IoT BASED UID CHARGING FOR ELECTRIC VEHICLES

19E720 – PROJECT WORK 1

GOKUL RAM K S	**(19E610)**
SAI RITHISH V V	**(19E638)**
SHARAN G	**(19E641)**
VINETH K S	**(20E908)**

Dissertation submitted in partial fulfillment of the requirements for the degree of

BACHELOR OF ENGINEERING

Branch: ELECTRICAL AND ELECTRONICS ENGINEERING (SANDWICH)

of Anna University

NOVEMBER 2023

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

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Dr. C. MAHESWARI	**Dr.J.KANAKARAJ**
Faculty Guide	**Head of the Department**

Certified that the candidate was examined in the viva-voce examination held on …………………….

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(Internal Examiner)	**(External Examiner)**

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SYNOPSIS

A recharge electric vehicle in communal parking areas employs an innovative approach to optimize charging costs. This system dynamically selects the power source based on pricing tiers and availability. The setup comprises a power supply unit connected to the grid via a relay, which seamlessly switches to the grid when solar power is insufficient. Simultaneously, a connection to solar panels is established through another relay, ensuring that solar power is utilized when available. This dual-source strategy ensures cost-effectiveness by prioritizing lower-cost solar energy. Furthermore, the system incorporates Internet of Things (IoT) capabilities, facilitating remote monitoring and control. This enables centralized management and allows for data analytics to optimize usage patterns over time. In a solar-to-battery connection is established through the relay, ensuring that excess solar energy is stored in a battery. This stored energy can be utilized during periods of low solar output or during grid outages, further enhancing system reliability.

If was used electric vehicle charges are low for used solar-connected vehicles. Grid connect is used electric vehicle medium charges. The double cost of the vehicle occurs during peak hours. The peak time is any time an emergency situation arises in the highest rates. In this innovative smart power meter for electric vehicle charging in communal parking areas employs a dynamic and cost-effective approach to power management. By intelligently utilizing solar and grid sources, monitoring voltage levels, implementing RFID payments, and incorporating IoT capabilities, it offers an efficient and sustainable solution for electric vehicle charging in urban environments. The addition of a switch mechanism for peak-time pricing and the use of a relay-driven system enhances overall functionality and reliability.

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CHAPTER 1

1.1 INTRODUCTION

In the face of growing environmental concerns and the imperative to transition towards sustainable transportation solutions, the integration of electric vehicles (EVs) into our daily lives has become paramount. To support this transition, there is a pressing need for efficient, cost-effective, and environmentally conscious charging infrastructure. The project at hand endeavors to address this need by introducing a groundbreaking innovation: an Electric Vehicle Charging in communal parking areas. This system represents a paradigm shift in the way we approach EV charging, by intelligently managing power sources and optimizing costs for both consumers and the grid.

With the increasing ubiquity of solar energy solutions, harnessing the power of the sun has never been more critical. This project capitalizes on this potential by prioritizing solar energy when it is abundant, seamlessly transitioning to the grid when solar power is insufficient. The heart of this system lies in its ability to provide real-time feedback to users. Through advanced voltage sensors and an intuitive LCD interface, individuals can monitor the status of both the battery and solar sources. This empowers users to make informed decisions about their charging habits, further contributing to cost savings and environmental responsibility.

In addition to its sustainable and cost-effective approach, this project places a strong emphasis on user convenience and security. An integrated RFID reader streamlines payment processing, ensuring a hassle-free transaction experience. Furthermore, a switch mechanism allows for adjustments in pricing during peak-demand periods, promoting responsible energy consumption. The incorporation of Internet of Things (IoT) capabilities takes this project to the next level. It enables remote monitoring and control, allowing for centralized management and data-driven insights. This not only enhances the efficiency of the system but also paves the way for future innovations in sustainable transportation infrastructure.

Furthermore, the inclusion of a relay-driven system and a solar-to-battery connection ensures uninterrupted charging availability, even in the event of solar or grid outages. By seamlessly integrating solar and grid power, providing real-time feedback, streamlining payments, and incorporating IoT capabilities, this Smart Power Meter not only addresses the pressing need for sustainable transportation solutions but also sets a new standard for efficiency, convenience, and environmental responsibility in communal parking areas.

1.2 INTERNET OF THINGS

The Internet of Things (IoT) is the network of devices such as vehicles, and home appliances that contain electronics, software, actuators, and connectivity which allows these things to connect, interact and exchange data. The IoT involves extending Internet connectivity beyond standard devices, such as desktops, laptops, smartphones and tablets, to any range of traditionally dumb or non-internet-enabled physical devices and everyday objects. Embedded with technology, these devices can communicate and interact over the Internet, and they can be remotely monitored and controlled.

The definition of the IoT has evolved due to convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems. Traditional fields of embedded systems, wireless sensor networks, automation (including home and building automation control systems, and others all contribute to enabling the Internet of things.

1.3 WORKING OF IoT

An IoT ecosystem consists of web-enabled smart devices that use embedded processors, sensors and communication hardware to collect, send and act on data they acquire from their environments. IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device where data is either sent to the cloud to be analyzed or analyzed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices -- for instance, to set them up, give them instructions or access the data. The connectivity, networking and communication protocols used with these web-enabled devices largely depend on the specific IoT applications deployed.

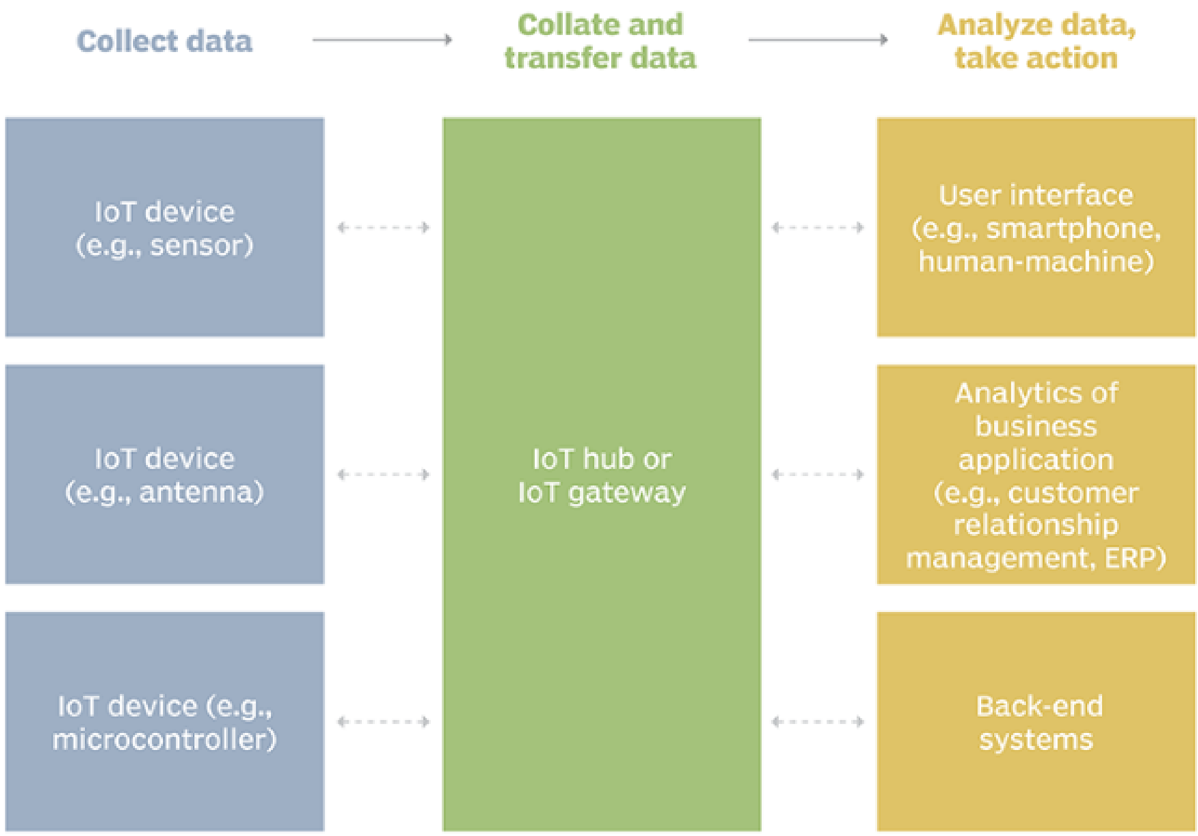

Fig1.1: Example of an IOT system

1.4 BENEFITS OF IoT

The internet of things offers a number of benefits to organizations, enabling them to:

- Monitor their overall business processes
- Improve the customer experience
- Save time and money
- Enhance employee productivity
- Integrate and adapt business models
- Make better business decisions
- Generate more revenue

1.5 IoT SECURITY AND PRIVACY ISSUES

The internet of things connects billions of devices to the internet and involves the use of billions of data points, all of which need to be secured. Due to its expanded attack surface, IoT security and IoT privacy are cited as major concerns. One of the most notorious recent IoT attacks was Mirai, a botnet that infiltrated domain name server provider Dyn and took down many websites for an extended period of time in one of the biggest distributed denial-of-service (DDoS) attacks ever seen. Attackers gained access to the network by exploiting poorly secured IoT devices.

Because IoT devices are closely connected, all a hacker has to do is exploit one vulnerability to manipulate all the data, rendering it unusable. And manufacturers that don't update their devices regularly -- or at all -- leave them vulnerable to cybercriminals. Additionally, connected devices often ask users to input their personal information, including names, ages, addresses, phone numbers and even social media accounts -- information that's invaluable to hackers. However, hackers aren't the only threat to the internet of things; privacy is another major concern for IoT users. For instance, companies that make and distribute consumer IoT devices could use those devices to obtain and sell users' personal data. Beyond leaking personal data, IoT poses a risk to critical infrastructure, including electricity, transportation and financial services.

1.6 IoT APPLICATION AREAS

Near Field Communication (NFC), Radio frequency Identification (RFID), Machine-to-Machine Communication (M2M) & Vehicle-to-Vehicle Communication (V2V) are the technologies by which IoT is being implemented exponentially. It is assumed that more than 50 billion IoT devices will be connected through internet. It is going to change human life, working style, entertaining ways and many more. IoT have many Applications Areas and domain of these application are increasing day by day.

There are ample of applications of IoT as follow:

- Smart Cities
- Building & Home automation
- Environmental Monitoring
- Automotive Industry
- Smart Retail
- Smart Agriculture
- Smart Industry
- Energy Management Healthcare Monitoring

1.7 EMBEDDED SYSTEM

An embedded system is one kind of a computer system mainly designed to perform several tasks like to access, process, store and also control the data in various electronics-based systems. Embedded systems are a combination of hardware and software where software is usually known as firmware that is embedded into the hardware. One of its most important characteristics of these systems is, it gives the o/p within the time limits. Embedded systems support to make the work more perfect and convenient. So, we frequently use embedded systems in simple and complex devices too. The applications of embedded systems mainly involve in our real life for several devices like microwave, calculators, TV remote control, home security and neighborhood traffic control systems, etc.

An embedded system is integration of hardware and software, the software used in the embedded system is set of instructions which are termed as a program. The microprocessors or microcontrollers used in the hardware circuits of embedded systems are programmed to perform specific tasks by following the set of instructions. These programs are primarily written using any programming software like Proteus or Lab-view using any programming languages such as C or C++ or embedded C. Then, the program is dumped into the microprocessors or microcontrollers that are used in the embedded system circuits.

