A

RESEARCH PAPER

ON

"DUAL BATTERY CHARGER SYSTEM FOR ELECTRIC VECHICLE"

Submitted by

WANI NILESH PANDIT

Nileshwani11@gmail.com

Contact No +91 9860077177

MIT ADT University

Under the Guidance of

PROF. SATEESH PATIL

DEPARTMENT OF MECHANICAL ENGINEERING

MIT SCHOOL OF ENGINEERING, MIT ADT UNIVERSITY

RAJBAUG, LONI KALBHOR,

PUNE – 412201

ACKNOWLEDGEMENT

I express my profound thanks to Guide **Prof. Sateesh Patil** Mechanical Engineering MIT School of Engineering, MIT-ADT University, Pune for his expert guidance, encouragement and inspiration during this Seminar work.

I am very thankful to **Prof. Dr. Sandeep Thorat,** PG Co-ordinator, Mechanical Engineering Department for his guidance and all kinds of help to complete my work.

I also express thanks to **Prof. Dr. Sudarshan Sanap**, Head, Department of Mechanical Engineering, being constant source of inspiration throughout the execution.

I am grateful to **Prof. Dr. Kishore Ravande**, Principal, MIT School of Engineering, MIT-ADT University, Pune, for providing me the facilities to carry out my work.

I am also thankful all the faculty members in the department for their support and advice. I am very much grateful to my Parents for their immense love, affection, help, cooperation and encouragement to complete this course.

Finally, a special thanks to all my classmates and friends who helped and encouraged me to complete successfully my seminar work.

– Nilesh Pandit Wani

ABSTRACT

This paper introduces a two-battery charging system using an Arduino controller. Today Electric cars are facing many problems due to increased battery charging time. This paper provides a solution to reduce charging time by integrating a two-battery charging system. The proposed two-battery charging system contains a number of cells to make a complete battery. The battery is divided into two parts using a switch during charging and charging the battery from both sides to fully charge it using two chargers. The battery automatically disconnects from the charger when fully charged, that is, it arrives at a fixed location and starts charging when the battery reaches its limit. By using this feature, the battery charging time is reduced to about half the required charge time. This program displays current status, voltage and battery charging on the display board, which helps monitor battery performance.

Keywords — Electrical Vehicle (EV), Arduino UNO, Dual battery charger, Rectifier circuit, Battery performance.

TABLE OF CONTENTS

ABSTRACT……..…..i
TABLE OF CONTENTS.....ii
LIST OF FIGURES iii
LIST OF TABLES..... iii
1.1. Introduction.....1
1.1.1 Batteries Used in Electric Vehicle…….……..…… …..1
1.1.2 Advantages and Limitations of Li-ion Batteries……..……..3
1.1.3 Comparison of Major Battery Technologies ……..……..6
1.2.Literature Review.....8
1.3.Proposed System 11
1.3.1. Theory of Li-ion Battery.....11
1.3.2. Working of lithium-ion battery.....11
1.3.3. Charging of Li-ion Battery.....12
1.3.4. Discharging of Li-ion Battery.....12
1.3.5. Characteristics of Li-ion Battery 13
1.3.6 Dual Battery Charging System……...14
1.3.6.1 Block Diagram of Dual Battery Charging System……..14
1.3.6.2 Circuit Diagram of Dual Battery System ……..15
1.3.7. Working of Dual Battery System ……..16
1.4. Hardware Implemention.....17
1.4.1. Component List 17
1.4.2. Ardunio UNO 19
1.4.3. Types of Arduino Boards 20
1.4.4. Features of Arduino 20
1.4.5. Potential Transformer (PT) 20
1.4.6. Current Transformer.....21
1.4.7. Relay 22

1.5. Result Discussion 24

1.6 Summary 26

References .....

LIST OF FIGURES

Fig. 1 Flow of Electron in Li-ion Battery 11

Fig 2 Charging of Li-ion Battery…….. ..12

Fig.3 Discharging of Li-ion Battery…… 12

Fig. 4 Block Diagram of Dual Battery System. 14

Fig. 5 Circuit Diagram of Dual battery System 15

Fig. 6 Hardware of Prototype.....18

Fig. 7 Circuit Diagram of Potential Transformer.....21

Fig. 8 Circuit Diagram of Current Transformer.....22

LIST OF TABLES

Table 1 Comparison of Major Battery Technologies ...……6

Table 2 Charging Time of INDIAN EVs.....7

Table 3 Components for hardware implementation.....17

Table 4 Results of dual battery charging system 24

1.1. INTRODUCTION

In recent years, environmental problems caused by fuel cars and fuel savings have worsened. The new, green, environmentally friendly and economical vehicles are not only important for the economic and social development of many countries, but also for future car development. The EV is a vehicle that emits zero pollution, miles and fuel vehicles can be compared to electric cars.

And as a result of the ever-increasing cost of fuel, travel costs for IC-engine vehicles are increasing. It raises the price of gasoline in transportation costs, hence the cost of all products.

Therefore, the use of electric vehicles is increasing day by day. Battery, Electric Vehicle, Controller are important parts of the E-vehicle system.

1.1.1 Batteries Used In Electric Vehicle

Lead-acid battery:

Founded in 1859, nowadays, lead-acid batteries are no longer used for pulls, but to power the electrical circuit of utensils or components for combustion engines as a starter. The lead-acid battery not only provides a limited capacity despite its bulk and its critical weight, but has the advantage of being both inexpensive and easy to produce and reuse. Used as a major energy-saving device in electric vehicles until the 80s, it was quickly released into another, more efficient technology.Nickel-cadmium battery.

If you used rechargeable batteries in the 90s, then you are already familiar with nickel-cadmium technology. The “Ni-Cd” accumulators have a host of advantages, with significant storage durability and a lifetime of approximately 500 to 1,000 charging cycles.

However, they have suffered from memory impairment, a visual phenomenon that sees battery performance drop when under partial "charging" cycles. Used in the production of electric vehicles in the 90s, Ni-Cd batteries have now been banned due to cadmium poisoning.

Nickel-metal hydride battery:

With performance similar to Ni-Cd technology, nickel-metal hydride (Ni-MH) accumulators have seen long-term success due to the lack of heavy metals. This portable battery technology was very popular in the early 2000s, which is why it dominated the hybrid car market, until the advent of lithium-ion technology.

