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EV BATTERY COOLING SYSTEM

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ABSTRACT

An expanding subject in the automotive and electrical industries is battery monitoring systems for electric cars. There hasn't been a mechanism in place in India for extensive battery monitoring. It is still a personal endeavor rather than a large-scale application. Aside from this, there are other approaches that rent the batteries to the user directly and depend only on the user's prompt payment done in person. An automatic system that supports a rechargeable battery is called a battery supervision scheme. It may do this by protecting the battery from using outside of its safe operating range, keeping an eye on its condition, scheming to obtain inaccurate statistics, providing commentary on the data, keeping an eye on its circumstances, and/or verifying or enhancing it. Additionally, the BMS will command the battery to be revived by reintroducing the enhanced energy into the battery pack. It is only used for handling battery charging and discharging during rummage sales. Our suggested approach allows the monitoring structure, which can manage, monitor, and record data to an online database, to be coupled with the battery management system. The voltage, current, temperature, power, and state of charge of the battery are all monitored by this system. The user may then see these parameters using an Android app once they have been sent and saved in a database over the internet. When a database has a large enough amount of data, clever machine learning algorithms may be used to forecast the battery's life cycle and provide recommendations to the user about the battery's condition, the length of each charge cycle, and many other topics. When battery rental firms apply this policy, the battery may only be charged when the renter pays on time.

Keywords: Android application, Arduino, and battery management system

I. INTRODUCTION

The introduction of electric vehicles (EVs) and associated batteries aimed to lessen dependency on fossil fuels and greenhouse gas emissions by providing an alternative to conventional gasoline-powered cars. Many governments across the globe started enacting laws and incentives to encourage the use of EVs and assist the advancement of EV battery technology as worries about climate change and air pollution increased.In addition, EV batteries provide a number of distinct benefits over conventional gasoline engines. Because of their increased efficiency and less waste heat production, the vehicle may use a larger portion of the battery's stored energy. In addition to being quieter and having fewer moving parts, EVs also provide smoother driving and cheaper maintenance.Furthermore, vehicle-to-grid (V2G) technology, which allows EVs to store extra power from renewable sources and send it back into the grid during times of high demand, is made possible by EV batteries. This may enhance the grid's balance and increase the supply of electricity's dependability.

In general, EV batteries were developed to offer a cleaner, more economical, and sustainable form of transportation while also addressing the environmental and financial issues related to conventional gasoline engines. It is anticipated that the use of EVs with high-performance, dependable, and safe battery systems will increase as battery technology develops and EV costs come down.Rechargeable energy storage batteries, or EV batteries, power the electric motors of electric cars. They are an electric vehicle's core component and have a

significant impact on the vehicle's performance, range, and overall driving experience.Thousands of individual battery cells are usually used in EV batteries, which are coupled in series and parallel combinations to provide the required voltage and capacity. Lithium-ion batteries, which have a high energy density, a long cycle life, and low self-discharge rates, are the most popular battery types used in electric vehicles.Range anxiety, or the concern that the battery may run out of energy before arriving at the desired location, is one of the biggest problems EV batteries face. In order to overcome this difficulty, EV producers are always striving to increase the cars' range by improving the energy density of their batteries and enhancing the vehicle's aerodynamics and motor efficiency.

Another challenge facing EV batteries is the need for proper management and protection. EV batteries require sophisticated battery management systems (BMS) that monitor the battery's state of charge, state of health, and other critical parameters to ensure safe and reliable operation. The BMS also provides protection against overcharging, undercharging, and thermal runaway, which can lead to battery damage or failure.Despite these challenges, EV batteries offer several advantages over traditional internal combustion engines, including lower operating costs, reduced emissions, and improved overall efficiency. As battery technology continues to advance and the demand for electric vehicles grows, the future looks promising for the widespread adoption of EVs powered by high-performance, reliable, and safe battery systems.An electric vehicle (EV) is a vehicle that uses one or more electric motors for propulsion. It can be powered by a collector system, with electricity from extravehicular sources, or it can be powered autonomously by a battery (sometimes charged by solar panels, or by converting fuel to electricity using fuel cells or a generator). EVs include, but are not limited to, road and rail vehicles, surface and underwater vessels, electric aircraft , and electric spacecraft. For road vehicles, together with other emerging automotive technologies such as autonomous driving, connected vehicles, and shared mobility, EVs form a future mobility vision called Connected, Autonomous, Shared, and Electric (CASE) Mobility.

