the character, symbols, or patterns to be displayed are coated on the inside surface of the glass plates. The polarise would cause the light rays going through the LCD to rotate, activating the desired characters. With a thickness of just a few millimetres, the LCD is thin and lightweight. The LCD can be powered for extended periods of time and is compatible with low power electronic circuits due to its lower power consumption.

Information like text, pictures, and movement graphics are shown digitally on a small, flat panel calledas an LCD. Its applications range from pc and tv displays to control panel and other gadgets including gaming consoles, timepieces, watches, calculators, and cellphones, as well as displays in aircraft cockpits.Its capacity to be created in far bigger screens that are practicable for the creation of cathode ray tube (CRT) displays is one of its key qualities, along with its lightweight design and portability.

Figure 5. LCD Display

The LCD is a crucial component of embedded systems. Nowadays, LCD is frequently used in place of CRT in the screen sector. The most adaptable ones use pixels. There are 8-bit and 4-bit LCD modes, depending on how many lines are used to connect an LCD to the microcontroller. 'Initialization' is the process of choosing the appropriate mode at the start of the operation. Data is transferred using outputs D0-D7 in the 8-bit LCD mode. The primary goal of the 4-bit LCD mode is to conserve the microcontroller's important I/O pins. Only the top four bits (D4–D7) are used for communication; the remaining bits might remain disconnected. Every data point is transmitted to the LCD in two stages: fourhigher bits are transmitted initially (typically via the lines D4–D7), followed by four lower bits. The LCDneeds initialization in order to link and correctly interpret bits that are received.

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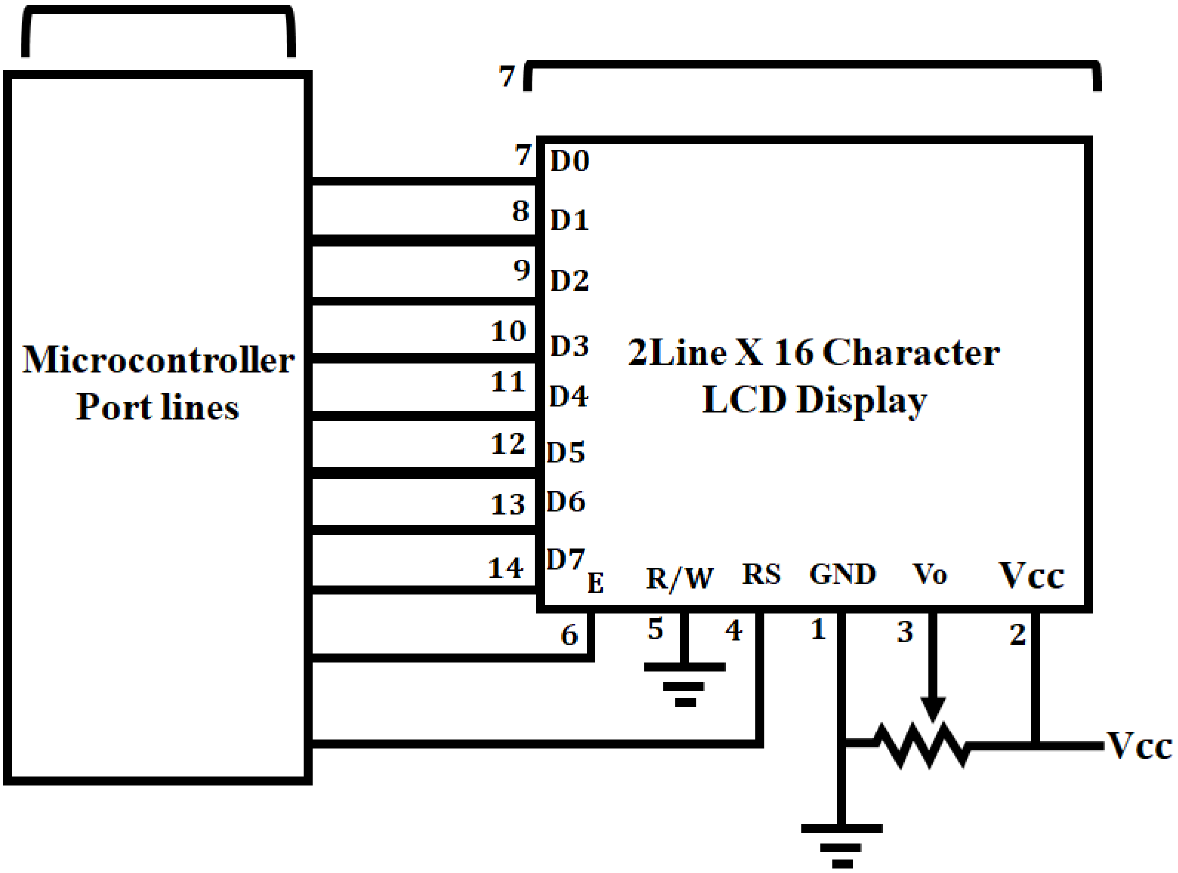

