SMART CHARGING SYSTEM FOR ELECTRICAL VEHICLE

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***Abstract*—As more countries are moving towards lowering the pollution caused due to vehicles, EVs are gaining more popularity across the globe. As the number of Electric Vehicles are increasing, Electric Vehicle charging infrastructure is something that has grabbed attention. A charging system with built in IoT will streamline the performance of EV charging stations and can ensure the smart way of the charging the vehicles. This method is helpful for transportation systems, and V2G systems. This proposed system will improve the city planning and makes the city life easy.**

With IoT we can easily manage the whole V2G system which will definitely saves time and money. This work is to make a smart application to connect with the grid and to know the different tariff rates of the grid. So, we will be concentrating mainly on the MATLAB simulation of charging system integrated with Node Red to make the system IoT based smart station. By gathering the necessary data, we are planning to create a smart charging system which can be controlled by buttons through node red and gather information about the characteristics of the battery of EV that will be charged/discharged.

***Index Terms*—**

I. Introduction

As the number of EVs grows, so does the demand for EV charging infrastructure. In this project, we will demonstrate MATLAB Simulink as the Grid to Charging Station circuit, and we will utilise NodeRED to demonstrate the interface that the EV user will have. Under the project taken, we intend to put forward a systematic protocol in which the NodeRED interface will be turned to an app that the user can use to monitor. A charging system with built-in IoT would undoubtedly improve the performance of EV charging stations and ensure the safe charging of automobiles. This approach is useful for transportation networks and Vehicle to Grid (V2G) systems. This proposed system will improve city planning and make city living easier. With IoT we can easily manage the whole V2G system which will definitely saves time and money. This work is to make a smart application to connect with the grid and to know the different tariff rates of the grid.

II. LITERATURE SURVEY

[1] Zweistra el at delivered real-world data insights that are utilised to forecast the near-future scenario and realistic smart charging implementations. Starting with the issues that arise as the number of Electric Vehicles (EVs) grows, and how this will put more strain on the grid. It also exhibits a smart charging method that monitors the amount of charging in relation to the transformer's available capacity in real time. Because the quantity of kWh flowing into the EV cannot be controlled by groups of chargers using CPO (Charge Point Operation) due to automobile characteristics, this study uses amperage protocol as a steering input for smart charging. It was built and tested on a wide scale using 1000 public chargers in a real-world setting, and it was found to be within the grid limit. Within the capacity constraints of the transformer the chargers are (virtually) linked to, the protocol enables for efficient charging of a large number of EVs (within the limitations employed). According to the study, improvement can be made if manufacturers provide the information about car battery.

[2] Wang el at put forward a survey of various dominating factors for coordinating charging from three different perspectives. The three perspective discussed are in terms of smart grid oriented, aggregator oriented, and customer-oriented smart charging. The smart grid perspective discusses load flattening, frequency regulation and voltage regulation to explore the nature and substantial similarities. The aggregator-oriented perspective categories the algorithmic approaches as direct and indirect coordinated control. Finally, the customer-oriented perspective explores reducing charging cost by generalising formulations. The properties of rechargeable batteries are also discussed in detail including power controllability, charging rate and battery ageing. It also gives a brief on communication protocols of EV with the smart grid and the requirements for it. The paper also discusses various uncertainty issues such as EV fleet uncertainty, electricity price uncertainty, regulation demand uncertainty among the three perspectives listed above. The challenging issues of smart interaction and future research topics such as charging concerns, charging patterns, EV scheduling, Communication requirements and communication security are discussed.

[3] Nour el at developed a new technique for smart charging of Electric Vehicles (EVs) and tested using simulation in this research. To optimise electric utility and to benefits EV

owner, a logic controller is employed to control and manage the EV charging process. The electricity price and the SoC are the controller's input, and the output is charging power. The goal is to create a MATLAB controller that can charge an electric vehicle at a reasonable cost. Instead of real-time communication between EVs and the electric utility, a simple communication system is used, with the energy price from the utility being received every hour. The benefit to the electric utility is that it can reduce the impact of EV charging on the distribution network by shifting EV charging to offpeak hours, while the benefit to EV owners is that they can charge their vehicles at a low cost. When compared to uncontrolled charging, smart charging reduces maximum power demand and maximum transformer loading by 20%, and cable maximum loading by more than 10%.

[4] Mehta el at describe for optimal integration of plug-in electric vehicles (PEVs) within the current distribution system infrastructure, two smart charging solutions integrating a unified grid-tovehicle and vehicle-to-grid charging framework in this research. For optimal integration within the current distribution system infrastructure, smart charging of PEVs arriving at work-place car parks is performed. PEV owners should submit initial vehicle data, battery information, and estimated charging time when their vehicles arrive in parking lots. The energy requirement is approximated based on the information obtained.The charge coordinator chooses the charging strategy based on the requirements, which could be either economic or technological. Strategy A (based on minimising total daily cost) offers large financial benefits, whereas Strategy B (based on minimising PAR) offers major technical benefits in terms of PAR and peak load reduction. When comparing the proposed techniques in the context of slow and fast charging, it was discovered that fast charging degrades both Strategy A and Strategy B's performance when compared to slow charging. The offered solutions provide insight into the amount of PEV penetration that can be integrated into the distribution network without requiring infrastructure reinforcement.

[5]Abousleiman el at describe a revolutionary smart grid system design and implementation logic that enables for dynamic interaction between electric/PEVs and the power grid in this research. This intelligent and dynamic interaction will allow for a safe and semi-stable load on the grid, lowering costs and avoiding harm from extreme loads. A spike in power use, primarily due to individuals charging their cars at the same time and at the utility's already peak load, could pose issues. The tremendous demand on the local voltage transformers and power sources is mostly responsible for these issues. The entire hardware system architecture is described, with a focus on the algorithms created to determine the cost, charge times, and end SOC for the cheapest, fastest, and best alternatives. The technology was created, implemented, and tested on RAM 1500 plug-in vehicle trucks from the US Department of Energy. The system was put to the test in a variety of circumstances and found to be fast, efficient, and capable of reducing the load on the electric grid.