Electric vehicles (EVs) were introduced into the world for a variety of reasons, including.,

Climate change: The transportation sector is a major contributor to greenhouse gas emissions, which are causing global climate change. Electric vehicles produce zero emissions at the tailpipe, which makes them an important tool for reducing carbon emissions and mitigating the impacts of climate change.

Air pollution: In addition to contributing to climate change, emissions from cars and trucks also cause air pollution that can harm human health. EVs produce no tailpipe emissions, which can help reduce air pollution in cities and improve public health.

Energy security: Electric vehicles can reduce our dependence on oil and help improve energy security. By using electricity from renewable sources like wind and solar, we can reduce our reliance on fossil fuels and create a more sustainable energy system.

Economic benefits: Electric vehicles can create new jobs in the automotive industry and related sectors, such as battery manufacturing and charging infrastructure. In addition, EVs can save consumers money on fuel and maintenance costs over the lifetime of the vehicle.

Technology innovation: The development of electric vehicles is driving innovation in battery technology, electric motors, and other areas of automotive engineering. This innovation can spill over into other sectors, leading to new technologies and economic growth.

Environmental benefits: Electric vehicles produce zero emissions at the tailpipe, which helps to reduce air pollution and greenhouse gas emissions. This can help to mitigate

climate change and improve the overall health and well-being of people and the planet.

Energy security: Electric vehicles can help reduce reliance on foreign oil and increase energy security by using domestic sources of electricity, such as renewable energy sources like wind, solar, and hydropower.

Cost savings: Electric vehicles can be cheaper to operate and maintain than conventional gasoline-powered vehicles, due to lower fuel and maintenance costs. Over the lifetime of the vehicle, the savings can be significant.

Improved performance: Electric motors offer instant torque, which can provide better acceleration and performance than internal combustion engines. Electric vehicles can also have a lower centre of gravity, which can improve handling and stability.

Technological innovation: Electric vehicles represent a major technological shift in the transportation industry, with advancements in battery technology, power electronics, and software leading to new innovations and opportunities.

Overall, electric vehicles are being introduced into the world as a way to address environmental, economic, and technological challenges, and to provide a cleaner, more sustainable mode of transportation for the future.EVs first came into existence in the late 19th century, when electricity was among the preferred methods for motor vehicle propulsion, providing a level of comfort and ease of operation that could not be achieved by the gasoline cars of the time. Internal combustion engines were the dominant propulsion method for cars and trucks for about 100 years, but electric power remained commonplace in other vehicle types, such as trains and smaller vehicles of all types.Government incentives to increase adoption were first introduced in the late 2000s, including in the United States and the European Union, leading to a growing market for vehicles in the 2010s. Increasing public interest and awareness and structural incentives, such as those being built into the green recovery from the COVID-19 pandemic, are expected to greatly increase the electric vehicle market. During the COVID-19 pandemic, lockdowns reduced the number of greenhouse gases in gasoline or diesel vehicles.

1.1 IOT

The Internet of Things (IoT) refers to the network of physical devices, vehicles, appliances, and other objects embedded with sensors, software, and connectivity that enables them to collect and exchange data over the internet. The IoT has emerged as a transformative technology with the potential to revolutionise various aspects of our daily lives, industries, and society as a whole. In this essay, we will explore the key aspects of the Internet of Things and its impact. The IoT ecosystem is vast and diverse, encompassing a wide range of devices such as smart thermostats, wearable fitness trackers, connected cars, industrial machinery, and even smart cities. These devices are equipped with sensors and actuators that allow them to gather data from their surroundings, communicate with each other, and take actions based on the information received. This interconnectedness and data exchange create a seamless and integrated network of devices, enabling unprecedented automation, efficiency, and convenience.