Figure 6. PIC16F877A with LCD interface

PIC16F877A with LCD interface is shown in Figure 6. An additional cost savings can be obtained when purchasing a crystal oscillator for applications where high time precision is not required. In this instance, a 4MHz crystal was used in the micro controller to obtain an internal frequency of 1MHz. A standard crystal oscillator provides an accurate frequency. Figure 9 illustrates the 4MHz crystal oscillator that was selected. The schematic illustrates how the PIC16F877A and XT oscillator are connected. The oscillator's clock needs to be divided by four. To test or synchronise other logical circuits, use the OSC2/CLK OUT pin to obtain the oscillator clock divided by four canals.

VI. E
V

According to Fig. 7, the EV platform consists of.

(1) an onboard flight control system composed of processing units managing mission planning, in-

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flight data collection and analysis, guidance, navigation, and control (GNC) algorithms, and communication with the ground station.
(2) A propulsion system that consists of a motor, propeller, energy management system, speedcontroller, converters, and power supply sources.
(3) the necessary sensors for continuing an autonomous flight, and
(4) payload: mission-specific hardware like actuators, cameras, and radar.

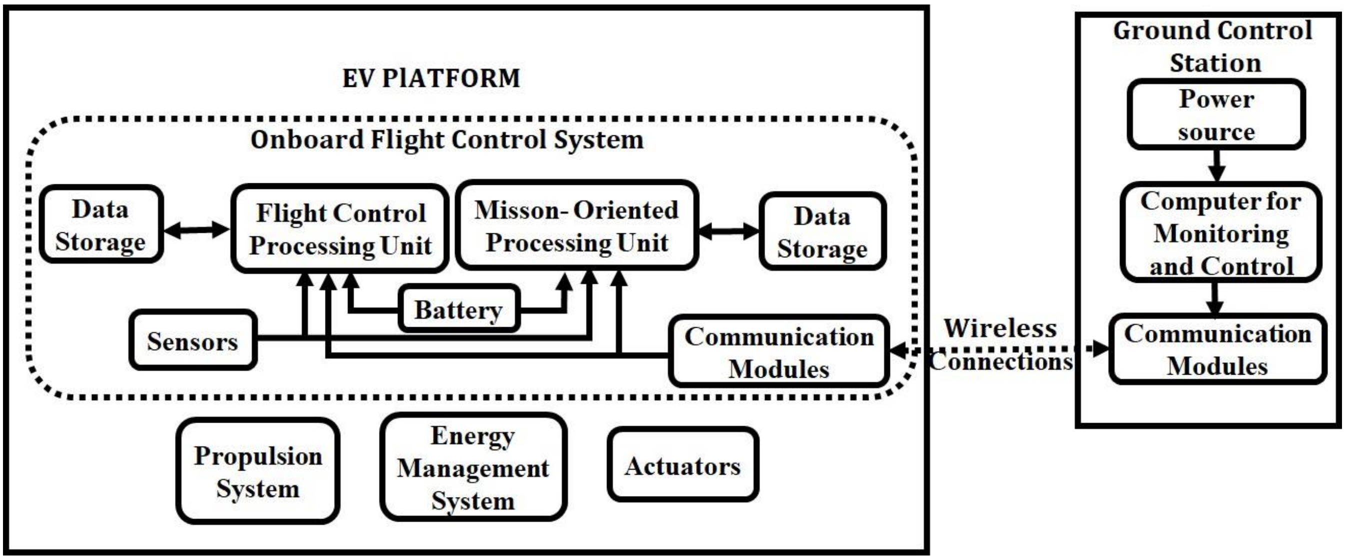

Figure 7. Block Diagram of EV

The primary onboard component of the EV that uses power is the propulsion system. In fact, it enables EV motion by transforming electrical energy stored in the motor-propeller system into mechanical power. In order to facilitate battery charging and discharging, the onboard sources provide power to the DC bus via unidirectional and bidirectional converters. The power flow can be controlled thanks to these converters. Power splitting is managed by the EMS, which sends them control signals.

VII. Battery

The most widely used electrical energy storage devices are batteries. The chemical reactions occurringwithin a battery determine how well it functions when connected to a source or load. The gradual decrease in the battery's energy storage capacity is reflected in the chemical degradation that occurs with time anduse. Reducing the battery depreciation process requires conditioning the battery properly, which includesmanaging its charging and discharging profile and different load scenarios. The primary goals of the research are to model a cascade battery management system and examine the key characteristics of lithium-ion batteries. It is necessary to identify all of the primary characteristics of lithium batteries and to be aware of the standards used to distinguish between them. Essentially, there are three different kinds of battery models: electric circuit-based, electrochemical, and experimental. For battery pack state-of- charge (SOC) estimations, cell

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dynamics are not well represented by experimental or electrochemical models. Nonetheless, models based on electric circuits can be helpful in simulating the electrical propertiesof batteries.
