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IoT-Based EV Charging & Its Energy Consumption Monitoring System

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Abstract: We are currently facing problems with a lack of fuel. That's why we're moving to electric cars. However, people were never ready to love electric cars more than they do now. This is because it costs and there is no place to pay. Although several charging stations are open to the public, it still takes more time to charge a car. In addition, usage is included, and the user cannot get information about electricity usage. Therefore, considering these issues, we can offer smart products that will attract the attention of many businesses. This paper examines the analysis of IoT-based EV charging and monitoring. This project focuses on remote electrical parameters such as electricity, current and frequency and transmits the results of this time and the temperature of the EV charging station over the IOT network using the IOT modem/phone number. Users can send commands based on IoT messages to read remote electronic devices. And the system's bill can also periodically (scheduled) send real-time electricity in the form of IOT. [1]
Keywords: EV-electric vehicle, paid maintenance, IoT-Internet of Things, cost.

I. INTRODUCTION

A. Background

Electric vehicles (EVs) can be classified as either grid- connected or off-grid. Grid-connected EVs rely on an external source of electricity, while off-grid EVs are self- sufficient and generate their own power through various means, such as solar panels or onboard generators. Additionally, EV technology is constantly evolving, with advancements in battery technology and charging infrastructure paving the way for a more sustainable transportation future. EVs for the road, along with other new vehicles such as driverless, connected and shared vehicles, are creating a vision of the future called Connected, Autonomous, Shared and Electric (CASE) mobility. Electric cars first appeared in the 1800s, providing a level of comfort where electricity was one of the attractions of driving. age. The internal combustion engine has been the main way to power cars and trucks for over 100 years, but electricity is still available in other types of vehicles such as trains and cars. In the 21st century, electric vehicles have been revived due to technological advances, a focus on renewable energy and the impact on lowering transportation costs, climate change, air pollution and other environmental concerns. According to Project Drawdown, the electric car is listed as one of 100 modern solutions to mitigate climate change. In the late 2000s, governments including the US and EU first offered incentives to increase adoption, leading to auto industry growth in the 2010s. Increasing public interest and awareness, coupled with strong incentives such as those created in the eco-friendly recovery from the COVID-19 pandemic, is expected to fuel the growth of the EV market. [1] Lockdowns have reduced greenhouse gas emissions from petrol or diesel vehicles during the COVID-19 pandemic. In 2021, the International Energy Agency emphasized that governments should implement policies that support the use of heavy-duty electric vehicles to meet climate goals. Global EV sales are expected to grow from 2 percent in 2016 to 30 percent by 2030.

There are more electric two- and three-wheeled vehicles than any other type of electric vehicle. Electric vehicles are partially electric or fully electric. The growth of electric vehicles can be attributed to their environmental friendliness and low cost. Electric cars are powered by an electric motor powered by a lithium-ion battery. These batteries are known for their stable power and long-lasting performance compared to other battery types.

B. Necessity

The first thing about an EV is not leaving any carbon footprints. Unlike an internal combustion engine that burns fuel to power the vehicle, the electric vehicle uses a battery to power the electric motor to turn the wheel, and using electricity to move a car does not release any harmful gases from the exhaust.[1] However, it indirectly contributes to environmental pollution as the electricity used to charge the batteries of an electric vehicle is produced from burning coal in a thermal power plant, which releases harmful gases and heat into the environment. Still, these are comparatively significantly less than that from an IC engine vehicle.

Fig.1. Electric Vehicle

1) *Low Cost of Maintenance*

Many parts in an internal combustion engine-powered vehicle have been eliminated from an all-electric vehicle. Such as manual transmission, fuel tank, fuel pump, radiator, starter motor, etc. Fewer parts mean less maintenance. An electric vehicle also does not require engine oil or filter change, with little to no care for the electric motor and batteries. Batteries of any EVs last for years.