Lithium-ion battery:

Developed in the early 90s, the lithium-ion battery gradually established itself as a leading technology, both in the transportation world and in the consumer electronics industry. With longevity, it offers the greatest dynamic of all competing technologies and is not subject to the effect of memory.

However, it requires proper packaging and precise control of the charging process, usually obtained by a dedicated electronic circuit. Renault uses lithium-ion technology in ZOE and other electric vehicles in the range. In addition, the Group is working to incorporate its batteries into a circular economy that aims to extend its life span as much as possible.

Solid-state battery:

Scientific research has long tested the concept of a solid state battery, but it is only 10 years since its continuation has made it possible to consider technological adoption by the automotive industry in the distant future.

The goal behind it involves replacing the liquid electrolyte with a solid material that can take the form of a polymer plastic, inorganic powdered powder or a combination of both. In theory, this technology is a good thing: it makes it possible to increase energy density and stability while making temperature control easier. However, the stable state is still in the laboratory model phase. The lithium-ion battery still has a lot of health left over.

1.1.2 Advantages and Limitation of Li-ion Batteries

Advantages of Lithium Ion Battery:

- High power density - Lithium-ion batteries can have high power without being too large. It is one of the main reasons why it is so popular in the mobile devices industry.
- Small and light - Lithium-ion battery is lighter and smaller than other rechargeable batteries considering the battery capacity. This makes it especially useful for portable electronic devices where physical specifications such as weight and form factor are considered important areas of sale.
- Low self-discharge battery - Lithium-ion battery has a very low discharge rate of about 1.5-3.0 percent per month. That means the battery has a longer shelf life when not in use because it runs longer than other rechargeable batteries. Note that the nickel-metal hydride battery is self-discharging 20 percent per month.
- Non-memory effect - Lithium-ion battery has zero to minor memory effect. Note the effect of memory on the rechargeable batteries when they lose their maximum capacity when recharged. This memory effect is common on nickel-metal hydride batteries that are recharged.
- Fast charging - Lithium-ion battery is faster than other rechargeable batteries. It actually takes a bit of time to charge compared to its counterparts.
- High open-circuit voltage - Lithium-ion battery has a higher voltage opening circuit than other liquid batteries such as lead acid, nickel-metal hydride, and nickel-cadmium.
- Long service life - Lithium-ion battery can handle hundreds of charging cycles. Some Lithium-ion batteries lose 20 percent of their initial capacity after 500 cycles, while the most advanced Lithium-ion batteries lose their power after 2000 cycles.
- Low maintenance - Lithium-ion batteries do not require maintenance to ensure their performance, as they have a low memory effect and low output.
- No need for reboot - Some regenerative cells need to be restarted when they get their first charge. There is no need for this with lithium ion cells and batteries.

- Diversity of species available - There are several types of Lithium-ion cells available that have a cylindrical or prismatic nature. This advantage of Li-ion batteries can mean that the right technology can be used in the specific system.
- High power density - Lithium-ion batteries can have high power without being too large. It is one of the main reasons why it is so popular in the mobile devices industry.
- Small and light - Lithium-ion battery is lighter and smaller than other rechargeable batteries considering the battery capacity. This makes it especially useful for portable electronic devices where physical specifications such as weight and form factor are considered important areas of sale.
- Low self-discharge battery - Lithium-ion battery has a very low discharge rate of about 1.5-3.0 percent per month. That means the battery has a longer shelf life when not in use because it runs longer than other rechargeable batteries. Note that the nickel-metal hydride battery is self-discharging 20 percent per month.
- Non-memory effect - Lithium-ion battery has zero to minor memory effect. Note the effect of memory on the rechargeable batteries when they lose their maximum capacity when recharged. This memory effect is common on nickel-metal hydride batteries that are recharged.
- Fast charging - Lithium-ion battery is faster than other rechargeable batteries. It actually takes a bit of time to charge compared to its counterparts.
- High open-circuit voltage - Lithium-ion battery has a higher voltage opening circuit than other liquid batteries such as lead acid, nickel-metal hydride, and nickel-cadmium.
- Long service life - Lithium-ion battery can handle hundreds of charging cycles. Some Lithium-ion batteries lose 20 percent of their initial capacity after 500 cycles, while the most advanced Lithium-ion batteries lose their power after 2000 cycles.
- Low maintenance - Lithium-ion batteries do not require maintenance to ensure their performance, as they have a low memory effect and low output.
- No need for reboot - Some regenerative cells need to be restarted when they get their first charge. There is no need for this with lithium ion cells and batteries.

Limitation of Lithium-ion battery:

- Expensive - The production of Lithium-ion batteries can be very expensive. The total production cost of these batteries is about 40% higher than nickel-metal hydride batteries.
- Protection is needed - Lithium-ion cells and batteries are not as durable as other rechargeable technologies, they need protection from excessive charging and can be charged.
- Impact of aging - Lithium-ion battery will naturally degrade as it suffers from aging. Normally Lithium-ion batteries will only be able to stand on 500 - 1000 charge cycles and discharge before their capacity drops to 50%.
- Transport problems - These disadvantages of Lithium-ion battery have become apparent in recent years. There are many restrictions on the transport of Lithium-ion batteries especially large amounts per aircraft.
- Deep output - Lithium-ion battery has low output. The general integrity of this battery remains the same even if it is slightly charged. However, deep emissions or when the voltage of the Lithium-ion cell drops below a certain level, it becomes unusable.
- Safety concerns - Lithium-ion batteries may explode when overheated or overcharged. This is because the gases formed by electrolyte decomposition increase the internal pressure of the cell. Excessive heat or a short internal circuit can ignite an electrolyte and cause a fire.
- High temperature sensitivity - Lithium-ion battery is exposed to high temperatures caused by device overheating or overcharging. The heat causes the cells or packets of this battery to drop faster than they normally would.

1.1.3 Comparison of Major Battery Technologies

A few popular batteries and their key features are compared in Table I. As compared to sp. fuel capacity (13,000 Wh / kg), batteries almost 50-100 times more powerful. The value of low battery density compared to fuel can be illustrated as follows.

With 50 liters of fuel, a standard motor vehicle (eg Suzuki SX4 @ 16-20 km / L) can have a travel distance of more than 700 km. A battery with the same capacity of 50 liters of fuel can be very heavy and can be extremely large in volume. Based on current battery technology, a 100 kWh Li-ion battery that can provide a distance of 500 km can weigh between 800-900 kg.