[6] Controlled electrical vehicle (EV) charging situations are planned, every characterised with Associate in Nursing algorithmic rule and associated machine and communication requirements, to be adopted by a heat unit aggregator or system operator. The proposed scenarios embrace uniform, random, conditional-random, and valley-filling charging scenarios. A modelling framework is conferred to analyze the impact of the proposed charging scenarios on energy losses in distribution systems, as compared to uncontrolled, uncertainties concerned with the behaviour of low voltage customers and EV charging loads

[7] This paper surveys the latest studies on sports associated with the rate control of electrical vehicles in a clever grid environment. The effect of EV rate control at the clever grid is first presented. Then, EV rate control techniques are divided into 3 categories. Centralized EV rate manipulates, which calls for a well-advanced verbal exchange infrastructure, is highlighted. Decentralized rate manipulation, which has restricted verbal exchange requirements, is then discussed. In addition, verbal exchange-free, independent EV rate manipulation is explored. The special methods suggested in the literature for addressing the stochastic nature of the EV rate manipulate system are overviewed. Special emphasis is likewise given to the problem of techniques appropriate for real-time EV rate dispatch.

[8] The proposed work aims to produce an online of Things (IoT)-based resolution for dominant the charges in vehicles and examines its usage in outside environments by sending knowledge to long detachments. the aim behind this projected technique is to save lots of the lifetime of people as a result of there's a prospect that the system can lead to a brief path that successively causes severe injury to human life. the most findings of the planned work are to investigate the utmost limits of charge capability with limitations in voltage sets. These parameters are calculated employing a gradient boosting algorithmic rule wherever prediction error will be lesser.

[9] Electrical Vehicle (EV) technology has existed for over a century peaking commercially around 1900. As per the report "Global heat unit outlook" of the International Energy Agency, the entire range of heat units are projected to achieve a hundred thirty million by 2030. However, high penetration of EVs additionally poses distribution network quality issues, notably network congestion, three-phase voltage imbalance and off-nominal frequency problems. the combination of considerable EV penetration within the distribution networks could be an important space of interest in the analysis and engineering community.

[10] In this paper, an surest charging scheduling method is proposed for maximizing the PEV penetration in a workplace automobile park. Based on the statistically advanced PEVs' driving pattern, a fuzzy inference gadget is designed to version the PEVs' strength requirement. A GA with heuristic initialization is then applied to carry out the surest charging scheduling of PEVs withinside the automobile park. Lastly, surest places withinside the commercial and business laterals of a 38-bus distribution gadget are decided for the auto park

such that the most variety of PEVs may be charged during the day. The simulation outcomes reveal that the implementationof the proposed method has led to better PEV penetration that may be accommodated withinside the automobile park with out overloading the distribution transformer and distribution lines. In addition, similar to the most PEV penetration, the proposed method has minimized the height load of the network integrating PEVs and additionally decreased the each day general price incurred via way of means of the parking operator significantly. Overall, the proposed method presents financial advantages to the parking operator via way of means of producing sales for supplying frequency law carrier and via way of means of promoting energy returned to the grid. It additionally presents technical advantages to the grid operator via way of means of shaving the height load and stopping the overloading of distribution infrastructure.

[11] Glanzer et al. had future view that all the combustion engine-based vehicles will be replaced by plug-in hybrid electric vehicles (PHEVs) and pure electric vehicles (EVs). And hence manufacture and power supply companies will face technological and economical challenges. This paper focus on cost effective on charging strategies mainly on simple charging, Dual tariff charging based on simple time-of-use (TOU) pricing, Smart charging. Smart charging can take place at consumer's home or at the public places like parking areas. All EVs must be included with either unidirectional or bidirectional charger. A bidirectional charger is a combined AC/DC rectifier and DC/AC inverter that enables V2G operation. By installing an integrated on-board charger, the size and weight of EV could be reduced. The best solution for this seems to be a global energy control strategy in combination with decentralized smart charging. The bidirectional integrated on-board chargers with smart charging functionality are necessary for the grid connection and integrating it with the motor inverter can be cost effective.

[12] Daina et al. suggests Amongst the challenges that large EV penetration may bring there is the potential increase of peak power demand if charging operations occur in the coincidence of current demand peaks. In this centralized framework EV load aggregators act as an intermediary between vehicle owners and grid markets and contract power demand from several EVs. The energy requirement specifies the battery level required by the end of the charging operation while the timing requirement specifies the time by which the charging operation must be completed. Under this scheme, users directly affect the flexibility of the controls that can be imposed on the charging operation through their charging preferences. Unlike previous charging behavior models used in integrated transport and energy system analyses, our model empirically captures the behavioral nuances of tactical charging choices in smart grid context. The results provide insights into the value placed by individuals on the main attributes of the charging choice. These attributes target energy, effective charging time and charging cost.

[13] Zhu et al. put forward a survey that the short-term load forecast is useful for complete operation and planning while long-term load prediction is brought to the planning stage of the system. In addition, minute-minute load forecasting is a very short-term load forecast and is used with real-time power quality and safety monitoring. The problem of forecasting is the problem of a time series that is very similar to natural language processing, where an in-depth learning approach can have the potential to contribute effectively. More accurate predictions of that type of novel load may have a significant impact on the power system user both from economic and security issues, where more powerful tools are needed. Among the deep learning modes, the Long short-term memory (LSTM) model is superior to other methods and has the ability to predict additional short-term PEV charging load. The proposed in-depth learning model provides an important tool for paving the way for greater entry of PEVs integrated into the energy system and provides a demonstration of competing practical performance in low-carbon energy systems.

[14] Jawad et al. found out that with the advancement of battery technology, the driving distance of EV models has greatly improved, where standard EV models have a range of 100-250 km, and some models can reach 300-500 km without charging or reducing battery. However, despite the many benefits, integration of highly dense adjoining networks may present a few new transport challenges that are electrically charged from charging, traffic flow, load charge on the power network, and cost concepts. In order to improve the development of electric vehicles and support the charging network infrastructure, this survey demonstrates the interdependence of networks across the entire charging service network, power distribution network, and transport network. Previously, the standard charging mode required 7 to 9 hours to fully charge the EV, but recent research suggests that the EV battery can be fully charged in 5 to 10 minutes, equivalent to 6 to 12 EV per hour.

[15] Lopes et al. discovered that the power to control the battery charge, when the EVs are connected to the grid, then allows to adopt smart charging techniques that allow for increased renewable energy output, which reduces the risk of power outages. The first part of this work focuses on determining the percentage of standard vehicles replaced by EVs, which can be connected to the selected grid, without violating the technical limitations of the system. The second task was to analyze the effects of both charging methods, dumb charging and intelligent charging. The results obtained show that, when used, this smart charging method allows for the integration of up to 61% of EVs without tightening the grid, only by continuously controlling the charging of 50% of those EVs. As the number of EVs grows, the benefits from smart charging strategy are high.

