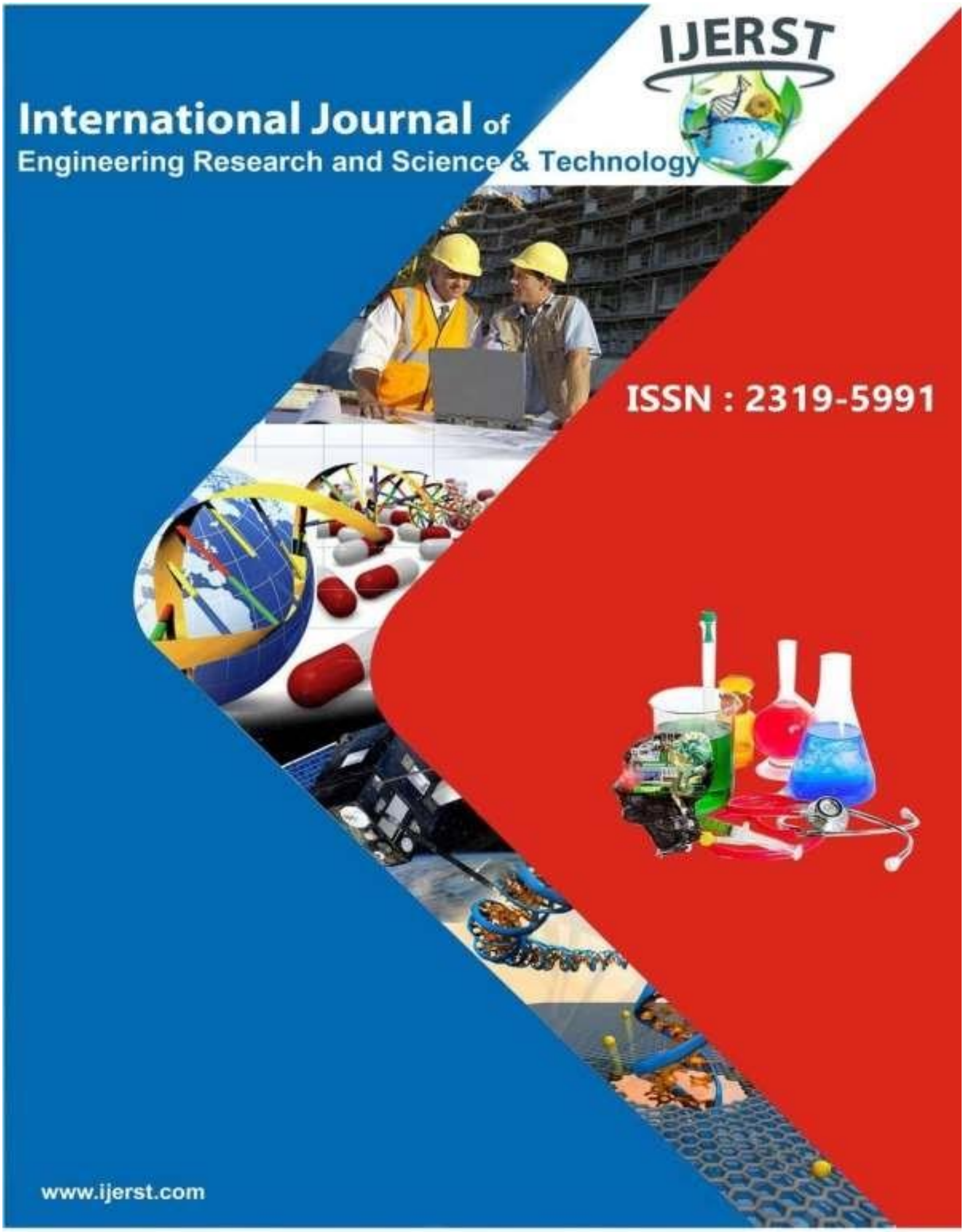

Email: editor@ijerst.com or editor.ijerst@gmail.com

ISSN 2319-5991 www.ijerst.com
Vol. 17, Issue.2, April 2024

ESTABLISHING COMMUNICATION LINK BETWEEN ELECTRIC VEHICLE AND NEARBY CHARGING STATION

[1]Mrs. M.V. SUSHUMNA, [2]A NAVAKANTH REDDY, [3]A RAHUL, [4]B SAI TEJA, [5]D VAISHNAVI
[1]ASSOCIATE PROFESSOR ,[2345]B.Tech Students,