Table 1:- Comparison of Major Battery Technologies. [19]

Battery Type	Nominal Voltage (V)	Specific Energy (Wh/kg)	Energy Density (Wh/L)	Specific Power (W/kg)	Life Cycle
Pb-acid	2.1	30-40	100	180	500
Ni-Cd	1.2	50-80	300	200	2000
Ni-MH	1.2	60-120	180-220	200-300	< 3000
ZEBRA	2.6	90-120	160	155	> 1200
Li-ion	3.6	120-250	200-600	200-430	2000
LiPo	3.7	130-225	200-250	260-450	> 1200

Pb-acid: Lead Acid, Ni-Cd: Nickel-Cadmium, Ni-MH: Nickel-Metal Hydride, ZEBRA: Zero Emissions Batteries Research Activity, Li-ion: Lithium-ion, LiPo: Lithium-ion polymer.[4]

Table 2:- Charging Time of INDIAN EVs [14]

Specification	**TATA NEXON-EV**	**HYUNDAI-KONA-EV**	**Mahindra E2O**
Charging Time:- at Residence Charger	-(SOC 10% to 90% from any 15 A plug point) - 8.5 hours	AC Charging (0-100%) Approx. 6 h 10 min	It takes 9 hours to charge fully.
Charging Time :- High Voltage Charging Station	(SOC 0%-80%) - 60 minutes	DC Charging (0-80%) @50 kW Approx. 57 min	Using the Rapid (CHAdeMO) 0-95% in 90 minutes only.

We can say that charging at home takes more time; i.e. 8-10 Hours. The limit is that it is used for long distances. Therefore, although there are stations that charge faster, but also the waiting time will be longer compared to the time to refuel with Petrol or Diesel.

1.2 LITERATURE REVIEW

Much of the project work is done in the field of battery management, improved control systems, improved battery performance. Two battery systems can increase efficiency by 13% -18%, improve fuel consumption by at least 14% over a distance of 100 miles, increase EV mode range by 12% -14%, reduce overall weight by 13% -17%, reduces initial battery and life cycle costs leading to total cost savings by 10% -12%, and provides flexibility in system design. [1]

One paper proposed a Plug-In Hybrid Electric Vehicle with a Dual Battery System. Here are the performance of the car, part upgrade and hybrid control system PHEV and dual battery system. But the cost of plugging in a hybrid electric car is higher. [2]

In another paper they showed the Super Capacitor Charging System for electric vehicles. In this program, the job is done to charge each battery cell in a fast charging mode. Our system is also used for fast charging. [3]

In one paper its proposed measurement of super capacitor modules is also done using an intelligent circuit for monitoring and evaluation. [4]

Proposed Future of Electric Car Charging. Here the focus was on five technologies that play a key role in smart charging, car charging to grid, EV charging from PV panels, wireless charging and road charging. But wireless charging is slow and inefficient and car charging to the grid has some limitations. [5]

One Handbook for Electric Car Charging and Battery Management System discusses the disadvantages of using EV for the amount of time required to charge the battery and discusses different charging methods. They also discuss faster charging of higher current values and the required voltage due to higher values there is a potential for battery damage. [6]

In another paper they present an overview of the current and proposed EV charging technology in terms of converter topology, power levels, and power flow indicators and charging control strategies. An overview of the main charging methods is also introduced; in particular the goal is to highlight the effective and fast charging method of lithium ion batteries which is related to extending cell cycle life and maintaining high charge efficiency. Once the most important aspects of charging

technology and techniques have been presented, in the last part of this paper, using a genetic algorithm, the full size of the charging systems is estimated and, on the basis of critical analysis, possible future styles. in this field they are finally appreciated. [7]

The recent shortage of fossil fuels and the problems associated with global warming have caused a dramatic shift from burning engines to EVs. This paper examines a comprehensive review of battery charging infrastructure from wireless to wireless EV charging. The first part of the paper deals with cable charging and its electrical infrastructure. The latest section deals with wireless charging when discussing both standalone and Street models. In addition, various aspects of wireless power transmission are also discussed. Market conditions and prospects for future growth are reviewed and presented in the final section of the paper. [8]

This paper examines the current and future use of fast charging stations for electric vehicles. The purpose of this paper is to analyse current charging patterns in charging stations and the role of fast charging between different charging options. These patterns are evaluated according to the automotive technology capabilities and it is found that with increasing battery capacity the need for faster charging decreases. However, for those vehicles with high charging capacity there are indications that fast charging is considered to be as simple as frequent use. Such results indicate a larger share of faster charging when the charging capacity increases in the future. Results from the local analysis show that much faster charging is done at a longer distance from home, which raises more frequent ‘street’ charging. Some fast charging sessions are closer to home, especially those that do not have access to home charging. This shows some of the future power of fast charging in cities with overcrowded parking lots. [10]

Rapid charging of lithium-ion batteries is a significant problem that prevents the transmission of electric vehicles on a large scale. To solve this problem, a new charging strategy is proposed for this paper. Three actual donations were made to this paper:

1) The development of a continuous multi-stage temperature improvement system that reduces both charging time and increasing temperature, by trading between charging time and temperature rise is analysed using a genetic algorithm (offline strategy).

2) Reduction of charging time by confirming the charging area by adjusting the charging capacity and charging time; and

3) to demonstrate that the proposed method can be used under different temperatures by comparing the proposed method with the constant current voltage rating (CCCV) under different temperatures; The comparative results suggest that the charging time of the proposed method is reduced by 1.9%, 5.3%, 8.56%, and 9.54% compared to the standard CCCV method below ambient temperature, 10 _C, 25 _C, and 40 _C, respectively. In addition, the proposed temperature rise was reduced by 48.6%, 28.3%, 67.3%, and 17.9% compared to the standard CCCV method below ambient temperatures of 10 _C, 25 _C, and 40 _C, respectively. [14]

1.3. PROPOSED SYSTEM

1.3.1. Theory of Li-ion Battery

A rechargeable lithium-ion battery is made up of one or more energy-efficient components called cells. Each cell has three parts.- Attractive electrode, negative electrode and electrolyte.