[16] Baghmare et al. dealt with the design of the controller for electrical vehicles to Grid power, by improving power requirement of the grid and reactive power compensation capability through this controller. During off peak load demand grid will supply the power to the battery and charge the battery.

During on peak load demand excess power of battery will supply to the grid. Bidirectional converter is very helpful during on peak load demand. The role of aggregator is to collect the power from all electrical vehicle first then it supply to the grid. All the control strategies of modern electrical vehicle to grid(V2G) is proposed like smart charging or discharging of batteries during off peak load demand and On peak load demand respectively. V2G controller allows the active power it act as an ancillary services to grid. Electrical vehicle controller has ability to exchange the active or reactive power capability. Simulation of bidirectional AC/DC and DC/DC controller and their control circuit are analyzed by using matlab Simulink software.

[17] Julia Hildermeier et al. authors of this paper conducted a qualitative review of policies s for Electric Vehicles (EV) grid integration in the EU and U.S. markets. They found that, in order to unlock the environmental and economic opportunities associated with market uptake, three policy strategies are most effective: cost-reflective pricing, intelligent technology, and integrated infrastructure planning. Since the electrification of transport in Europe is in the early stages of a market transformation that has the potential to significantly cut emissions in both the transportation and energy sectors, while generating wider benefits for society. The research underpinning this study finds that the greatest value from integrating EVs into the power grid can be generated by charging them when and where it is most beneficial for the power system, while ensuring consumers' mobility needs are met at an affordable cost. The authors of this article explored best practices for ensuring that charging is managed and unnecessary investment costs can be avoided.

[18] João C. Ferreira et al. this work proposes the design of a system that will create and handle Electric Vehicles (EV) charging procedures. This system will be based on the intelligent process. Due to the electrical power distribution network limitation and absence of smart meter devices, Electric Vehicles charging should be performed in a balanced way, taking into account past experience, weather information based on data mining, and simulation approaches. In order to allow information exchange and to help user mobility, it was also created a mobile application to assist the EV driver on these processes. This proposed Smart Electric Vehicle Charging System uses Vehicle-to-Grid (V2G) technology, in order to connect Electric Vehicles and also renewable energy sources to Smart Grids (SG). This system also explores the new paradigm of Electrical Markets (EM), with deregulation of electricity production and use, in order to obtain the best conditions for commercializing electrical energy.

[19] Simth et al. this paper presents a plug-in electric vehicle (PEV) charging control algorithm, Adjustable Real-Time Valley Filling (ARVF), to improve PEV charging and minimize adverse effects from uncontrolled PEV charging on the grid. ARVF operates in real time, adjusts to sudden deviations between forecasted and actual baseloads, and uses fuzzy logic to deliver variable charging rates. Fuzzy logic is selected for this application because it can optimize nonlinear systems, operate in real time, scale efficiently, and be computationally fast, making ARVF a robust algorithm for real-world applications. This work presents Adjustable Real-Time Valley Filling (ARVF), a practical valley filling strategy that determines its solutions in real time. AVRF is created d as a strategic way to decrease the enormous demand on household transformers caused by unregulated PEV charging. . According to the findings of this study, ARVF functions best when the load limit is equal to the average value plus 0.75 of its standard deviation.

[20] Yuana et al. this paper proposes a novel charge scheduling strategy for Electric Vehicles (EVs). : Charge scheduling can mitigate against issues arising from excessive electric vehicle (EV) charging loads and is commonly implemented using time-of-use pricing. A charge scheduling strategy to suit vertically structured power systems without relying on time-of-use pricing has not yet been reported, despite being needed by industry. The main content includes the provision of a decision-making framework that accommodates for the considerations of transmission and distribution network operators, and the allowance for dynamically changing charging loads through timely forecast updates with reduced communication requirements. Different and realistic EV uptake scenarios are considered, using probabilistic modeling, survey work, and a Monte Carlo modeling approach. Even under slow EV charging conditions case study results show assets are overloaded and high electricity production costs are incurred. These are alleviated through adopting the proposed strategy.

[21] Esha Sharma et al. highlighted the essence of smart charging stations with the increase of Electric Vehicles using Arduino. As Electrical Vehicles are something that is being adopted by the nations across the globe. So, setting up new smart electrical vehicle charging will become essential for both the charging point network operators, and the National electricity grid. With the use of Arduino and integrating it with the Internet of Things (IoT) and cloud storage will take the smart charging concept to another level. This work is to make a smart application to know the different tariff rates of the grid by connecting to the grid. Grid to Vehicle (G2V) and Vehicle to Grid (V2G) will be the concepts this work is based on. The application will allow the user to navigate the State of Charge (SoC) and different parameters related to his/her electrical vehicle. Optimization of low carbon technologies through one connected platform for decarbonizing both the production and consumption of energy is the main agenda of this work.

[22] Arunkumar P et al. describe the system of using an application which can help user to perform Vehicle to Grid(V2G) or Grid to Vehicle(G2V) operations. As pollution free traffic is what every country is seeking, more and more developments are leading towards the Electrical Vehicle (EV) charging infrastructures. By introducing IoT, Vehicle to Grid (V2G) system can also be introduced with ease which can improve the city planning and also helps in the grid load man-

agement. The prime objective is to make a smart application to connect with the grid and to have a measure of the different tariff rates of the grid. If any Electrical Vehicle user have fully charged vehicle when it's not required, then he/she can transfer some power to grid in order to decrease the load on the grid in peak hours. The application will also display the battery status (SoC) of the user when he/she comes to the grid.

[23] G. Themozhi et al. describes the application of Internet-of-things (IoT) in monitoring the performance of electric vehicle battery. As the word electrical vehicle simply implies that it needs an electrical source that is the battery. However there is always some degradation in the battery when we use it continuously. In this paper it is described that using IoT we can have include two major features. One is regular battery monitoring device and the another one is it is completely user friendly which will help the user to have the correct idea of what is the current condition of the battery. One way of enhancing the quality and service of the Electrical Vehicle charging is by using Internet of Things (IoT) to make them smart. A system with IoT will definitely streamline the performance of Electrical Vehicle charging and looks the impacts. They proposed this implementation with IoT will lead us to easily management of the whole V2G system which will definitely save time and money.

