IJMRT: Volume (5), Issue 5, 2023
International Journal of Multidisciplinary Research Transactions
(A Peer Reviewed Journal)
www.ijmrt.in
ISSN (Print):2663-2381
ISSN(Online):2663-4007

Autonomous Electric Vehicle Charging Station Based on LabVIEW

Gaayathry. K[1], Darwin. I[2] ,Thaneshwaran. S[3*], Raghuram. M[4], Sundharadevan. S[5]

[1] *Professor, Department of Instrumentation and Control Engineering, Saranathan College of Engineering, India.*
[2,3,4,5] *Student, Department of Instrumentation and Control Engineering, Saranathan College of Engineering, India.*

[*]Corresponding author
DoI: https://doi.org/10.5281/zenodo.7895033

Abstract

As individuals become more environmentally conscious, electric vehicles are growing in popularity. Also, there is a growing demand for electric vehicle charging stations. Electric car charging stations must be reliable and secure in order to accommodate this demand. The prevalence of charging stations in both public and private garages will rise as the number of electric vehicles (EVs) on the road rises. These stations will be in charge of fulfilling the demands of EV owners, parking structure operators, and the distribution grid. In order to meet the demands of both EV users and the local distribution grid, charging infrastructure is becoming increasingly crucial as the number of Electric Vehicles (EVs) on the road increases .One of the main reasons for the recent growth and acceptance of electric cars (EVs) in contemporary smart cities is the hazardous CO2 emissions from traditional fuel-based vehicles. In the contemporary smart city, EVs offer an environmentally favorable setting. Yet, there are numerous obstacles to the use of EVs in the contemporary smart city (such as smart charging, route planning, information distribution, etc.). So, new methods and approaches are required to raise the effectiveness of the EVs' current charging system. Bearing these concerns in mind, this study suggests a new method for wirelessly charging electric vehicles using RFID tags in conjunction with optimized path planning to have the lowest possible charging costs. Presently, user identification and charging initiation at electric vehicle charging stations are done manually. The vehicle must be manually plugged into the charging station in order to start the charging process. This process takes a lot of time and might not be effective. Furthermore, since anyone may access the charging station, it offers no security. As a component of a smart charging infrastructure that offers charge monitoring and control, this suggested system uses RFID technology for user identification and charging authorization. The suggested system authenticates individuals and their electric vehicles (EVs) using Radio Frequency Identification (RFID) technology. Each user receives an RFID tag with information about their EV and preferred charging methods. The charging process can be started by scanning the user's RFID tag as they approach the charging station. Further security measures included in the system include user authentication, automatic shutdown in the event of a system failure or user unauthorized access, and real-time monitoring of charging station activity. These safety precautions guarantee the user's EV's security and stop any unwanted access to the charging station.

Keywords: E Vehicle, PIC Microcontroller, LabVIEW, RFID,Voltage Sensor.

1. Introduction

In order to minimize carbon emissions from the transportation sector and assist solve climatic challenges, electric vehicles (EVs) are being quickly incorporated into the energy systems of many nations. Ambitious EV targets have been set at the national and regional levels. More specifically, the push for EVs is motivated by the global climate agenda set forth by the Paris Agreement to cut carbon emissions worldwide in order to solve the escalating global warming problem. Importantly, switching from combustion-engine vehicles to EVs would result in lower emissions as well as significantly less local air pollution from EVs. In addition, national plans to cut oil demand and reliance on oil imports, as well as the promotion of a local EV manufacturing industry, are other factors that are driving the deployment of EVs.

Over 873,301 electric vehicles were registered in India as of 30 November 2021, according to the Vahan database maintained by the Indian government. Almost 30% of new automobiles are anticipated to be electrified by 2030. (Global EV Outlook 2020).India has a fleet of about 250 million vehicles, the majority of which are two-wheelers (78% of the total).Public buses, taxi fleets, two-wheelers, and three-wheelers are anticipated to be the first vehicle types to adopt EVs among the various vehicle types.

