International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 06 | June - 2023 SJIF Rating: 8.176 ISSN: 2582-3930

Dynamic Wireless Battery Charging of Electrical Vehicle

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ABSTRACT

In a world where charging electric cars is a key point in boosting the energy transition, other solutions can come alongside electric charging stations is "Wireless Charging System". Conductive charging by cable consists of manually connecting a conductor between the charging station and the vehicle. Depending on the size of the cable, the current flows through this wired connection, allowing very high charging capacities and giving drawbacks of inefficiency, increased costs and lesser safety towards the personnel.

Today, EV battery charging is mainly done through a connected medium. It consumes a lot of time and providing a well-connected charging infrastructure for EVs requires a lot of capital investment and maintenance. Wireless charging, on the other hand, has many advantages over wired charging. It has the potential to simplify and solve the charging infrastructure issues to a large extent. Wireless charging has therefore garnered a lot of interest and is attracting a lot of research in various areas of applications.

The wired charging is replaced by wireless charging due to plug, socket and shock free recharging. In this charging the power can be transferred from source to load side without any wired connection. As the usage of electric vehicle by consumers is increasing day by day, the wireless charging is also a charging option for them. The wireless charging is an alternate to charge an EV because of its high reliability with plugging system removed.

Wireless charging provides increased efficiency, reduced costs and most important the safety towards the personnel. Electric vehicles have been continuously evolving energy-efficient alternatives to vehicles powered by combustion engines during the last decade. EV's are getting more reliable with increased range and

performance. Electric vehicles can be made more accessible by introducing wireless charging to them.
Also, as a backup solar energy is used whenever the vehicle is not able to reach the charging station. Wireless charging for an electric vehicle is an intriguing innovation that makes electric vehicle charging more convenient. This mode of charging improves the usability of Electric vehicles and wireless power transfer allows transferring power from a power source without clutters of

CHAPTER 1

1. LITERATURE REVIEW

1) From paper "Coupled Wireless Charging System for electric vehicles" Akhil A. G., Hari Sankar S., Jishnu K., Sreenand S., Vivek Vijay, Asha C. A., Dr. Preetha P. K they discussed about wireless power transfer method (Magnetic Resonant coupling), also they used ANSYS Maxwell software to design the 3D model of the coils and used simulation to observe the changes in the resonance frequency of the transmitter and receiver changes along with changes in the coil spacing. From this they concluded that the maximum efficiency of the wireless charging depends on resonance, coil spacing and the impedance of the circuit.

2) From paper "Arduino based Platform for Managing a PV Battery Charge" Karima, Rashid, Mohammed and Maha concluded that as the increasing need for renewable energies like solar
, wind battery storage is also concerned so they come up with hardware and software model based on Arduino mega. They added that Solar batteries are slow charging and discharging, and they support alternating phases of loading and unloading quite well. However, to have an optimal life a solar battery must keep a charge rate between 90% and 40%. Hence, one needs to use a battery management system to optimize its parameters.

3) From **paper "Wireless Communication System for Wireless Charging of an Arduino- Based Car"** by Ya-Hui Wu, Dariusz Czarnowski, Francisco de Leon, and Ashish Upadhyay, Noah Taylor IEEE, 2019 This paper presented a novel quasi-dynamic wireless charging system that comprises a wireless charging system and a wireless communication system. The wireless communication system enables the system to function as the IoT and provide energy without human intervention. This paper aims to describe the Wireless charging system for EVs with a communication system

4) From paper **"Solar Based Fast Tag Charger for Electrical Vehicle"** it was mentioned that Arduino uno is used as the main component of the circuit orders the whole circuit and progress the program, relay, voltage sensor, RFID card etc. components are used for completing the solar based charger. From the paper the photovoltaic framework for battery charging is proposed by giving power supply and managing git with the help of Arduino based system.

CHAPTER 2

2. INTRODUCTION

Wireless charging is a type of charging method which uses an electromagnetic field to transfer energy through electromagnetic induction. Energy is transferred between devices (transmitter and receiver) through the process of mutual induction. Power from solar is given as input to transmitter inductive coil, the receiver inductive coil receives the power and converts it into electric current to charge the battery.

The increase in price of oil and environmental issues has resulted in growing interest in clean vehicle technologies such as EV, solar technology. Stationary wireless charging of electric vehicles is becoming a preferred method since it enables power exchange between the vehicle and the grid while the vehicle is at rest.

Solar energy is a very environment-friendly power source and one type of renewable energy. The solar or photovoltaic system is a very effective energy resource that has established a great impact on the society and industries A photovoltaic (PV) panel harnesses the solar radiation into electrical energy to be supplied to the electric vehicle batteries.