[24] Koko Friansa et al. put forward a battery monitoring system based on Internet of Things (IoT) that has been developed to monitor the operational and performance of batteries in a smart microgrid system. In order to provide a battery performance, it is necessary to enhance the Battery Management System (BMS). Different parameters such as voltage, current and temperature of battery during charge and discharge of the battery are measured in order to estimate the State of Charge (SoC) and state of health (SOH) of the battery. Cloud service is also introduced and tested in order to reduce the cost of data storage and give the user a better experience with the application using Internet of Things (IoT). Energy domain based on IoT allows users to visualize energy consumption in real time. One of application from energy domain is smart grid. Application of smart grid based on IoT has been developed for contingency management using smart loads.

[25] Emmanouil D. Kostopoulos et al. highlighted that the Electrical Vehicle charging stations accompanied with the Renewable Energy Sources (RES) will be one of the solutions for decarbonization of the transport sector. Although the proper utilization of the battery in the Electrical Vehicles is the topic of discussion since the last decade. Since, Li-ion batteries are the heart of Electrical Vehicle sector, a better understanding of the batteries is what done and experimented on. The present study, that was experimentally conducted under real-world driving conditions, quantitatively analyzes the energy losses that take place during the charging of a Battery Electric Vehicle (BEV), focusing especially in the previously unexplored 80%–100% State of Charge (SoC) area. In the results, it is shown that the losses during charging and discharging of the batteries are almost double compared to the 20%–80% SoC area and vehicle's average specific real energy consumption is almost 2 kWh/100 km more, compared to what the driver sees on the EV's dashboard.

III. METHODOLOGY

A. BLOCK DIAGRAM

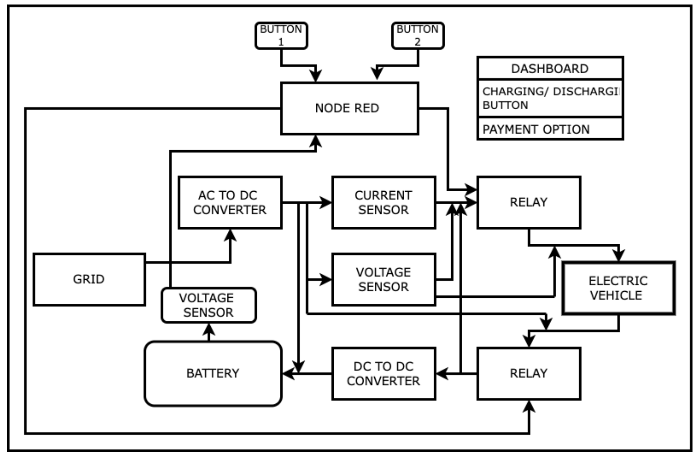

Fig. 1. Block Diagram

B. WORKING

We have five main subsystems: Connection Control, DC-AC/AC-DC Converter, Buck-Boost Converter, DC-DC Controller with battery controller and Battery Switching Control. Depending on the option selected by the user i.e either Charging or Discharging the first and last block will select the required mode. We used the universal gate for AC-DC conversion which is required when we supply energy from grid to the battery and a buck boost converter is used to get the voltage to the required level. DC-DC converter with battery controller consists of PID controller which is essential to charge the battery.

When discharging, the energy is taken from the Electric Vehicle which is depicted as the battery module in Simulink. It passes through the battery controller and then it is supplied to the buck boost converter where we set the voltage to the right level. A DC-AC converter circuit will convert the DC supply from the battery to AC which is then given to the grid. We observe the output on scope. Later we store the output of SoC (State of Charge), current and voltage in a csv file. This csv file is read on NodeRED for visualization.

In NodeRED we have used two switches that will indicate if the user wants to charge the Electric Vehicle or discharge it. We are using the inject, read file, csv, function nodes and the chart node from dashboard will help in plotting the values. We have created two charts, one to show the state of charge(SoC) of the battery and other to show the cost.