Smart homes and cities are another area where the IoT is making significant strides. Smart home devices, such as smart thermostats, lighting systems, and security cameras, can be controlled remotely and learn user preferences, optimising energy consumption and enhancing security. In smart cities, IoT applications can improve traffic management, waste management, and resource allocation, leading to reduced congestion, better sustainability, and enhanced quality of life for citizens.However, the widespread adoption of IoT also raises concerns regarding security and privacy. With billions of connected devices transmitting and receiving data, the potential for data breaches and

cyberattacks increases. Safeguarding sensitive information and ensuring robust security measures become paramount to mitigate these risks. Additionally, the collection and storage of massive amounts of data generated by IoT devices raise privacy concerns. Clear policies and regulations must be established to address these issues and protect users' rights.

In conclusion, the Internet of Things represents a transformative force that is reshaping our world. From enhancing industrial processes and healthcare delivery to revolutionising our homes and cities, the IoT offers unprecedented opportunities for efficiency, convenience, and connectivity. However, its widespread adoption also necessitates addressing security and privacy concerns. As technology continues to evolve, the Internet of Things will undoubtedly continue to revolutionise industries, drive innovation, and shape our future.

1.1.1 IOT ON ELECTRIC VEHICLE BATTERY

The Internet of Things (IoT) has the potential to revolutionise the electric vehicle (EV) industry, particularly in the realm of battery management. The battery is a critical component of an electric vehicle, and optimising its performance, efficiency, and longevity is crucial. In this essay, we will explore how the IoT can be leveraged to enhance electric vehicle battery management.The IoT enables the connection of various devices and systems, allowing for real-time data collection, analysis, and remote control. In the context of electric vehicle batteries, IoT technologies can provide valuable insights into battery health, charging patterns, and performance. This data can be utilised to improve battery management strategies and enhance the overall driving experience.

One of the key benefits of the IoT in battery management is remote monitoring and diagnostics. Connected sensors within the battery pack can continuously monitor important parameters such as temperature, voltage, and state of charge. This data can be transmitted in real-time to a central server or cloud platform for analysis. By remotely monitoring battery performance, potential issues and anomalies can be detected early, allowing for timely maintenance or replacement. This proactive approach can minimise the risk of battery failure and improve overall reliability. Furthermore, the IoT can enable predictive maintenance for electric vehicle batteries. By analysing the collected data, machine learning algorithms can identify patterns and trends that may indicate potential battery degradation or failure. Based on this analysis, predictive models can generate alerts or recommendations for maintenance actions, such as optimising charging patterns or scheduling battery replacements. Predictive maintenance can help extend the lifespan of the battery, reduce unplanned downtime, and ultimately lower the total cost of ownership for electric vehicle owners.

The IoT can also facilitate optimised charging strategies for electric vehicle batteries. Connected EVs can communicate with charging infrastructure or smart grid systems to determine the most efficient and cost-effective charging schedules. For example, if electricity rates are lower during off-peak hours, the IoT can enable the EV to automatically schedule charging during those times. Additionally, data on charging patterns and energy consumption can be analysed to identify opportunities for load balancing and grid optimization. This can contribute to a more stable and efficient power grid, accommodating the increasing number of electric vehicles on the road.Another area where the IoT can make a significant impact is in battery performance optimization. Through data analysis, machine learning algorithms can identify patterns and correlations between battery performance and external factors such as temperature, driving conditions, and user behaviour. This knowledge can be utilised to develop intelligent algorithms that optimise

battery usage and performance in real-time. For example, the system can adjust charging and discharging rates based on environmental conditions to maximise efficiency and prolong battery life.