This energy is used to charge the battery and it can support more than one device. Thus, it become more beneficial. Power transmission using cables lost 25-30% power and by using cables for power transmission it has many accidents But WPT is completely safe for human. Thus, it is become safe for environment and for climate than conventional cars. Modern wireless power transmission techniques are more reliable, efficient.

2.1 NEED

In today's developing and advancing world, it has become more important for the transmission of power to be efficient, reliable, safe and uninterruptible. Use of wired connections for transmission has various drawbacks incorporated within itself. Hence, with the use of wireless charging those drawbacks are overcome and efficiency of overall system is improved.

Along, with improved efficiency uninterruptible supply to the battery can be maintained using solar energy

which is used as a backup power source to charge the battery whenever it is not possible to charge the battery via charging station.

2.2 ADVANTAGES

- **Reduced infrastructure costs:** with wireless transmission, the use of conductor wires is eliminated.
- **High power transfer efficiency:** As the conductor wires are not used, so heat losses and losses incorporated with wires are reduced increasing overall power transfer efficiency.
- **Possibility of high-speed charging:** As the losses are reduced, possibility of high- speed charging can be achieved.
- **Low maintenance requirements:** Due to the elimination of conductor wires, the maintenance requirements cost due to it is reduced tremendously.
- **Safety:** One of the most important factors considered is the safety of personnel which is achieved using this system.
- **User-friendliness**: Wires easily become entangled. In wireless charging, wires are removed to improve the charging experience of the user.
- **Size reduction**: Wireless charging provides easy charging, which allows devices to charged more frequently. Therefore, batteries in devices can be reduced in size, and the size of devices can consequently be reduced.
- **Durability**: Wires are not required in these types of devices for charging. Therefore, these devices can be better sealed to prevent water or dust intrusion. In some devices, such as underwater unmanned vehicles, medical implants, it is expensive or dangerous to replace batteries or to charge with a cord. Wireless charging provides a convenient method to charge such device.

CHAPTER 3

3. CONCEPT (PROPOSED METHODOLOGY)

3.1 The systems are powered by Arduino Nano as the microcontroller.

3.2 Wireless charging modules are used in this system in order to charge a lithium ion battery.

3.3 The battery can also be charged using Solar Panel when there is no wireless charging source available.

3.4 This is sensed by the current sensor. If a wireless charging source is present the current sensor sends a signal to the microcontroller to deenergizes the relay which switches off the solar power source.

3.5 In the absence of wireless charging source, the relay remains energized which means battery starts charging on solar source.

3.6 Voltage from solar source is monitored using voltage sensor. Depending on the threshold the solar source can be switched on or off using relay.

3.7 A TP4056 Battery Charging & Protection Module is used to protect battery from overload and short circuits. Complete dat

CHAPTER 4

4. COMPONENTS

4.1. Arduino Nano

Fig no 4.1 Arduino Nano

4.1.1 Description

It is fairly similar to Arduino Uno board but when it comes to pin-configuration and features, this nano board has replaced Arduino Uno due to small in size.

As we know that while designing an embedded system small size component are preferred. Arduino boards are mainly used to build electronic projects.

4.2 ACS712 Current Sensor

Fig no 4.2 ACS712 Current Sensor

4.2.1 Description:

The ACS712 Module uses the famous ACS712 IC to measure current using the Hall Effect principle. These ACS712 module can measure current AC or DC current ranging from +5A to - 5A, +20A to -20A and +30A to -30A. You have to select the right range for your project since you have to trade off accuracy for higher range modules. This modules outputs Analog voltage (0-5V) based on the current flowing through the wire; hence it is very easy to interface this module with any microcontroller.

4.2.2 Features

The features of ACS712 include:

- 80kHz bandwidth
- 66 to 185 mV/A output sensitivity
- Low-noise analog signal path
- Device bandwidth is set via the new FILTER pin
- 1.2 mΩ internal conductor resistance
- Total output error of 1.5% at TA = 25°C
- Stable output offset voltage.
- Near zero magnetic hysteresis

4.3. Voltage Sensor

Fig 4.3 Voltage Sensor

4.3.1 Description

A voltage sensor is a sensor used to calculate and monitor the amount of voltage in an object. Voltage sensors can determine the AC voltage or DC voltage level. The input of this sensor is the voltage, whereas the output is the switches, analog voltage signal, a current signal, or an audible signal.

4.3.2 Specification

- Divider ratio: 5:1
- Resistor Tolerance: 1%

- Max input voltage: 25V
- Resistor value: 30k/7.5K ohm

4.4. I2C LCD DISPLAY

Fig 4.4 I2C LCD DISPLAY

4.4.1 Description

The character LCD is ideal for displaying text and numbers and special characters. LCDs incorporate a small add-on circuit (backpack) mounted on the back of the LCD module. The module features a controller chip handling I2C communications and an adjustable potentiometer for changing the intensity of the LED backlight.