1.7.1 EMBEDDED SYSTEM CLASSIFICATION

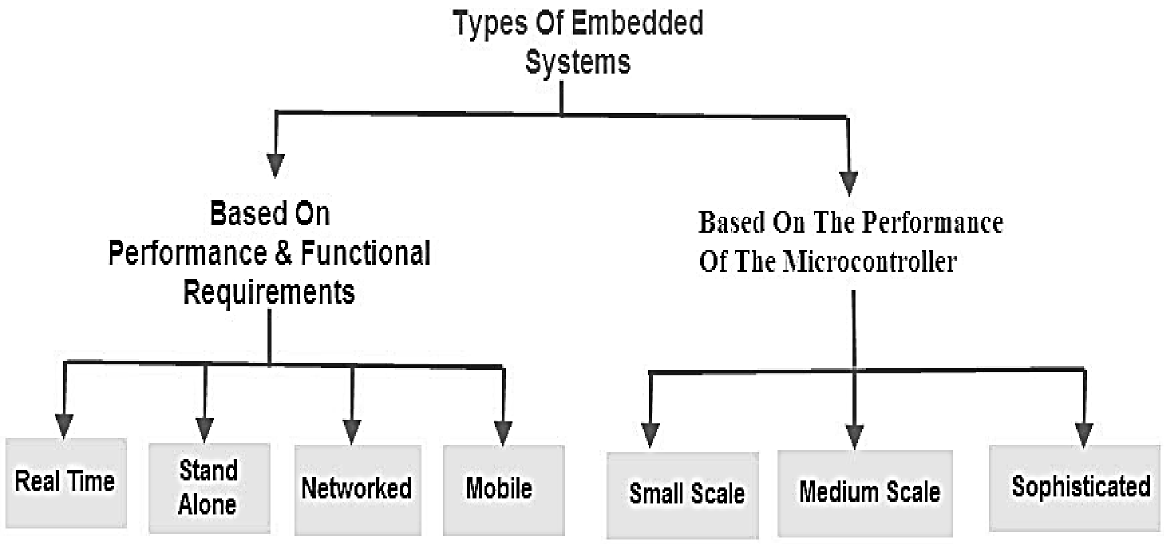

Fig:1.2: Embedded System Classification

Embedded systems are primarily classified into different types based on complexity of hardware & software and microcontroller (8 or 16 or 32-bit). Thus, based on the performance of the microcontroller, embedded systems are classified into three types such as:

- Small scale embedded systems
- Medium scale embedded systems
- Sophisticated embedded systems

Further, based on performance and functional requirements of the system embedded system classified into four types such as:

- Real time embedded systems
- Standalone embedded systems
- Networked embedded systems
- Mobile embedded systems

1.7.2 EMBEDDED SYSTEM HARDWARE

An embedded system uses a hardware platform to perform the operation. Hardware of the embedded system is assembled with a microprocessor/microcontroller. It has the elements such as input/output interfaces, memory, user interface and the display unit. Generally, an embedded system comprises of the following

- Power Supply
- Memory
- Processor
- Timers
- Output/Output circuits
- Serial communication ports
- SASC (System application specific circuits)

1.7.3 EMBEDDED SYSTEM SOFTWARE

The software of an embedded system is written to execute a particular function. It is normally written in a high-level setup and then compiled down to offer code that can be stuck within a non-volatile memory in the hardware. Embedded system software is intended to keep in view of the following three limits

- Convenience of system memory
- Convenience of processor's speed
- When the embedded system runs constantly, there is a necessity to limit power dissipation for actions like run, stop and wake up.

1.7.4 RTOS (REAL TIME OPERATING SYSTEM)

A system which is essential to finish its task and send its service on time, then only it said to be a real time operating system. RTOS controls the application software and affords a device to allow the processor run. It is responsible for managing the different hardware resources of a personal computer and also host applications which run on the PC.

This operating system is specially designed to run various applications with an exact timing and a huge amount of consistency. Particularly, this can be significant in measurement & industrial automation systems where a delay of a program could cause a safety hazard.

1.7.5 MEMORY AND PROCESSORS

The different kinds of processors used in an embedded system include Digital Signal Processor (DSP), microprocessor, RISC processor, microcontroller, ASSP processor, ASIP processor, and ARM processor. The different types of memories of an embedded system are given in the below chart.

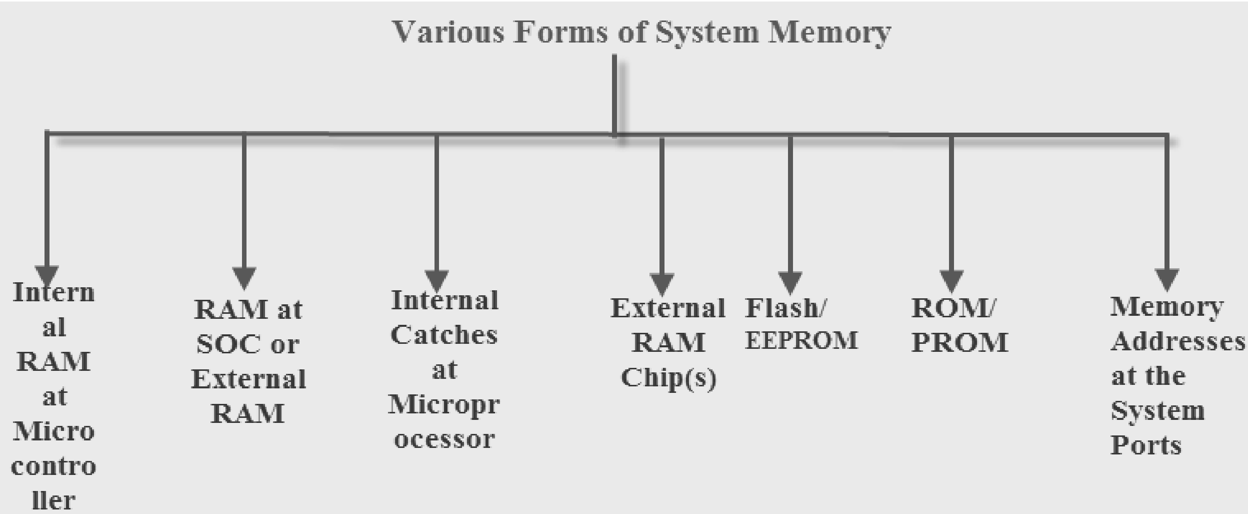

Fig:1.3: Memory & Processors

1.7.6 EMBEDDED SYSTEM CHARACTERISTICS

- Generally, an embedded system executes a particular operation and does the similar continually. For instance: A pager is constantly functioning as a pager.
- All the computing systems have limitations on design metrics, but those can be especially tight. Design metric is a measure of an execution features like size, power, cost and also performance.
- It must perform fast enough and consume less power to increase battery life.
- Several embedded systems should constantly react to changes in the system and also calculate particular results in real time without any delay. For instance, a car cruise controller; it continuously displays and responds to speed & brake sensors. It must calculate acceleration/de-accelerations frequently in a limited time; a delayed computation can consequence in letdown to control the car.
- It must be based on a microcontroller or microprocessor based.
- It must require a memory, as its software generally inserts in ROM. It does not require any secondary memories in the PC.

CHAPTER 2
LITERATURE SURVEY

2.1 TITLE: Energy management for building resilience against power outage by shared parking station for electric vehicles and demand response program

AUTHOR: Man-Wen Tian, Pouyan Talebizadehsardari.

YEAR: 2020

DESCRIPTION:

This paper considers two commercial and residential buildings for building energy resilience against natural disasters that cause a power outage. The options are a peer-to-peer operation of the building, electrical vehicle charging-discharging, partial charge ability, load curtailment, and load adjustment. The proposed model only utilizes available components of the buildings and it does not need to install further components. The purpose is to minimize energy cost and maximize energy resilience under natural disasters. The resilience is defined as critical load restoration and minimum energy loss under various power outages. The results demonstrate that the designated energy management options can practically minimize energy cost and improve energy resilience following blackouts. The electric vehicles can reduce energy cost by about 25% and supply the loads under 7-hour power outage.

Problem Identification

Revolves around enhancing the energy resilience of commercial and residential buildings in the face of natural disasters causing power outages. The paper considers various strategies and models that leverage the existing components of these buildings to achieve improved energy resilience without the need for additional installations.

2.2 TITLE: Analysis of residential EV energy flexibility potential based on real-world charging reports and smart meter data

AUTHOR: A.L. Sorensen, K.B. Lindberg Sartori, Andresen

YEAR: 2021

DESCRIPTION:

The increase in the number of electric vehicles leads to an increased demand for residential charging. While EV electric loads can have a negative impact on the power grid, they also represent a large potential for energy flexibility. This study proposes a methodology to describe charging habits, electricity load profiles, and flexibility potentials of EV charging in apartment buildings. The input data used for the method are generally available for buildings with multiple EV charge points: EV charging reports with individual charging sessions and aggregated smart meter data. The case study is a large housing cooperative in Norway, with a combination of private and shared charge points for the residents. The study compares two charging power assumptions of 3.6 kW and 7.2 kW. The flexibility potential increases with higher charging power. The study reveals a significant potential for residential EV charging flexibility when private parking spaces have EV charge points.

Problem Identification

Centers around the growing adoption of electric vehicles (EVs) and its impact on residential charging demand. As more EVs are introduced into the market, there is a corresponding rise in the need for residential charging infrastructure. While this increase in EVs and their associated electric loads can strain the power grid, it also presents a substantial opportunity for energy flexibility and optimization.

2.3 TITLE: An Integrated Optimisation-Simulation Framework for Scalable Smart Charging and Relocation of Shared Autonomous Electric Vehicles

AUTHOR: Riccardo Iacobucci, Raffaele Bruno and Jan-Dirk Schmocker

YEAR: 2021

DESCRIPTION:

Ride-hailing with autonomous electric vehicles and shared autonomous electric vehicle (SAEV) systems are expected to become widely used within this decade. These electrified vehicles can be key enablers of the shift to intermittent renewable energy by providing electricity storage to the grid and offering demand flexibility. In order to accomplish this goal, practical smart charging strategies for fleets of SAEVs must be developed. In this work, we present a scalable, flexible, and practical approach to optimize the operation of SAEVs including smart charging based on dynamic electricity prices. Our approach integrates independent optimization modules with a simulation model to overcome the complexity and scalability limitations of previous works. We tested our solution on real transport and electricity data over four weeks using a publicly available dataset of taxi trips from New York City. Our approach can significantly lower charging costs and carbon emissions when compared to an uncoordinated charging strategy, and can lead to beneficial synergies for fleet operators, passengers, and the power grid.

Problem Identification:

Revolves around the potential of ride-hailing services utilizing autonomous electric vehicles (AEVs) and shared autonomous electric vehicle (SAEV) systems to become increasingly prevalent in the coming years. These electrified vehicles possess the capability to act as significant contributors to the integration of intermittent renewable energy sources into the power grid by serving as energy storage units and offering demand flexibility.

2.4 TITLE: Analysis and Design of a Standalone Electric Vehicle Charging Station Supplied by Photovoltaic Energy

AUTHOR: Ibrahem E. Atawi, Essam Hendawi and Sherif A. Zaid

YEAR: 2021

DESCRIPTION:

Nowadays, there is a great development in electric vehicle production and utilization. It has no pollution, high efficiency, low noise, and low maintenance. However, the charging stations, required to charge the electric vehicle batteries, impose high energy demand on the utility grid. One way to overcome the stress on the grid is the utilization of renewable energy sources such as photovoltaic energy. The utilization of standalone charging stations represents good support to the utility grid. Nevertheless, the electrical design of these systems has different techniques and is sometimes complex. This paper introduces a new simple analysis and design of a standalone charging station powered by photovoltaic energy. Simple closed-form design equations are derived, for all the system components. Case-study design calculations are presented for the proposed charging station. Then, the system is modeled and simulated using MATLAB/Simulink platform. Furthermore, an experimental setup is built to verify the system physically. The experimental and simulation results of the proposed system are matched with the design calculations.