However, it is essential to address security and privacy concerns associated with IoT-enabled electric vehicle battery management. The vast amount of data transmitted and stored raises potential vulnerabilities and the risk of unauthorised access. Robust security measures and encryption protocols must be implemented to protect sensitive information and ensure user privacy. In conclusion, the Internet of Things has the potential to revolutionise electric vehicle battery management. By leveraging IoT technologies, such as remote monitoring, predictive maintenance, optimised charging, and performance optimization, the efficiency, reliability, and longevity of electric vehicle batteries can be enhanced. However, it is crucial to address security and privacy concerns to ensure the widespread adoption and success of IoT-enabled battery management systems in the electric vehicle industry.

II. LITERATURE SURVEY

[1]This paper deals with "Battery-Management System (BMS) and SOC Development for Electrical Vehicles". Battery monitoring is vital for most electric vehicles (EVs), because the safety, operation, and even the life of the passenger depends on the battery system. This attribute is exactly the major function of the battery-management system (BMS)-to check and control the status of batteries within their specified safe operating conditions.In this paper, a typical BMS block diagram has been proposed using various functional blocks. The state of charge (SOC) estimation has been implemented using Coulomb counting and open-circuit voltage methods, thereby eliminating the limitation of the stand-alone Coulomb counting method. By modelling the battery with SOC as one of the state variables, SOC can be estimated, which is further corrected by the Kalman filtering method. The battery parameters from experimental results are integrated in the model, and simulation results are validated by experiment.

This paper proposed [2]"Battery Management System Using State of Charge Estimation An IOT Based Approach". Battery monitoring and management is vital for most of the battery operated vehicles (BOVs), because of the safety, operation, and even to improve the longevity of the lead acid battery. Lead acid battery operated three wheeled brushless DC (BLDC) motor based vehicles are newly added to the transportation sector of rural Bengal playing a significant role as a means of transport for short distances as well as an employment generating source for unemployed people since the introduction of this in the year of 2008 in India. These vehicles are sometimes known as 'TOTOs'.The object of this paper is to investigate the discharging of batteries particularly for TOTOs in rural Bengal and its relation with the estimated kilometre runs with the help of a real time monitoring system based on an internet of things (IOT) to improve the utilisation and health of BOVs. The battery depreciation process needs to be reduced by conditioning the battery in a suitable manner such as controlling frequent charge and deep discharge cycles. In order to find the relation between travelling distance and discharge cycle an analysis based on IOT with real time wireless battery management system(WBMS) is presented in this paper. The algorithm applied in the proposed system is experimentally validated.

This section provides "New Battery Model and State-of-Health Determination Through Subspace Parameter Estimation and State-Observer Techniques"[3]. This paper describes a novel adaptive battery model based on a remapped variant of the well-known Randles' lead-acid model. Remapping of the model is shown to allow improved modelling capabilities and accurate estimates of dynamic

circuit parameters when used with subspace parameter-estimation techniques[3]. The performance of the proposed methodology is demonstrated by application to batteries for an all-electric personal rapid transit vehicle from the urban light transport (ULTRA) program, which is designated for use at Heathrow Airport, U.K. The advantages of the proposed model over the Randles' circuit are demonstrated by comparisons with alternative observer/estimator techniques, such as the basic Utkin observer and the Kalman estimator.These techniques correctly identify and converge on voltages associated with the battery state-of-charge (SoC), despite erroneous initial conditions, thereby overcoming problems attributed to SoC drift (incurred by Coulomb-counting methods due to overcharging or ambient temperature fluctuations). Observation of these voltages, as well as online monitoring of the degradation of the estimated dynamic model parameters, allows battery ageing (state-of-health) to also be assessed and, thereby, cell failure to be predicted. Due to the adaptive nature of the proposed algorithms, the techniques are suitable for applications over a wide range of operating environments, including large ambient temperature variations. Moreover, alternative battery topologies may also be accommodated by the automatic adjustment of the underlying state-space models used in both the parameter-estimation and observer/estimator stages.

[4]This work has a lot of descriptions about "State of charge estimation of sealed lead-acid batteries used for electric vehicles". Various estimation methods for the state of charge of the sealed lead-acid battery have been proposed. However, no method can accurately predict the residual capacity. A new equation of estimating the residual capacity of the sealed lead-acid battery is proposed. The experiments were performed for verification of the proposal estimation.