2) *Low Operating Cost*

Electric vehicles (EVs) have a lower cost per kilometer than traditional fuel-powered vehicles. A small electric car like the Mahindra E2O running costs just 0.45 rupees per kilometer which is cheaper than any trim petrol or diesel car. Numerous countries generate a portion of their electrical power using natural gas, a relatively low-emission source, as well as zero- emission sources like wind, water, solar, and nuclear power. This allows producing electrical power cheaper and reduces the harmful gases from the thermal power plant by reducing the load of generating electric power.

3) *Better Driving Experience*

An electric car runs on an electronic motor that gives high torque, and the initial pickup is so quick and smooth that a petrol or diesel car can never catch them.[3] With the performance, you also get a comfortable ride in an EV. The all-electric vehicle runs on an electric motor, which gives you a quiet and smooth ride. The EV comes with superb interior IoT Based EV Charging, and Its Energy Consumption Monitoring System is highly equipped with electronics and features. Driving an electric vehicle (EV) can be both enjoyable and calming, as the vehicle's torque provides a seamless power delivery without the need for gear shifting. The EV does not shake or vibrate. There is no engine sound. It provides the feel of sitting in a luxury car. An electric car is better than a petrol or diesel vehicle.

II. PROBLEM STATEMENT

Currently, we are facing issues related to lack of fuel, pollution, so we are moving towards the EV. Still, people are not ready to prefer EVs because of the consumption price and the need for charging stations.

Due to concerns about difficulties in EV charging and the imbalance of the utilization rate, i.e., the price of charging facilities. So, by viewing these issues, we can provide intelligent charging availability.

III. LITERATURE REVIEW

1) Technology-Based on Wireless Communication Wireless communication refers to the transmission of data without the use of physical cables or wires. This umbrella term encompasses all the methods and techniques used for establishing and maintaining communication between two or more devices using wireless signals, wireless communication technologies, and wireless devices. [9] The previous work has used several types of technology for wireless battery monitoring systems, such as GSM, ZigBee, GPRS, Android, WIFI, and Bluetooth communication. Global Positioning System (GPS) utilizes satellites to transmit global data that provides a GPS receiver's location and current time. It synchronizes the operation so that these repeating signals are sent simultaneously. The signs, moving at the speed of light, arrive at a GPS receiver at slightly different times because some satellites are further away than others. The Global Positioning System (GPS) determines the distance between a receiver and GPS satellites by estimating the time taken by the satellite's signal to reach the receiver. When the receiver is able to determine the distance to at least four GPS satellites, it can precisely calculate its position in three dimensions. The distance to the GPS satellites can be determined by estimating the time it takes for their signals to reach the receiver. When the receiver estimates the distance to at least four GPS satellites, it can calculate its position in three dimensions. The accuracy of a status determined with GPS depends on the type of receiver. Android is an open-source operating system designed for a range of devices, including

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smartphones, tablets, and emerging technologies like wearable's and in-car entertainment systems. The operating system can inform you of a new notification, SMS, Email, or even the latest articles. Unfortunately, it always needs an active or GPRS internet connection in that place so that the device can go online to suit people's needs. Furthermore, the operating system has many processes in the background, causing the waste of batteries.

2) Technology-Based on wireless battery monitoring system Reliable battery management is necessary for safety purposes. Several reasons cause battery breakdowns, such as deterioration of the battery and design defects. A manual battery monitoring system is like a regular one, meaning it does not save the data in the database. But only show the data collected in real-time. Therefore, it is essential to monitor battery systems using wireless technology remotely; it indicates that no automatic monitoring system is available to notify the user regarding the battery's performance. Therefore, using IoT technology within the monitoring system can help improve preventive maintenance, ensuring battery quality and increasing user safety.[3]
3) Optimal Scheduling Mechanism for EV Charging and Discharging with Multi-Price Scales and Comprehensive Demand With the development of the electric vehicle (EV) industry, EVs have also begun to be more integrated into the distribution network and become an essential part of the distribution network. However, the uncertainty of EV user behavior and load brings significant challenges to the stable operation of the distribution network. This paper introduces an optimal scheduling mechanism that addresses the issue of electric vehicle (EV) charging and discharging in the presence of multi-price scales and complex demand patterns. EV's charging and discharging prices are determined by different time-of-use price strategies based on other regions, and the load uncertainty is reduced by complete request. In addition, this methodology proposes three quantitative metrics to assess the level of satisfaction with electricity costs, network loss, and load peak-valley differences. The effectiveness of the proposed method is evaluated through simulation results based on an IEEE 33-node system, demonstrating its capability in optimizing the EV charging and discharging process.