An I2C LCD advantage is that wiring is straightforward, requiring only two data pins to control the LCD. A standard LCD requires over ten connections, which can be a problem if your Arduino does not have many GPIO pins available. If you happen to have an LCD without an I2C interface incorporated into the design, these can be easily acquired separately.

4.3. Solar Panel

Fig 4.5 Solar Panel

4.3.1 Description

Photovoltaic solar panels absorb sunlight as a source of energy to generate direct current electricity. A photovoltaic (PV) module is a packaged, connected assembly of photovoltaic solar cells available in different voltages and wattages. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications.

4.4. 18650 Li-on Battery Pack:

Fig. 4.6 18650 Li-on Battery Pack

4.4.1 Description

This battery pack is protected with a BMS connection. This means the battery comes with overcharge protection. This battery pack weight is very low than normal lead-acid battery and can provide appropriate power as per requirement. This battery provides a lifespan of max 10 years.

4.5. Single Channel Relay

Fig 4.7.1 Single Channel Relay

4.7.1 Description

This 1-channel 5V control Single-Pole Double-Throw (SPDT) High-level trigger AC power relay board can be controlled directly via a microcontroller and switch up to 10A at 250 VAC. The inputs of 1 Channel 5V Relay Module are isolated to protect any delicate control circuitry.

The default state of the relay when the power is off for COM (Power) to be connected to NC (Normally Closed). This is the equivalent of setting the relay board IN pin to HIGH (has +5V sent to it). A wide range of microcontrollers such as Arduino, AVR, PIC, ARM, etc. can be used to control this 5V relay module.

4.7.2 Specification

Supply Voltage	**3.75 to 6 V**
Supply Current with Relay De-Energized	2 mA
Supply Current with Relay Energized	70 to 72 mA
Input Control Signal	Active Low
Input Control Signal Current	1.5 to 1.9 mA
Relay Max Contact Voltage	250 VAC or 30 VDC
Relay Max Contact Current	10 A

4.7.2 Specifications of single channel relay

4.8 Wireless Charging Modules

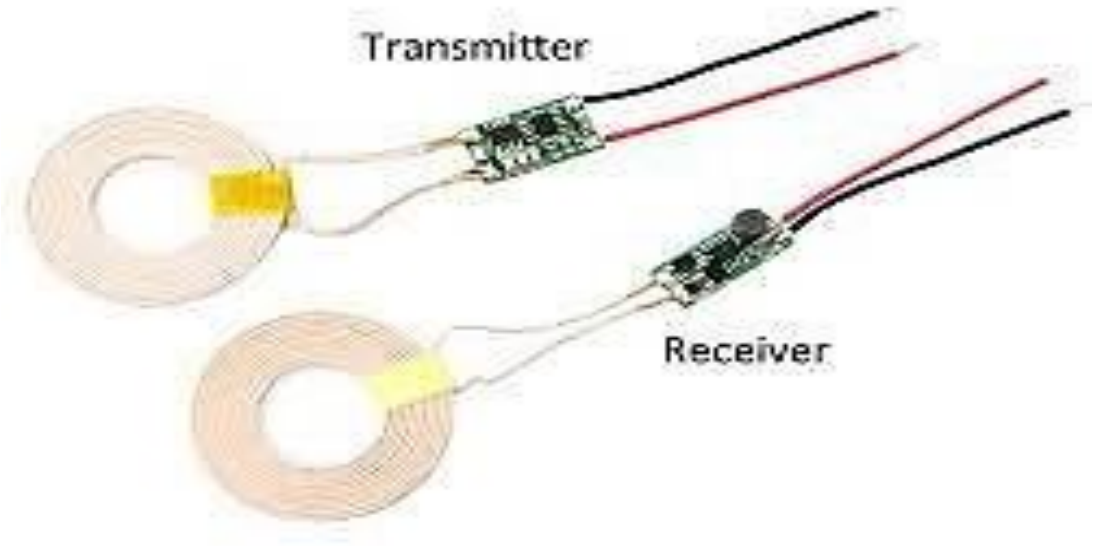

Fig 4.8 Wireless Charging Modules

4.8.1 Description

The wireless charging system comprises of both the transmitter and the receiver. The principle is similar to that of voltage transformer. With a coil at emitting and receiving ends respectively, the module has a wired power supply at the emitting terminal to produce electromagnetic signal.