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

TEEGALA KRISHNA REDDY ENGINEERING COLLEGE

ABSTRACT
As the demand for electric vehicles (EVs) continues to rise, efficient and reliable communication between EVs and charging stations becomes essential. This project presents an innovative solution for "Establishing Communication Link between Electric Vehicle and Nearby Charging Station" utilizing the NodeMCU ESP-NOW protocol. The aim is to facilitate seamless interaction and data exchange between EVs and charging infrastructure. The NodeMCU ESP-NOW protocol offers a low-power, short-range communication method that is well-suited for establishing direct links between devices. In this project, the EV is equipped with a NodeMCU module, while the nearby charging station is also equipped with a NodeMCU module. These modules establish a robust and secure communication link, enabling real-time data exchange. The communication link supports various functionalities, including transmitting EV battery status, charging requirements, and availability of charging slots. EV drivers can receive immediate updates on charging station availability and make informed decisions regarding their charging needs. Charging stations can optimize their operations based on real-time data, ensuring efficient resource utilization. By harnessing the capabilities of NodeMCU ESP-NOW, this project showcases the potential of direct device-to-device communication in the context of EV charging infrastructure. The solution enhances user convenience, reduces waiting times, and contributes to the development of smart and connected charging networks.

INTRODUCTION

The growing concern regarding fossil fuel depletion and environmental pollution significantly impacts transportation systems, thereby leading to the gradual shift from conventional internal combustion engine (ICE)-based vehicles toward more environmentally friendly solutions. Electric vehicles (EVs) have been receiving considerable attention as an eco-friendly alternative transportation solution to reduce air pollution and conserve energy. However, the large-scale adoption of EVs is still limited due to the significantly longer recharging time compared to the refueling time of ICE vehicles, the limited driving range restricted by the EV battery capacity, and the higher initial investment costs due to the relatively higher EV purchase prices compared to their fuel-operated counterparts.

In fact, efforts to reduce range anxiety by increasing EV battery capacity further contribute to higher EV purchase prices and discourage mass adoption of EVs. Nevertheless, according to the total cost of operation (TCO) of EVs can be lower than that of diesel and gasoline operated vehicles when acknowledging factors such as the higher efficiency of EV motors and the comparatively lower cost of electricity, particularly with the utilization of renewable energy sources and smart grids. Furthermore, the increasing deployments of EV charging infrastructures as well as the government subsidies and other incentive-based green energy programs all motivate the adoption of EVs.

In the dynamic landscape of modern transportation, the integration of electric vehicles (EVs) has emerged as a pivotal solution in addressing environmental concerns and advancing sustainable

ISSN 2319-5991 www.ijerst.com

Vol. 17, Issue.2, April 2024

mobility. As the demand for cleaner and more energy-efficient transportation options continues to grow, the seamless communication between electric vehicles and nearby charging stations becomes paramount. This imperative connection forms the bedrock of an efficient and user-friendly EV charging infrastructure.

The introduction of a robust communication link between electric vehicles and nearby charging stations represents a significant leap forward in optimizing the charging process. This technology not only enhances the convenience for EV users but also plays a crucial role in maximizing the utilization and efficiency of charging station networks. By establishing a reliable communication channel, EVs can interact with charging stations in real-time, allowing for dynamic adjustments to charging protocols, personalized user experiences, and improved grid management.

This intersection of electric vehicle technology and charging infrastructure signifies a transformative era in sustainable transportation. As we delve into the intricacies of establishing a communication link between EVs and charging stations, we unlock the potential to create a seamlessly connected ecosystem that empowers users, promotes energy efficiency, and propels us towards a cleaner, greener future of mobility.

II.LITERATURE SURVEY

A literature survey on establishing communication links between electric vehicles (EVs) and nearby charging stations reveals a diverse range of research efforts aimed at enhancing the efficiency, reliability, and interoperability of EV charging infrastructure. Several studies have focused on developing communication protocols and standards to facilitate seamless interaction between EVs and charging stations. Research has explored the use of standard communication protocols such as ISO 15118 and Open Charge Point Protocol (OCPP) for enabling bidirectional communication between EVs and charging infrastructure. Additionally, novel communication protocols based on blockchain technology have been proposed to ensure secure and tamper-proof data exchange between EVs and charging stations.

Vehicle-to-Grid (V2G) communication enables EVs to not only receive power from charging stations but also to feed excess energy back into the grid, thereby providing grid services and revenue opportunities. Pioneering research has demonstrated the potential of V2G communication to enhance grid stability and support renewable energy integration. Further studies have explored the technical and economic aspects of V2G communication, highlighting its benefits for both EV owners and grid operators. Wireless charging technologies, such as inductive power transfer (IPT), offer convenience and flexibility for EV charging by eliminating the need for physical plugs and cables. Research has investigated the communication requirements for wireless EV charging systems, emphasizing the importance of real-time data exchange between vehicles and charging infrastructure to optimize charging efficiency. Additionally, novel communication-assisted IPT systems have been proposed, enabling dynamic power control and automatic alignment between the vehicle and charging pad.