Problem Identification:

Journal paper pertains to the challenge of the high energy demand imposed on the utility grid by charging stations required for electric vehicles, despite the numerous benefits EVs offer, such as pollution-free operation, high efficiency, low noise, and reduced maintenance. To address the stress on the grid, the paper explores the potential of utilizing renewable energy sources, particularly photovoltaic energy, to power standalone charging stations.

2.5 TITLE: Low-risk Privacy-preserving Electric Vehicle Charging with Payments

AUTHOR: Andreas Unterweger, Fabian Knirsch, Clemens Brunner and, Dominik Engel

YEAR: 2021

DESCRIPTION:

The increasing number of electric vehicles and a growing electric vehicle ecosystem is becoming a highly heterogeneous environment with a large number of participants that interact and communicate. Finding a charging station, performing vehicle-to-vehicle charging or processing payments poses privacy threats to customers as their location and habits can be traced. In this paper, we present a privacy-preserving solution for grid-to-vehicle charging, vehicle-to-grid charging and vehicle to-vehicle charging, that allows for finding the right charging option in a competitive market environment and that allows for built-in payments with adjustable and limited risk for both, producers and consumers of electricity. The proposed approach builds on blockchain technology and extends a state-of-the-art protocol with payments, while still preserving the privacy of the users. The protocol is evaluated with respect to privacy, risk and scalability. It is shown that pseudonymity and location privacy (against third parties) is guaranteed throughout the protocol, even beyond a single protocol session. In addition, both, risk and scalability can be adjusted based on the used blockchain.

Problem Identification:

This journal paper addresses the privacy concerns associated with the increasing prevalence of electric vehicles (EVs) and the growing complexity of the EV ecosystem. With numerous participants engaging in interactions and communications within this environment, concerns arise regarding the privacy of users during various EV-related activities such as locating charging stations, conducting vehicle-to-vehicle charging, and handling payment transactions.

CHAPTER 3

EXISTING SYSTEM

3.1 EXISTING SYSTEM FOR EV CHARGING

Formal method of charging electric vehicles requires manual effort for bill payment. It consists of only charging port to charge the electric vehicles. The energy consumed by electric vehicle is displayed on LCD display. This method of charging is time consuming and requires human intervention. When usage electric vehicle is increased in future then this method will be no longer useful. An efficient and fast method of charging station is required to overcome this existing method.

Electric vehicle charging station with charging port that charges electric vehicles and the charged voltage is displayed on LCD. In this system the bill payment is manual and information's are not stored.

EV can be slowly charged using a common 230 V / 16 A socket (single phase), it is not a desired approach as charging time will be too large, even for a whole night. According to Tesla, that connection only provides power but that will depend on the car use of a driver according to certain variables such as distance to work and the type of driving activity. This can be scaled depending on many factors such as cost.

EXISTING BLOCK DIAGRAM

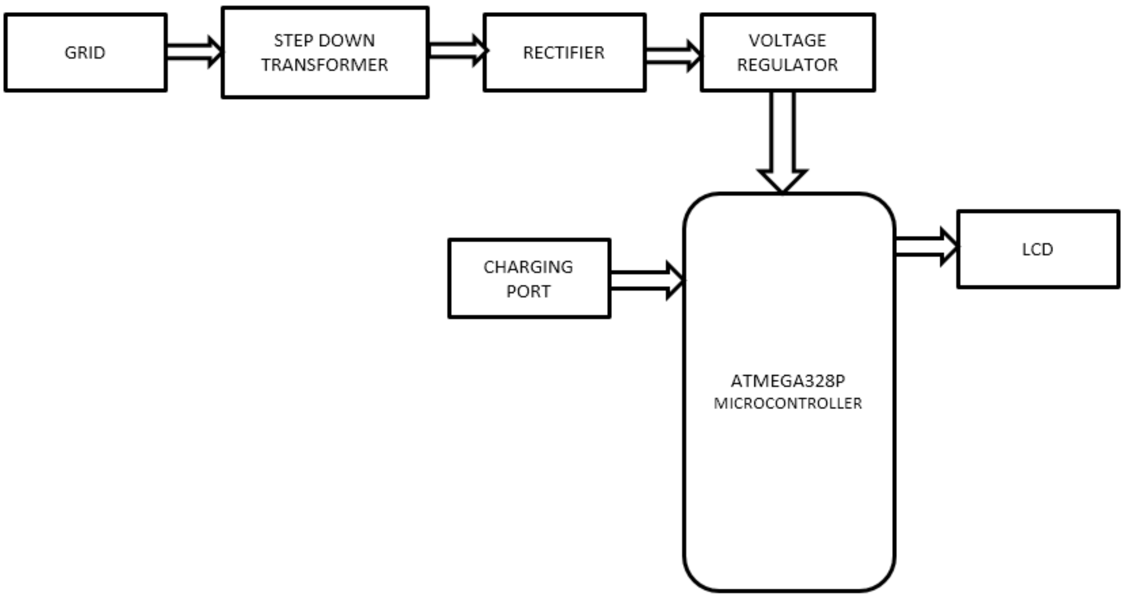

Fig.3.1:Block Diagram of Existing Method

3.2 DISADVANTAGES OF EXISTING SYSTEM

There are a few disadvantages associated with the existing system of electrical vehicle charging methods:

1. Limited charging infrastructure: The current charging infrastructure for electric vehicles is not as widespread as traditional fuel stations. This can make it challenging for EV owners to find convenient charging locations, especially in rural areas or during long-distance travel.

2. Charging time: Charging an electric vehicle takes significantly longer than refueling a traditional combustion engine vehicle. Depending on the charging method and the battery capacity, it can take several hours to fully charge an EV. This can pose an inconvenience for drivers who require quick refueling.

3. Range anxiety: EV drivers often experience range anxiety, which is the fear of running out of battery power before reaching their destination. The limited range of electric vehicles, combined with the uneven distribution of charging stations, can cause anxiety and limit the flexibility of travel.

4. Cost of infrastructure: Building and maintaining a comprehensive charging infrastructure is a costly endeavor. This cost is often passed on to the consumers, making electric vehicles more expensive to own and operate compared to conventional vehicles.

5. Compatibility issues: Different electric vehicles use various charging standards, such as CHAdeMO, CCS, or Tesla's Supercharger network. This lack of standardization can create compatibility issues, limiting the availability and convenience of charging options for EV owners.

CHAPTER 4

PROPOSED METHODOLOGY

4.1 PROPOSED METHOD

A scarcity of charging stations may make EVs less convenient and contribute to range anxiety resulting in less people embracing the use of electric vehicles. In existing system the electric vehicle is charged by using ATMEGA328P microcontroller. The power for the system is dram from the grid. The power from the grid is given to the rectifier circuit through step down transformer. The rectified output is given to voltage regulator for the optimization of regulated voltage. This existing system uses a charging port to charge the electric vehicle. This system is similar to the ordinary charging of electric vehicle using a charging port and displaying the charging information in the LCD display.

4.2 PROPOSED SYSTEM SPECIFICATION

The proposed system is a revolutionize Electric Vehicle (EV) charging in communal parking areas. It leverages advanced technology to optimize energy usage, reduce costs, and promote sustainability. Here's an overview of the key components and functionalities:

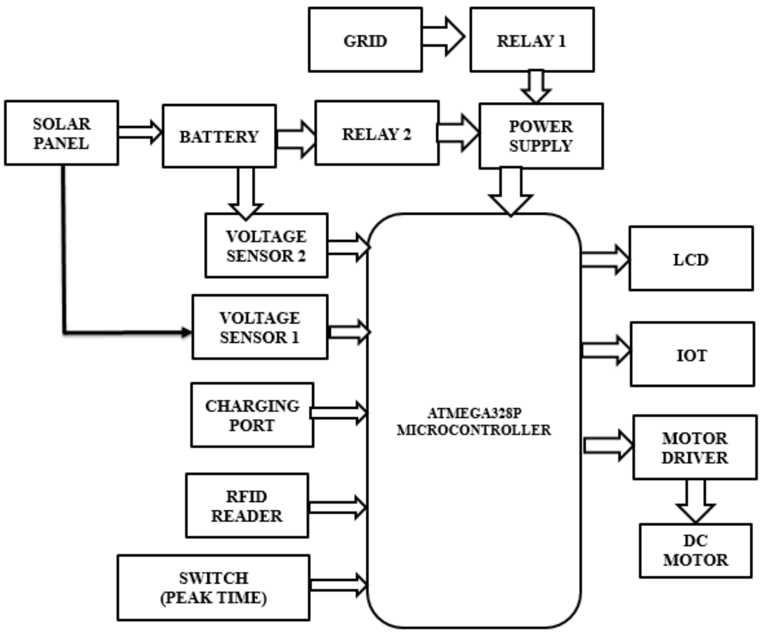

Fig.4.1: Proposed block diagram for EV charging

4.2.1 DUAL POWER SOURCE INTEGRATION:

The system seamlessly integrates two power sources: solar energy and the grid. When solar power is available and cost-effective, it takes precedence for charging EVs. If solar power is insufficient, the system automatically switches to grid power.

4.2.2 RELAY-BASED POWER SUPPLY UNIT:

A relay-based mechanism is employed to facilitate the seamless transition between the solar and grid power sources. This ensures uninterrupted charging availability.

4.2.3 VOLTAGE SENSORS AND LCD DISPLAY:

The system incorporates voltage sensors to monitor the status of the battery and solar power sources in real-time. The information gathered is displayed on an LCD interface, providing users with immediate feedback on the power availability and charging status.

4.2.4 CHARGING PORT FOR ELECTRIC VEHICLES:

The system features a dedicated charging port designed to accommodate electric vehicles. This port is equipped to draw power from both the solar and grid sources.

4.2.5 RFID READER FOR PAYMENT PROCESSING:

An RFID reader is integrated into the system for secure and efficient payment processing. Users can seamlessly authenticate and authorize payments for the charging services.

4.2.6 SWITCH MECHANISM FOR PEAK-TIME PRICING:

A switch mechanism allows for the adjustment of charging rates during peak-demand periods. This encourages responsible energy consumption and contributes to grid stability.

4.2.7 IOT CAPABILITIES:

The system is equipped with Internet of Things (IoT) capabilities, enabling remote monitoring and control. This allows for centralized management, data analytics, and the potential for future optimizations.

4.2.8 L293D DRIVER CIRCUIT FOR MOTOR CONTROL:

The L293D driver circuit is utilized for driving DC motors. This can be employed for tasks such as controlling relay switches or other auxiliary functions within the system.

4.2.9 REDUNDANCY FOR RELIABILITY:

The relay-driven system and solar-to-battery connection ensure uninterrupted charging availability, even in cases of solar or grid outages. This redundancy guarantees reliability and accessibility.