The receiving terminal receives the signal from the emitting end to produce current to electrify the battery. The 5V 2A Large Current Wireless Charger Module Transmitter Receiver Charging Coil Module is for a variety of small electronic products, wireless charging, power supply development, and design, with a small size, easy to use, high efficiency, low price characteristics.

4.8.2 Features

- The size of transmission module: 17mm x 12mm x 4mm
- The size of transmitting coil and receiving coil: 40mm (OD) x 1.8mm(thickness)
- Connection Mode: pin1 to negative electrode of power supply; pin2 to positive electrode; pin3 and pin4 to external transmission coils.
- Working voltage of the transmission module: 5V~12V

- Working current of the transmission module: decreases with the receiving load current getting lower.
- Output current of the receiving module: 5V/500mA
- Sensing distance: 1~20mm (this range can be broadening by increasing the number of turns of the receiving coil under the low current working mode).

4.9 Zero PCB (Perf Board)

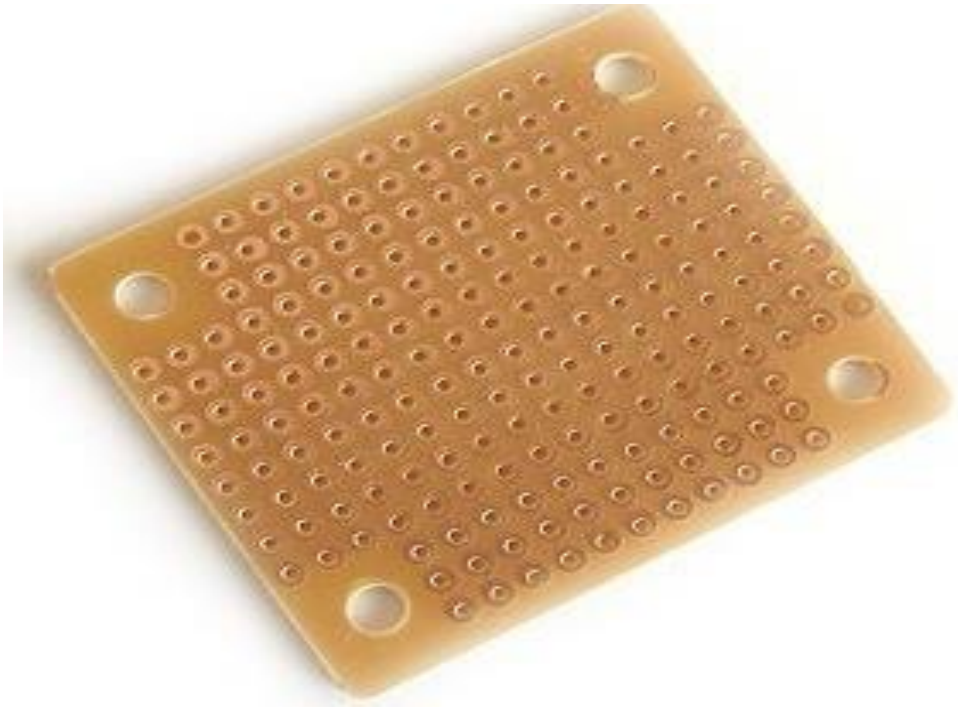

Fig 4.9 Zero PCB (Perf Board)

4.9.1 Description

Perfboard or Zero Pcb is a material for prototyping electronic circuits (also called DOT PCB). It is a thin, rigid sheet with holes pre-drilled at standard intervals across a grid, usually a square grid of 0.1 inches (2.54 mm) spacing. These holes are ringed by round or square copper pads, though bare boards are also available. Inexpensive perfboard may have pads on only one side of the board, while better quality perfboard can have pads on both sides (plate-through holes).

Since each pad is electrically isolated, the builder makes all connections with either wire wrap or miniature point to point wiring techniques. Discrete components are soldered to the prototype board such as resistors, capacitors, and integrated circuits. The substrate is typically made of paper laminated with phenolic resin (such as FR-2) or a fiberglass-reinforced epoxy laminate (FR-4).

4.10 Female Burg Strips

Fig 4.10 Female Burg Strips

4.10.1 Description

The female connector is generally a receptacle that receives and holds the male connector. Burgs strips are the most useful type of connectors used in electronics a pair of Burg strip (Male and Female) can be used **to connect two boards**. Burgs strips are the most useful type of connectors used in electronics a pair of Burg strip (Male and Female) can be used to connect two boards.

4.11. Jumper Wires

Fig 4.11 Jumper wires

4.11.1 Description

Jumper wires are simply wiring that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed. A jump wire is an electrical wire, or group of them in a cable, with a connector or pin at each end, which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

4.12. Connecting Wires

Fig 4.12 Connecting wires

Since stranded wire is more flexible than solid core wire of equal size, it can be used when the wire needs to

move around frequently. Connecting wires **allows an electrical current to travel from one point on a circuit to another** because electricity needs a medium through which it can move. Most of the connecting wires are made up of copper or aluminum.