1)MATLAB ENVIRONMENT

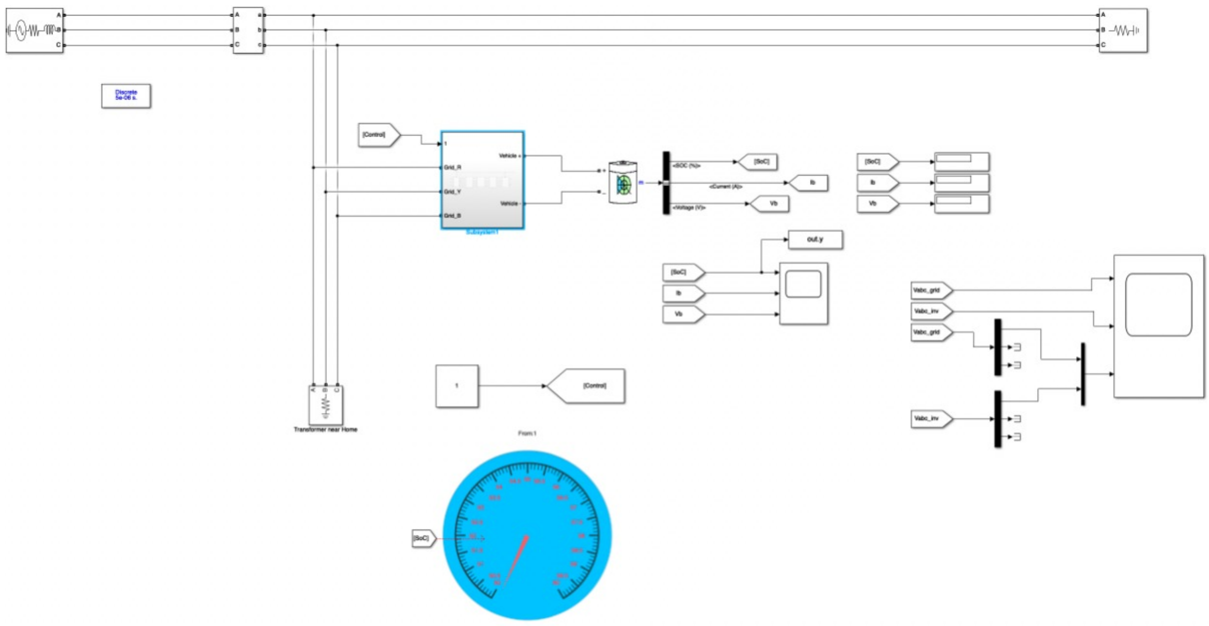

Figure 1: Proposed MATLAB System

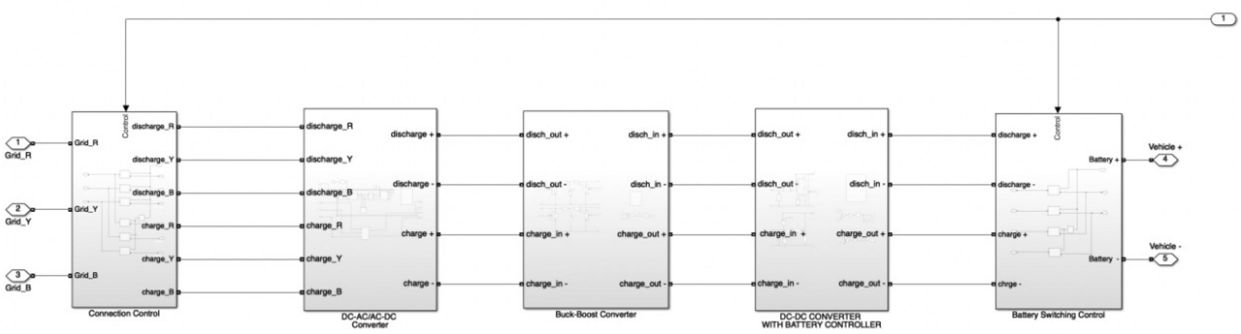

Figure 2: Main Subsystem

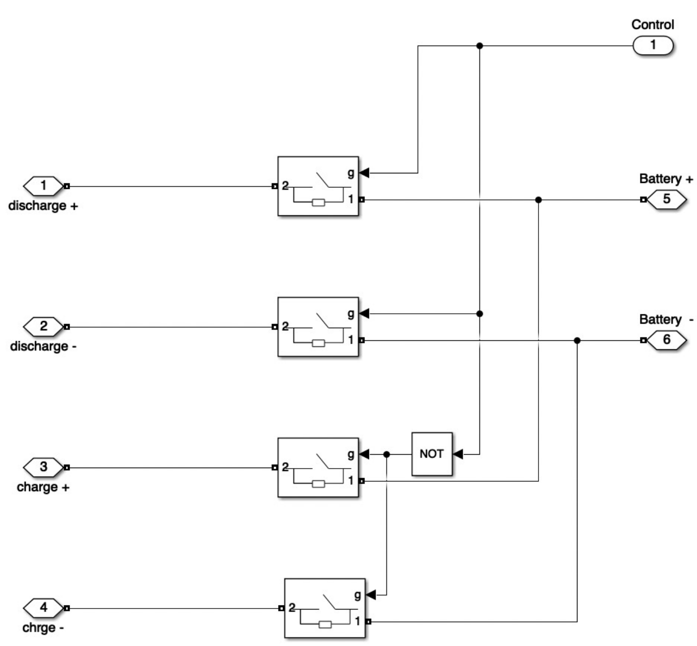

Figure 3: Battery Switching Control