Public charging infrastructure is currently sparse in the country because of the early stage of EV deployment, but it is anticipated to expand quickly due to the goal of EV integration. Nine significant cities and twelve intercity routes have previously been recognized by the Ministry of Power (Mop).

Here we use Radio frequency Identification tag(RFID) to enable autonomous charging .The RFID offers a low-cost method of identifying and authorizing vehicles for charging, enabling effective EV charging while taking grid limits and EV drivers' needs into consideration. Following RFID reader setup, an LCD display shows information about the RFID tag that was read by the RFID reader using a PIC microcontroller. The cost of charging a vehicle is determined by how much it costs (for example, an hour of charging will cost Rs. 50) and is immediately deducted from the account using an RFID and keypad.

2. Existing Idea

The E-vehicle charging station uses AC & DC current. Batteries can only be charged with direct current, while most electricity is delivered from the power stations as alternating current (AC). Presently the E-vehicle charging stations uses an manually enabled and operated type of charging. This type of charging forces to charge in an undisputed manner and moreover this type of charging can only be done based on time.To ensure accurate and fair billing, many charging stations use a time-based billing system that charges customers based on the amount of time their vehicle is connected to the charging station. This helps to ensure that customers are only charged for the actual amount of time they spend using the charging station, rather than an estimated amount based on the amount of energy transferred.