4.12.1 Types of electronics connecting wire

- **Bare copper wire: Wire that is not insulated can be used in a variety of ways. ...**
- **Enameled copper wire: This type of copper wire has a form of insulation made from enamel. ...**
- **PVC wire: PVC wire is the most common form of wire today.**

CHAPTER 5

5. PROPOSED BLOCK DIAGRAM

5.1 BLOCK DIAGRAM

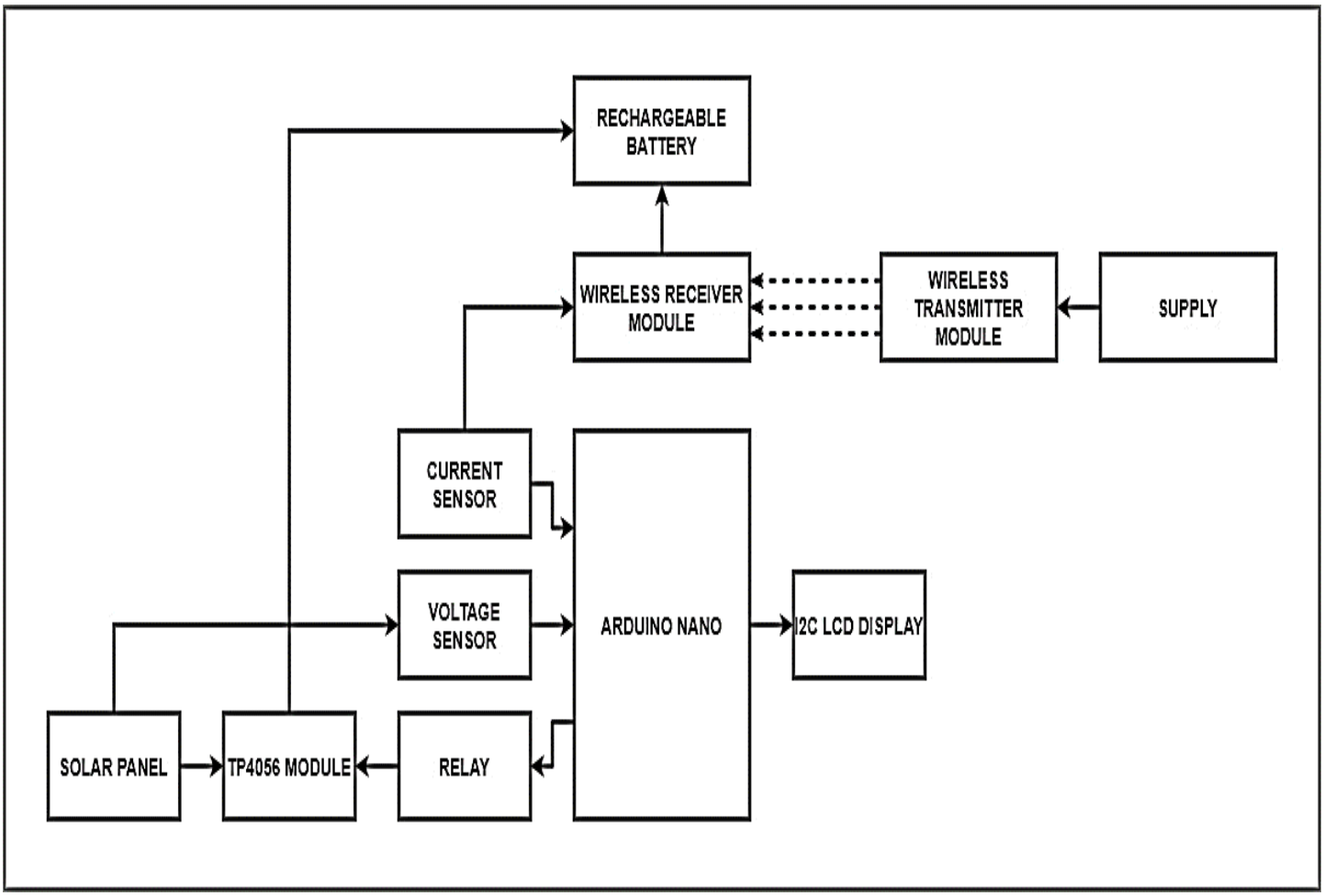

Fig. 5.1: Proposed Block Diagram

5.2 WORKING

Whenever, the battery is needed to be charged it can be charged through 230 V Ac supply available from the grid. Through the transmitter towards the receiver coil, power is transmitted and the battery can be charged. In case, the 230V ac supply is not available for the charging of the battery, Solar energy is used as a backup source. Through the solar panel, the battery can be charged.