Since Li-ion batteries have lower self-discharge levels, a higher operating voltage, a higher energy density, and a longer lifespan than lead-acid and nickel-based batteries, they have become widely available for use in a variety of applications. In other words, lithium-ion batteries store electrical energy and subsequently release it through internal electrochemical reactions to power electrical systems. In addition to the established benefits, Lithium-Ion batteries have a dearth of adverse effects brought on by operation. side effects that result in a reduction in battery capacity and material ageing. which may therefore result in a decline in performance and unanticipated electrical system damage. The battery management system (BMS) controls every action that takes place in between the battery and the necessary load. The protection of battery cells from overuse and charging, short circuiting, and other hazards, is one of the tasks completed. An explosion or flame may result from overcharging the battery, which can also produce excessive heat. Excessive purchases will result in a permanent battery in the interim. As a result, BMS is crucial to both improving battery power and security. Battery cell monitoring, battery cell balancing, and protection make up the BMS.

VIII. BATTERY MONITORING SYSTEM BASED ON IOT

The management of battery power has gained significance in the design of portable devices. Batteries are being utilised in a greater variety of devices and are getting more powerful as technology develops, from smartphones and laptops to electric cars and renewable energy sources. The creation of an Internet of Things-based remote battery monitoring device could yield useful data regarding battery performance, facilitating enhanced power management and extended battery life. As a result, battery power managementsystems and the Internet of Things are highly relevant to both the developing energy power market and the growing Internet of things marketplace. Creative solutions for enhancing the power market have alsobeen developed.
The Human Machine Interface (HMI), a way to communicate that links the user to the IED, data collecting, internet structure, and connected to the internet of Battery Monitoring System are all components of this framework. All battery system settings have been built into a system with embedded components that functions like the IoT that enables communications between and to the IED, collecting data, and a portal to the internet. This allows for the storage, processing, and utilization of every parameter via the system of clouds. The information produced by the cloud-based method's processing and analysis of the data can be seen in a HMI using the ExtJS/HTML5 architecture and may be viewed on mobile or desktop computers.
Every industry is becoming more and more dependent on batteries. Batteries are used as the power source for everything from small mobile devices to large vehicles. Researchers from across the world are still working on the optimal battery selection and the creation of electrical circuitry and methods for betterbattery usage. The paper discusses a few of the battery's tracking devices used to keep track of the battery'snumerous metrics. All the required variables must be monitored in order for the battery bank to operate continuously. The report suggests using the IoT to track batteries in real-time. The device keeps track of and retains data that shows the voltage, current, and temperature of the power source in real-time. The network's backbone is made up of the wireless surveillance system. The control unit analyzes the data gathered from each related battery-

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interfaced sensor in the entire system.