IV. METHODOLOGY

1) The problem statement states that we are developing an IOT- based electric vehicle charging and energy consumption monitoring system.
2) Planning to develop a system by which users can monitor electricity consumption and pay accordingly.
3) The smartphone can control or monitor it using IOT devices.
4) It is an IOT-based system that shares information with the EV user regarding EV Charging monitoring. In which users can access data on energy consumption and its charges.
5) We will need the following components for the IOT based Energy Consumption Monitoring System Project.

V. PROPOSED SYSTEM

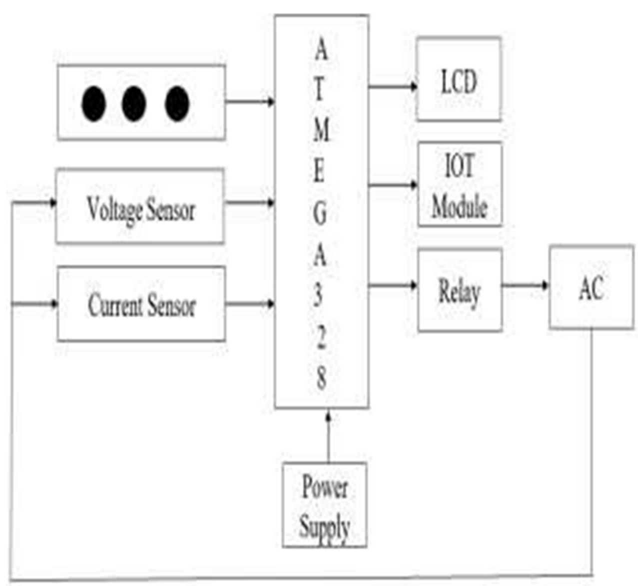

Fig.2. Block Diagram

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A. *Working On The Model*

1) This project uses an onboard computer, commonly term microcontroller.
2) The microcontroller monitors the behavior of analysts at different time intervals, monitoring the voltage, current, and temperature fluctuations in the electricity distribution at the EV changings.
3) By incorporating an IoT alert system, this design can be customized to send out notifications whenever the Circuit Breaker trips, or if Voltage or Current levels surpass pre- set limits.
4) Relay gets activated whenever the electrical parameters exceed the predefined values.
5) The block diagram consists of Atmega 328, three push switches, a voltage sensor, a current sensor, LCD, IOT Module, Relay, bulb, and Battery.
6) Three push switches charge the EV for a specific time, such as 10sec, 20sec, and 30sec resp.
7) As we push the switch, it will charge the EV according to the switch value, measure the voltage and current, and send it to the IOT, which will be shown in graphical format.