For monitoring the current and voltage level provided to the battery and to avoid conditions like Overcharging, short circuit, over discharging Current and voltage sensors are provided. Current and Voltage sensors continuously monitor and displays the values in the LCD so as the operator can easily work on it. Relay is used as a switch which will discriminate, whether the input is available from the grid, in order to connect the battery with solar panel. Arduino which is the main source connecting all the peripherals for the operation. Hence, along with wireless charging continuity in charging can be maintained through the solar panel as

CHAPTER 6

6. HARDWARE AND WORKING

6.1 CIRCUIT DIAGRAM

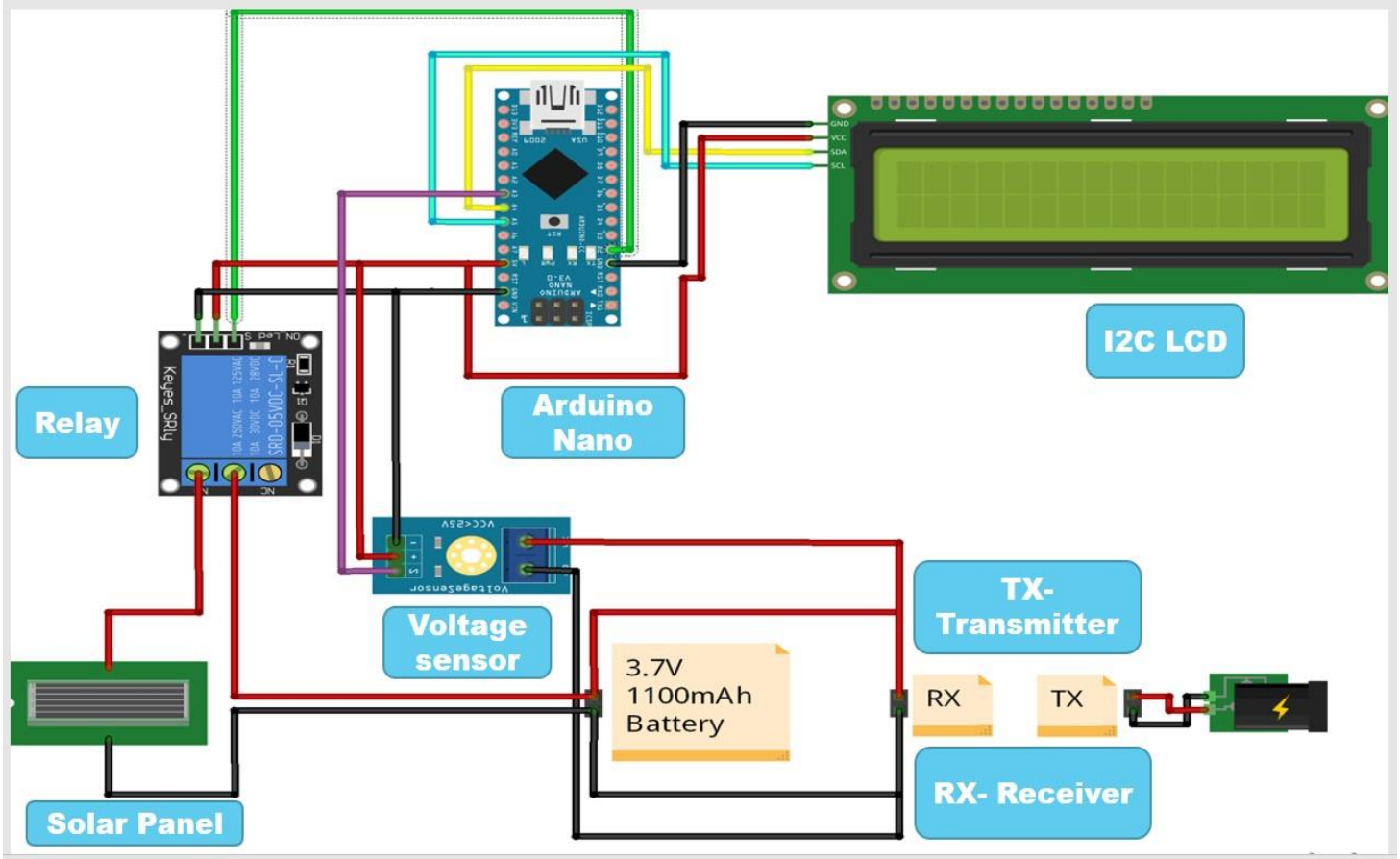

Fig 6.1 CIRCUIT DIAGRAM IN FRITZING

6.1.1 SOFTWARE USED

Arduino IDE – For coding Arduino Nano Microcontroller Fritzing – For Circuit Designing

6.2 WORKING

The proposed system uses Arduino Nano making the system advantageous in terms of costing, and easy accessibility and availability towards the user. In the proposed system charging of the battery is incorporated using two inputs, one from the grid and the other from solar panel. Along with charging, various parameters

like, voltage, current, etc.