Integrating EV charging with smart grid technologies allows for dynamic control of charging patterns based on grid conditions, electricity prices, and renewable energy availability. Studies have explored the use of demand response strategies to coordinate EV charging schedules and alleviate grid congestion during peak demand periods. Furthermore, the role of vehicle-to-home (V2H) communication has been investigated in enabling bidirectional energy flow between EVs and residential energy systems, enhancing energy resilience and cost savings for consumers. Ensuring the security and privacy of communication between EVs and charging stations is paramount to safeguarding against cyber threats

International Journal of Engineering Research and Science & Technology

ISSN 2319-5991 www.ijerst.com

Vol. 17, Issue.2, April 2024

and unauthorized access. Research has addressed cybersecurity challenges in EV charging infrastructure, proposing encryption techniques and authentication mechanisms to protect sensitive data and prevent cyber attacks. Techniques such as differential privacy and secure multiparty computation have been employed to enhance privacy in V2G communication, anonymizing user data while preserving data utility. In conclusion, the literature survey highlights the multidisciplinary nature of research on establishing communication links between electric vehicles and nearby charging stations, encompassing technical, regulatory, economic, and cybersecurity considerations. While significant progress has been made in developing communication protocols, wireless charging technologies, and smart grid integration strategies, further research is needed to address remaining challenges and accelerate the deployment of reliable, interoperable, and secure EV charging infrastructure.

III.ESTABLISHING COMMUNICATION LINK BETWEEN ELECTRIC VEHICLE AND NEARBY CHARGING STATION

3.1 Introduction To Proposed System:

The proposed system envisions the establishment of a sophisticated communication link between electric vehicles (EVs) and nearby charging stations, addressing the evolving demands of the electric vehicle market. At the core of this innovation are IoT-enabled charging stations equipped with sensors that provide real-time monitoring of station status, availability, and performance. These charging stations integrate RFID or NFC technology for user authentication, ensuring both security and convenience in the charging process.

To facilitate seamless interaction between electric vehicles and charging stations, bidirectional communication capabilities will be embedded in the EVs. This communication allows for the exchange of real-time data, enabling users to stay informed about their vehicle's status, charging requirements, and transaction details. Users can initiate charging requests through the vehicle interface, providing a user-friendly and efficient means of accessing the charging infrastructure.

A centralized management system, hosted on a cloud-based platform, acts as the nerve center of this communication network. This system oversees the coordination of information flow between electric vehicles and charging stations. It employs advanced data analytics to process historical data, predict charging demand, and optimize charging station utilization. This intelligent management contributes to efficient energy distribution and load balancing within the charging infrastructure.

To further enhance user experience, a dedicated mobile application interface is developed. This user-friendly app empowers electric vehicle owners to effortlessly locate nearby charging stations, check real-time availability, and initiate or schedule charging sessions remotely. Seamless transactions are ensured through the integration of secure payment gateways within the application, streamlining the entire charging process.

The proposed system also incorporates dynamic scheduling and pricing mechanisms. AI-driven algorithms dynamically schedule charging sessions based on demand patterns, optimizing the overall efficiency of the charging infrastructure. To incentivize off-peak charging and alleviate strain on the power grid, the system implements dynamic pricing models that offer users cost advantages for charging during periods of lower demand.

In summary, the envisioned communication link between electric vehicles and charging stations represents a leap forward in the evolution of electric vehicle charging infrastructure. Through the integration of IoT, cloud-based management, user-friendly interfaces, and intelligent algorithms, this

ISSN 2319-5991 www.ijerst.com
Vol. 17, Issue.2, April 2024

system aims to provide an efficient, user-centric, and environmentally sustainable solution to the challenges posed by the increasing adoption of electric vehicles.

3.2 Block Diagram

Here is the combined Block Diagram of Establishing Communication Link Between Electric Vehicle and Nearby Charging Station