B. *Circuit Diagram*

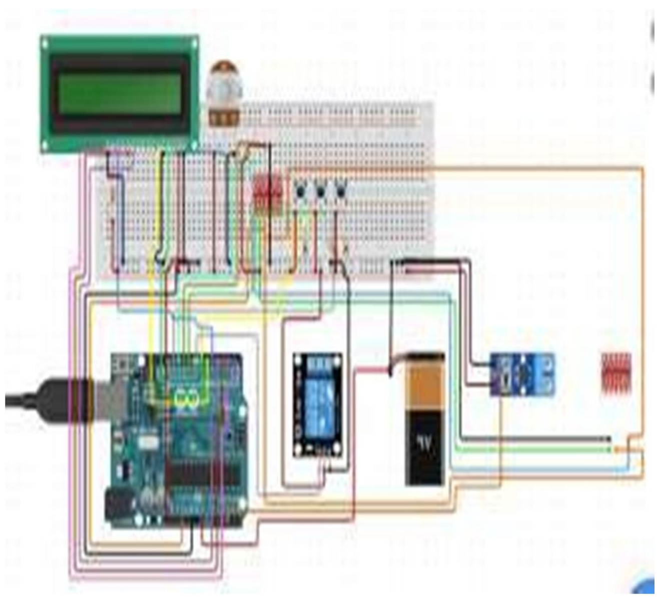


Fig.3. Circuit diagram

C. *Flowchart*

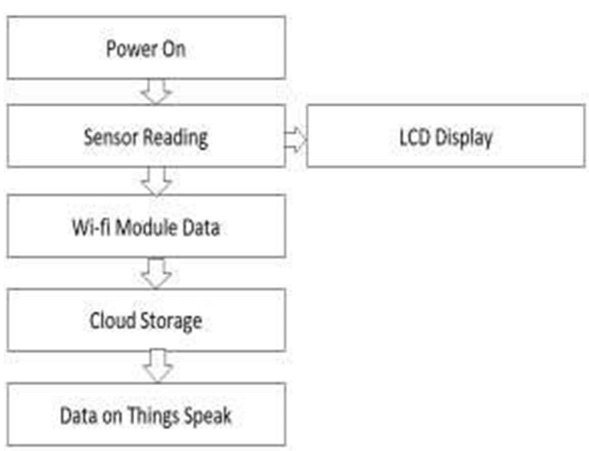


Fig.4. Flowchart

VI. SOFTWARE REQUIREMENT

A. ARDUINO Software is used

Programming Languages - Embedded C, ALP (Assembly Language)

How To Start With Arduino Software

- Get an Arduino or Genuino board and USB cable.
- Download and install the Arduino Software (IDE)
- Connect the board. ...
- Install the board drivers. ...
- Launch the Arduino Software (IDE) ...
- Open the blink example. ...
- Select your board. ...
- Select your serial port.

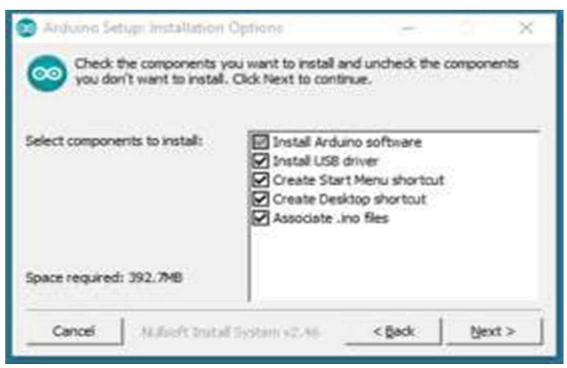
1) Get an Arduino or Genuino board and a USB cable

We assume you are using Arduino or Genuino Uno in this tutorial. If you are using an older development board such as Arduino Duemilanove, Nano or Diecimila, please refer to the driver installation instructions at the end of this document. If you have another board, please read the links on the homepage to get started.

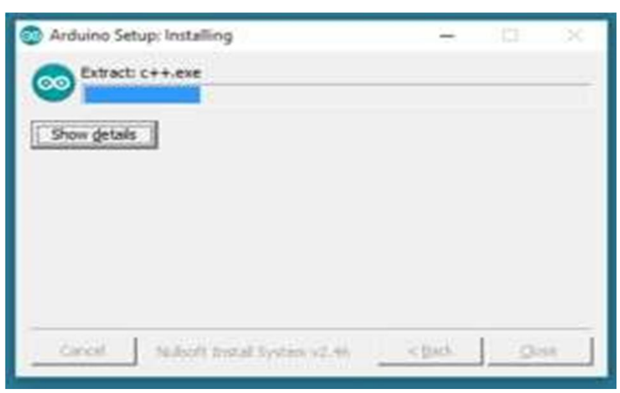
2) Download and install the Arduino software (ide)

Get the latest version from the download page. You can choose between an installer (.exe) and a Zip package. We recommend using the first one directly to install everything you need using the Arduino software (IDE), including the drivers. For zip packages, you must install the drivers manually.