3. Block Diagram

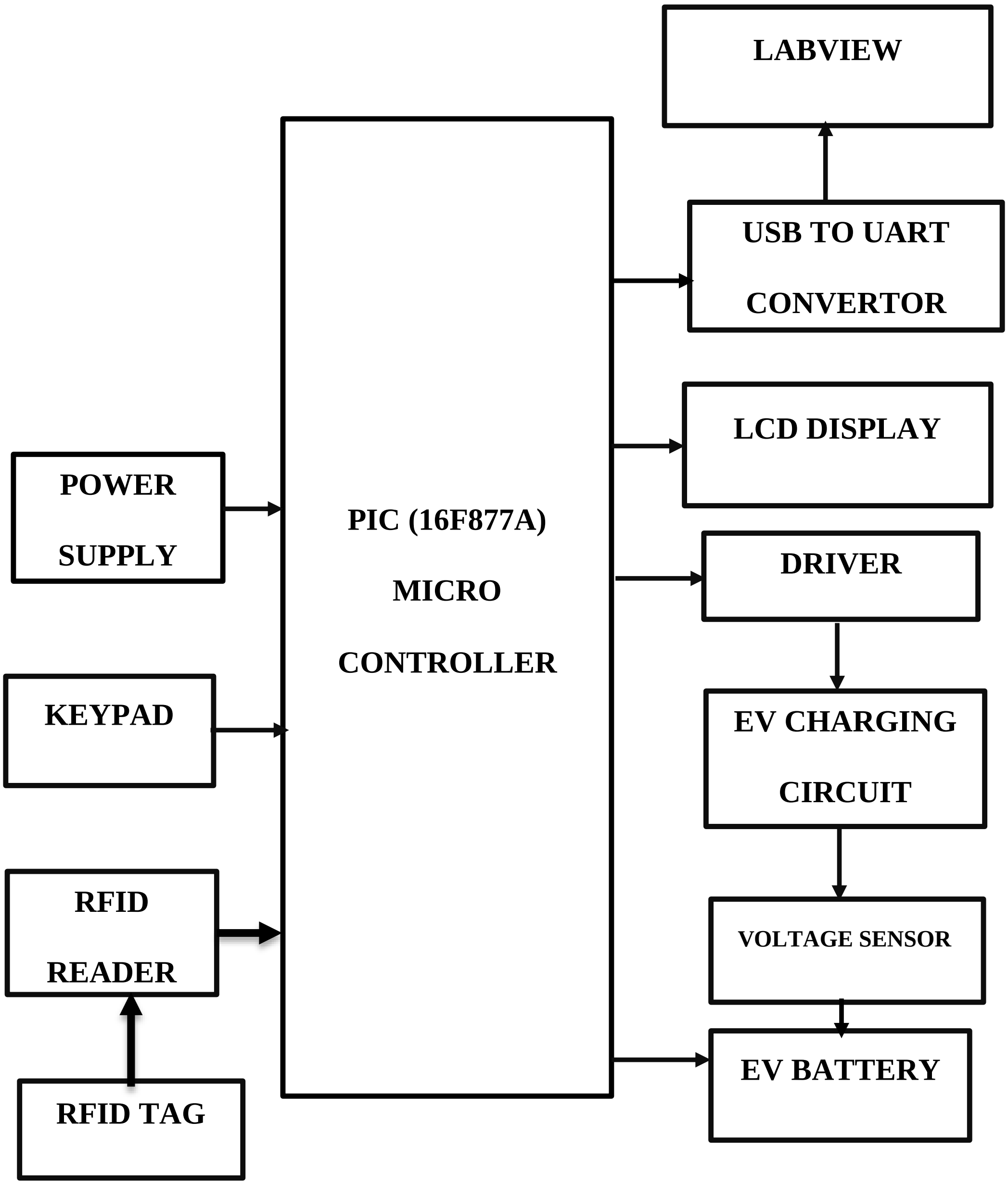

Figure.1. Block Diagram

4. Hardware Description

4.1. PIC16F877A Microcontroller

A peripheral interface controller (PIC) is a type of microcontroller component that is used in the development of electronics, computers, robotics and similar devices. The PIC was produced by Microchip Technology and is based on Harvard Computing architecture, where code and data are placed in separate registers to increase input/output (I/O) throughput.

PIC16F877a is a 40-pin PIC Microcontroller, designed using RISC architecture, manufactured by Microchip and is used in Embedded Projects. It has three Timers in it, two of which are 8-bit Timers while 1 is of 16 Bit.

It supports many communication protocols like:

- Serial Protocol.
- Parallel Protocol.
- I2C Protocol.

It supports both hardware pin interrupts and timer interrupts.

Pins of PIC Microcontroller have more than one name, it’s because each pin of PIC can perform multiple tasks.

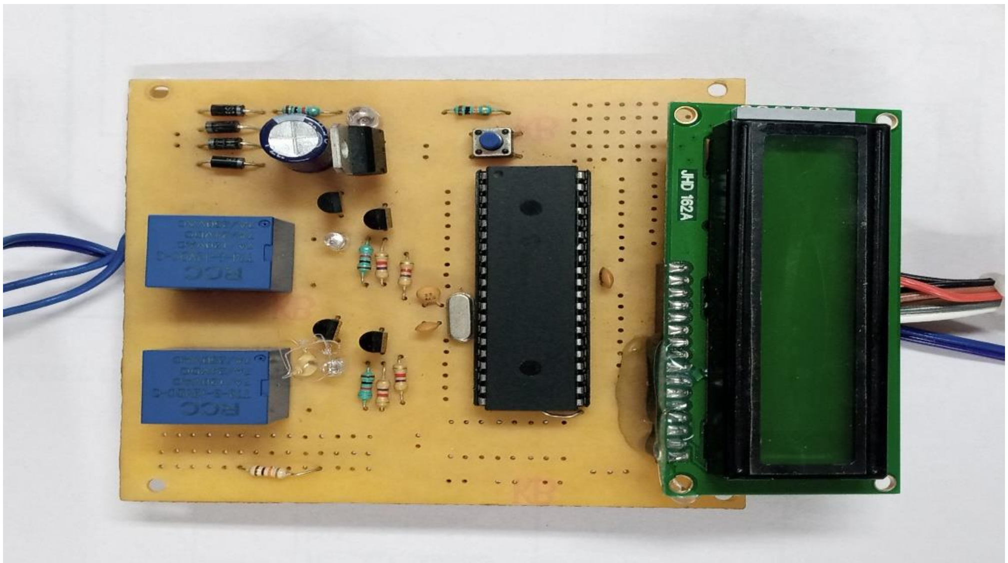

Figure.2. PIC Microcontroller

For example, check Pin # 25 from Fig 3, it can be used as a digital Port C Pin # 6 (RC6) and can also be used as a Transmitter (TX) for serial communication.Providing power to PIC Microcontroller and it works on +5V level. we also need to provide the frequency at which it will operate. In order to provide frequency to PIC Microcontroller, we use a crystal oscillator and for PIC16F877a, you can use a crystal oscillator of frequency range from 4MHz to 40MHz.