III. BLOCK DIAGRAM

The Electric Vehicle (EV) block diagram is for an IOT(Internet Of Things) system that uses temperature sensor,pressure sensor,humidity sensor and smoke sensor to gather data.The data is sent to Node MCU,which is a small Wi-Fi enabled microcontroller.The Node MCU then sends the data to google firebase,which is a cloud-based database.The Firebase database stores the data and makes it available for analysis and visualisation.There is also mobile application and location tracking,you can your phone to view the data collected by the sensors.

The sensors measure different environmental conditions like temperature,humidity,smoke and pressure.The Node MCU reads the data and send it to google firebase.The mobile application can access the data from firebase and display it to to the user.There are two block diagrams,they are one is for Electric Vehicle and another one is for traffic signal.

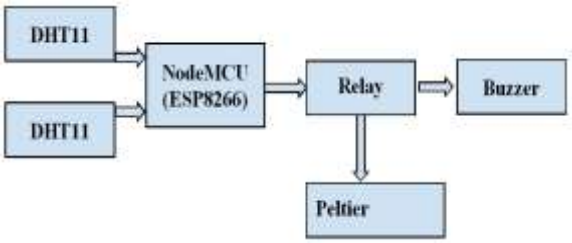

Fig:.1. Block diagram for the EV Vehicle

IV. HARDWARE AND SOFTWARE CONSTRAINTS

4.1 HARDWARE CONSTRAINTS

4.1.1 NodeMCU ESP8266

The NodeMCU (Node Microcontroller Unit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (Wi-Fi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds.

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However, as a chip, the ESP8266 is also hard to access and use. You must solder wires, with the appropriate analog voltage, to its pins for the simplest tasks such as powering it on or sending a keystroke to the "computer" on the chip. You also have to program it in low-level machine instructions that can be interpreted by the chip hardware. This level of integration is not a problem using the ESP8266 as an embedded controller chip in mass-produced electronics. It is a huge burden for hobbyists, hackers, or students who want to experiment with it in their own IoT projects.

The Arduino project created an open-source hardware design and software SDK for their versatile IoT controller. Similar to NodeMCU, the Arduino hardware is a microcontroller board with a USB connector, LED lights, and standard data pins. It also defines standard interfaces to interact with sensors or other boards. But unlike NodeMCU, the Arduino board can have different types of CPU chips (typically an ARM or Intel x86 chip) with memory chips, and a variety of programming environments. There is an Arduino reference design for the ESP8266 chip as well. However, the flexibility of Arduino also means significant variations across different vendors. For example, most Arduino boards do not have Wi-Fi capabilities, and some even have a serial data port instead of a USB port.

4.1.2 OFFICIAL AMICA NodeMCU

Amica NodeMCU measures 49mm x 26mm with a standard pin space of 0.1″ between pins and 0.9″ between rows. The Amica NodeMCU is approximately 25% smaller in size than a closely compatible LoLin style NodeMCU.

Fig: 2. Official amica NodeMCU

OFFICIAL AMICA NodeMCU ON CARRIER BOARD

Amico NodeMCU mounted to a 102mm x 51mm carrier board with dual DB-09 male/female connectors.

Fig: 3: Official Amica NodeMCU on carrier board

4.1.3 LOLIN NodeMCU

LoLin style NodeMCU measures 58mm x 32mm with a pin spacing of 0.1″ between pins and 1.1″ between rows.

Fig: 4. Lolin NodeMCU

Fig: 5. ESP8266 NODE MCU

The ESP8266 Wi-Fi Module changed the DIY and Hobbyist scene completely. It paved the way for small creators to build IoT and 'Smart' things. You can design a Smart Bulb or Smart Relay using ESP8266.

Since it has a powerful microprocessor, you can use it as a standalone device for the processor as well as for Wi-Fi connectivity. But the benefit of ESP8266 is that you can use another processor as the 'main processing

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unit' and use the ESP8266 just as a Wi-Fi chip.