IV. RESULTS AND DISCUSSION

MATLAB simulation is used to investigate the performance of a proposed model; the findings are listed below. The MATLAB simulation outputs are displayed below, and the generated waveforms are used to analyse the suggested design's efficacy in detail. This section displays the input voltage and current, output waveforms, and battery webpage waveforms for the system. Table 1 shows the Parameterspecifications of the battery.

Table 1. Parameter Specifications

Parameters	Ratings
Battery SOC	80%
Battery Current	10A
Battery Voltage	24V

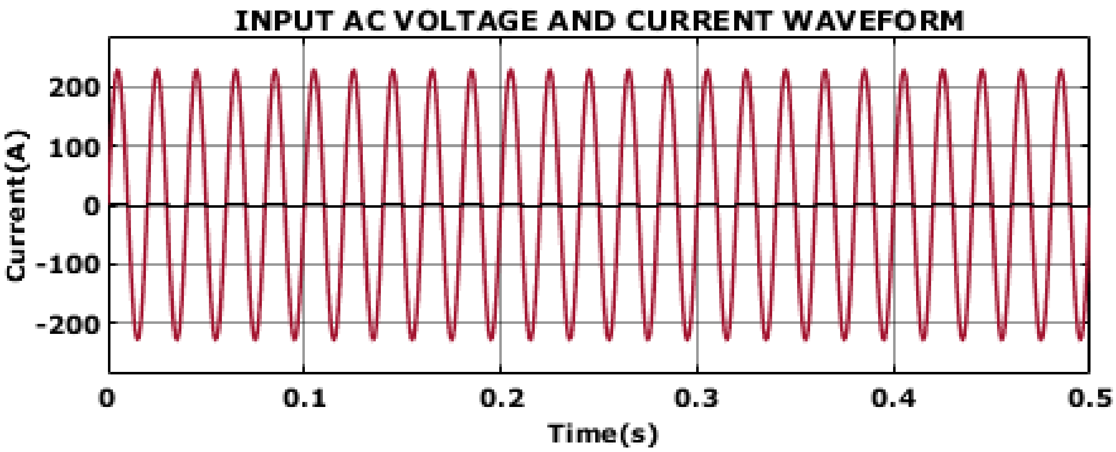

Figure 8. Input Voltage and Current Waveform

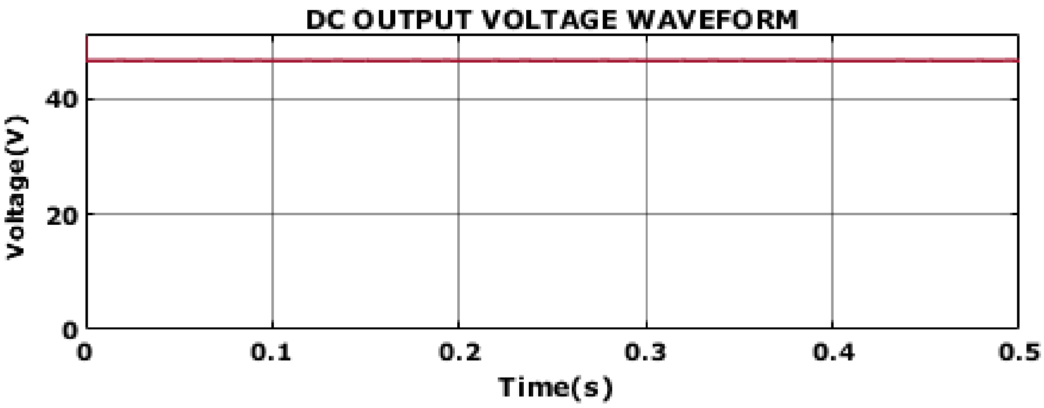

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Figure 9.Output Voltage Waveform