4.2. Lead Acid Battery

The lead–acid battery is a type of rechargeable battery. The lead–acid battery consists of two electrodes submerged in an electrolyte of sulfuric acid. The positive electrode is made of grains of metallic lead oxide, while the negative electrode is attached to a grid of metallic lead. Lead–acid batteries are classified into two types: flooded and valve-regulated. Sealed lead acid batteries can have a design life of anywhere from 3 – 5 years all the way up to 12+ years depending on the manufacturing process of the battery.

A lead-acid battery is a type of rechargeable battery that stores and releases electrical energy through a chemical reaction involving lead, lead oxide, and sulfuric acid. The battery is made up of multiple cells, each with lead plates submerged in a sulfuric acid electrolyte solution. Lead sulphate is changed back into lead and lead oxide when the battery is charged, and sulfuric acid is also recycled. Lead and lead oxide combine with sulfuric acid to generate lead sulphate during battery discharge, which releases electrical energy.

As well as in backup power systems, uninterruptible power supplies (UPS), and other situations where a dependable source of electrical power is required, lead-acid batteries are frequently utilised in cars, boats, and other types of vehicles. They Are relatively inexpensive and have a high power density, but they are also heavy, have a limited lifespan, and require regular maintenance to ensure proper function. Additionally, lead-acid batteries are prone to environmental issues due to the toxic nature of lead and sulfuric acid.

4.3. Power Supply

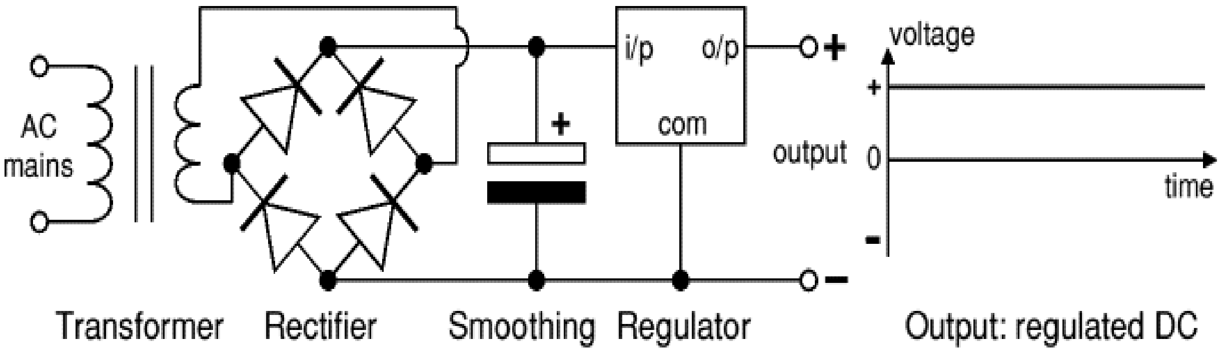

Figure.3. Circuit Diagram of Power Supply

The operation of power supply circuits built using filters, rectifiers and then voltage regulators. Starting with an AC voltage, a steady DC voltage is obtained by rectifying the AC voltage, then filtering to a DC level, and finally regulating to obtain a desired fixed DC voltage. The regulation is usually obtained from an IC voltage regulator unit, which remain the same if the input DC voltage varies or the output load connected to DC voltage changes. A diode rectifier that provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a DC voltage.

A regulated circuit can use this DC inputs to provide a DC voltage that not only has much less ripple voltage but also remains the same DC value even if the input DC voltage varies somewhat or the load connected to the output DC voltage changes this voltage regulation is usually obtained using one of a number of popular voltage regulation IC unit. In this circuit 230v AC is given as input to the primary windings of the transformer, which step-down's the 230v into 12v Ac supply. Then the 12v Ac supply is converted into the 12v dc supply using bridge rectifier.1000 uf capacitor is used to change the pulsating dc into pure dc.5v dc output is taken from the voltage Regulator-7805, which consists of 3 pins. First pin is given input 12v dc and center pin given ground supply, output 5v dc is taken from the third pin.