4.1.4 ESP8266 NODEMCU PINOUT

The ESP8266 NODEMCU has 32-pins in total. For convenience, pins with similar functionality are grouped together. The pinout is as follows:

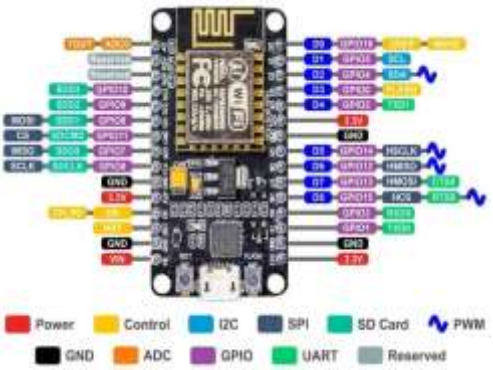

Fig:6. NodeMCU Pin Diagram

NodeMCU COMPATIBILITY WITH ARDUINO IDE

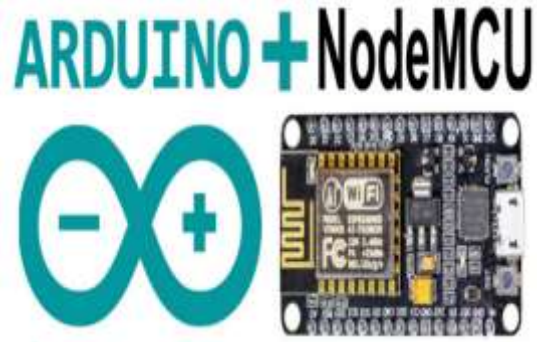

Fig: 7. Arduino & NodeMCU

The NodeMCU offers a variety of development environments, including compatibility with the Arduino IDE (Integrated Development Environment). The NodeMCU/ESP8266 community took the IDE selection a step further by creating an Arduino add-on. If you're just getting started programming the ESP8266 or even an established developer, this is the highly recommended environment. Visit our dedicated page on setting up and configuring the Arduino IDE for a NodeMCU ESP8266.

4.1.5 DHT11 PINOUT

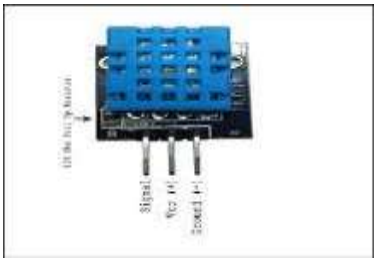

Fig: 8. DHT11 Pin configuration

VCC pin provides power to the sensor. Despite the fact that the supply voltage ranges from 3.3V to 5.5V, a 5V supply is recommended. With a 5V power supply, the sensor can be placed up to 20 metres away. With 3.3V supply voltage, the sensor can be placed up to 1 metre away; otherwise, the line voltage drop will cause measurement errors.

Data pin is used for communication between the sensor and the microcontroller.

GND is the ground pin.

NC Not connected.

4.1.6 BUZZER

An audio signalling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & siren.

Fig:9. Buzzer

4.1.7 JUMPER WIRES

Jumpers are typically tiny metal connections that are used to open or close a component of a circuit. They use two or more connection points to control an electrical circuit board. They are in charge of configuring hardware components like the motherboard. Imagine your motherboard has a system for detecting intrusions. One can set a

jumper up to be activated or disabled. Jumper wires are electrical cables with connector pins on both ends. Without using solder, they are used to connect two sites in a circuit. Jumper wires can be used to diagnose or fix circuit problems. They work best when used to go around a suspected problematic part of the circuit that doesn't include a resistor. Additionally, a cable or switch is included in this.

Fig: 10. Jumper Wires

4.1.7.1 JUMPER WIRE COLOURS

Although jumper wires are available in a number of colours, none of them have any significance. The wire colour is merely a tool to make it easier for you to remember what is connected to what. The circuit's functionality won't be impacted. As a result, a red jumper wire and a black one are equivalent in concept. Nevertheless, you can use the colours to your advantage to distinguish between the many connections. For instance, black is power and red is the ground.