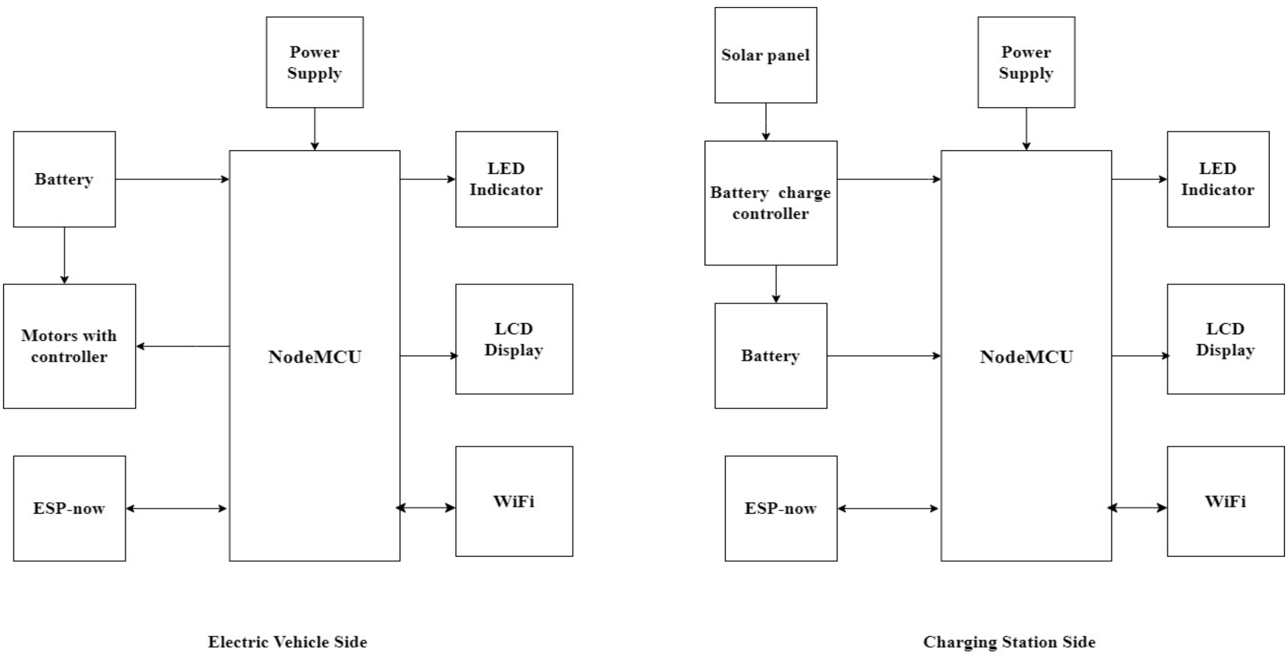

Fig 3.1: Block diagram

NodeMCU:

NodeMCU is an open-source firmware and development kit that helps in building IoT (Internet of Things) applications. It is based on the ESP8266 Wi-Fi module, which is a low-cost Wi-Fi module developed by Espressif Systems, a company based in Shanghai, China. The ESP8266 module allows for wireless communication and is widely used for IoT projects due to its affordability and ease of use.

ISSN 2319-5991 www.ijerst.com
Vol. 17, Issue.2, April 2024

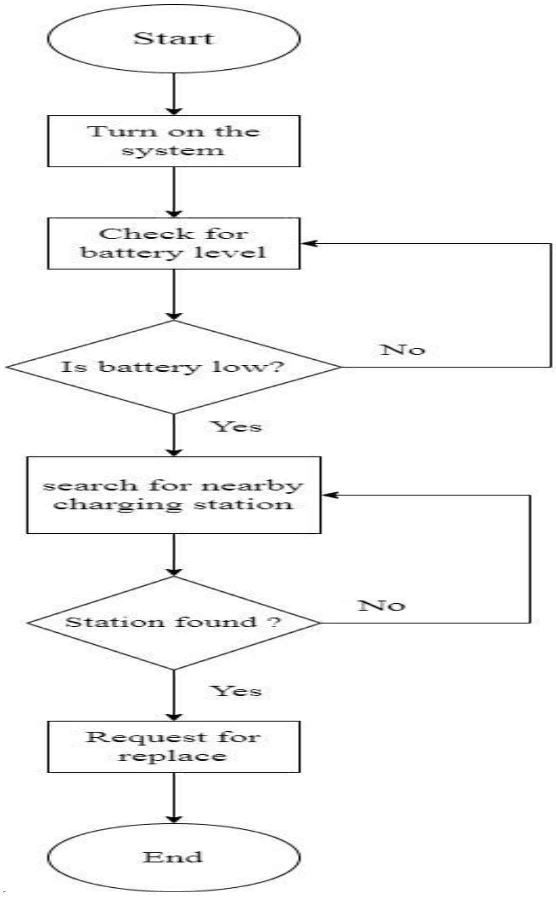

Fig 3.2: Flow Chart

This flow indicates that if the battery is low, the system searches for a charging station. If a station is found, the user is prompted to replace the battery before concluding the process.

Comparison Between Existing System and Proposed System:

The existing methods of establishing a communication link between electric vehicles (EVs) and nearby charging stations have primarily relied on traditional technologies such as RFID (Radio-Frequency Identification) and NFC (Near Field Communication). In these conventional methods, EV owners typically use physical cards or key fobs embedded with RFID or NFC tags to authenticate themselves at charging stations. While these methods have been functional, they often lack the flexibility and user-friendliness that modern technologies can offer. The proposed systems, on the other hand, introduce advancements such as mobile applications and cloud-based platforms for user authentication. This not only enhances the security of the communication link but also provides EV owners with more convenient and versatile means to initiate and monitor charging sessions.