4.4. Voltage Sensor

A voltage sensor is a tool or equipment used to gauge the current flow in an electrical system or circuit. It is a particular kind of sensor that transforms the voltage signal into a quantifiable output that can be shown on a meter or recorded by a data logger. Voltage sensors come in a variety of forms, including contact and non-contact ones. Non-contact sensors can measure voltage without establishing physical contact with the circuit or component being monitored, in contrast to contact sensors. Capacitive and electromagnetic sensors are two types of non-contact voltage sensors. Power distribution systems, renewable energy systems, battery management systems, and electronic gadgets are just a few of the applications where voltage sensors are frequently employed.

4.5. RFID Reader

An RFID reader is a device that uses radio waves to wirelessly read the information stored on an RFID tag. RFID stands for Radio Frequency Identification, and it is a technology that allows for contactless communication between a tag or transponder and a reader. RFID readers typically consist of an antenna, a transceiver, and a control unit. The antenna emits radio waves that activate the RFID tag and collect the information stored on it. The transceiver converts the radio waves reflected back from the tag into digital information that the control unit can process. The control unit manages the communication with the tag and can interface with other devices, such as a computer or a database.

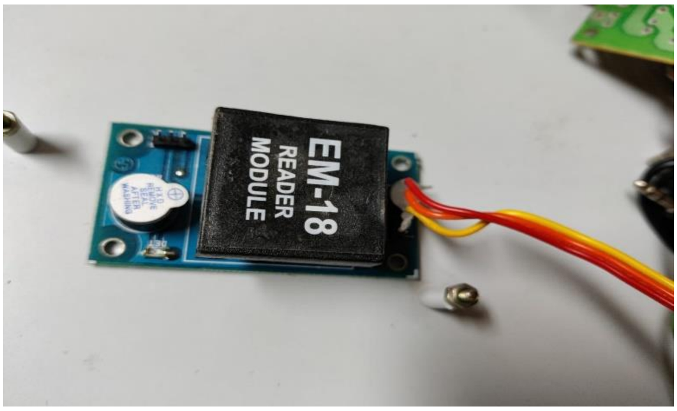

Figure.4. RFID Reader

There are different types of RFID readers, including handheld readers, fixed readers, and mobile readers. Handheld readers are portable devices that allow for on-the-spot data collection, while fixed readers are typically installed in a specific location and provide continuous monitoring. Mobile readers are used in vehicles or other mobile applications.

4.6. RFID Tag

An RFID tag is a piece of equipment that serves as the owner identification card for electric vehicles.The LCD display shows the battery voltage information for RFID-enabled devices. By using RFID to distinguish between things that each have a distinct RF-tag, it is possible to process information uniquely for each tagged object. An RF-tag, an RF-tag reader, and operation software make up RFID.

Figure.5. RFID Tag

The RF-tag reader can recognize the tag in 0.01~0.1 second and hence employed in real-time application. In a 05 m area, the identification rate is greater than 99.9%, enabling full-duplex communication that can save up to 64 Kbyte of data. An antenna and wire circuit are included in RFID tags for data transfer. The RFID reader supplies the antenna with the necessary power. Moreover, it reacts to the reader's questioning signal. RFID tags can range in size from a pin-sized object to an identity card-sized object.

4.7. Driver and Relay Circuit

A driver relay circuit is an electrical circuit used to manage a relay's functionality. When switching high power loads with low power signals, relays are electromechanical devices. The driver circuit isolates the control signal from the load being switched while also supplying the relay coil with the necessary voltage and current to ignite it. In many different applications, including industrial control systems, automobile electronics, and home automation systems, driver relay circuits are frequently employed. They are a crucial part of many electrical systems and are used to control loads including motors, solenoids, valves, and lights.