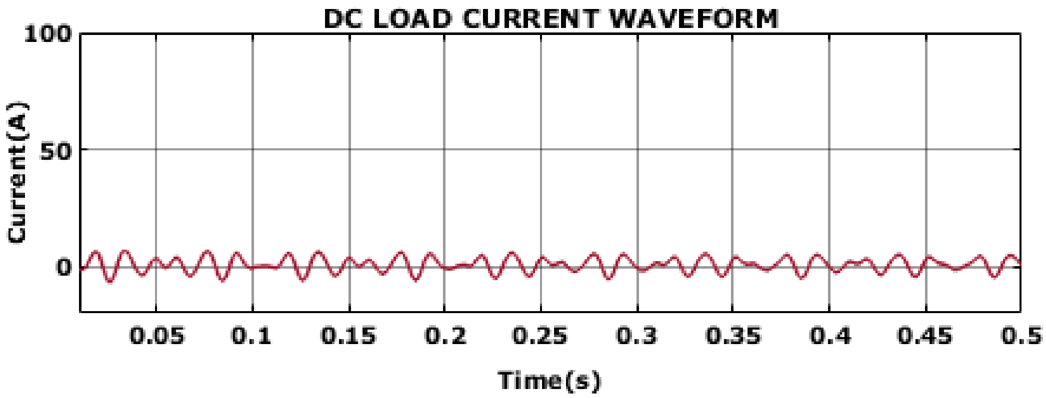

Figure 10. Load Current Waveform

Figure 8 illustrates how the system's input voltage and current waveforms are kept at 220V and 10A, respectively. It is fed into the battery of the suggested system. Figure 9 displays the output voltage waveform, indicating that the system's output voltage is 50V and its load current is 10A, as depicted in Figure 9.The system for the IoT platform is further supplied with 10A of current and 50V of voltage.

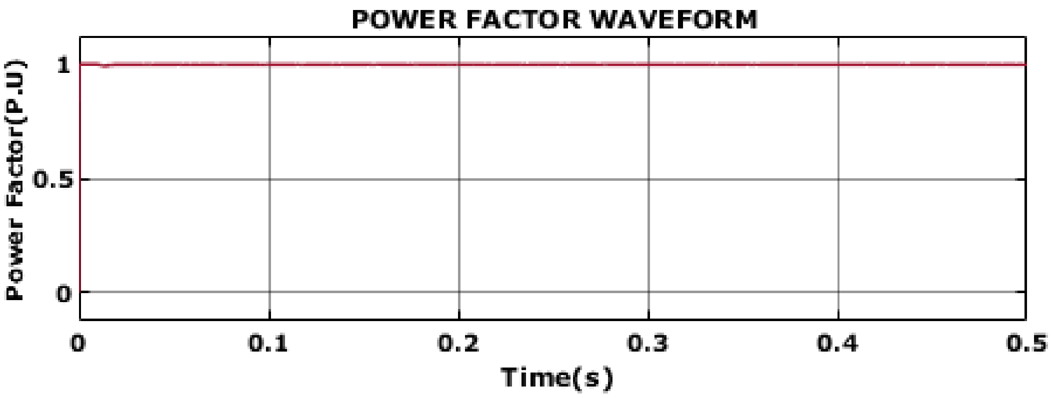

Figure 11. Power Factor Waveform

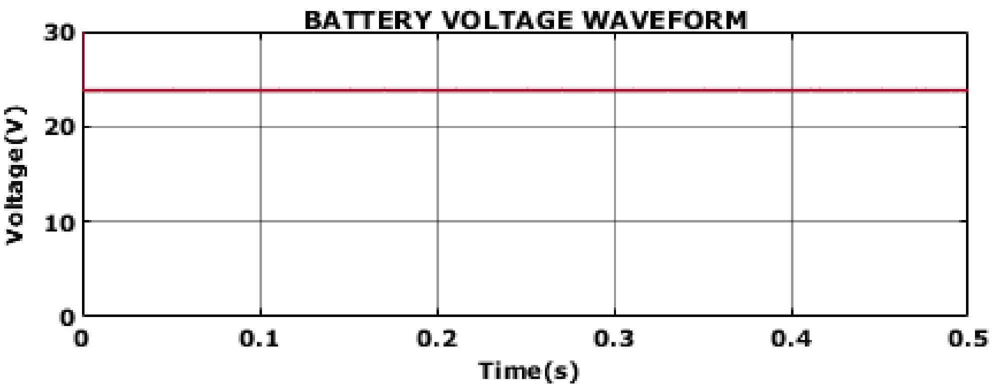

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Figure 12.Battery Voltage Waveform