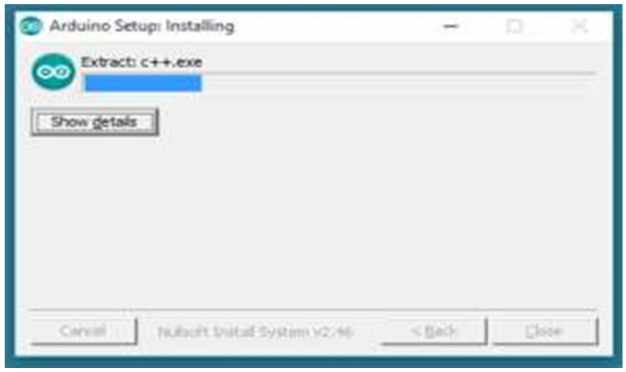
Continue with the installation after the download is complete, please allow the driver installation process.



Choose the components to install.



Choose the installation directory (we suggest keeping the default one.



The process will extract and install all the required files to execute the Arduino Software (IDE) properly.

3) *Connnect the Board*

Connect the card to your computer with a USB cable. USB connection to a PC requires power for the board, just no power. Uno and Mega automatically draw power from USB or other power sources. The green power LED (labeled PWR) should illuminate.

4) *Install the Board Drivers*

If you use the installer, Windows - from XP to 10 - will automatically install the drivers when you connect the card. If you download and extract the

Zip package or if for some reason the clipboard is not recognized, follow the steps below.

Click on the Start menu and open Control Panel.

Go to System and Security in Control Panel. Next, click System.

When the system window opens, open Device Manager. Look under

Ports (COM and LPT). You should see an open port named "Arduino UNO (COMxx)". If there is no COM & LPT partition, look for "Unknown Device" under "Other Devices". Right click on the

"Arduino UNO (COMxx)" port and select "Update Driver Software".

Next, select "Search my computer for driver software".

Finally, navigate to and select the driver file "Arduino.inf" located in the "Drivers" folder are using an old version of the IDE (1.0.3 or older), choose the Uno driver file named "Arduino UNO.inf."

5) *Launch the Arduino Software (IDE)*

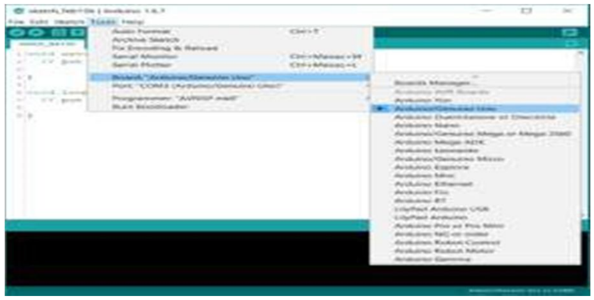
a) Windows will finish up the driver installation from there.
b) Double-click the Arduino icon (arduino.exe) created by the installation process. (Note: if the Arduino Software loads in the wrong language, you can change it in the preferences dialog.

6) *Open the Blink Example*

Open the LED blink example sketch: File > Examples >01.Basics > Blink.

7) Select your Board

You must select the entry in the Tools > Board menu corresponding to your Arduino or Genuino board.



8) Select your Serial Port

Select the Serial Port tool from the Serial Port Tools menu. This can be COM3 or higher (COM1 and COM2 are usually reserved for hardware serial ports). You can cut the board and reopen the menu to find out; the missing input must be an Arduino or Genuino board. Reconnect the panel and select the serial port.

9) Upload the program

Now, click the "Install" button in the environment. Wait a few seconds - you should see the RX and TX LEDs flashing on the board. If the installation is complete, the message "Installation complete" is displayed. will appear in the status bar.

A few seconds after the upload finishes, you should see the pin 13 (L) LED on the board start to blink (in orange). If it does, congratulations! You've gotten Arduino or Genuino up and running.

VII. DETAILS OF HARDWARE

A. Microcontroller -

In this project we are using ATmega328 microcontroller. It is a single-chip microcontroller created by Atmel in the mega AVR family. It has Harvard architecture 8-bit RISC processor core. ATmega328 is used in many projects and autonomous systems where a simple, low-powered, low- cost microcontroller is needed. At which programming language compiler and a boot loader that executes on the microcontroller.