Due to this, user can easily understand the conditions of the battery and can avoid situations like short circuit, overcharging, undercharging, etc. which eventually leads to faulty condition and may even damage the battery. Wireless charging of the battery takes place through the 230 Vac Supply from the grid and the sensors detect the condition of the battery by measuring the values and indicate using LCD Display.

Relay has been set with threshold values so that it will operate according to the input conditions,

i.e. the feasibility of connecting with the grid or with solar panel will be decided by the relay. Battery when charging from solar panel through the charging module is being monitored continuously through the sensors. The charging module within the battery allows safe charging and discharging of lithium cells making the system more reliable. Hence, Continuous supply with reliable operation is maintained.

CHAPTER 7

7. SIMULATION MODEL

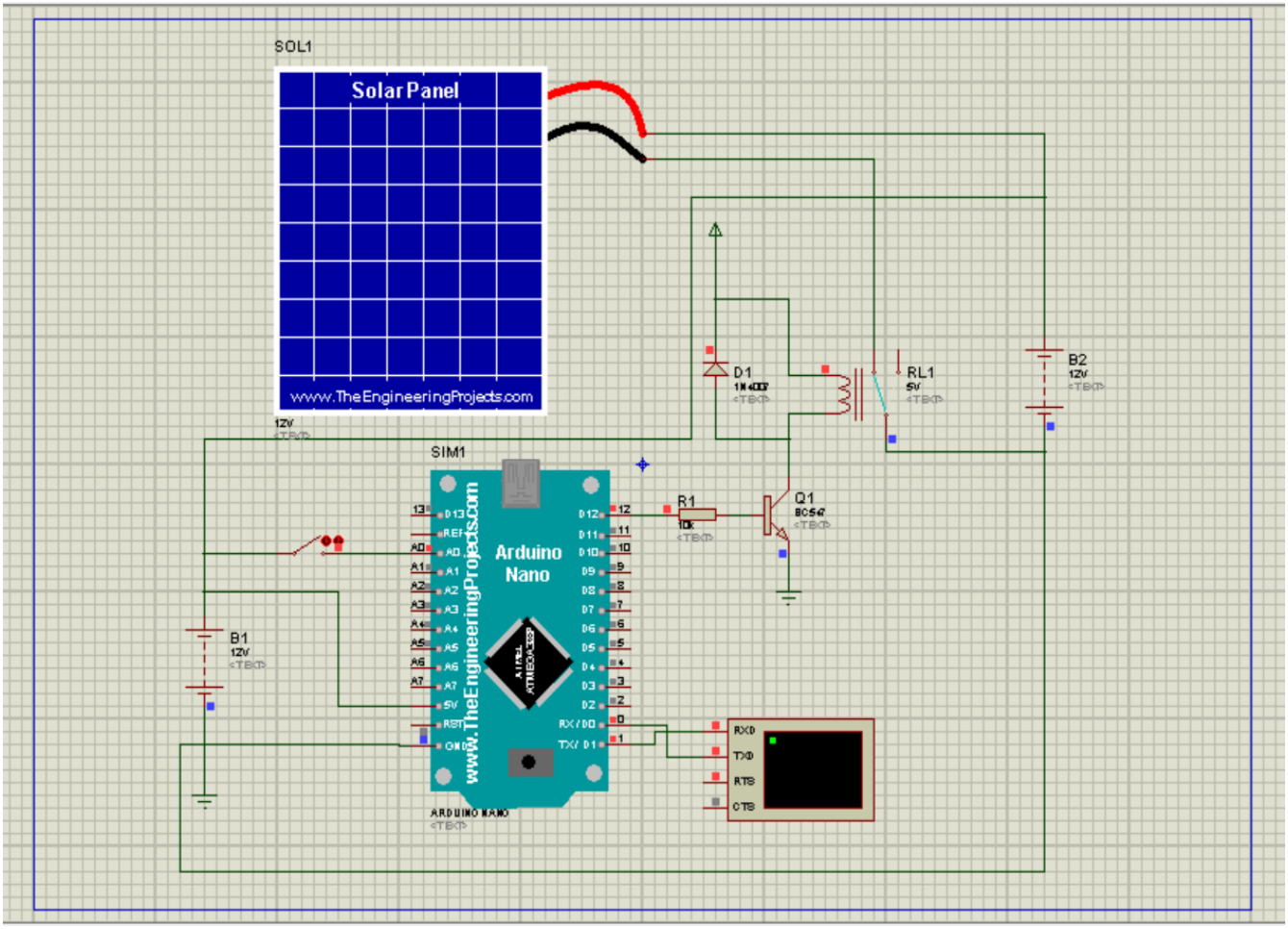

Fig 7: SIMULATION MODEL

Programme:

```
#include <LiquidCrystal_I2C.h>
#include <Wire.h>

LiquidCrystal_I2C lcd(0x27,16,2);

#define vol A3
#define relay 2

int volval;

void setup()
{
Serial.begin(9600);
lcd.init();
lcd.backlight();
pinMode(vol,INPUT);
}

void loop()
{
volval = analogRead(vol);
Serial.println(volval);
if (volval > 150)
{
pinMode(relay,INPUT);
lcd.clear();
lcd.setCursor(0,0);
lcd.print("MODE : WIRELESS");
lcd.setCursor(0,1);
lcd.print("VOLTAGE : ");
lcd.print(volval/1024.0*25);
lcd.print(" V");
delay(1000);
}
else
{
pinMode(relay,OUTPUT);
lcd.clear();
lcd.setCursor(0,0);
lcd.print("MODE :SOLAR");
lcd.setCursor(0,1);
lcd.print("VOLTAGE : ");
lcd.print(volval/1024.0*25);
lcd.print(" V");
delay(1000);
}
```

CHAPTER 8

Future Scope for wireless battery charging of Electric Vehicle

Implementation of stringent emission norms, increasing focus on R&D activities, and rapid technological changes are projected to drive the wireless charging for electric vehicle market.

Wireless vehicle charging is one of the advanced technologies that is being significantly developed and it also likely to boost the electric car industry. It's estimated that by 2040 more than 50% of new car sales will be electric vehicles. Despite the fact that wireless charging would be a must-have for electric vehicles, there are a few potential drawbacks that need to be considered. Such as loss of energy while charging, lack of availability of proper charging infrastructure, high cost, etc.

The successful convergence of new technologies will require electric vehicles (EVs) that are low cost and fully autonomous. These attributes can be realized through wireless charging.