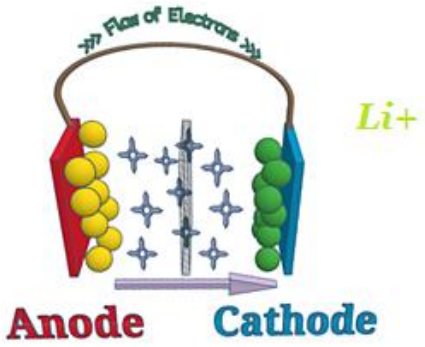

Fig.1:- Flow of Electron in Li-ion Battery [18]

The positive electrode connects to the battery point or + terminal. The negative electrode connects to the negative or - terminal. And a chemical called electrolyte between them.

The constructive electrode is usually made from a chemical called lithium-cobalt oxide (LiCoO2) or lithium iron phosphate (LiFePO4). The negative electrode is usually made of carbon (graphite). Electrolytes vary from one type of battery to another. [17]

1.3.2 Working of lithium-ion battery

The electrolyte carries a positively charged lithium ion from anode to cathode. The movement of the lithium ion creates free electrons in the anode which creates a charge in the positive current collector. Electricity then flows from the current collector through the power cord (mobile phone, computer, etc.) to the current negative collector. The separator blocks the flow of electrons inside the battery. [17]

1.3.3 Charging of Li-ion Battery

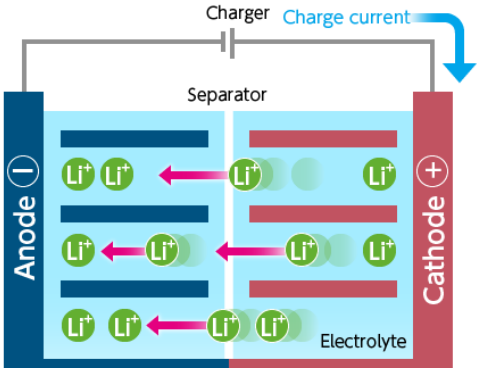

Fig.2:- Charging of Li-ion Battery [18]

While the battery emits and supplies electricity, the anode releases the lithium ion to the cathode, producing electrons flow from one side to the other. When you connect the device, a reverse reaction occurs, the cathode releases the lithium ion and the anode receives them. This is how a Lithium-ion battery works.

1.3.4 Discharging of Li-ion Battery

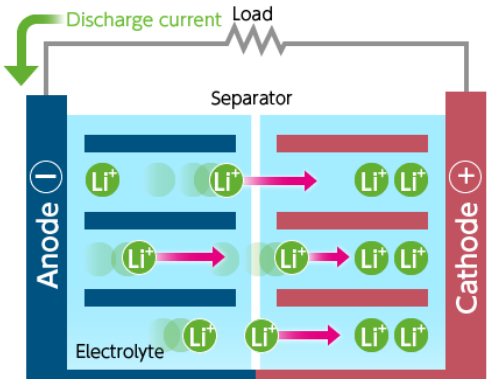

Fig.3:- Discharging of Li-ion Battery [18]

In this battery, compression and compression are the most common causes of battery life. Generally, power density is measured in watt-hours per kilogram (wh / kg) and the amount of energy a battery can consume in relation to its weight. Measurements of power consumption are watts per kilogram (W / kg) and the amount of battery power in relation to its weight. [17]

1.3.5 Characteristics of Li-ion Battery

Charge/ Ahr capacity

The battery charger that the battery can supply is obviously the most important parameter. The SI unit for this is Coulomb, a charge where one Amp flows one second. Battery capacity can be, say, 10Amphours. This means it can give

1Amp /10 hours.

Energy stored

The energy stored in a battery depends on voltage in it , also the charge stored. The SI unit is the Joule, and so we use the Whr instead. Hr. (Energy :- Whr =V × Ahr)

Specific energy

Specific energy is the amount of electrical energy stored for every kilogram of battery mass. Their unit is $Wh.kg^{-1}$.

Energy density

Energy density is the amount of electrical energy stored per cubic metre of battery volume. Their unit is $Wh.m^{-3}$.

Specific power

Specific power is the amount of power obtained per kilogram of battery. It is a highly variable and rather anomalous quantity, since the power given out by the battery depends far more upon the load connected to it than the battery itself.

Energy efficiency

This is another very important parameter and it is defined as the ratio of electrical energy supplied by a battery to the amount of electrical energy required to return it to the state before discharge.

Ahr (or charge) efficiency

In an ideal world a battery would return the entire charge put into it, in which case the amp hour efficiency is 100%. However, no battery does; its charging efficiency is less than 100%. It will vary with the state of charge.

1.3.6 Dual Battery Charging System

1.3.6.1 Block Diagram for Dual Battery Charging System

We have proposed a dual battery charge for electric vehicles. Figure 1 shows the block diagram of the proposed system. According to the circuit diagram the hardware prototype of the two-battery charging system has improved.