Microcontroller: ATmega328

1) Operating Voltage: 5V
2) Input Voltage (recommended):7-12V
3) Input Voltage (limits): 6-20V
4) Digital I/O Pins: 14
5) Analog Input Pins: 6
6) DC Current per I/O Pin: 40mA
7) DC Current for 3.3V Pin: 50mA
8) Flash Memory: 32 KB (ATmega328)
9) SRAM: 2 KB (ATmega328)
10) EEPROM: 1 KB (ATmega328)
11) Clock Speed: 16 MHz

Fig.5. Microcontroller

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B. LCD Display

LCD stands for Liquid Crystal Display. This LCD is named 16x2 because; it has 16 Columns and 2 Rows.
There are a lot of combinations available, like 8×1, 8×2, 10×2, 16×1, etc. But the most used one is the 16*2 LCD; hence we are using it here.

Fig.6. LCD Display

C. IOT Module

The ESP8266 Wi-Fi Module is simply a SOC microchip used to build the ultimate IoT (Internet of Things). It is an inexpensive standalone wireless transceiver. It is used to provide Internet connectivity for various internal applications. It is widely used in robotics and IoT applications due to its low cost and size. Maximum operating power 3.6v power. Requires only 3.3 volt power supply.

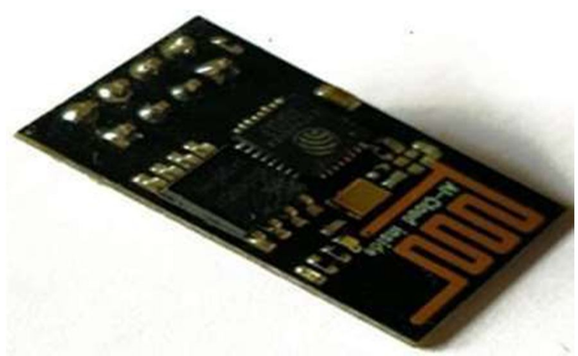

Fig.7. IOT Module

D. Voltage Sensor

It is a precise, low-cost sensor for measuring voltage. It is based on the principle of resistive voltage divider design. It can make the red terminal connector input voltage five times smaller.

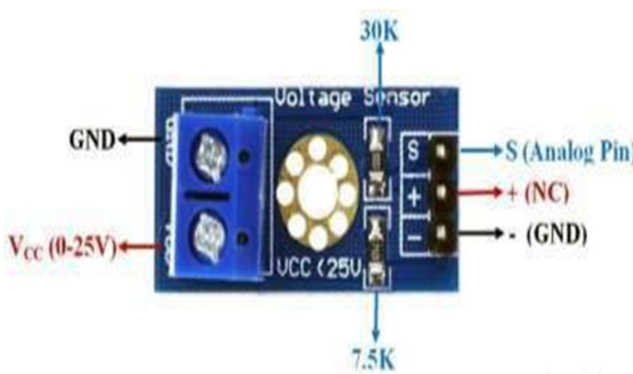

Fig.8. Voltage sensor

E. Current Sensor

A current sensor is a device that used to detects and converts current to an easily measurable output voltage, which is proportional to the current through the measured path. Various sensors are suitable for a specific current range and environmental conditions.

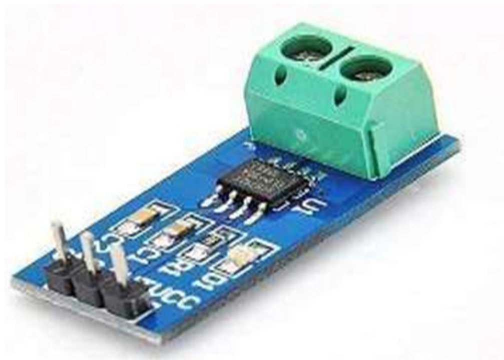

Fig.9. Current sensor

F. Relay

The traditional relay form uses an electromagnet to close or open the contacts. Relays with calibrated functional characteristics and sometimes multiple operating coils protect electrical circuits from overload or faults. Still, relays using other active principles, such as solid-state relays, which use semiconductor properties for control without relying on moving parts, have also been invented.