Moreover, in the existing methods, communication protocols for EV charging, such as OCPP (Open Charge Point Protocol), have been widely adopted. While these protocols have standardized communication between charging stations and electric vehicles, the proposed systems seek to refine and optimize these protocols further. They integrate advanced features like predictive analytics, dynamic scheduling, and artificial intelligence to enhance the efficiency of the charging process. By

ISSN 2319-5991 www.ijerst.com

Vol. 17, Issue.2, April 2024

leveraging real-time data and historical usage patterns, the proposed systems can dynamically adjust charging rates, optimize energy distribution, and incentivize off-peak charging, contributing to a more intelligent and sustainable charging infrastructure.

In terms of user interaction, existing methods often rely on basic user interfaces at charging stations or limited mobile apps. The proposed systems, however, introduce more sophisticated and user-centric mobile applications. These applications offer a holistic user experience, allowing EV owners to not only initiate and monitor charging sessions remotely but also access features like locating nearby charging stations, checking real-time availability, and seamlessly processing secure payments. The proposed systems prioritize user convenience and aim to streamline the entire charging experience, promoting widespread adoption of electric vehicles.

Furthermore, in the existing methods, the negotiation of charging parameters such as power and voltage is typically a static process, with limited adaptability to real-time conditions. In contrast, the proposed systems incorporate dynamic scheduling and pricing mechanisms. They utilize artificial intelligence algorithms to predict charging demand, optimizing the utilization of charging infrastructure based on fluctuating patterns. This dynamic approach enhances the proposed systems' ability to balance the load on the power grid, incentivize efficient charging behavior, and contribute to the overall stability of the electric grid.

Existing methods have laid the groundwork for establishing communication links between electric vehicles and charging stations, proposed systems introduce innovative technologies and features to elevate the efficiency, security, and user experience of the entire charging process. The shift towards mobile applications, cloud-based platforms, and intelligent algorithms signifies a promising evolution in the realm of electric vehicle charging infrastructure.

To provide a meaningful comparison between an existing system and a proposed system for establishing a communication link between an electric vehicle (EV) and a nearby charging station, we need to consider various factors. Below are some key aspects to compare:

Aspect	**Existing Method**	**Proposed Method**
Communication Protocol	Standardized protocols like OCPP	Enhanced or alternative protocols for efficiency
Communication Medium	Wired connections (RFID cards, plugs/cables)	Exploration of wireless technologies (Bluetooth, Wi-Fi, cellular)
Data Transfer Speed	Varies based on protocol and connection type	Aim to increase data transfer speed for faster charging
Security	Encryption, authentication	Advances in security measures for enhanced protection
Interoperability	Standardized protocols promote interoperability	Continued emphasis on interoperability for diverse EV models

ISSN 2319-5991 www.ijerst.com
Vol. 17, Issue.2, April 2024

User Experience	Relies on physical actions (plugging, card insertion)	Aim for seamless and user-friendly experiences (e.g., wireless)
Scalability	Scalable to an extent with current infrastructure	Solutions that can accommodate a growing number of EVs
Flexibility	Limited flexibility with wired connections	Greater flexibility with wireless technologies
Maintenance Requirements	Regular maintenance of physical connectors	Potentially reduced maintenance with wireless systems
Cost Implications	Costs associated with physical connectors and cables	May incur costs for upgrading to wireless technologies
Reliability	Generally reliable, but can be affected by physical wear	Aims for enhanced reliability and robustness

Table 3.1: Comparison Between Existing & Proposed system

IV.HARDWARE DESCRIPTION

As in below figure this circuit is an approach to obtain both 12V and 5V DC power supply. The circuit uses two ICs 7812(IC1) and 7805 (IC2) for obtaining the required voltages. The AC mains voltage will be stepped down by the transformer T1, rectified by filtered by capacitor C1 to obtain a steady DC level. The IC1 regulates this voltage to bridge B1 and obtain a steady 12V DC. The output of the IC1 will be regulated by the IC2 to obtain a steady 5V DC at its output. In this way both 12V and 5V DC are obtained. Such a circuit is very useful in cases when we need two DC voltages for the operation of a circuit. The LM78XX series of three terminal positive regulators are available in the TO-220 package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shut down and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents. The power supply section is the section which provide +5V for the components to work. IC LM7805 is used for providing a constant power of +5V.

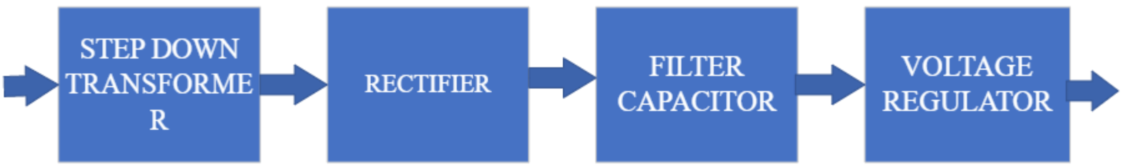

Fig 4.1 Regulated Power Supply

The NodeMCU (Node MicroController Unit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266.