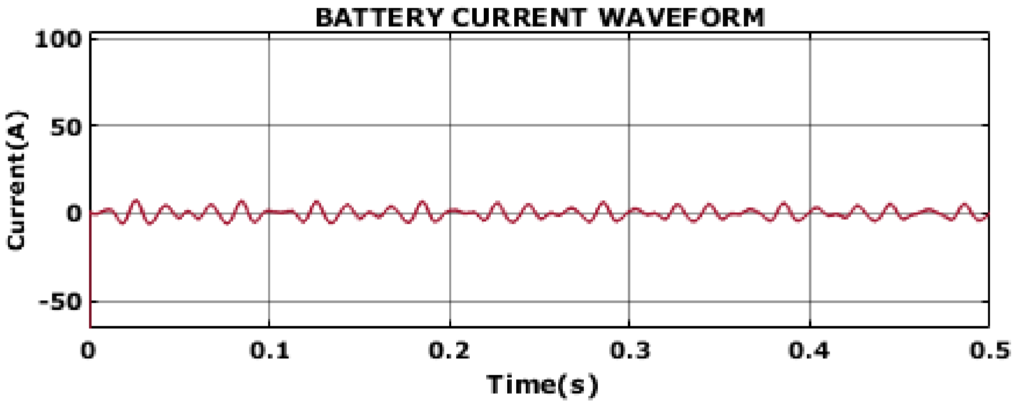

Figure 13.Battery Current Waveform

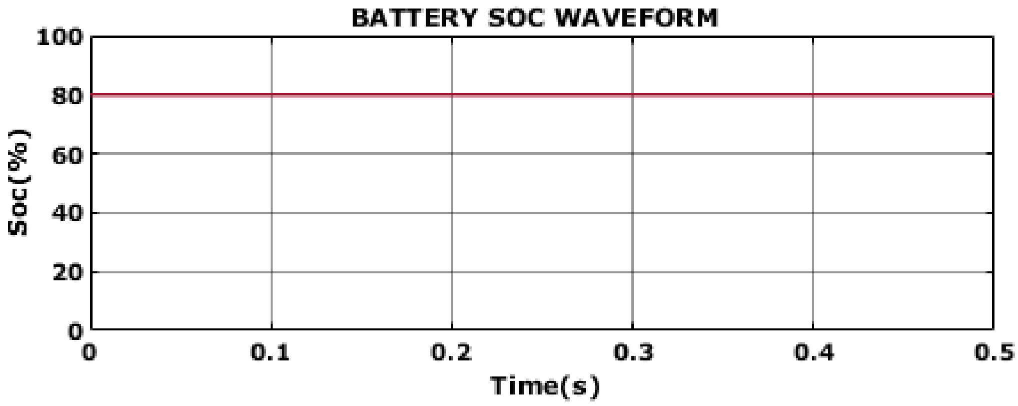

Figure 14.Battery SOC Waveform

The power factor waveform is shown in Figure 11. A power factor value that is closer to unity, or about 0.9989, is attained after 0.001 seconds.The suggested design's battery waveforms are displayed in Figures 12, 13, and 14. Figures 12 and 13 illustrate the battery voltage, which was 24 volts and remained constant throughout, and the system's approximate current, which fluctuated slightly over time, was 10 a current. As Figure 14 illustrates, the battery's SOC waveform shows a consistent value of 80% over time.

IoT is a crucial component for developing innovative uses like vehicle-to-grid networks and intelligentcharging. Therefore, an IoT-based BMS is used for this study. It is a cloud-based system which is statistical analysis on information acquired from IoT sensors and terminals. Internet tracking, balancing the load, visualizations, managing configurations, updates to firmware, alerts, and alerts are among the duties it is in the position of overseeing. The output of the adafruit software for the online graphical user interface isshown in Figure 15, where the voltage is 24V and

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the battery temperature is 33°C. The interface can onlybe used after the user has signed in. On the login page, which is designed for secured storage of data, individuals must enter a username and a password.