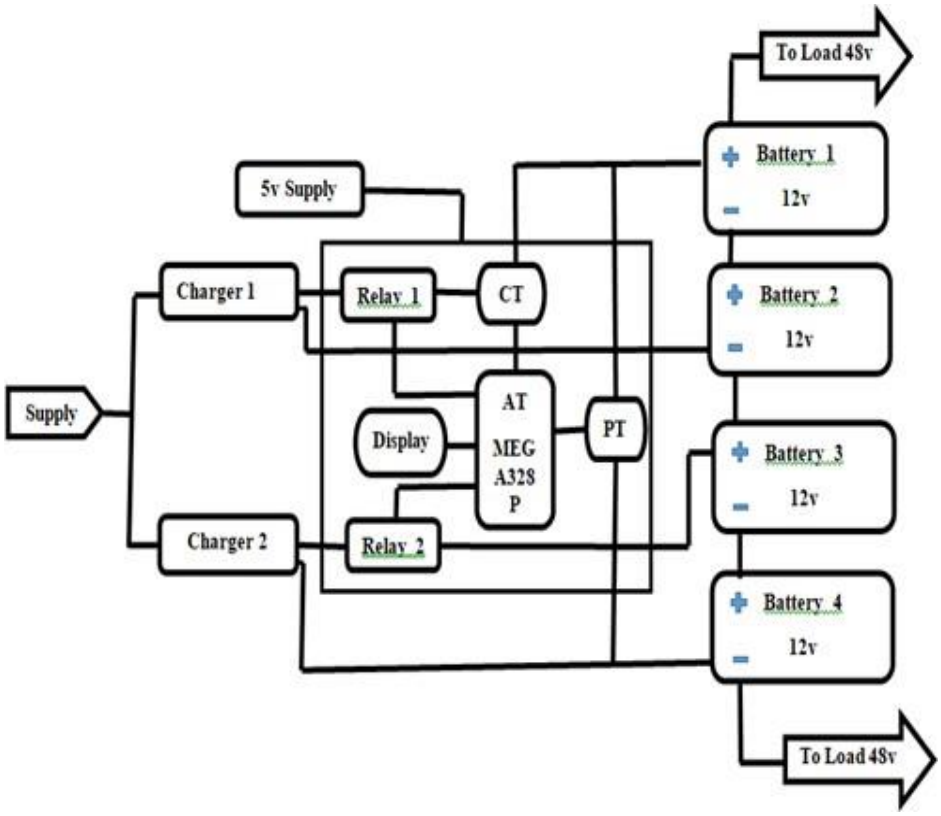

Fig. 4:-Block Diagram of Dual Battery System [17]

A block diagram of the proposed system is shown in fig.4. The system contains four batteries, chargers, Arduino, relays, transformer, CT, PT, resistors, capacitors, diodes, oscillator, LCD display and PCB. The charger is connected to the battery via a transmission system, a number of battery cells connected to the series to provide the car's electric motor. After using the charger referral then CT is connected to measure the current. The PT is connected to the entire battery to monitor voltage. Arduino UNO is used for control. CT, PT, relay and display are connected to Arduino.

1.3.6.2 Circuit Diagram of Dual Battery System

Image number. 5 show the complete circuit diagram of the proposed system. First, the supply is given to two transformers. A diode and capacitor are used to create a rectifying circuit, which converts the AC supply to a DC supply. Demonstrates the interaction of various components of the system. The 5V supply is supplied by the Arduino A5 PIN for the controller to use. Reset circuit connected to Pin 1. By using PT form resistors connected to A4 pin. PIN 2, 3, 4, 5, 6, 7 is connected to D7, D6, D5, D4, RS, EN LCD display pin. The X1 and X2 are connected to a crystal oscillator used to generate frequency. Pin 13 and Pin 12 are connected to relay 1 and relay2.

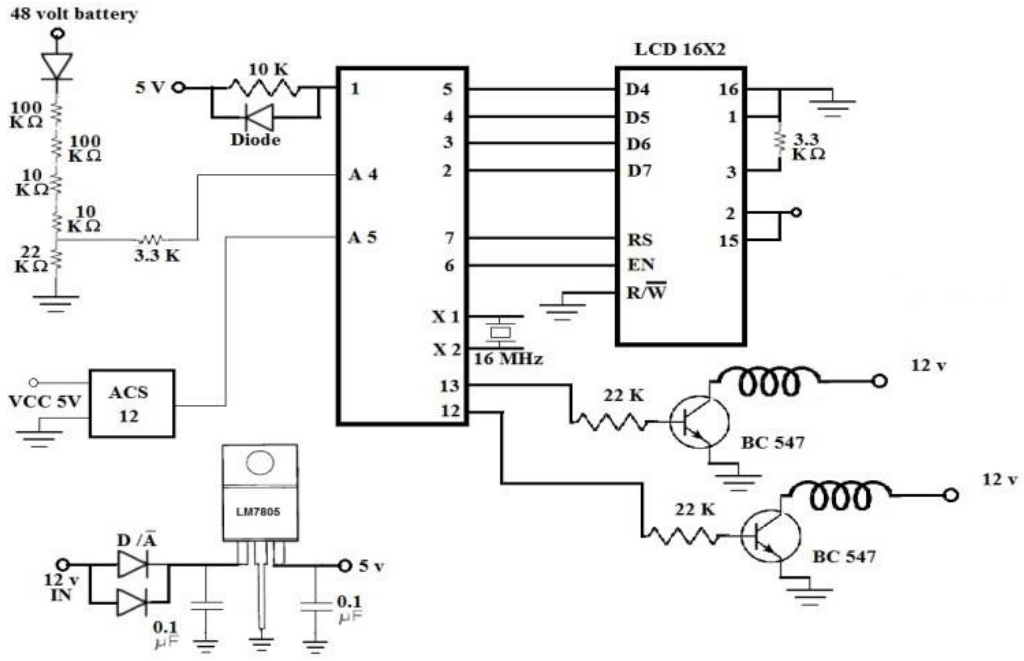

Fig.5:- Circuit Diagram of Dual battery System [17]

For charging, an initial 230V supply is supplied to a transformer used to reduce the voltage and then a reset circuit is used to convert AC voltage to DC voltage.

In this way by using a transformer and rectifier a charger circuit is constructed. This circuit is then connected to a relay that acts as a switch. Then Relay1 is connected to battery 1 and battery 2, relay2 is connected to battery 3 and battery 4 respectively. This charger circuit is connected to batteries via a relay.

1.3.7. Working of Dual Battery System

In a dual-battery charging system, electric car batteries can be charged on both sides at a time to reduce battery charge time. These batteries are divided into two equal parts and charged on both sides. The 5A charger is operated using a transformer and a rectifier. The Arduino UNO ATmega328p is used for control purposes. It can also activate the charging system if the battery is discharged from the charger and the charger disconnects when the battery is fully charged. CT referral is used to measure current strength. CT, PT, relay and display are connected to Arduino. According to the release of CT and PT, Arduino is active. If there is a need to charge the battery, the relay will shut down both chargers that begin charging the batteries. CT and PT measure current and voltage and those values are displayed on the display board. A high current charger is used and they charge batteries on both sides at a time which is why fast charging happens. When the battery is fully charged i.e. the fixed point is 54.5V then the charger is disconnected automatically using a relay.

1.4. HARDWARE IMPLEMENTATION

1.4.1. Component List

Table 3 shows the required components of hardware. The battery pack is built by connecting 4 batteries in the series. The charger is self-contained using transformers as well repair region. Relay is used to change the purpose. The Arduino UNO ATmega328p is used for control purposes.