4.3 CIRCUIT DIAGRAM FOR PROPOSED METHOD

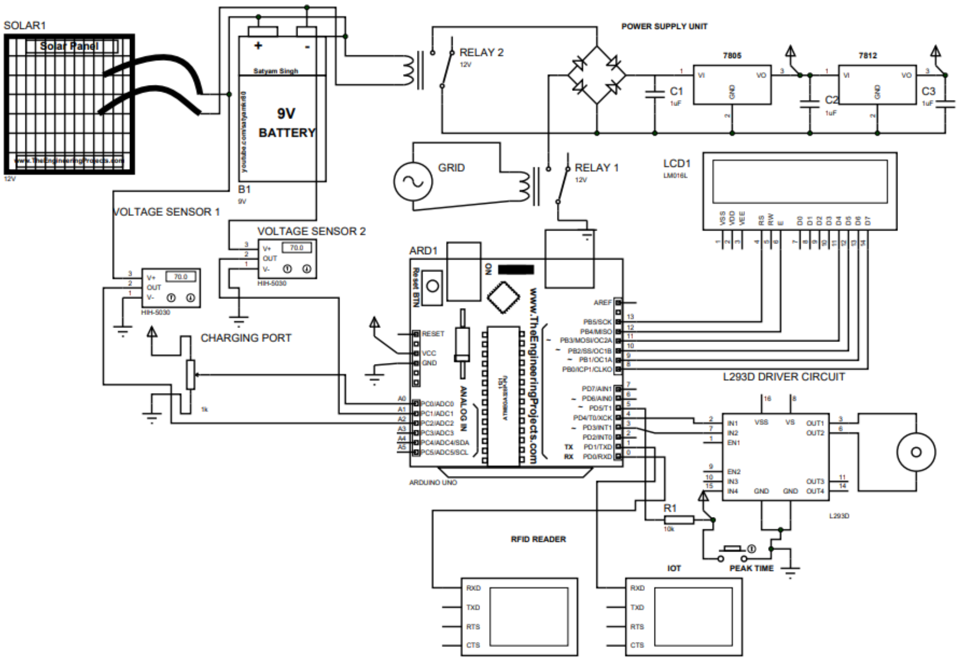

Fig.4.2: Proposed circuit diagram

4.4 ADVANTAGES

- It is eco-friendly and requires less components to design.
- RFID has used in this charging station to make easy payment there is no need to frequent maintenance
- Low power losses.
- Possibility of high-speed charging
- No human intervention
- Low maintenance requirements
- Less time consumption
- Management of Power demand

CHAPTER 5

SOFTWARE RESULT AND DISCUSSION

5.1 ARDUINO IDE

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino board.

The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU tool chain, also included with the IDE distribution. The Arduino IDE employs the program argued to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board.

The Arduino IDE is incredibly minimalistic, yet it provides a near-complete environment for most Arduino-based projects. The top menu bar has the standard options, including “File” (new, load save, etc.), “Edit” (font, copy, paste, etc.), “Sketch” (for compiling and programming), “Tools” (useful options for testing projects), and “Help”. The middle section of the IDE is a simple text editor that where you can enter the program code. The bottom section of the IDE is dedicated to an output window that is used to see the status of the compilation, how much memory has been used, any errors that were found in the program, and various other useful messages.

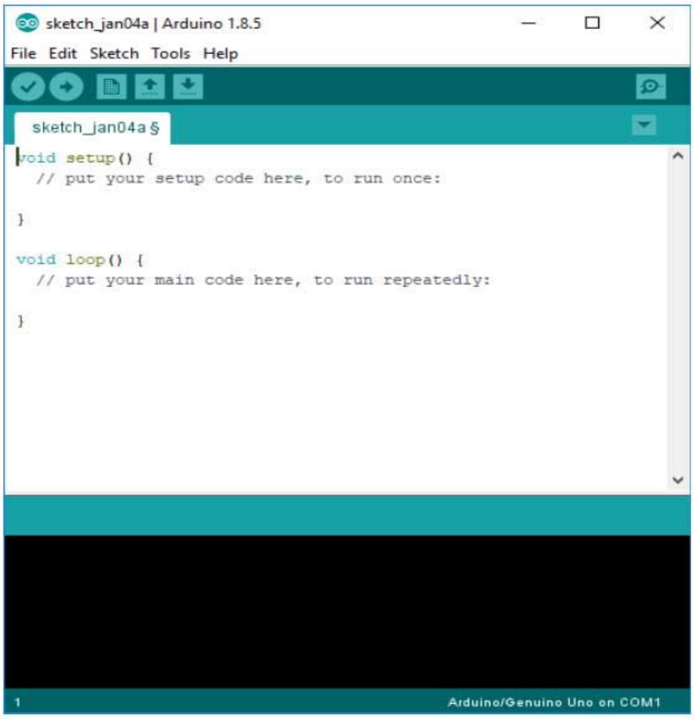

Fig.5.1: Arduino IDE

Projects made using the Arduino are called sketches, and such sketches are usually written in a cut-down version of C++ (a number of C++ features are not included). Because programming a microcontroller is somewhat different from programming a computer, there are a number of device-specific libraries (e.g., changing pin modes, output data on pins, reading analog values, and timers). This sometimes confuses users who think Arduino is programmed in an "Arduino language." However, the Arduino is, in fact, programmed in C++. It just uses unique libraries for the device.

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuine hardware to upload programs and communicate with them.

Programs written using Arduino Software (IDE) are called **sketches**. These sketches are written in the text editor and are saved with the file extension.ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right-hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

5.1.1 CONNECTING THE ARDUINO

Connecting an Arduino board to your PC is quite simple. On Windows:

1. Plug in the USB cable - one end to the PC, and one end to the Arduino board.

2. When prompted, select "Browse my computer for driver" and then select the folder to which you extracted your original Arduino IDE download.

3. You may receive an error that the board is not a Microsoft certified device - select “Install anyway.”

4. Your board should now be ready for programming.

When programming your Arduino board it is important to know what COM port the Arduino is using on your PC. On Windows, navigate to Start->Devices and Printers, and look for the Arduino. The COM port will be displayed underneath.

Alternatively, the message telling you that the Arduino has been connected successfully in the lower-left hand corner of your screen usually specifies the COM port is it using.

5.1.2 PREPARING THE BOARD

Before loading any code to your Arduino board, you must first open the IDE. Double click the Arduino .exe file that you downloaded earlier. A blank program, or "sketch," should open.

The Blink example is the easiest way to test any Arduino board. Within the Arduino window, it can be found under `File->Examples->Basics->Blink`.

Before the code can be uploaded to your board, two important steps are required.

1. Select your Arduino from the list under `Tools->Board`. The standard board used in RBE 1001, 2001, and 2002 is the Arduino Mega 2560, so select the "Arduino Mega 2560 or Mega ADK" option in the dropdown.

2. Select the communication port, or COM port, by going to `Tools->Serial Port`.

If you noted the COM port your Arduino board is using, it should be listed in the dropdown menu. If not, your board has not finished installing or needs to be reconnected.

5.1.3 LOADING CODE

The upper left of the Arduino window has two buttons: A checkmark to Verify your code, and a right-facing arrow to Upload it. Press the right arrow button to compile and upload the Blink example to your Arduino board.

The black bar at the bottom of the Arduino window is reserved for messages indicating the success or failure of code uploading. A "Completed Successfully" message should appear once the code is done uploading to your board. If an error message appears instead, check that you selected the correct board and COM port in the Tools menu, and check your physical connections.

If uploaded successfully, the LED on your board should blink on/off once every second. Most Arduino boards have an LED prewired to pin 13.

It is very important that you do not use pins 0 or 1 while loading code. It is recommended that you do not use those pins ever.

Arduino code is loaded over a serial port to the controller. Older models use an FTDI chip which deals with all the USB specifics. Newer models have either a small AVR that mimics the FTDI chip or a built-in USB-to-serial port on the AVR micro-controller itself.

5.2 PROTEUS

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

Proteus is design software developed by Lab center Electronics for electronic circuit simulation, schematic capture and PCB design. Its simplicity and user-friendly design made it popular among electronics hobbyists. Proteus is commonly used for digital simulations such as microcontrollers and microprocessors. It can simulate LED, LDR, USB Communication.

Proteus is a simulation and design software tool developed by Lab center Electronics for Electrical and Electronic circuit design. It also possesses 2D CAD drawing feature. It deserves to bear the tagline “From concept to completion”.

5.2.1 CIRUCUIT DIAGRAM IN PROTEUS

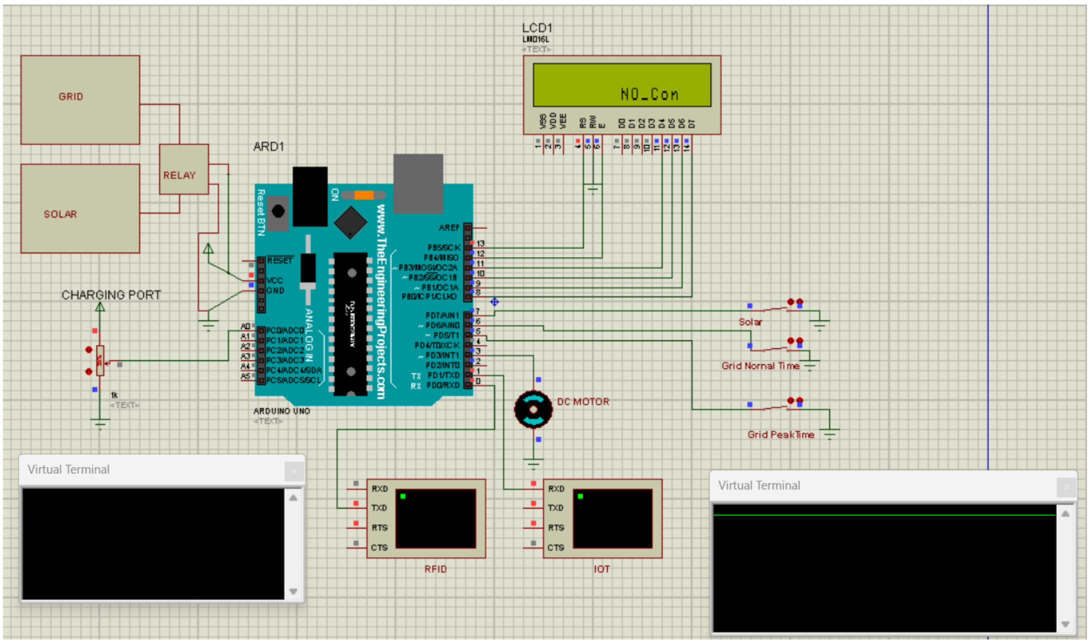

Fig.5.2 Circuit diagram of EV charging system

5.2.2 FEATURES

ISIS has wide range of components in its library. It has sources, signal generators, measurement and analysis tools like oscilloscope, voltmeter, ammeter etc., probes for real time monitoring of the parameters of the circuit, switches, displays, loads like motors and lamps, discrete components like resistors, capacitors, inductors, transformers, digital and analog Integrated circuits, semi-conductor switches, relays, microcontrollers, processors, sensors etc.

5.2.3 PRODUCT MODULES

The Proteus Design Suite is a Windows application for schematic capture, simulation, and PCB (Printed Circuit Board) layout design. It can be purchased in many configurations, depending on the size of designs being produced and the requirements for microcontroller simulation. All PCB Design products include an auto-router and basic mixed mode SPICE simulation capabilities.

5.2.4 MICROCONTROLLER SIMULATION

The micro-controller simulation in Proteus works by applying either a hex file or a debug file to the microcontroller part on the schematic. It is then co-simulated along with any analog and digital electronics connected to it. This enables its use in a broad spectrum of project prototyping in areas such as motor control, temperature control and user interface design. It also finds use in the general hobbyist community and, since no hardware is required, is convenient to use as a training or teaching tool. Support is available for co-simulation of:

- Microchip Technologies PIC10, PIC12, PIC16, PIC18, PIC24, dsPIC33 Microcontrollers.
- Atmel AVR (and Arduino), 8051 and ARM Cortex-M3 Microcontrollers
- NXP 8051, ARM7, ARM Cortex-M0 and ARM Cortex-M3 Microcontrollers.
- Texas Instruments MSP430, PICCOLO DSP and ARM Cortex-M3 Microcontrollers.
- Parallax Basic Stamp, Freescale HC11, 8086 Microcontrollers.

5.2.5 PROTEUS SIMULATIONS

Proteus's simulation feature. Many of the components in Proteus can be simulated. There are two options for simulating: Run simulator and advance frame by frame. The "Run simulator" option simulates the circuit in a normal speed (If the circuit is not heavy). "Advance frame by frame" option advances to next frame and waits till you click this button for the next time.

This can be useful for debugging digital circuits.You can also simulate microcontrollers. The microcontrollers which can be simulated include PIC24, dsPIC33, 8051, Arduino, ARM7 based microcontrollers. You can download the compilers for Proteus or use different compiler and dump the hex files in the microcontroller in Proteus. You can even interact in real-time with the simulation using switches, resistors, LDRs, etc. There are even virtual voltmeter, ammeter, oscilloscope, logic analyzer, etc.