In a world where charging electric cars is a key point in boosting the energy transition, other solutions can come alongside electric charging stations. One such solution is wireless charging. Wireless car charging is an enhanced version of smartphone charging with several differences. Wireless inductive charging allows an electric vehicle to automatically charge without the need of cables.

"Technically, everything is scalable; however, as power transfer rates go up, the complexity and size of the power management electronics must go up," he added. "More importantly, as the power goes up, a number of additional factors needs to be considered, such as thermal losses and thermal management. The higher the inefficiency, and the higher the power, the higher the heat losses and more that must be done to manage that heat."

8.1 APPLICATIONS

1. Electric Vehicles.
2. Mobile Phones.
3. Biomedical devices.
4. Smartphones and wearable
5. Notebooks and tablets
6. Power tools and service robots, such as vacuum cleaners.
7. Multi-copters and electric toys
8. Medical devices

CHAPTER 9

CONCLUSION

Hence, in the conclusion it can be stated that wireless Power Transfer (WPT) from receiver transmitter coil makes the system more efficient. Also, with the use of Renewable resource, i.e. “Solar Photovoltaic (PV) energy” it makes the system environmentally beneficial. Also, through the continuous monitoring of system parameters the battery remains safeguarded and healthy. With the use of Arduino Nano, it becomes easier to understand the conditions within the battery.

As solar energy is a renewable source and as solar cells do not generate any emissions, byproducts or waste it is an advantage for using as a backup to the system. In today’s era an India is still a developing nation so the use of Electric Vehicle (EV) are still Wanders and the charging station available are limited to an extent. Also, the Electric Vehicles are permitted to travel to a short distance due to the discharging of the battery.

Here, with the help of Back Provide by Solar Photovoltaic (PV) panel this drawback can be overcome. With the help of Solar Photovoltaic (PV) energy Continuity in the supply can be maintained as well as Continuity in travelling making user reliable on the system.

So, with the help of wireless charging through Wireless power transfer (WPT) the system is more safe, efficient, and reliable. Hence, with the use of “of Solar Photovoltaic (PV) energy” which itself is a clean source makes the system efficient and put it at advantageous side.

Also, as continuous monitoring the parameters of the battery state with the help of sensors attached, the battery can be prevented from situations like undercharging, overcharging and the battery can be safeguarded and protected

CHAPTER 10

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