Table3:- Components for hardware implementation [17]

Sr. no	Components	Specifications	Quantity
1	Battery Pack	12 V, 1.2 Ah	04
2	Relay Part	12V,10A	02
3	Transformer Part	12V-0-12V,5A	02
4	Arduino UNO Board	ATmega328p	01
5	Current sensor Kit	10A	01
6	Voltage Regulator Kit	7805	01
7	LCD Display	16*2	01
8	Resistor	-	-
9	Diode	-	-
10	Capacitor	-	-
11	Transistor	-	02
12	Crystal Oscillator	12 11.0592MHZ	01
13	Switches	-	01

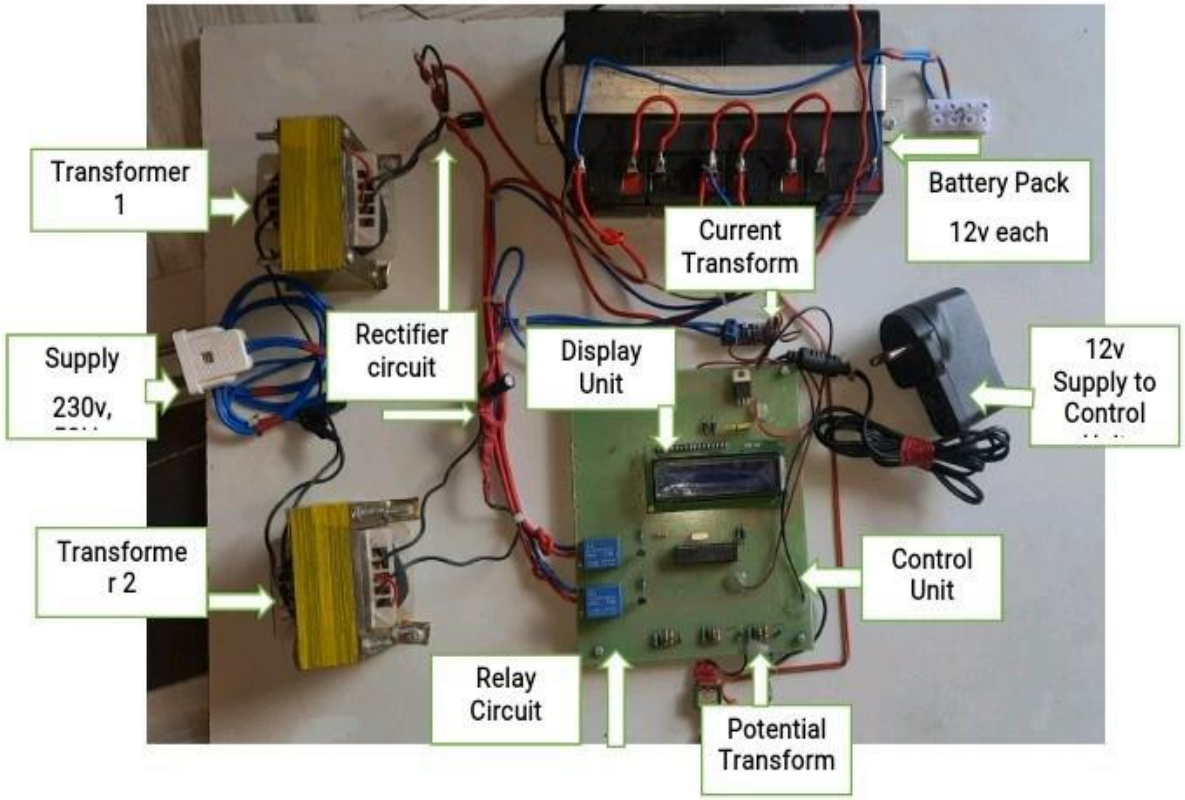

Fig.6:- Hardware of Prototype [17]

Fig.6 shows the hardware prototype used as a project function. In this example, four batteries, two transformers, two repair circuits, two relays, transistors, CT, PT, Aurdino Uno, LCD display, power controller are connected in a built-in circuit. . The transformer output is supplied in a bridge reset cycle to convert the AC voltage to DC voltage. In this way the transformer and rectifier form a dual charger circuit. Charger circuit 1 is connected to battery 1 and battery 2 via relay 1. Similarly charger 2 is connected to battery 3 and battery 4 via relay 2. Aurdino is used to control the target. PT measures battery voltage and provides Aurdino control. When the battery comes out at 49V, the relay will operate and connect the charger to the battery. Then the battery starts charging up to the maximum limit set at the 54.5V control unit. If the battery is to charge up to 54.5V the battery will disconnect the charger. These batteries can be charged on both sides at a time by using two chargers. This will therefore reduce the battery charging time by approximately half the time. In this way the system also avoids deep waste and overcharging the battery. Various parameters such as voltage, current conditions and charging of the battery indicators on the LCD display. The dual charging system uses a rotating control to quickly

charge the batteries without damaging any battery cells. And due to automatic charging the battery temperature can be avoided.

1.4.2. Arduino UNO

Arduino is an open source controller that can be easily edited, deleted and rearranged at any time. Launched in 2005, the Arduino platform is designed to provide an inexpensive and easy way for hobbyists, students and professionals to build devices that work with their environment using sensors and actuators. Based on simple microcontroller boards, it is an open source computer platform used to build and organize electrical equipment. It can also operate like a small computer like other microcontrollers by taking inputs and outgoing controls for a variety of electronic devices. It is also capable of obtaining and sending information online with the help of various Arduino shields, discussed in this paper. Arduino uses hardware known as the Arduino development board and code-building software known as Arduino IDE (Integrated Development Area). Built with 8-bit Atmel AVR microcontroller's manufactured by Atmel or 32-bit Atmel ARM, these small controls can be easily configured using the C or C ++ language in Arduino IDE.

Unlike other microcontroller boards in India, Arduino boards entered the electronic market a few years ago, and were restricted to only small projects. The people associated with electronics are now slowly rising and embracing the role of Arduino in their projects. This upgrade board can also be used to burn (upload) new code to the board by simply using a USB cable for upload. Arduino IDE provides a simplified integrated platform that can work on ordinary human computers and allows users to write Arduino programs using C or C ++.