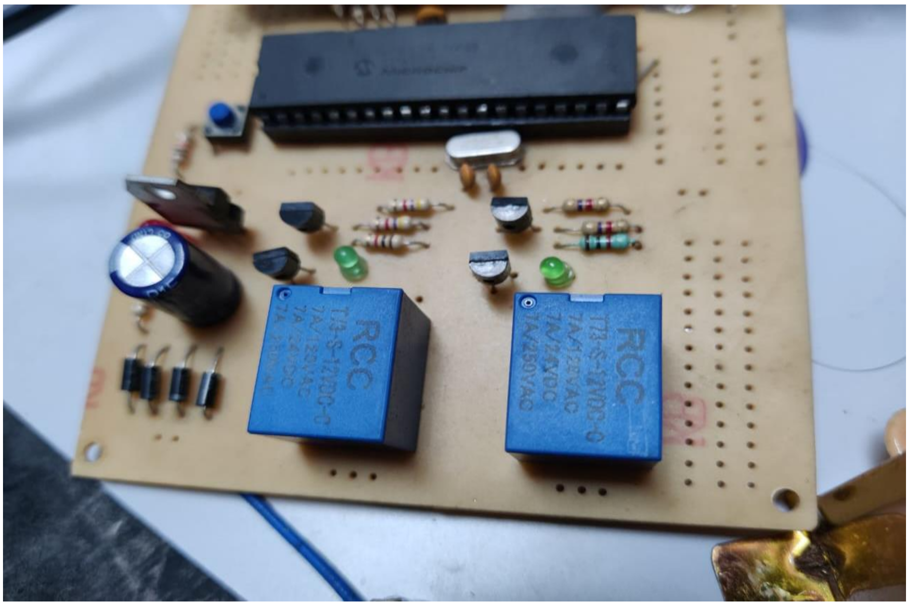

Figure.6. Driver and Relay Circuit

If you wish to use a low voltage circuit to turn on and off a light bulb (or anything else linked to the 220v mains supply), a relay is an electro-magnetic switch that can be beneficial. A transistor is typically required since the current required to run the relay coil is greater than what most chips (op-amps, etc.) can provide.

The microcontroller's digital pins are connected to the driver relay circuit, and dc loads will be directly interfaced with the relay module. The controller will transmit a signal (ON/OFF) to the driver/relay circuit in accordance with the pre-loaded code. The load will be turned on using a 230 volt AC supply when the driver/relay circuit enters the ON condition.

4.8. LCD Display

A flat panel display called an LCD (Liquid Crystal Display) uses liquid crystals to produce images. An electric current is used to regulate the orientation of the liquid crystals, which in turn affects the quantity of light that travels through the polarizing filters to produce the image. The liquid crystals are sandwiched between two polarizing filters and electrodes. A variety of electronic gadgets, including televisions, computer monitors, cellphones, digital cameras, and more, frequently use LCD screens. In comparison to other display technologies,

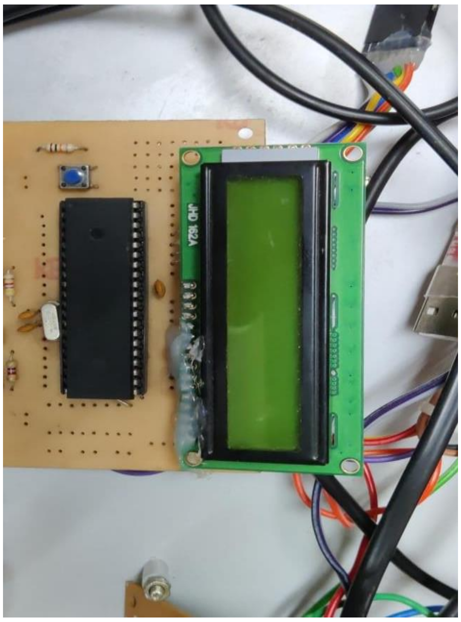

Figure.7. LCD Display

they have a number of benefits, including low power consumption, great brightness, wide viewing angles, and the capacity to display high-quality images and movies

6. Results and Discussion

Automated charging stations for electric vehicles offer several advantages over manual charging methods. With RFID tags and readers, the process of charging becomes more convenient, efficient, and reliable.One of the significant benefits of an automated charging station is that it can charge electric vehicles based on their individual power requirements. This means that the charging process can be optimized to match the vehicle's battery capacity, avoiding overcharging or undercharging, which can lead to battery damage and reduced lifespan. Additionally, this ensures that vehicles are only charged for the energy they need, reducing energy waste and optimizing the use of renewable energy sources.