ISSN 2319-5991 www.ijerst.com
Vol. 17, Issue.2, April 2024

The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (WiFi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds.

However, as a chip, the ESP8266 is also hard to access and use. You must solder wires, with the appropriate analog voltage, to its pins for the simplest tasks such as powering it on or sending a keystroke to the "computer" on the chip. You also have to program it in low-level machine instructions that can be interpreted by the chip hardware. This level of integration is not a problem using the ESP8266 as an embedded controller chip in mass-produced electronics. It is a huge burden for hobbyists, hackers, or students who want to experiment with it in their own IoT projects.

But, what about Arduino? The Arduino project created an open-source hardware design and software SDK for their versatile IoT controller. Similar to NodeMCU, the Arduino hardware is a microcontroller board with a USB connector, LED lights, and standard data pins. It also defines standard interfaces to interact with sensors or other boards. But unlike NodeMCU, the Arduino board can have different types of CPU chips (typically an ARM or Intel x86 chip) with memory chips, and a variety of programming environments. There is an Arduino reference design for the ESP8266 chip as well. However, the flexibility of Arduino also means significant variations across different vendors. For example, most Arduino boards do not have WiFi capabilities, and some even have a serial data port instead of a USB port.

The lithium-ion (Li-ion) battery is the predominant commercial form of rechargeable battery, widely used in portable electronics and electrified transportation. The rechargeable battery was invented in 1859 with a lead-acid chemistry that is still used in car batteries that start internal combustion engines, while the research underpinning the Li-ion battery was published in the 1970s and the first commercial Li-ion cell was made available in 1991. In 2019, John B. Goodenough, M. Stanley Whittingham, and Akira Yoshino received the Nobel Prize in Chemistry for their contributions to the development of the modern Li-ion battery.

Fig 4.6: Lithium Ion Battery

4.1 LCD:

Alphanumeric displays are used in a wide range of applications, including palmtop computers, word processors, photocopiers, point of sale terminals, medical instruments, cellular phones, etc. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. A full list of the characters and symbols is printed on pages 7/8 (note these symbols can vary between brand of LCD used). This booklet provides all the technical specifications for connecting the unit, which requires a single power supply (+5V).

ISSN 2319-5991 www.ijerst.com
Vol. 17, Issue.2, April 2024

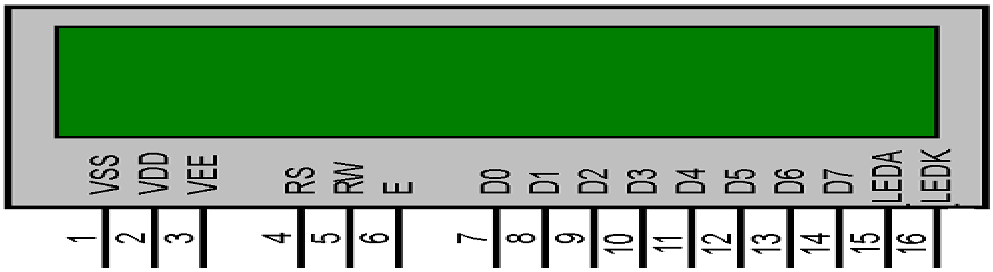

Fig 4.9 16x2 LCD Display

V.RESULTS

Traditional communication methods between EVs and charging stations may not provide real-time updates and can result in longer waiting times. This project presents an innovative solution for "Establishing Communication Link between Electric Vehicle and Nearby Charging Station" utilizing the NodeMCU ESP-NOW protocol. The aim is to facilitate seamless interaction and data exchange between EVs and charging infrastructure. The NodeMCU ESP-NOW protocol offers a low-power, short-range communication method that is well-suited for establishing direct links between devices. In this project, the EV is equipped with a NodeMCU module, while the nearby charging station is also equipped with a NodeMCU module. These modules establish a robust and secure communication link, enabling real-time data exchange.

The communication link supports various functionalities, including transmitting EV battery status, charging requirements, and availability of charging slots. EV drivers can receive immediate updates on charging station availability and make informed decisions regarding their charging needs. Charging stations can optimize their operations based on real-time data, ensuring efficient resource utilization. By harnessing the capabilities of NodeMCU ESP-NOW, this project showcases the potential of direct device-to-device communication in the context of EV charging infrastructure. The solution enhances user convenience, reduces waiting times, and contributes to the development of smart and connected charging networks.