5.2.6 ADVANTAGES OF PROTEUS ISIS PROFESSIONAL: -

1.It gives the proper idea and implementation of your code and circuit before implementing on hardware.

2. It reduces the time on creating hardware and testing your errors directly on hardware. You can analyses your circuit and code both on Proteus and find the errors encountering before implementing on hardware.

3. Reduces project cost and software dependency.

CHAPTER 6

HARDWARE MODULES

6.1 HARDWARE DETAILS:

- SOLAR PANEL
- GRID
- RELAY
- SWITCH
- BATTERY
- POWER SUPPLY
- ATMEGA328P MICROCONTROLLER
- RFID READER
- VOLTAGE SENSOR
- LCD
- NODEMCU
- MOTOR DRIVER
- DC MOTOR

6.2 HARDWARE DESCRIPTION

6.2.1 SOLAR PANEL

A solar panel is a set of solar photovoltaic modules electrically connected and mounted on a supporting structure. A photovoltaic module is a packaged, connected assembly of solar cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 320 watts. The efficiency of a module determines the area of a module given the same rated output - an 8% efficient 230 watt module will have twice the area of a 16% efficient 230 watt module. A single solar module can produce only a limited amount of power; most installations contain multiple modules. A photovoltaic system typically includes a panel or an array of solar modules, an inverter, and sometimes a battery and/or solar tracker and interconnection wiring.

6.2.1.1FIXED RACKS

Fixed racks hold modules stationary as the sun moves across the sky. The fixed rack sets the angle at which the module is held. Tilt angles equivalent to an installation's latitude are common. Most of these fixed racks are set on poles above ground.

6.2.1.2 GROUND MOUNTED

Ground mounted solar power systems consist of solar modules held in place by racks or frames that are attached to ground based mounting supports.

Ground based mounting supports include:

- Pole mounts, which are driven directly into the ground or embedded in concrete.
- Foundation mounts, such as concrete slabs or poured footings
- Ballasted footing mounts, such as concrete or steel bases that use weight to secure the solar module system in position and do not require ground penetration. This type of mounting system is well suited for sites where excavation is not possible such as capped landfills and simplifies decommissioning or relocation of solar module systems.

6.2.1.3 ROOF MOUNTING

Roof-mounted solar power systems consist of solar modules held in place by racks or frames attached to roof-based mounting supports.

Roof-based mounting supports include:

- Pole mounts, which are attached directly to the roof structure and may use additional rails for attaching the module racking or frames.
- Ballasted footing mounts, such as concrete or steel bases that use weight to secure the panel system in position and do not require through penetration. This mounting method allows for decommissioning or relocation of solar panel systems with no adverse effect on the roof structure.
- All wiring connecting adjacent solar modules to the energy harvesting equipment must be installed according to local electrical codes and should be run in a conduit appropriate for the climate conditions

6.2.2 GRID

The grid, in the context of this project, refers to the electrical power grid, a vast network of interconnected power generation, transmission, and distribution infrastructure. It serves as the backbone of our electrical supply system, enabling the transfer of electricity from power plants to homes, businesses, and various facilities. The grid plays a crucial role in supplying electricity to meet the demands of consumers. It encompasses power stations, substations, transformers, and high-voltage transmission lines that transport electricity over long distances.

Communal parking areas often rely on the grid as a primary source of electrical power.

The grid typically draws energy from various sources, including coal, natural gas, nuclear, and renewable energy. In this project, the grid serves as one of the two primary sources for charging electric vehicles, providing power when solar energy is insufficient. Additionally, the system incorporates a switch mechanism to adjust charging rates during peak-demand periods, helping to optimize grid usage and promote grid stability. In the grid forms an integral part of the proposed Smart Power Meter system, offering a reliable and accessible source of electricity to support sustainable transportation solutions.

6.2.3: 12V 5Ah BATTERY

6.2.3.1 BATTERY CHARGER

The rechargeable backup battery provides power to Finger Tec terminals when the primary source of power is unavailable. With the right backup battery, your system won’t have to be interrupted during a power failure. 12V1.5Ah Backup Battery Access Control System: The external Rechargeable Backup Batteries are almost always used in an access control system. The backup battery prevents intruders from disabling the access control by turning off power to the building, and continues locking the doors secured by the system. Time & Attendance System: For Time and Attendance System that records clocking-in and out data for employees, power failure might cause discrepancies in the payroll system. Thus, external rechargeable backup batteries are often used in Time & Attendance terminals as a backup power.

A battery charger is a device used to put energy into a cell or (rechargeable) battery by forcing an electric current through it. Lead-acid battery chargers typically have two tasks to accomplish. The first is to restore capacity, often as quickly as practical. The second is to maintain capacity by compensating for self-discharge. In both instances optimum operation requires accurate sensing of battery voltage. When a typical lead-acid cell is charged, lead sulphate is converted to lead on the battery’s negative plate and lead dioxide on the positive plate. Over-charge reactions begin when the majority of lead sulphate has been converted, typically resulting in the generation of hydrogen and oxygen gas. At moderate charge rates, most of the hydrogen and oxygen will recombine in sealed batteries. In unsealed batteries however, dehydration will occur.

Power capacity is how much energy is stored in the battery. This power is often expressed in Watt-hours (the symbol Wh). A Watt-hour is the voltage (V) that the battery provides multiplied by how much current (Amps) the battery can provide for some amount of time (generally in hours). Voltage * Amps * hours = Wh. Since voltage is pretty much fixed for a battery type due to its internal chemistry (alkaline, lithium, lead acid, etc.), often only the Amps*hour measurement is printed on the side, expressed in Ah or mAh (1000mAh = 1Ah). To get Wh, multiply the Ah by the nominal voltage. For example, let's say we have a 3V nominal battery with 1Amp-hour capacity, therefore it has 3 Wh of capacity. 1 Ah means that in theory we can draw 1 Amp of current for one hour, or 0.1A for 10 hours, or 0.01A (also known as 10 mA) for 100 hours. However, the amount of current we can really draw (the power capability) from a battery is often limited. For example, a coin cell that is rated for 1 Ah can't actually provide 1 Amp of current for an hour, in fact it can't even provide 0.1 Amp without overextending itself. It's like saying a human has the capability to travel up to 30 miles: of course, running 30 miles is a lot different than walking! Likewise, a 1Ah coin cell has no problem providing a 1mA for 1000 hours but if you try to draw 100mA from it, it'll last a lot less than 10 hours.

6.2.3.2 OPERATING INSTRUCTIONS

Once the connection instructions have been followed, plug-in AC power cord, the "POWER" Red (LED) will be on, the charger will begin charging automatically and the "CHARGING" Yellow (LED) will be on during charging. When the battery is fully charged the "CHARGING" Yellow (LED) will be off and the "FULL/FLOAT" Green (LED) will be on. Float Mode allows the charger to effectively be left connected to your batteries, over the course of a season, without overcharging your batteries and maintains your battery's full charge.

Specifications:

9.1 Input voltage: 120Vac 50/60Hz 0.4A Max.
9.2 Charging starting conditions: Battery not less than 5.5V
9.3 Rating output: 12Vdc 1.5A
9.4 Battery type: Lead-acid battery
9.5 Maximum charging voltage: 14.4V
9.6 Maintenance charging voltage: 13.2V~14.0V
9.7 Operating Environmental: -10~40℃, 90% RH Maximum
9.8 Weight: 0.62Lbs (0.28kg) approx.
9.9 Dimensions: L4.65" x W1.18" x H2.83" (L118 x W30 x H72mm)

REVERSE BATTERY / OUTPUT PROTECT CONDITION. The charger has reverse battery and output short circuit protection. If a reverse battery charger condition exists ("FAULT" Red L.E.D.) solid, while output leads are connected backwards), simply unplug charger from AC power and properly remake the connections as described in this manual.

Mounting the charger to vehicle:

The battery charger is mounted directly to the fender well of your vehicle as shown in figure -1. If using the nuts and bolts provided, drill two 1/8’’ holes in diameter. If the backside of the mounting surface is hard to reach, you may consider using two 1/2’’ long sheet-metal screws (not supplied) instead of the nuts and bolts provided.

Mounting the charger alongside the battery:

If more convenient to do so, as the following figure-2, using the mounting bracket (supplied) to mount the battery charger alongside of the battery. If possible, mount the charger to the side of the battery away from the engine and fan blades. Mount the bracket to the charger as shown, using the nuts and bolts provided. Loosen the battery retaining hardware enough that you can insert the bracket between the bottom of the battery and the battery mounting tray as shown. Position the charger so that it will not rub against the battery or any other part of the vehicle, and then tighten the battery retaining hardware.

MAINTENANCE Store in a clean and dry place; occasionally clean the case and cords with a dry cloth.

6.2.4 RELAY

A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. It was invented by Joseph Henry in 1835. Because a relay is able to control an output circuit of higher power than the input circuit, it can be considered to be, in a broad sense, a form of an electrical amplifier.

6.2.4.1 BASIC OPERATION:

A simple electromagnetic relay, such as the one taken from a car in the first picture, is an adaptation of an electromagnet. It consists of a coil of wire surrounding a soft iron core, an iron yoke, which provides a low reluctance path for magnetic flux, a moveable iron armature, and a set, or sets, of contacts; two in the relay pictured. The armature is hinged to the yoke and mechanically linked to a moving contact or contacts.

It is held in place by a spring so that when the relay is de-energized there is an air gap in the magnetic circuit. In this condition, one of the two sets of contacts in the relay pictured is closed, and the other set is open. Other relays may have more or fewer sets of contacts depending on their function. The relay in the picture also has a wire connecting the armature to the yoke. This ensures continuity of the circuit between the moving contacts on the armature, and the circuit track on the Printed Circuit Board (PCB) via the yoke, which is soldered to the PCB.

When an electric current is passed through the coil, the resulting magnetic field attracts the armature and the consequent movement of the movable contact or contacts either makes or breaks a connection with a fixed contact. If the set of contacts was closed when the relay was de-energized, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open.

When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position. Usually this force is provided by a spring, but gravity is also used commonly in industrial motor starters. Most relays are manufactured to operate quickly. In a low voltage application, this is to reduce noise. In a high voltage or high current application, this is to reduce arcing.

6.2.4.2 RELAY CONTACT CONDITIONS:

- **Normally Open Contact (NO)** – NO contact is also called a make contact. It closes the circuit when the relay is activated. It disconnects the circuit when the relay is inactive.

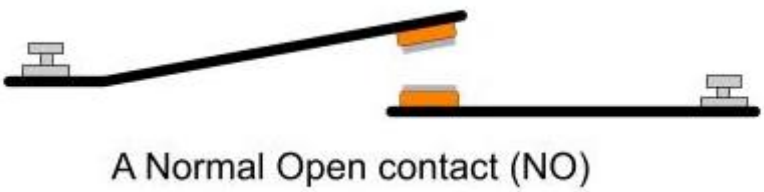

Fig.6.1: Normally Open Contact (NO)

- **Normally Closed Contact (NC)** – NC contact is also known as break contact. This is opposite to the NO contact. When the relay is activated, the circuit disconnects. When the relay is deactivated, the circuit connects.

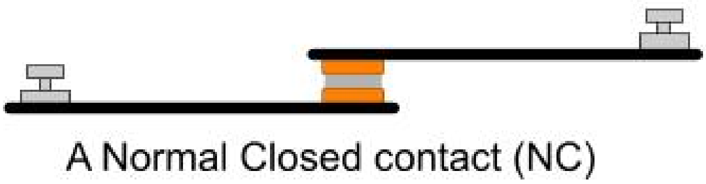

Fig.6.2: Normally Closed Contact (NC)

- **Change-over (CO) / Double-throw (DT) Contacts** – This type of contacts are used to control two types of circuits. They are used to control a NO contact and also a NC contact with a common terminal. According to their type they are called by the names **break before make** and **make before break** contacts.