As there are many Arduino boards available in the market, choosing a specific development board requires a variety of research conducted on its specificity and strengths, which can be used for project implementation according to its stated plans [16]

1.4.3. Types of Arduino Boards

Arduino boards are available in many different types of modules built into them. Boards like the Arduino BT come with a built-in Bluetooth, wireless module. These built-in modules can also be accessed separately from which they can be connected (installed). These modules are known as Shield.

Below are the most commonly used Shields :

1. Arduino Ethernet Shield: Allows the Arduino board to connect to the Internet using the Ethernet library and read and write the SD card using the SD library.

2. Arduino Wireless shield: Allows your Arduino board to connect wirelessly using Zigbee.

3. Arduino Motor Driver Shield: Allows your Arduino boards to communicate with the driver of the vehicle etc. [16]

1.4.4. Features of Arduino

- Project file or project drawings are saved with the .ino file extension
- Features such as cut / copy / paste are supported in this IDE.
- There is also a place to find a word and add it by pressing the Ctrl + F keys on the keyboard.
- The most basic component or skeleton of all Arduino codes will have two functions [16]

1.4.5. Potential Transformer (PT)

Definition - A potential transformer can be defined as a metal transformer used to convert voltage from high value to low value. This converter lowers the voltage into a safe limit that can be easily measured by a standard low power tool such as voltmeter, Wattmeter and watt hourly meter, etc.

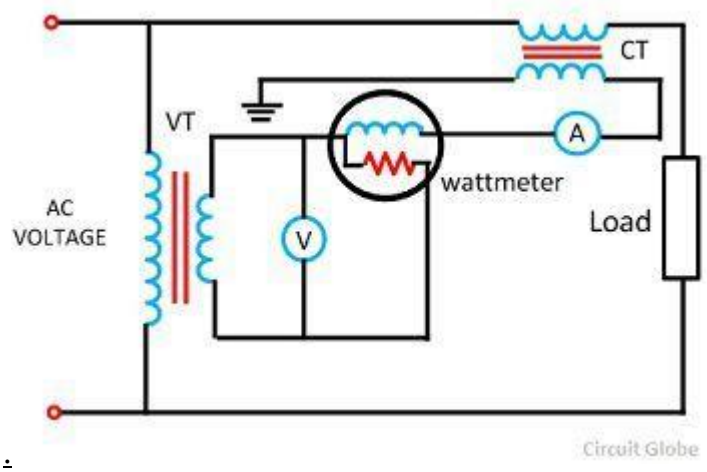

Fig.7:- Circuit Diagram of Potential Transformer [16]

Applications of Potential Transformer

1. Used for calculation purposes.
2. To protect the suppliers.
3. Protect the impedance of generators.
4. By synchronizing generators and servers.

Potential transformers are used in the coil protection system because the potential coils of the protective device are not directly connected to the system in the event of high voltage. Therefore, it is necessary to reduce the voltage and also install protective equipment from the main circuit.

1.4.6. Current Transformer (C.T.)

Current Transformer is a type of "instrument transformer" designed to produce alternating current in its second curves corresponding to the main current measurement. Current transformers reduce the high voltage to a very low value and provide an easy way to safely monitor the actual electricity flowing in the AC transmission line using a standard ammeter. The operating current of a primary current transformer is slightly different from that of a conventional voltage transformer.

Unlike a pre-defined voltage or power transformer, a current transformer contains one or very few turns as its main turn. This main bend can be a single flat turn, a coil of heavy twisted cords in the middle or just a conductor or bus bar mounted in the centre hole as shown.

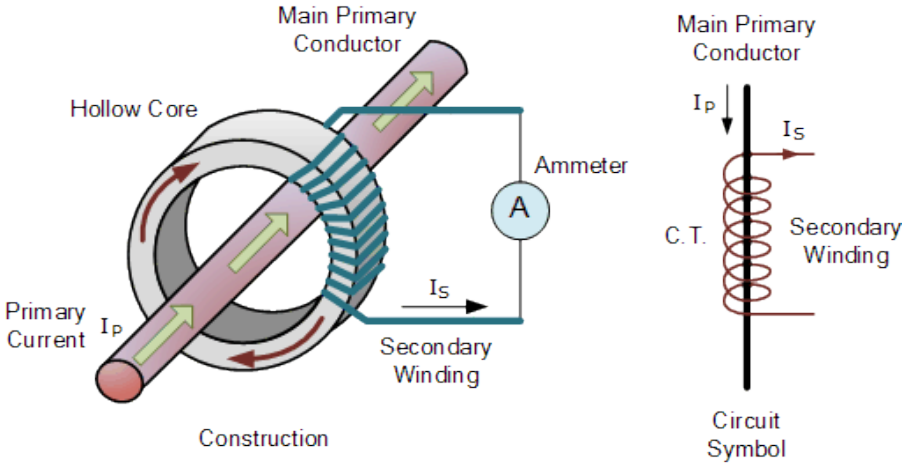

Fig.8:- Circuit Diagram of Current Transformer [16]

Because of this type of arrangement, the current transformer is often referred to as the "series transformer"

Current Transformers Applications

1. Extend the width of measuring instruments such as ammeter, power meter, KVA meters, wattmeter, etc.
2. Different current rotating protection systems.
3. Protect distance from power transmission systems.
4. Over-protection of errors.

1.4.7. Relay

A relay is an electric switch. Contains a set of terminals for input of one or more control signals, as well as a set of active communication terminals. The switch can have any number of contacts in most contact forms, such as contacts, cut contacts, or your combinations.

Relays are used when it is necessary to control a circuit with an independent low power signal, or where several circuits have to be controlled by a single signal.

The traditional type of relay transmission uses an electromagnet to turn on or off the contacts, but other operating systems have been developed, such as solid-state relays that use semiconductor structures to control without relying on moving parts.

Relays have limited operating features and sometimes multiple operating coils are used to protect electrical circuits from overloading or errors; in modern power systems these functions are performed by digital tools called protection relays.

1.5. RESULT DISCUSSION

To determine the required battery charge time using a two-battery charging system three cycles of charging and charging were performed and the duration of each cycle was considered as shown in Table 4.