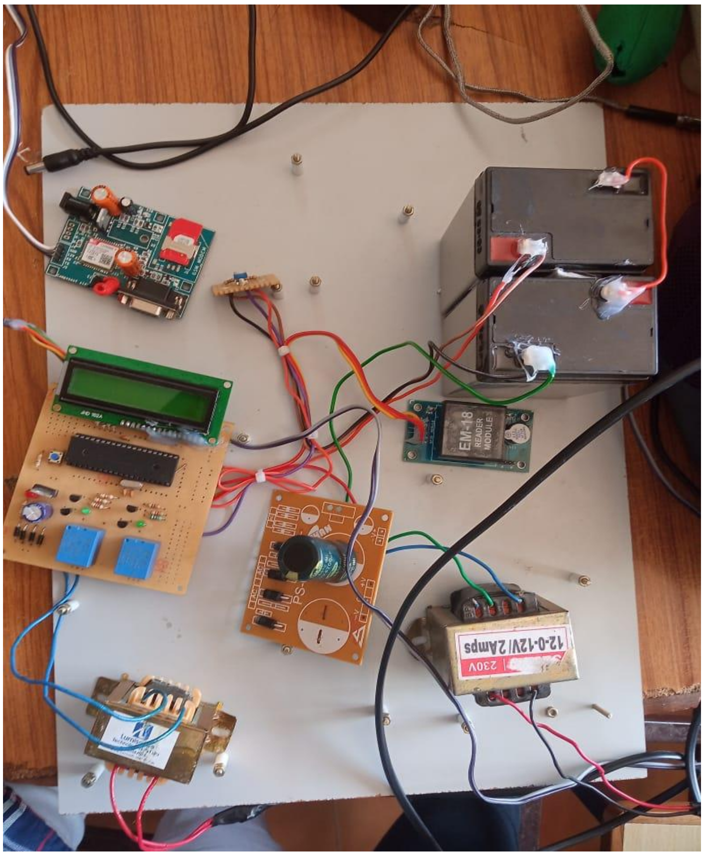

Figure.8. Overview

The use of RFID technology also eliminates the need for human intervention in the charging process, reducing the risk of errors, accidents, and delays. Users can customize their input data, such as charging times, preferred charging levels, and payment options, through an easy-to-use interface, which can be accessed via a mobile app or a web portal.Automated charging stations can also help reduce the load on the power grid by allowing the charging to be scheduled during off-peak hours, when the demand for electricity is lower. This can help balance the load on the grid and reduce the risk of power outages.

Figure.9. Front Panel

Overall, automated charging stations offer a more convenient, efficient, and reliable method for charging electric vehicles, helping to promote the widespread adoption of e-vehicles and reduce the carbon footprint of the transportation sector.

8. Conclusion

The smooth operation of the setup can be attributed to the use of advanced technology and proper monitoring techniques. The integrated circuits and microprocessor played a crucial role in regulating the voltage and current flow, preventing any fluctuations or surges that could potentially damage the system. These components also helped to optimize energy usage, reducing any potential wastage.Additionally, the monitoring of the charging process allowed for accurate recording of the time and energy consumption, providing valuable data for future analysis and optimization. The supervision of the entire system ensured that there were no flaws or defects that could compromise the charging process.The successful performance of the setup is a testament to the importance of precision and attention to detail in engineering and technology. By utilizing the latest advancements and employing effective monitoring and control techniques, the system was able to operate efficiently and reliably, meeting its intended objectives.

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