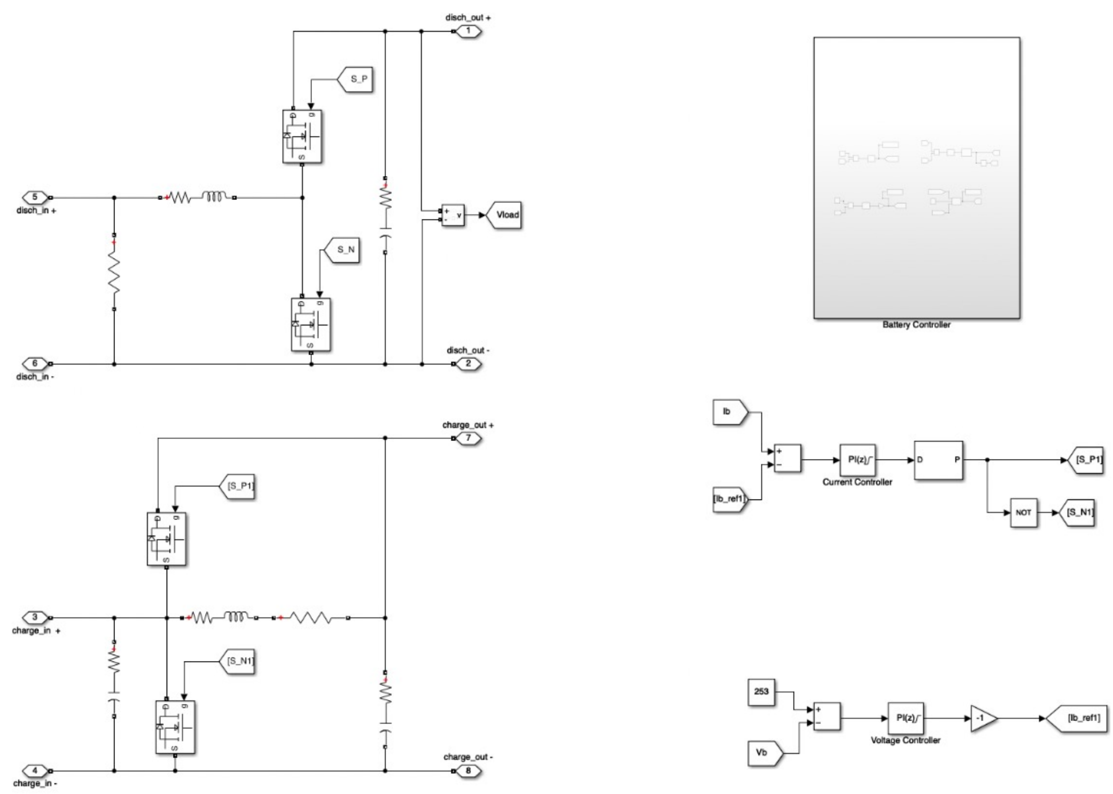

Figure 4: DC-DC Converter with Battery Controller

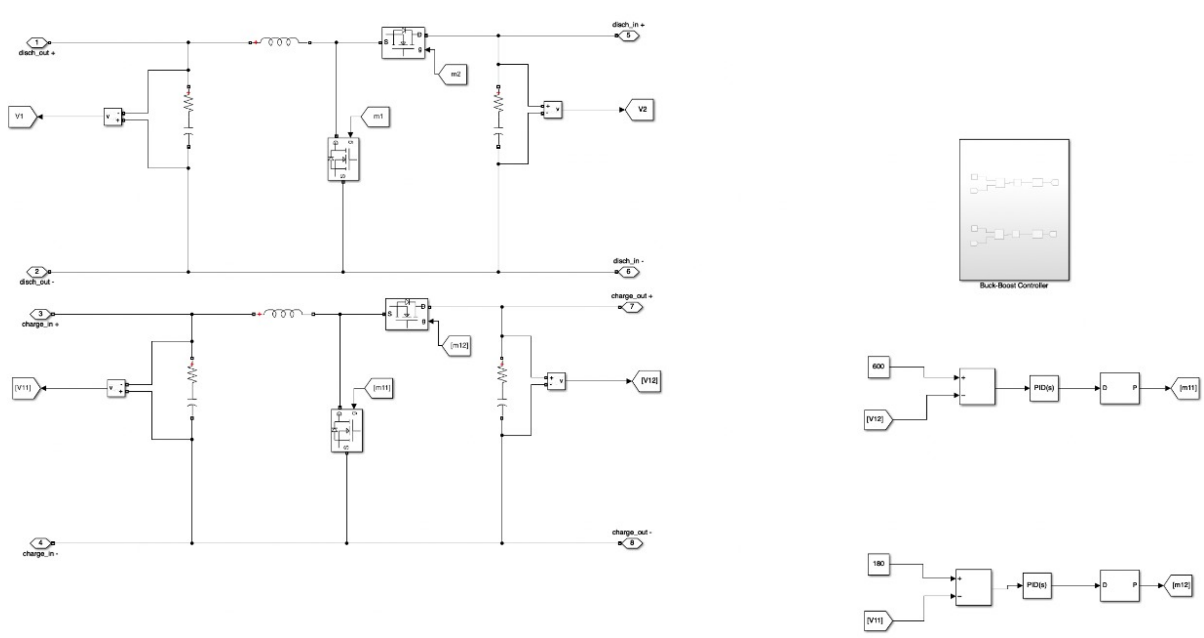

Figure 5: Buck Boost Convertor

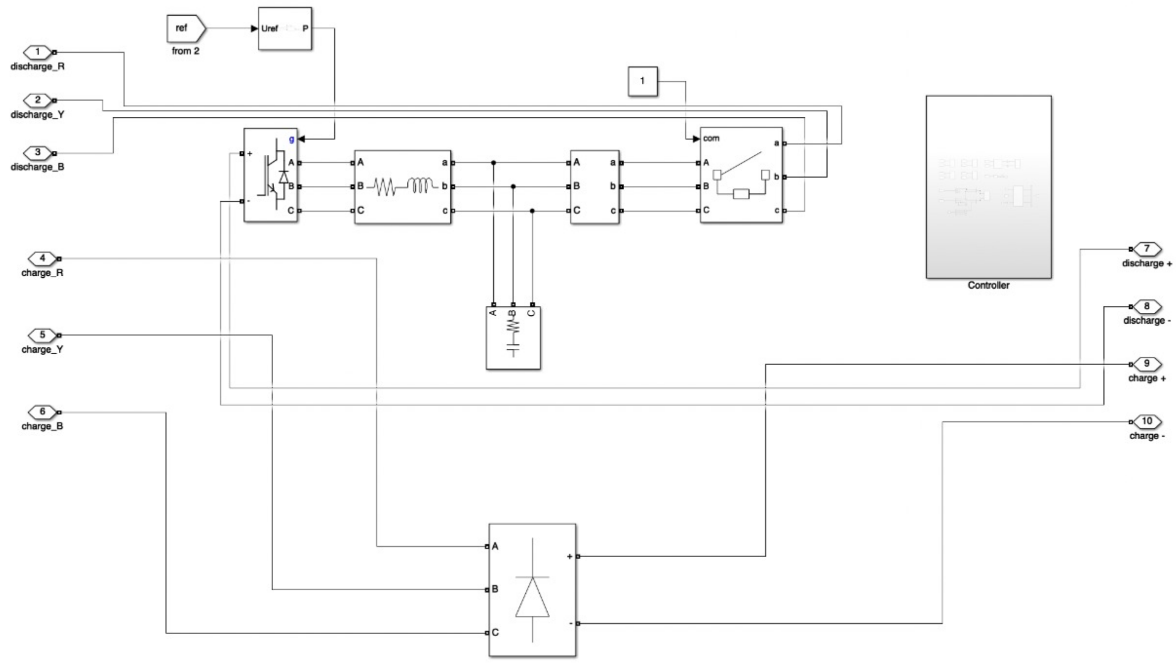

Figure 6: DC-AC /AC-DC Converter