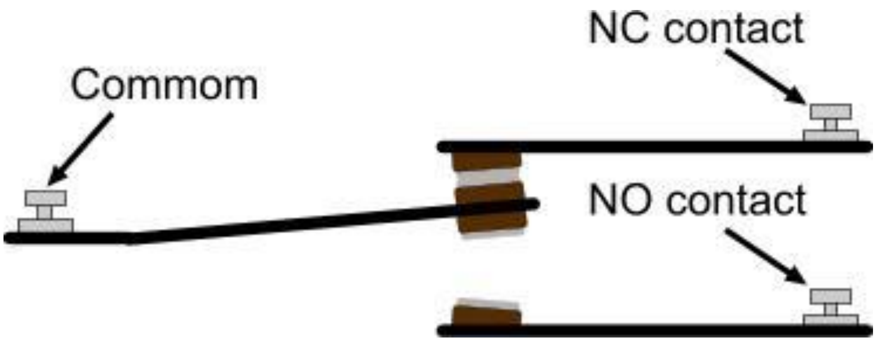

Fig.6.3: Relay Contacts

6.2.4.3 RELAY TYPES:

- **Single Pole Single Throw (SPST)** – This type of relay has a total of four terminals. Out of these two terminals can be connected or disconnected. The other two terminals are needed for the coil.
- **Single Pole Double Throw (SPDT)** – This type of a relay has a total of five terminals. Out f these two are the coil terminals. A common terminal is also included which connects to either of two others.
- **Double Pole Single Throw (DPST)** – This relay has a total of six terminals. These terminals are further divided into two pairs. Thus they can act as two SPST's which are actuated by a single coil. Out of the six terminals two of them are coil terminals.

- **Double Pole Double Throw (DPDT)** – This is the biggest of all. It has mainly eight relay terminals. Out of these two rows are designed to be change over terminals. They are designed to act as two SPDT relays which are actuated by a single coil.

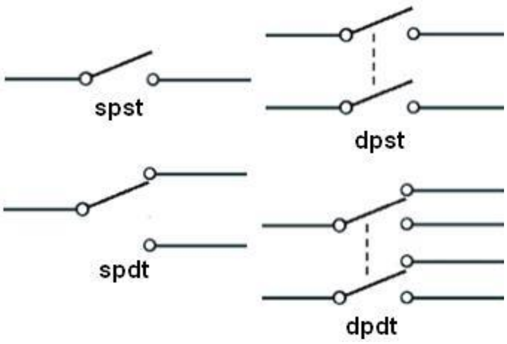

Fig.6.4: Relay Types

6.2.4.4 RELAY WORKING PRINCIPLE:

6.2.4.4.1 CONDITION I: RELAY IN ON STATE.

- Coil is energized.
- Contact becomes NO to NC position then load is activated.

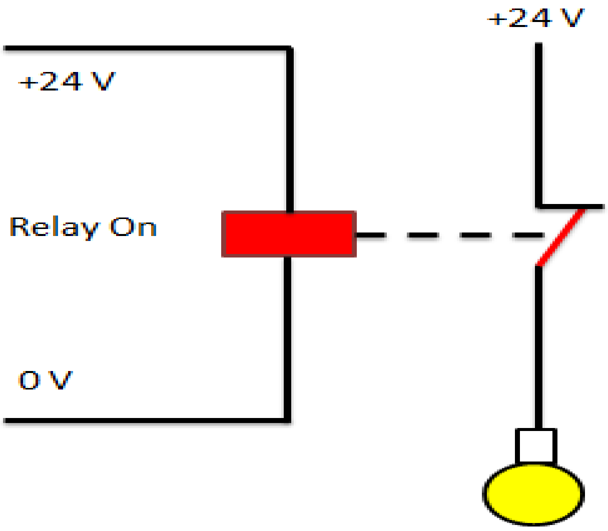

Fig.6.5: Relay ON State

6.2.4.4.2 CONDITION II: RELAY IN OFF STATE.

- Coil is de-energized.
- Contact in NC position then load is de activated.

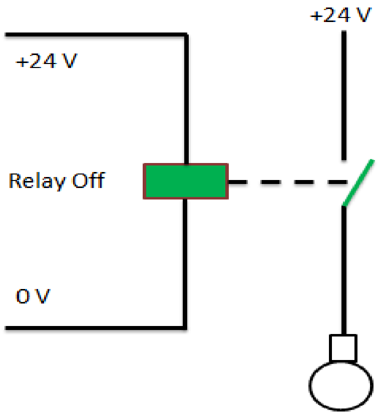

Fig.6.6: Relay in OFF State

6.2.4.4.3 RELAY CONNECTION CIRCUIT

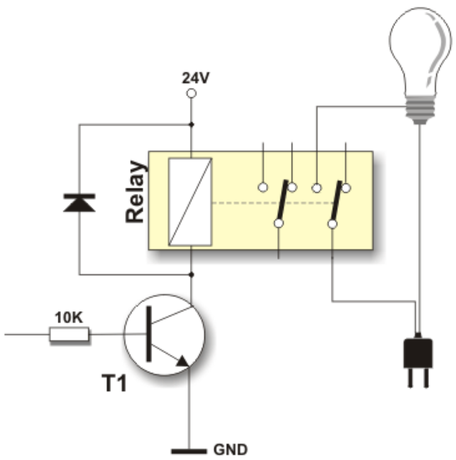

Fig.6.7: Relay Connection Circuit

6.2.4.5 RELAY SPECIFICATIONS

- Nominal Voltage (VDC): 12V
- Coil Resistance (Ω) (± 10%): 400Ω
- Power Consumption (W): 0.36 W
- Nominal Current (mA) (± 10%): 30 mA
- Pull in Voltage (VDC): 75% Max.
- Drop Out Voltage (VDC): 10% Min.
- Max. Allowable Voltage (VDC): 130%

6.2.4.6 RELAY APPLICATIONS

- Relays are used to realize logic functions. They play a very important role in providing safety critical logic.
- Relays are used to provide time delay functions. They are used to time the delay open and delay close of contacts.
- Relays are used to control high voltage circuits with the help of low voltage signals. Similarly they are used to control high current circuits with the help of low current signals.
- They are also used as protective relays. By this function all the faults during transmission and reception can be detected and isolated.

6.2.5 POWER SUPPLY CIRCUIT:

Power supply is a reference to a source of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others.

Power supplies for electronic devices can be broadly divided into linear and switching power supplies. The linear supply is a relatively simple design that becomes increasingly bulky and heavy for high current devices; voltage regulation in a linear supply can result in low efficiency. A switched-mode supply of the same rating as a linear supply will be smaller, is usually more efficient, but will be more complex.

6.2.5.1 LINEAR POWER SUPPLY:

An AC powered linear power supply usually uses a transformer to convert the voltage from the wall outlet (mains) to a different, usually a lower voltage. If it is used to produce DC, a rectifier is used. A capacitor is used to smooth the pulsating current from the rectifier. Some small periodic deviations from smooth direct current will remain, which is known as ripple. These pulsations occur at a frequency related to the AC power frequency (for example, a multiple of 50 or 60 Hz).

6.2.5.2 TRANSFORMER:

Transformers convert AC electricity from one voltag with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC. Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in UK) to a safer low voltage.

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core. Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up.

The ratio of the number of turns on each coil, called the turn's ratio, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.

6.2.5.3 BRIDGE RECTIFIER:

A bridge rectifier can be made using four individual diodes, but it is also available in special packages containing the four diodes required. It is called a full-wave rectifier because it uses the entire AC wave (both positive and negative sections). 1.4V is used up in the bridge rectifier because each diode uses 0.7V when conducting and there are always two diodes conducting, as shown in the diagram below. Bridge rectifiers are rated by the maximum current they can pass and the maximum reverse voltage they can withstand (this must be at least three times the supply RMS voltage so the rectifier can withstand the peak voltages). Please see the DIODES page for more details, including pictures of bridge rectifiers.

Alternate pairs of diodes conduct, changing over the connections so the alternating directions of AC are converted to the one direction of DC.

6.2.5.4 REGULATOR:

Voltage regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').

The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, Hi-Fi, and other solid state electronic equipment. Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and current.

Many of the fixed voltage regulator ICs has 3 leads and look like power transistors, such as the 7805 +5V 1A regulator shown on the right. They include a hole for attaching a heat sink if necessary.

1. Positive regulator
    1. input pin
    2. ground pin
    3. output pin

It regulates the positive voltage

2. Negative regulator
    1. ground pin
    2. input pin
    3. output pin

It regulates the negative voltage

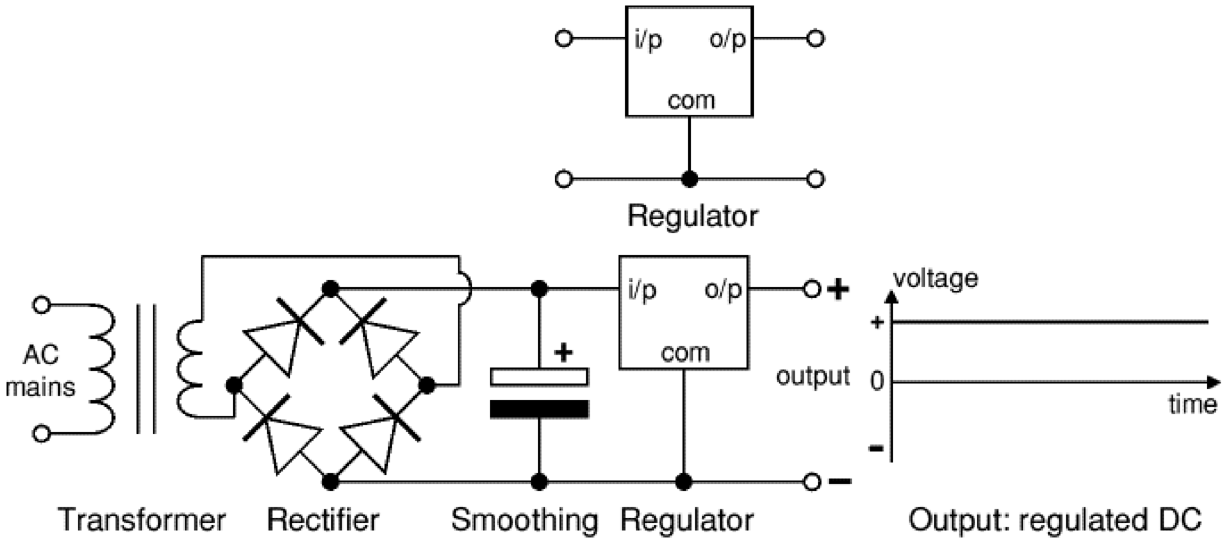

Fig.6.8: Regulator

The regulated DC output is very smooth with no ripple. It is suitable for all electronic circuits.

6.2.6 VOLTAGE SENSOR

This sensor is used to monitor, calculate and determine the voltage supply. This sensor can determine the AC or DC voltage level. The input of this sensor can be the voltage whereas the output is the switches, analog voltage signal, a current signal, an audible signal, etc. Some sensors provide sine waveforms or pulse waveforms like output & others can generate outputs like AM (Amplitude Modulation), PWM (Pulse Width Modulation) or FM (Frequency Modulation). The measurement of these sensors can depend on the voltage divider.