International Journal of Engineering Research and Science & Technology

ISSN 2319-5991 www.ijerst.com

Vol. 17, Issue.2, April 2024

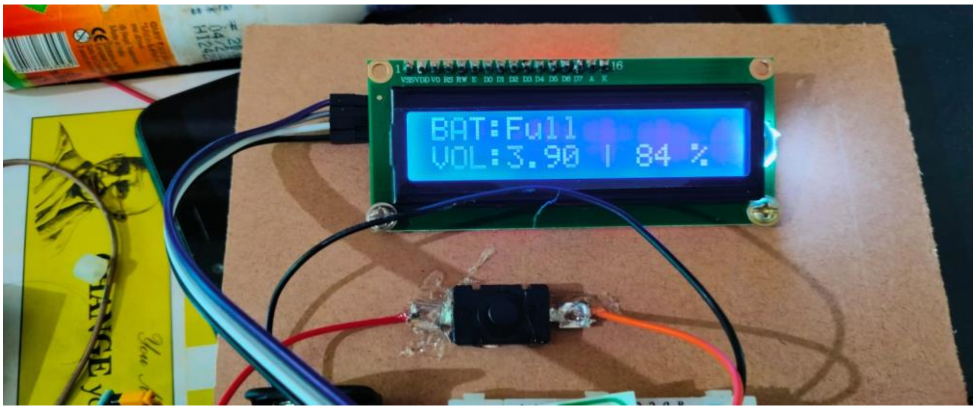

Fig 6.1: Battery Is Full

When battery is full, on LCD it will display BAT: FULL and the percentage of battery

Fig 6.2: Battery Is Low

When battery is low, on LCD it will display BAT: LOW and the percentage of battery

Fig 6.3: Station Found

ISSN 2319-5991 www.ijerst.com
Vol. 17, Issue.2, April 2024

When charging station found, on LCD it will display EV STATION: FOUND & CNTCD

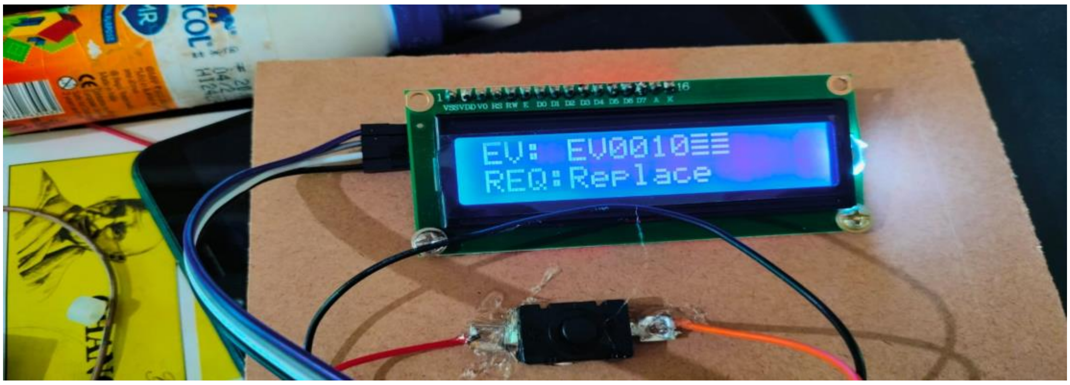

Fig 6.4: Request to Replace

When the station found, electric vehicle request to replace the battery

Fig 6.5: Request Accepted

When the charging station receives the request from electric vehicle side it may accept or deny the request based upon the requirements

ISSN 2319-5991 www.ijerst.com
Vol. 17, Issue.2, April 2024

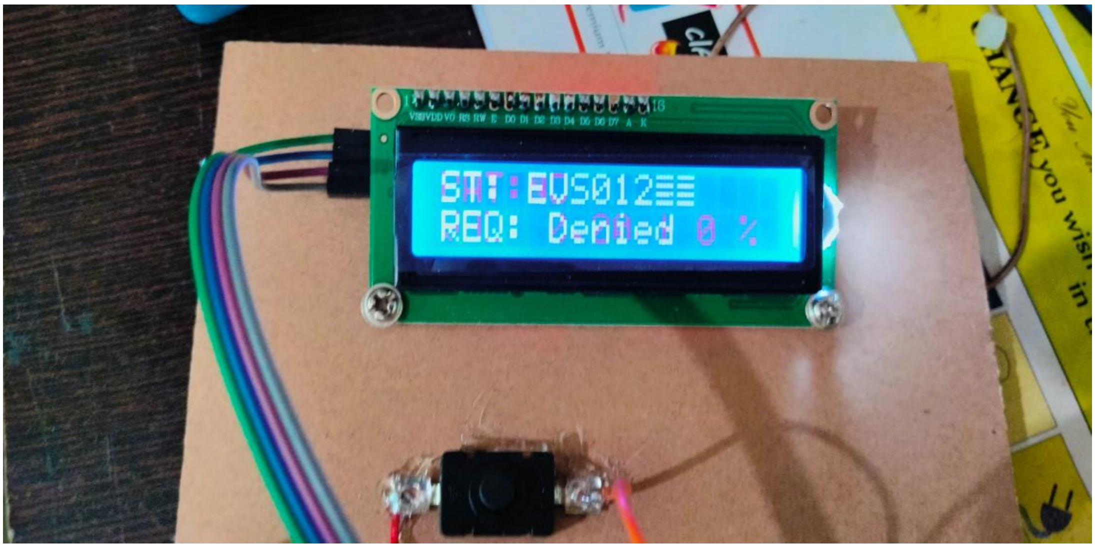

Fig 6.6: Request Denied

CONCLUSION:

The "Establishing Communication Link between Electric Vehicle and Nearby Charging Station" project leverages the NodeMCU ESP-NOW protocol to provide efficient and reliable communication between EVs and charging infrastructure. It offers real-time updates to EV drivers, optimizing their charging experience, and allows charging stations to improve resource utilization. This project contributes to the development of smart charging networks for electric vehicles. In conclusion, forging a robust communication link between electric vehicles (EVs) and nearby charging stations is paramount for advancing the efficacy and accessibility of electric mobility. This imperative connection not only mitigates range anxiety but also optimizes charging infrastructure utilization. Future endeavors should continue to innovate in communication solutions, considering evolving technologies and cybersecurity, to propel the seamless integration of electric mobility into our transportation landscape.

FUTURE SCOPE:

The future scope for establishing a communication link between electric vehicles (EVs) and nearby charging stations holds immense potential for transformative advancements in the realm of electric mobility. As the electric vehicle market continues to expand, there is a growing need to enhance the communication infrastructure to accommodate increasing demand and evolving technologies. Future developments may focus on leveraging emerging communication protocols and standards to foster even greater interoperability among diverse EV models and charging networks. The future landscape holds promise for continued innovation, ensuring that the communication link between EVs and charging stations evolves to meet the evolving needs of a sustainable and interconnected electric transportation ecosystem.

REFERENCES:

[1] He, Y.; Venkatesh, B.; Guan, L. Optimal scheduling for charging and discharging of electric vehicles. IEEE Trans. Smart Grid 2012, 3, 1095–1105.

[2] Patil, D.; McDonough, M.K.; Miller, J.M.; Fahimi, B.; Balsara, P.T. Wireless Power Transfer for Vehicular Applications: Overview and Challenges. IEEE Trans. Transp. Electrif. 2018, 4, 3–37.

ISSN 2319-5991 www.ijerst.com

Vol. 17, Issue.2, April 2024

[3] Habib, S.; Khan, M.M.; Abbas, F.; Sang, L.; Shahid, M.U.; Tang, H. A Comprehensive Study of Implemented International Standards, Technical Challenges, Impacts and Prospects for Electric Vehicles. IEEE Access 2018, 6, 13866–13890.

[4] Desreveaux, A.; Hittinger, E.; Bouscayrol, A.; Castex, E.; Sirbu, G.M. Techno-Economic Comparison of Total Cost of Ownership of Electric and Diesel Vehicles. IEEE Access 2020, 8, 195752–195762.

[5] Institution of Engineering and Technology (IET). What Is a Smart Grid? 2013. Available online: https://www.theiet.org/media/1251/smart-grids.pdf (accessed on 1 June 2021).

[6] Javaid, N.; Hafeez, G.; Iqbal, S.; Alrajeh, N.; Alabed, M.S.; Guizani, M. Energy Efficient Integration of Renewable Energy Sources in the Smart Grid for Demand Side Management. IEEE Access 2018, 6, 77077–77096.

[7] Mude, K.N.; Dashora, H.K.; Bertoluzzo, M.; Buja, G. From wired to in-moving charging of the electric vehicles. In Proceedings of the WSEAS International Conference on Development, Energy, Environment, Economics (DEEE), Lisbon, Portugal, 30 October–1 November 2014; pp. 33–42.

[8] Ahmad, A.; Alam, M.S.; Chabaan, R. A Comprehensive Review of Wireless Charging Technologies for Electric Vehicles. IEEE Trans. Transp. Electrif. 2018, 4, 38–63.

[9] Jang, Y.J. Survey of the operation and system study on wireless charging electric vehicle systems. Transp. Res. Part C Emerg. Technol. 2018, 95, 844–866.

[10] Panchal, C.; Stegen, S.; Lu, J. Review of static and dynamic wireless electric vehicle charging system. J. Eng. Sci. Technol. 2018, 21, 922–937.

[11] ElGhanam, E.; Hassan, M.; Osman, A. Design of a High Power, LCC-Compensated, Dynamic, Wireless Electric Vehicle Charging System with Improved Misalignment Tolerance. Energies 2021, 14, 885.

[12] Mohamed, A.A.; Lashway, C.R.; Mohammed, O. Modeling and feasibility analysis of quasi-dynamic WPT system for EV applications. IEEE Trans. Transp. Electrif. 2017, 3, 343–353.

[13] Liu, Z.; Song, Z. Robust planning of dynamic wireless charging infrastructure for battery electric buses. Transp. Res. Part C Emerg. Technol. 2017, 83, 77–103.