Fig: 10. Different Colours of Jumper Wires

4.2 SOFTWARE CONSTRAINTS

4.2.1 INTRODUCTION TO ARDUINO IDE

Arduino is a prototype platform (open-source) based on easy-to-use hardware and software. It consists of a circuit board, which can be programmed (referred to as a microcontroller) and a ready-made software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board.

Fig: 11. Arduino IDE

4.2.2 INSTALLING CODE INTO ESP8266

Before starting this installation procedure, make sure to have the latest version of the ArduinoIDE installed on the computer. The latest Arduino IDE software installed from arduino.cc/en/Main/Software.

Fig: 12 . Arduino IDE Setup

4.3 HARDWARE AND SOFTWARE IMPLEMENTATION

4.3.1 HARDWARE IMPLEMENTATION

The hardware implementation of block diagram would involve physically connecting all of the components together according to the diagram. This would involve selecting the appropriate sensors, microcontroller, wireless communication modules, and power supply, and then wiring them together in the correct way. You would also need to choose an appropriate form factor for your device, such as a PCB or a breadboard, and design the layout of the components to fit within that form factor. Once you have all of the components connected and the device physically assembled, you would then need to write the software that runs on the microcontroller and controls the flow of data between the different components.

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The hardware implementation process would also involve selecting the appropriate connectors, cables, and other components needed to connect everything together. You would need to carefully consider the power requirements of each component and ensure that your power supply can provide enough power to run everything. Additionally, you would need to carefully test and debug your hardware implementation to ensure that everything is working correctly and that there are no issues with the wiring or connections.

4.3.2 ECHIP MODULE

The below figures explains the connection between the Node MCU ESP8266, BMP180 Atmospheric Pressure Sensor, MQ2 Flying Fish Smoke Sensor, DTH11 Temperature and Humidity sensor and Buzzer.

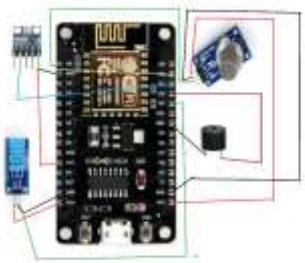

Fig: 13. a) NodeMCU Module for EV Vehicle

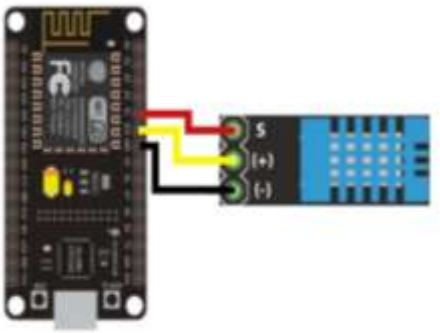

Fig: 14. b) NodeMCU Module for Traffic Signal

4.3.3 Pin Wiring

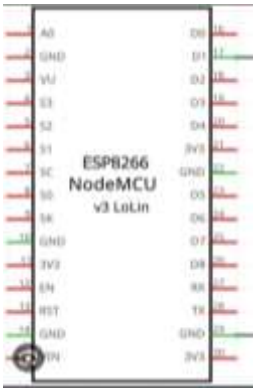

Fig: 15. Reference ESP8266 NodeMCU pin configuration

Fig: 16. Login page for he mobile app

Step 11: Logging in with Admin credentials will result in the display of the location map.

Fig: 17. Admin's login

Step 12: When you use the provided User credentials to access the system, you will retrieve the parameter values for the Electric Vehicle as well as the surrounding conditions.

V. CONCLUSION

You may use this electric vehicle battery monitoring system to keep an eye on the condition of the batteries in electric cars, motorcycles, and trucks in real time. By combining data from batteries and other similar sources into one location for analysis and applications, it prepares the way. This may also be used to forecast and prolong the life of batteries for commercial uses, such as households and businesses that rely on big batteries for backup power. Knowing the life sooner would allow for the replacement of the parts in a timely manner without interfering with an individual's or industry's daily operations.

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