Fig.10. Relay

VIII. PERFORMANCE PARAMETERS

Table. I. Performance parameters

Sr. No.	Name of Components	Specifications
1	Microcontroller ATMEGA328P	Operating Voltage: 2.7V-5.5V Temperature Range: -40°C to 85°C
2	ESP8266 Wi-Fi IOT Module	(I/O) Voltage: 3.6 Volts,2.4 GHz Supports WPA/WPA2 and open networks
3	LCD Display	Size - 16*2 Operating Voltage: 4.7V to 5.3V
4	Current Sensor	Supply Voltage: 5Vdc Measurement Range: -5 to +5 Amps
5	Voltage Sensor	Input Voltage: 0 to 25V Dimensions: 4*3*2 cm Voltage Detection: 0.02445 to 25

IX. RESULT

All data of voltage consumption and current and unit according to it will be shown in IoT through the graph.

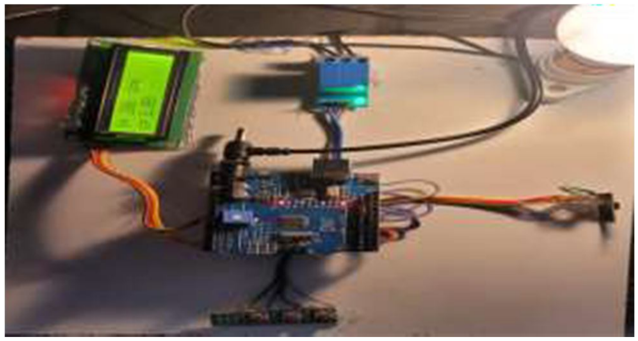

Fig.11. Hardware

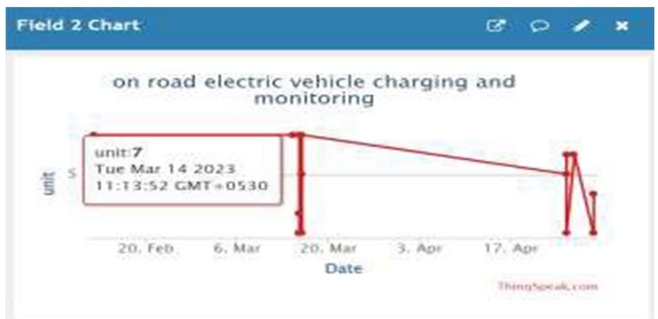

Fig.12. Unit Consumption Graph

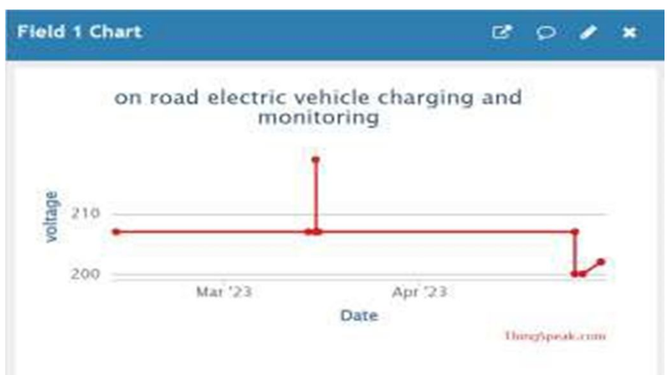

Fig.13. Voltage Consumption Graph

Fig.14. Current Consumption Graph

X. CONCLUSION

1) Developing the Charging system for batteries project comprised various disciplines like electrical, electronics, and mechanical engineering technologies. This project attempted to provide a framework for the battery charging station.
2) Integrating features of all the hardware components have been developed. Every module has been reasoned out and it is placed carefully, thus contributing to the best working of the unit.
3) This project attempted to provide a framework for the EV charging station. The proposed EV charging and energy consumption monitoring system will be one of the initiatives taken to achieve a green campus.