The applications of this sensor include the following:

- Detection of power failure
- Detecting of load
- Safety switching
- Controlling temperature
- Controlling of power demand
- Detection of fault
- Variation of load measurement of Temperature

6.2.7 ARDUINO UNO

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform. The ATmega328 on the Arduino Uno comes preprogrammed with a boot loader that allows uploading new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. The Uno also differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter

The Arduino project started at the Interaction Design Institute Ivrea (IDII) in Ivrea, Italy. At that time, the students used a BASIC Stamp microcontroller at a cost of $100, a considerable expense for many students. In 2003 Hernando Barragán created the development platform Wiring as a Master's thesis project at IDII, under the supervision of Massimo Banzi and Casey Reas, who are known for work on the Processing language. The project goal was to create simple, low-cost tools for creating digital projects by non-engineers. The Wiring platform consisted of a printed circuit board (PCB) with an ATmega168 microcontroller, an IDE based on Processing and library functions to easily program the microcontroller. In 2003, Massimo Banzi, with David Mellis, another IDII student, and David Cuartielles, added support for the cheaper ATmega8 microcontroller to Wiring. But instead of continuing the work on Wiring, they forked the project and renamed it Arduino. Early arduino boards used the FTDI USB-to-serial driver chip and an ATmega168. The Uno differed from all preceding boards by featuring the ATmega328P microcontroller and an ATmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

6.2.7.1 SPECIFICATION

- Microcontroller: Microchip ATmega328P
- Operating Voltage: 5 Volt
- Input Voltage: 7 to 20 Volts
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by boot loader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Length: 68.6 mm
- Width: 53.4 mm
- Weight: 25 g

6.2.7.2 COMMUNICATION

The Arduino/Genuino Uno has a number of facilities for communicating with a computer, another Arduino/Genuino board, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The 16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows serial communication on any of the Uno's digital pins

Fig.6.9: Arduino UNO

6.2.7.3 PINS GENERAL PIN FUNCTIONS

- **LED**: There is a built-in LED driven by digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
- **VIN**: The input voltage to the Arduino/Genuino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V**: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.
- **3V3**: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND**: Ground pins.
- **IOREF**: This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 3.3V.
- **Reset**: Typically used to add a reset button to shields which block the one on the board.

6.2.7.4 SPECIAL PIN FUNCTIONS

Each of the 14 digital pins and 6 Analog pins on the Uno can be used as an input or output, using pinMode (), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50k ohm. A maximum of 40mA is the value that must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller.

The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analog Reference() function.

In addition, some pins have specialized functions:

- **Serial** / UART: pins 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- **External Interrupts**: pins 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- **PWM** (**P**ulse **W**idth **M**odulation): 3, 5, 6, 9, 10, and 11 Can provide 8-bit PWM output with the analogWrite() function.
- **SPI** (**S**erial **P**eripheral **I**nterface): 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.
- **TWI** (**T**wo **W**ire **I**nterface) / I²C: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library.
- **AREF** (**A**nalog **REF** erence): Reference voltage for the analog inputs

6.2.8 RFID READER:

An RFID reader's function is to interrogate RFID tags. The means of interrogation is wireless and because the distance is relatively short; line of sight between the reader and tags is not necessary. A reader contains an RF module, which acts as both a transmitter and receiver of radio frequency signals. The transmitter consists of an oscillator to create the carrier frequency; a modulator to impinge data commands upon this carrier signal and an amplifier to boost the signal enough to awaken the tag. The receiver has a demodulator to extract the returned data and also contains an amplifier to strengthen the signal for processing. A microprocessor forms the control unit, which employs an operating system and memory to filter and store the data. The data is now ready to be sent to the network. RFID reader types are fixed, mobile or handheld units. Fixed readers are often used for large-scale deployments; installed in portals at dock doors and conveyor belts to capture inventory or for tracking parts, tools and equipment.

Fixed RFID readers require access to a grounded power source and usually connect to the network by cables such as RS-232, RJ-45 or USB. Mobile RFID readers come into play for hard to reach areas where it would be difficult to install a fixed reader. Their robustness is beneficial when it comes to mounting them on moving vehicles such as forklifts. When self-contained, with their own battery and antennas, their wireless communication allows them to connect to a network from a trolley or cart. Now you can bring hands free reading to the source. Handheld RFID readers are light, compact and ruggedly built to withstand being mishandled. By tethering a cable to the reader, you can assure yourself of having constant power and communication to the network. Because mobility is usually more important, most have wireless capability with integrated antennas and a rechargeable battery.

Radio-frequency identification (RFID) is the wireless use of electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects. The tags contain electronically stored information. Some tags are powered by electromagnetic from magnetic fields produced near the reader. Some types collect energy from the interrogating radio waves and act as a passive transponder.

6.2.8.1 RFID TAG:

An RFID tag is a microchip combined with an antenna in a compact package; the packaging is structured to allow the RFID tag to be attached to an object to be tracked. "RFID" stands for Radio Frequency Identification. The tag's antenna picks up signals from an RFID reader or scanner and then returns the signal, usually with some additional data (like a unique serial number or other customized information).RFID tags can be very small - the size of a large rice grain. Others may be the size of a small paperback book. A significant advantage of RFID devices over the others mentioned above is that the RFID device does not need to be positioned precisely relative to the scanner. We could just put all of your groceries or purchases in a bag, and set the bag on the scanner.

An RFID tag is an active tag when it is equipped with a battery that can be used as a partial or complete source of power for the tag's circuitry and antenna. Some active tags contain replaceable batteries for years of use; others are sealed units. (Note that It is also possible to connect the tag to an external power source.)

The major advantages of an active RFID tag are:

- It can be read at distances of one hundred feet or more, greatly improving the utility of the device
- It may have other sensors that can use electricity for power.

The problems and disadvantages of an active RFID tag are:

- The tag cannot function without battery power, which limits the lifetime of the tag.
- The tag is typically more expensive, often costing $20 or more each
- The tag is physically larger, which may limit applications.
- The long-term maintenance costs for an active RFID tag can be greater than those of a passive tag if the batteries are replaced.
- Battery outages in an active tag can result in expensive misreads.

Active RFID tags may have all or some of the following features:

- longest communication range of any tag
- the capability to perform independent monitoring and control
- the capability of initiating communications
- the capability of performing diagnostics
- the highest data bandwidth
- Active RFID tags may even be equipped with autonomous networking; the tags autonomously determine the best communication path.

The antenna in an RFID tag is a conductive element that permits the tag to exchange data with the reader. Passive RFID tags make use of a coiled antenna that can create a magnetic field using the energy provided by the reader's carrier signal.

6.2.9 LIQUID CRYSTAL DISPLAY

A liquid crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements. An LCD is a small low-cost display. It is easy to interface with a micro-controller because of an embedded controller (the black blob on the back of the board). This controller is standard across many displays (HD 44780) which means many micro-controllers (including the Arduino) have libraries that make displaying messages as easy as a single line of code.

LCDs are used in a wide range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, and signage. They are common in consumer devices such as video players, gaming devices, clocks, watches, calculators, and telephones, and have replaced cathode ray tube (CRT) displays in most applications. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they do not suffer image burn-in. LCDs are, however, susceptible to image persistence.

PinNo	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	V_{EE}
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight V_{CC} (5V)	Led+
16	Backlight Ground (0V)	Led-

Table.6.1: LCD Pin Details

6.2.10 NODE MCU

NodeMCU is an open-source firmware and development board designed for IoT applications. It utilizes the ESP8266 Wi-Fi SoC from Espressif Systems, and its hardware is based on the ESP12 module. The NodeMCU ESP8266 development board features the ESP-12E module, which houses the ESP8266 chip with a 32-bit LX106 RISC microprocessor. This microprocessor supports RTOS and operates at a clock frequency of 80MHz to 160MHz. NodeMCU has 128KB RAM and 4MB Flash memory for data and program storage

NODEMCU ESP8266 Specifications & Features

Microcontroller: Ten silica 32-bit RISC CPU Xtensa LX106

Operating Voltage: 3.3V

Input Voltage: 7-12V

Digital I/O Pins (DIO): 16

Analog Input Pins (ADC): 1

UARTs: 1

SPIs: 1 I2Cs: 1

Flash Memory: 4 MB

SRAM: 64 KB

Clock Speed: 80 MHz

USB-TTL based on CP2102 is included onboard, Enabling Plug n Play

PCB Antenna

Small Sized module to fit smartly inside your IoT projects

Pin Descriptions

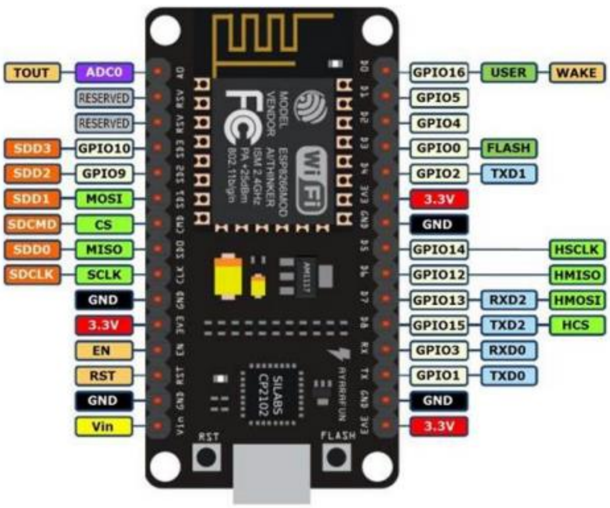

Fig.6.10: Esp8266 NODEMCU Pinout

Pin Category	Name	Description
Power	Micro-USB, 3.3V, GND, Vin	Micro-USB: NodeMCU can be powered through the USB port 3.3V: Regulated 3.3V can be supplied to this pin to power the board GND: Ground pins Vin: External Power Supply
Control Pins	EN, RST	The pin and the button reset the microcontroller
Analog Pin	A0	Used to measure analog voltage in the range of 0-3.3V
GPIO Pins	GPIO1 to GPIO16	NodeMCU has 16 general purpose input-output pins on its board
SPI Pins	SD1, CMD, SD0, CLK	NodeMCU has four pins available for SPI communication.
UART Pins	TXD0, RXD0, TXD2, RXD2	NodeMCU has two UART interfaces, UART0 (RXD0 & TXD0) and UART1 (RXD1 & TXD1). UART1 is used to upload the firmware/program.
I2C Pins		NodeMCU has I2C functionality support but due to the internal functionality of these pins, you have to find which pin is I2C.

Table.6.2: Pin Description Of NODEMCU

6.2.11 L293D –DC MOTOR DRIVER IC

We start with the L293D. L293D is a popular motor driving IC. It is a 16 pin IC. The IC has 8 pins on both the sides. It has 2 enable pins, 1 V_{SS} pin, 1 V_S pin, 4 ground pins, 4 input pins and 4 output pins. Though not required here, but in case you wish to learn how to interface L293D with a microcontroller.

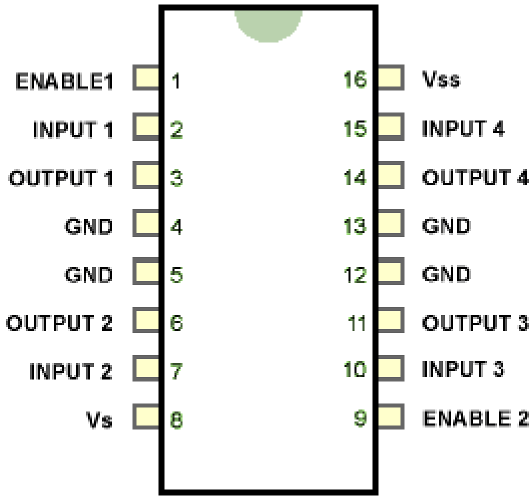

Fig.6.11: L293D Pin Configuration

PIN DESCRIPTIONS

Enable – the enable pins, when are given **true,** (i.e. 1) then they enable the respective part of the IC. The enable 1 chip enables the Left part of the IC for inputs and outputs, and so does the Enable 2 does to the right part of the IC.