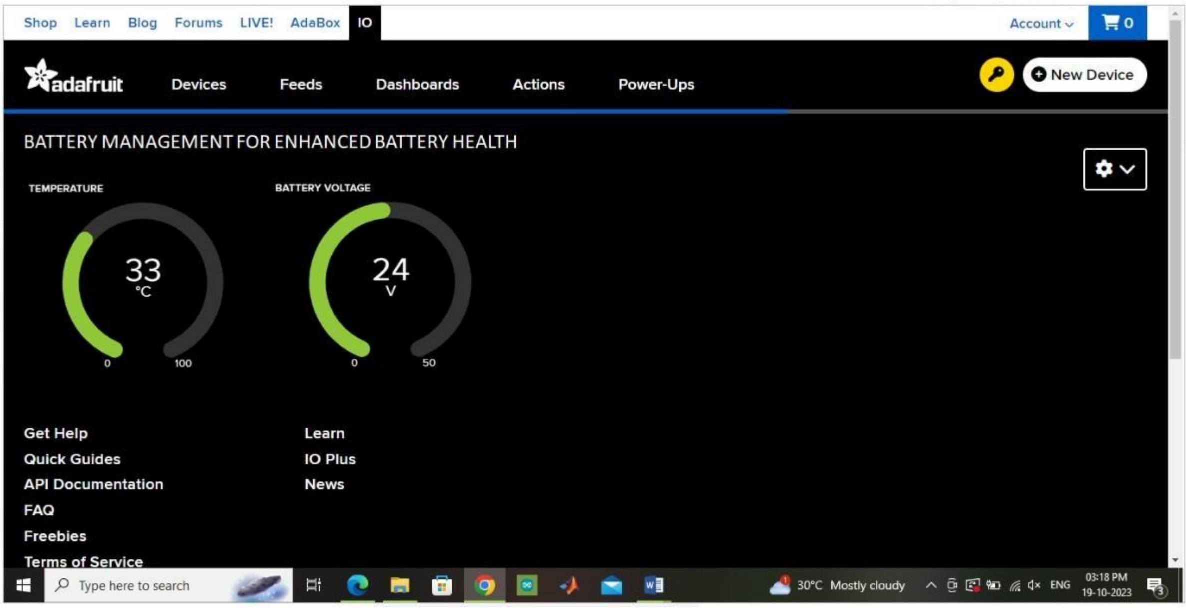

Figure 15. Output showing the display of various sensor

After a user successfully signed to the user experience, the battery monitoring interface is displayed. A customer or admin can use this data to notify the users or consumers if a battery has begun to fail or is in an emergency. The individual is able to log out safely by clicking Logout. Consumers can look over a list of active battery tracking devices. As additional consumers to be monitored, new battery tracking gadgets may be introduced.

V. CONCLUSION

In today's technologically advanced society, intellectual battery management has shown to be essential. Battery lifespan as well as efficiency can be significantly improved by integrating modern technologies like EB Power, converters, sensors, and IoT. The addition of these characteristics not only increases device efficiency generally but also increases battery life. This idea offers a great deal of promise for satisfying the always growing need for dependable and durable battery remedies, which makes it an important tool for the development of technology. For the foreseeable future, battery-powered EVs will continue to rule the market. For EVs to operate dependably, the EV BMS is essential. It is anticipated that research on EV

BMS will continue to advance due to the ongoing advancements in battery technology as well as control and data processing methods. Using networks and integrating with cloud platforms is the main trend in data storage and communication. Real-time data transmission and processing without delays is still a difficult problem to solve, though. Furthermore, it is crucial to guarantee

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the security of the communication process. The obtained results highlight how crucial it is to consider the battery perspective when looking into EV-based problems like resource optimisation, path planning, and EV placement. In fact, it has been demonstrated that the traditional energy viewpoint is overly cautious and underutilizes the energy that is available. However, it is modifiable by suitably assessing the energy in relation to the EV's motion regime. Lastly, the effects of a number of factors are examined, highlighting the importance of these factors in the design of EV missions. Since temperature greatly affects battery performance, it is essential to precisely define the battery's thermal model and use optimisation algorithms to forecast BMS temperatures. It can assure the proper operation of numerous gadgets and work toward an environmentallyfriendly future by putting a priority on the health of batteries.

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