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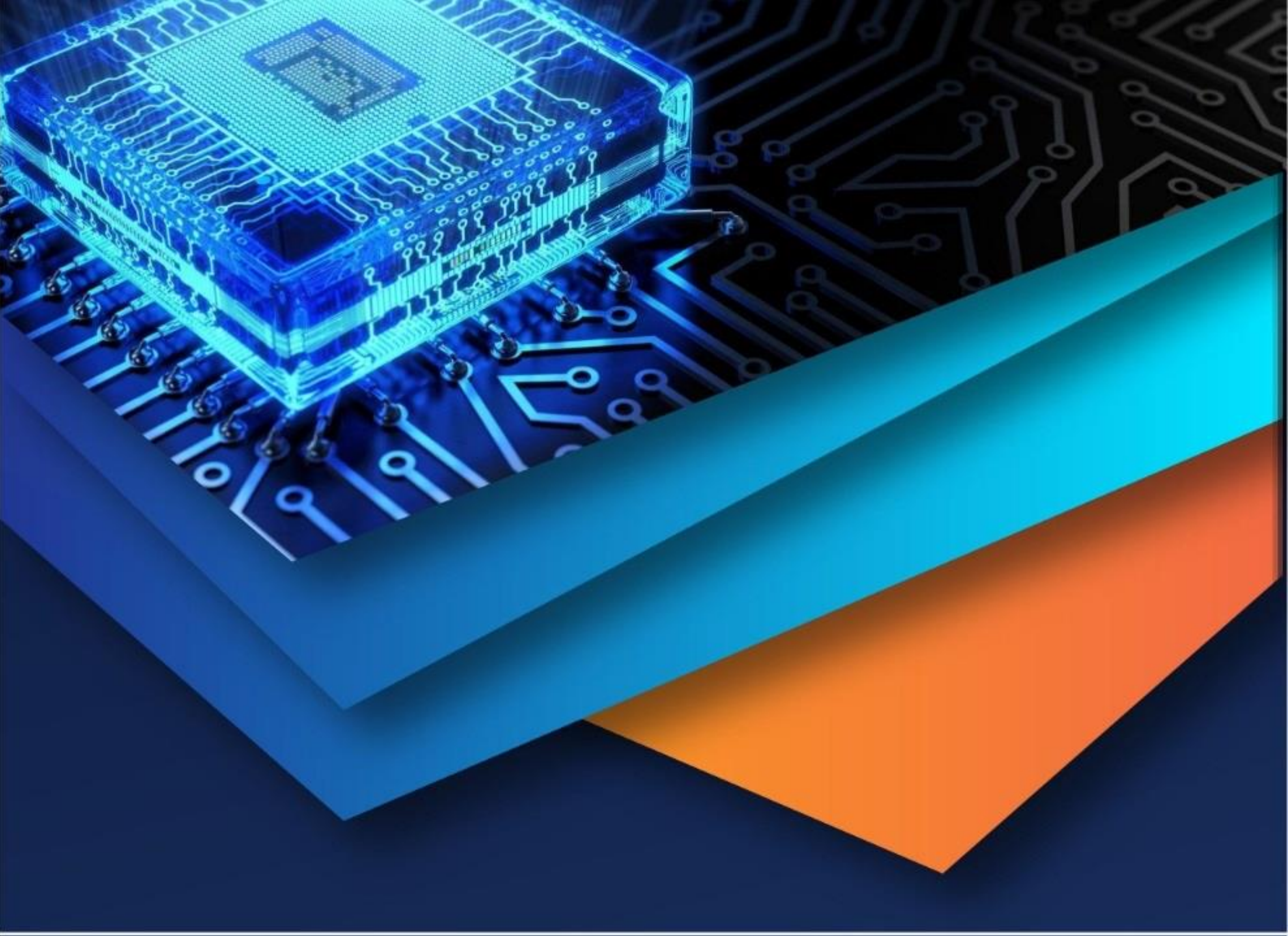

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