1. **V_{SS}** – this pin is to be given an input of 5 volts. This is used to power up the chip for its operations.
2. **V_S** – this pin is given the voltage that we have to supply to the motors. This voltage comes out through the output pins. Due to the gates used in the IC, the output is usually 1.8 to 2 volts less than the V_s.
3. **Input** – the input pin decides whether output has to be given to he respective output pin or not. When the Input is true, then output is also 1in the respective output pin. When input in the Input pin is 0, and then output in the respective output pin is also 0.
4. **Output** – the output pin is connected to the terminals of the motor. The input pins, as stated above, control its output.
5. **GND –** these pins are the ground pins, or, in other words, Zero.

The L293D IC can be used to control a maximum of 4 motors simultaneously. When 4 motors are connected to the IC, then for operation, -ve of each of the motors is connected to the **GND,** and the +ve terminal to the **output**s. For bidirectional control, you can connect only two motors simultaneously as per the circuit diagram below:

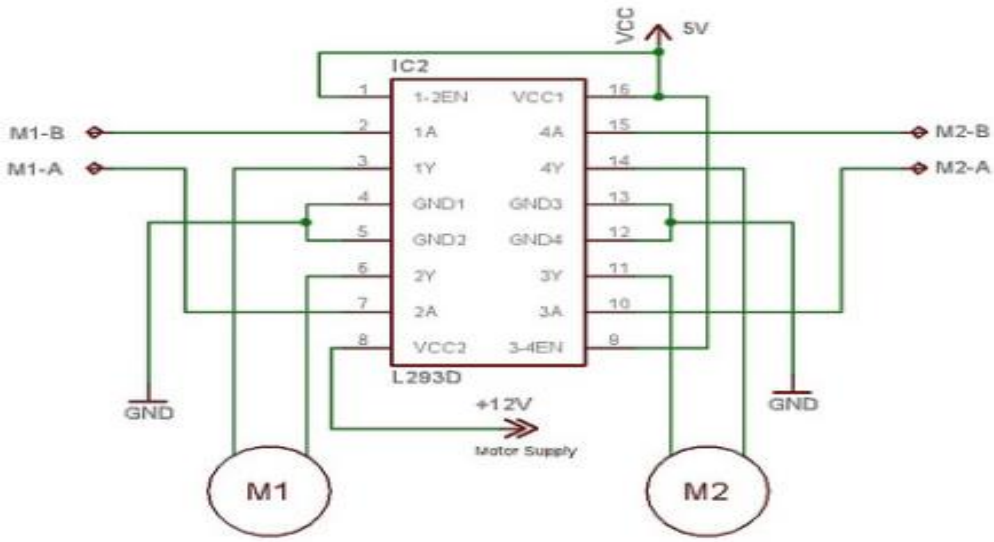

Fig.6.12: L293D Based Motor Driver

6.2.12 DC MOTOR

A DC motor is a mechanically commutated electric motor powered from direct current (DC). The stator is stationary in space by definition and therefore the current in the rotor is switched by the commutator to also be stationary in space. This is how the relative angle between the stator and rotor magnetic flux is maintained near 90 degrees, which generates the maximum torque.DC motors have a rotating armature winding (winding in which a voltage is induced) but non-rotating armature magnetic field and a static field winding (winding that produce the main magnetic flux) or permanent magnet. Different connections of the field and armature winding provide different inherent speed/torque regulation characteristics. The speed of a DC motor can be controlled by changing the voltage applied to the armature or by changing the field current.

An Electric DC motor is a machine which converts electric energy into mechanical energy. The working of DC motor is based on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a mechanical force. The direction of mechanical force is given by **Fleming's Left-hand Rule** and its magnitude is given by F = BIL Newton.

WORKING OF DC MOTOR

Consider a part of a multipolar d.c. motor as shown in Figure below. When the terminals of the motor are connected to an external source of d.c. supply:

1. The field magnets are excited developing alternate N and S poles
2. The armature conductors carry currents.

All conductors under N-pole carry currents in one direction while all the conductors under S-pole carry currents in the opposite direction.

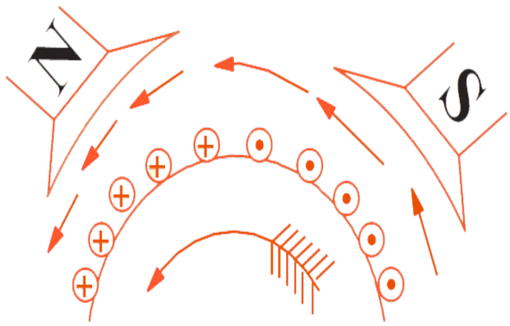

Fig.6.13: Multipolar D.C. Motor

Suppose the conductors under N-pole carry currents into the plane of the paper and those under S-pole carry currents out of the plane of the paper as shown in Figure.

Since each armature conductor is carrying current and is placed in the magnetic field, mechanical force acts on it. On applying Fleming's left-hand rule, it is clear that force on each conductor is tending to rotate the armature in anticlockwise direction. All these forces add together to produce a driving torque which sets the armature rotating. When the conductor moves from one side of a brush to the other, the current in that conductor is reversed and at the same time it comes under the influence of next pole which is of opposite polarity. Consequently, the direction of force on the conductor remains the same.

It should be noted that the function of a commutator in the motor is the same as in a generator. By reversing current in each conductor as it passes from one pole to another, it helps to develop a continuous and unidirectional torque.

RESULT

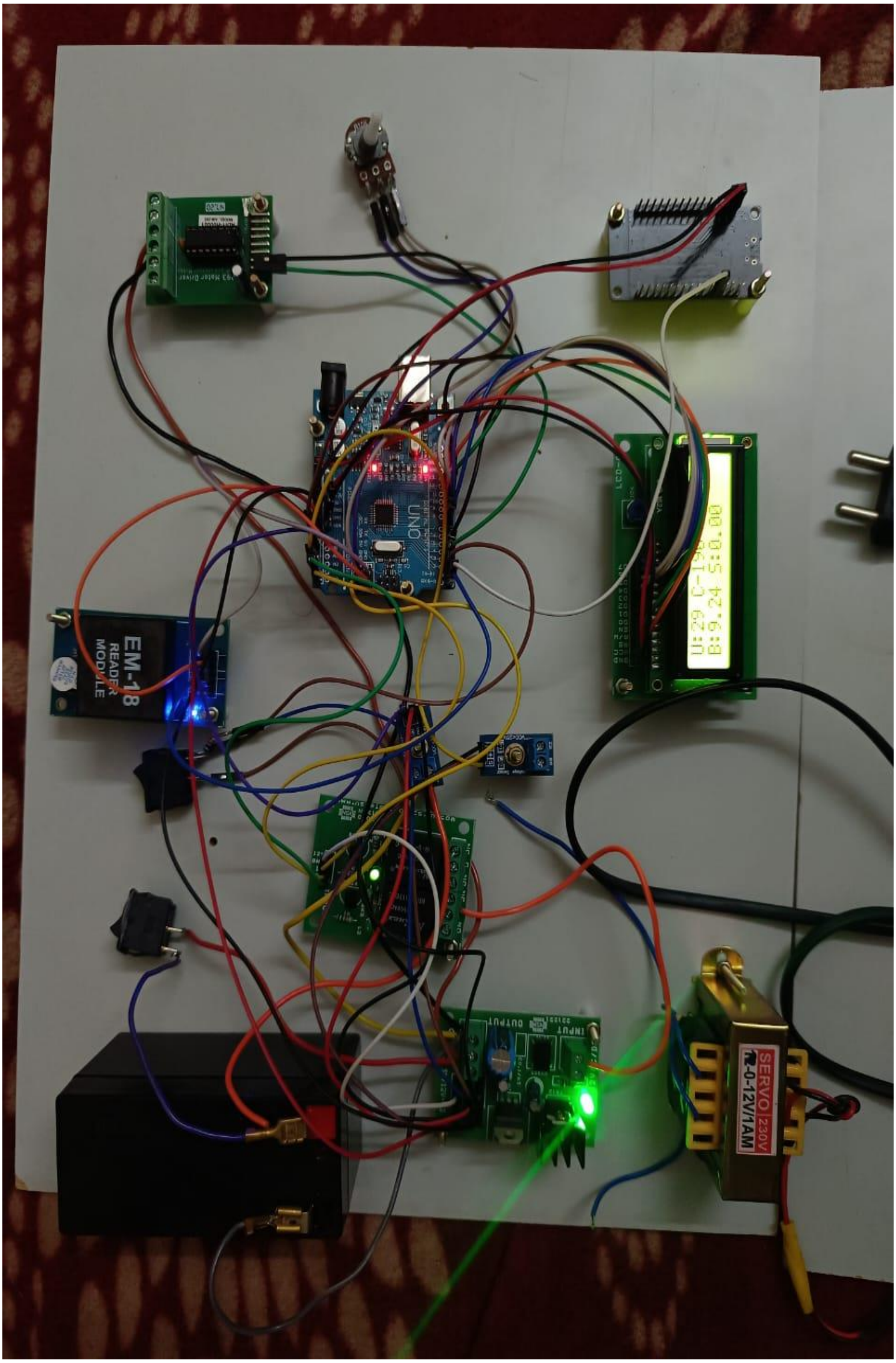

Fig.6.14 Hardware setup of Proposed methodology

CONCLUSION

In conclusion, the Electric Vehicle (EV) Charging in communal parking areas represents a significant advancement in sustainable transportation infrastructure. By intelligently integrating solar and grid power sources, monitoring voltage levels, streamlining payments, and incorporating Internet of Things (IoT) capabilities, this system offers an efficient and environmentally conscious solution for EV charging. The dynamic dual-source strategy prioritizes solar energy, harnessing the power of the sun when available, and seamlessly transitioning to the grid as needed. This not only optimizes charging costs but also significantly reduces the environmental footprint associated with EV charging.

The switch mechanism for peak-time pricing promotes responsible energy consumption, contributing to grid stability during periods of high demand. Additionally, the relay-driven system and solar-to-battery connection provide redundancy, ensuring uninterrupted charging availability even in the event of solar or grid outages. With IoT capabilities, the system enables remote monitoring, centralized management, and data-driven insights, paving the way for future optimizations and innovations in sustainable transportation solutions.

In this project sets a new standard for efficiency, convenience, and environmental responsibility in communal parking areas. It not only addresses the pressing need for sustainable transportation solutions but also serves as a blueprint for future advancements in EV charging infrastructure. By promoting accessibility to EV charging and reducing reliance on conventional vehicles, this Smart Power Meter contributes to a more sustainable and environmentally conscious urban transportation ecosystem. Advanced Energy Storage Integration: Incorporate advanced energy storage solutions like lithium-ion batteries or other emerging technologies to further optimize energy usage and provide a more reliable power supply during periods of low solar output or grid outages.

Dynamic Load Management: Implement intelligent load management algorithms to distribute available power more efficiently among multiple EVs, ensuring equitable charging rates and minimizing grid strain.

Vehicle-to-Grid (V2G) Integration: Explore the potential for bidirectional energy flow, allowing EVs to discharge energy back to the grid during peak demand periods, providing valuable grid services and potentially earning revenue for vehicle owners.

Predictive Charging: Utilize machine learning algorithms to predict solar energy availability and grid demand, enabling the system to proactively optimize charging schedules for cost savings and grid stability.

Demand Response Integration: Integrate with demand response programs, allowing the system to participate in grid-balancing initiatives and earn incentives for adjusting charging rates during high-demand periods.

Enhanced User Interface and Mobile App: Develop an intuitive mobile application to allow users to remotely monitor and control their charging sessions, view historical data, and receive notifications about charging status and cost updates.

Energy Source Prioritization: Introduce a feature that allows users to set preferences for power source utilization (e.g., prioritize solar over grid, or vice versa) based on individual preferences or cost considerations.

Energy Trading and Peer-to-Peer Transactions: Explore the possibility of allowing users to engage in energy trading, enabling surplus energy from solar sources to be shared or sold to neighboring EV owners.

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