Table 4:- Results of dual battery charging system [16]

Sr. No	**Specific battery voltage**	**By normal charging method**	**By dual battery Charging method**
1	48V	1 hr. 52 min	48 min
2	48V	1 hr. 30 min	40 min
3	48V	1 hr. 35 min	43 min
	Average Time	1 hr. 39 min	44 min

Table 4 shows the battery charging time with a standard charging system and a two-battery charging system. Here it shows that by using a two-battery charging system the battery charge time decreases by about half the normal charging time. From five to six such cycles to charge and discharge all batteries and to measure from this time limit can be determined. The charging time of the standard charging method is 1 39 Minutes and with the use of two battery charging mode the battery is charged within 44 minutes which is almost half of the previous output i.e. Normal Charging. A two-battery charging system is very useful for charging two or more battery packs. (I.e., battery bank, EVs, etc.) In this way a fully charged 48V battery, 1hr 8 min required which is a very short time compared to conventional charging. Current status, power supply and charging are displayed on an LCD display that helps monitor. This way the system works. From the results it is clear that using a conventional charging method is time consuming, and we charge the batteries separately, that is only one battery charge at a time. So this system takes more time to charge the batteries.

By using a two-battery charging system we separate the battery capacity and charge the battery separately at a time. For two batteries to be charged at a time to save charging time. We found that by using a two-battery charging system we save about half of the previous results which is a standard charging system.

1.6 SUMMARY

This project is useful in reducing the battery charge of an electric car that requires an electric car in the latest cases. This program is also applicable to any type of charging system. So the two-battery charging system used saves time due to faster charging. This charging system charges the battery on both sides while dividing the battery cells into two parts and then charging them separately. This application can automatically turn on or off the charger according to the battery capacity. Disconnects the charger when the battery is fully charged to avoid overcharging. In this program the use of the display displays information about the battery and thermal power parameters. Provides a visual indication of the battery charge status. So by using this we can save the battery from overcharging or overheating. By using a battery indicator (LCD Display) we save the battery from overheating and as a result the battery life increases. In a two-battery charging system, the battery discharges evenly due to cell alignment to get the right output. In this way the two-battery charging system will appear to benefit the electric car as well as any other charging system.

REFERENCES

[1] Farzad Ahmad Khanlou, Abas Goodarzi and Don King, "Plug in hybrid electric vehicle with dual battery system" EVS-25 Shenzhen, China, Nov. 5-9-2010, *The 25th World Battery, Hybrid and Fuel Cell Electric Vehicle Symposium & Exhibition*.

[2] Monzer AI Sakka, Hamid Gualous, Noshin Omar and Joeri Van Mierlo, "Batteries and Supercapacitors for Electric Vehicles" *Open access peer-reviewed chapter Published: Dec. 19th 2012.*

[3] Ciprian Ionescu, Andrei Drumea, Paul Svasta, AlexandruVasile, Norocel Codreanu, "Evaluation of Active Balancing Circuits for Supercapacitors", *Presented by C. Lonescu at the 2nd PCNS 10-13th September 2019, Bucharest, Romania as paper 5.3*

[4] https://youtu.be/PbjGIIxzBbU/ battery charging model on matlab/Simulink(CCCV charging)

[5] K. Morrow, D. Karner and J. Francfort, "Plug-in hybrid electric vehicle charging infrastructure review" in, Washington, *DC: U.S. Dept. Energy–Veh. Technol. Program, 2008.*

[6] Kadlag Sunildatta Somnatha, Mukesh Kumar Gupata, "Review Paper on Electric Vehicle Charging and Battery Management System", *International Conference on Communication and Information Processing, (ICCIP- 2019).*

[7] Morris Brenna ·Federica Foiadelli ·Carola Leone ·Michel a Longo, "Electric Vehicles Charging Technology Review and Optimal Size Estimation", *Journal of Electrical Engineering & Technology (2020) 15, pp. 2539–2552.*

[8] Kishore Naik Mude, "Battery Charging Method for Electric Vehicles: From Wired to On-Road Wireless Charging", *Chinese Journal of Electrical Engineering, Vol.4, No.4, pp. 1-15, December 2018.*

[9] Afida Ayob, Wan Mohd Faizal Wan Mahmood, Azah Mohamed, Mohd Zamri Che Wanik, MohdFadzil Mohd Siam, Saharuddin Sulaiman, Abu Hanifah Azit and Mohamed Azrin Mohamed Ali, "Review on Electric Vehicle, Battery Charger, Charging Station and Standards, *Research Journal of Applied Sciences, Engineering and Technology 7(2): 364-373, 2014.*

[10] Rick Wolbertus, Robert van den Hoed, "Fast Charging Systems for Passenger Electric Vehicles", *World Electric Vehicle Journal 2020, pp. 2-11.*

[11] Won Jung and Ismail, M.F. Ariffin and S. A. Noor, "Study of Electric Vehicle Battery Reliability improvement", *International Journal of Reliability and Applications, Vol. 12, No.2, pp. 123-129, 2011.*

[12] Jaewan Kim, Jinwoo Oh, Hoseong Lee, "Review on battery thermal management system for electric vehicles", *Applied Thermal Engineering 149 (2019) 192-212.*

[13] Ahmed Al-karakchi, Ghanim Putrus, Gillian Lacey, "A Method of Electric Vehicle Charging to Improve Battery Life", *Conference Paper: September 2015, DOI: 10.1109/UPEC.2015.7339846.*

[14] Min Ye, Haoran Gong, Rui Xiong, Senior member, Hao Mu, "Research on the Battery Charging Strategy with Charging and Temperature Rising Control Awareness", *DOI 10.1109/ACCESS.2018.2876359, IEEE Access.*

[15] Galassi, M. C., Stutenberg, K., Garcia Otura, M., Trentadue, G., "Electric and hybrid vehicle testing*", JRC Science for Policy Report, 2018.*

[16] Working Principle of Arduino and using it as a tool for study and research Leo Louis Department of Electronics and Communication Engineering, Gujarat Technological University, Ahmedabad, India, *International Journal of Control, Automation, Communication and Systems (IJCACS), Vol.1, No.2, April 2016*

[17] Miss. Jyoti M. Kharade, "Dual Battery Charger System for Electric Vehicle", *Proceedings of the Second International Conference on Electronics and Sustainable Communication Systems (ICESC-2021)*

[18] https://robu.in/working-of-lithium-ion-battery/#:~:text=When%20plugging%20in%20the%20device,common%20things%20of%20the%20battery.(Working of Lithium-ion Battery)

[19] K.V. Vidyanandan, "Batteries for Electric Vehicles", *19 November 2019.*