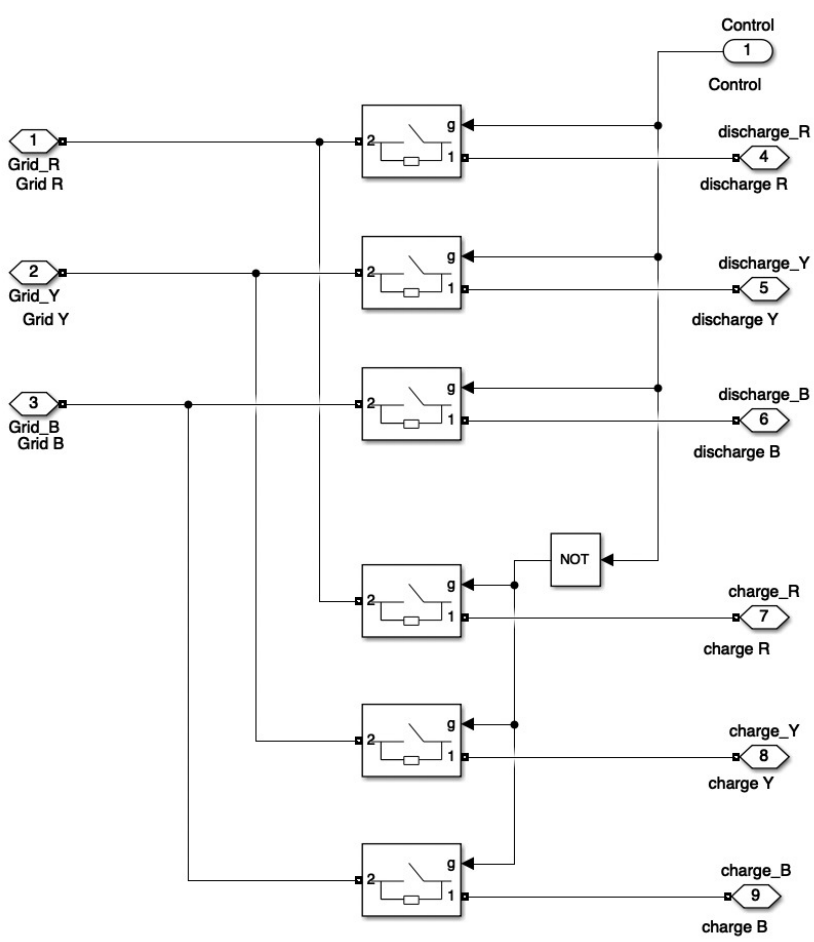

Figure 7: Connection Control SubSystem

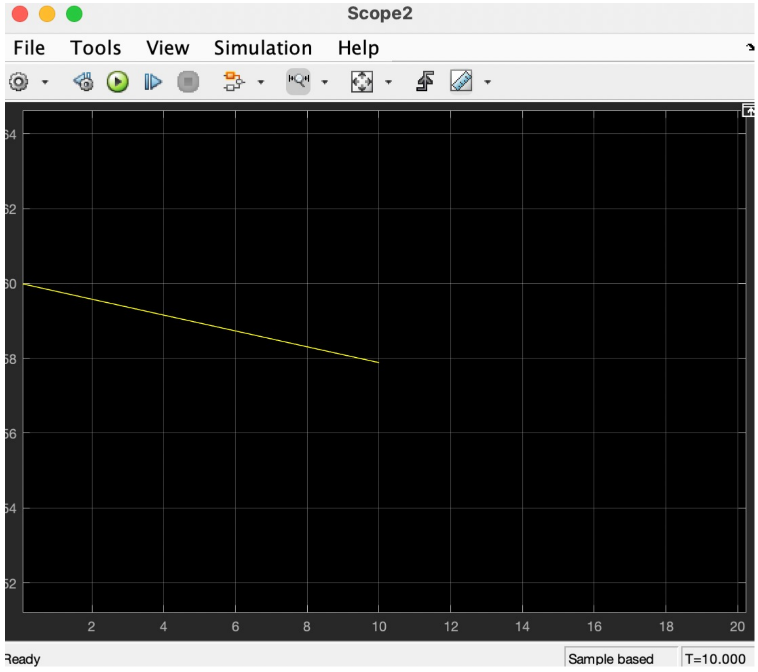

Figure 8: SoC of the Battery

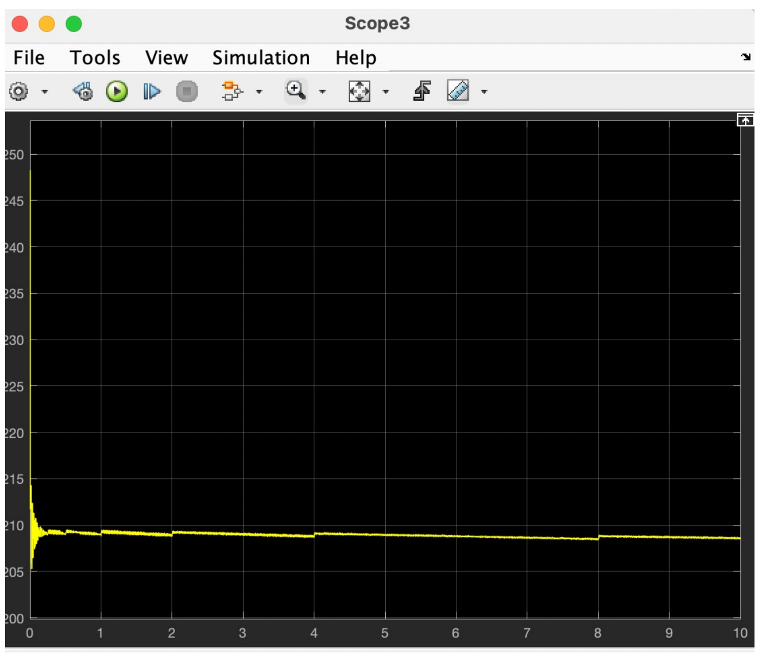

Figure 9:

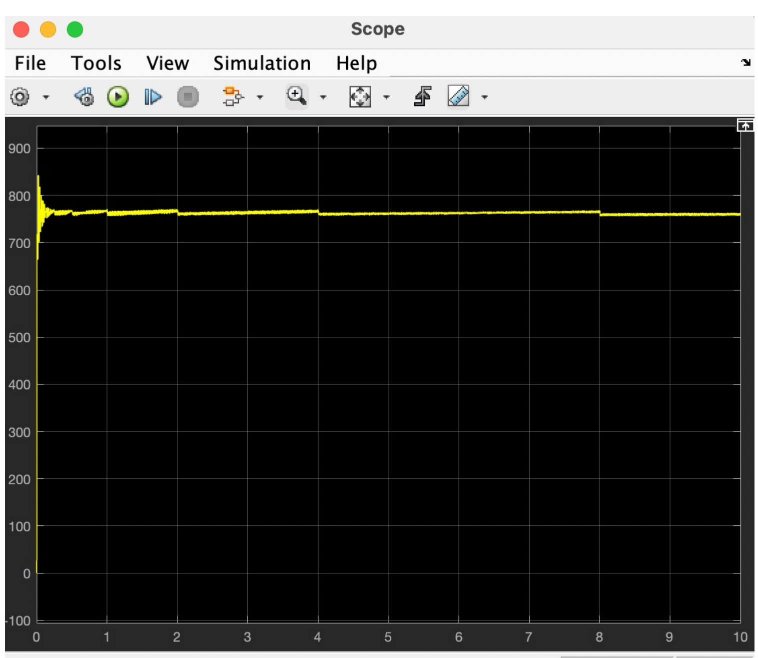

Figure 10:

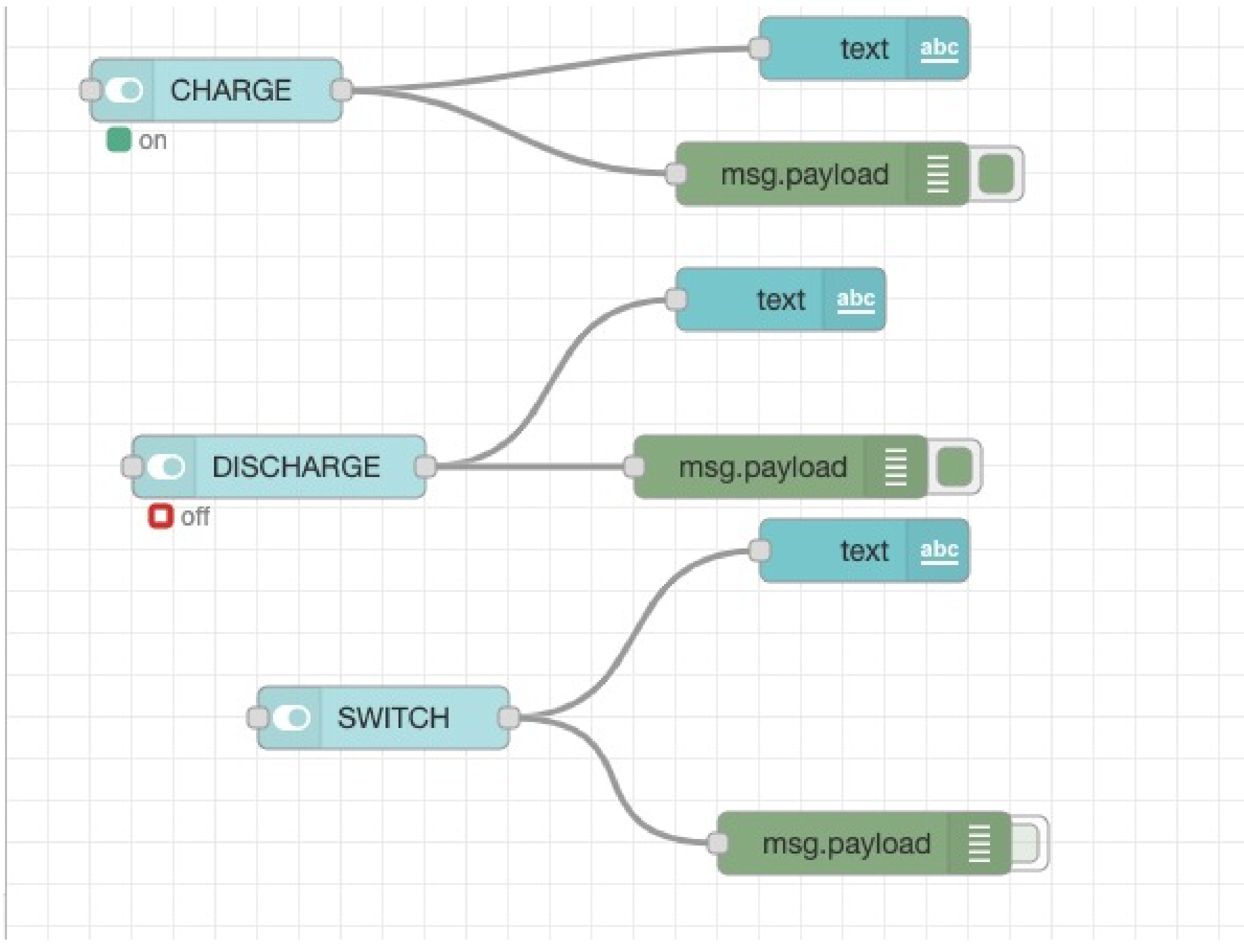

Figure 11:

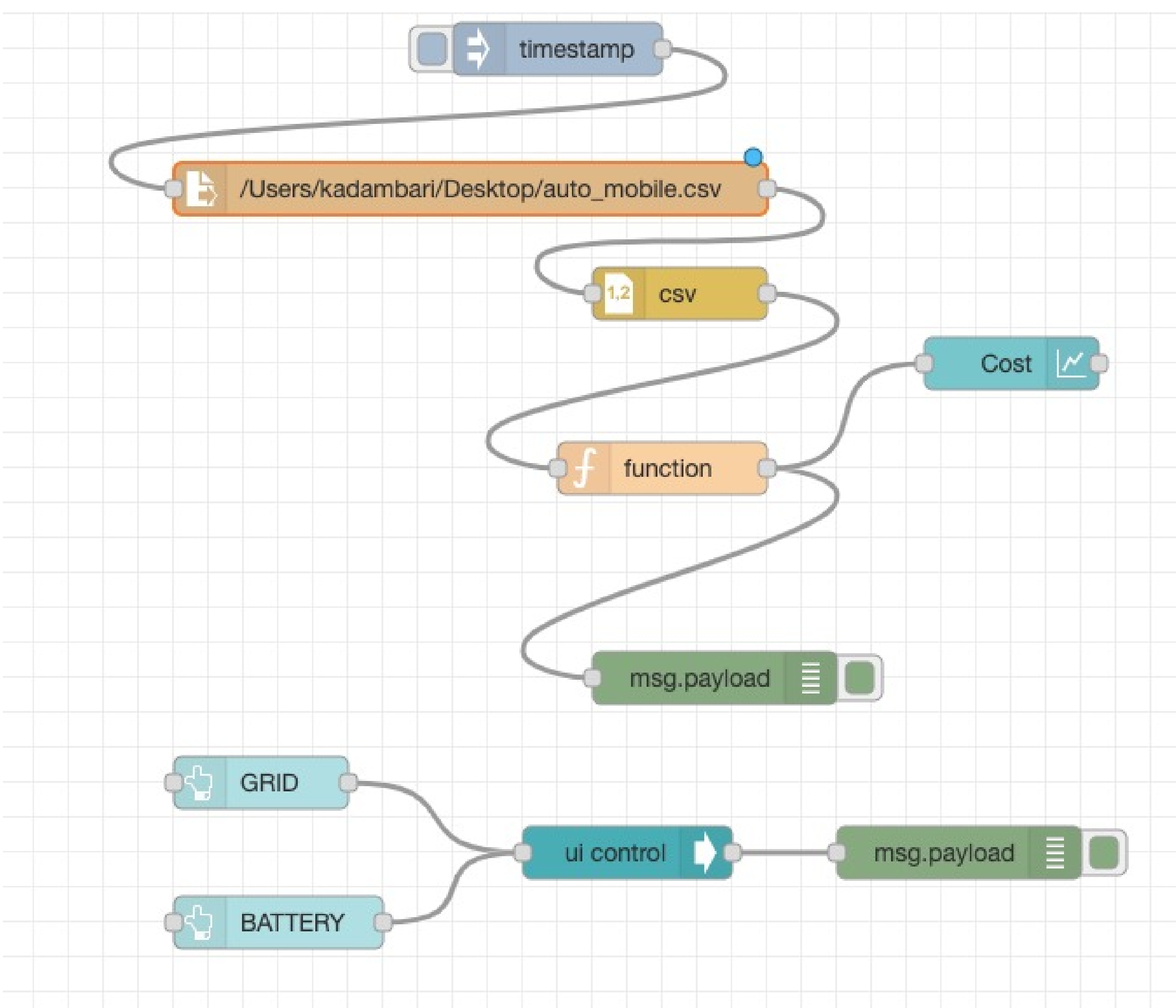

Figure 12:

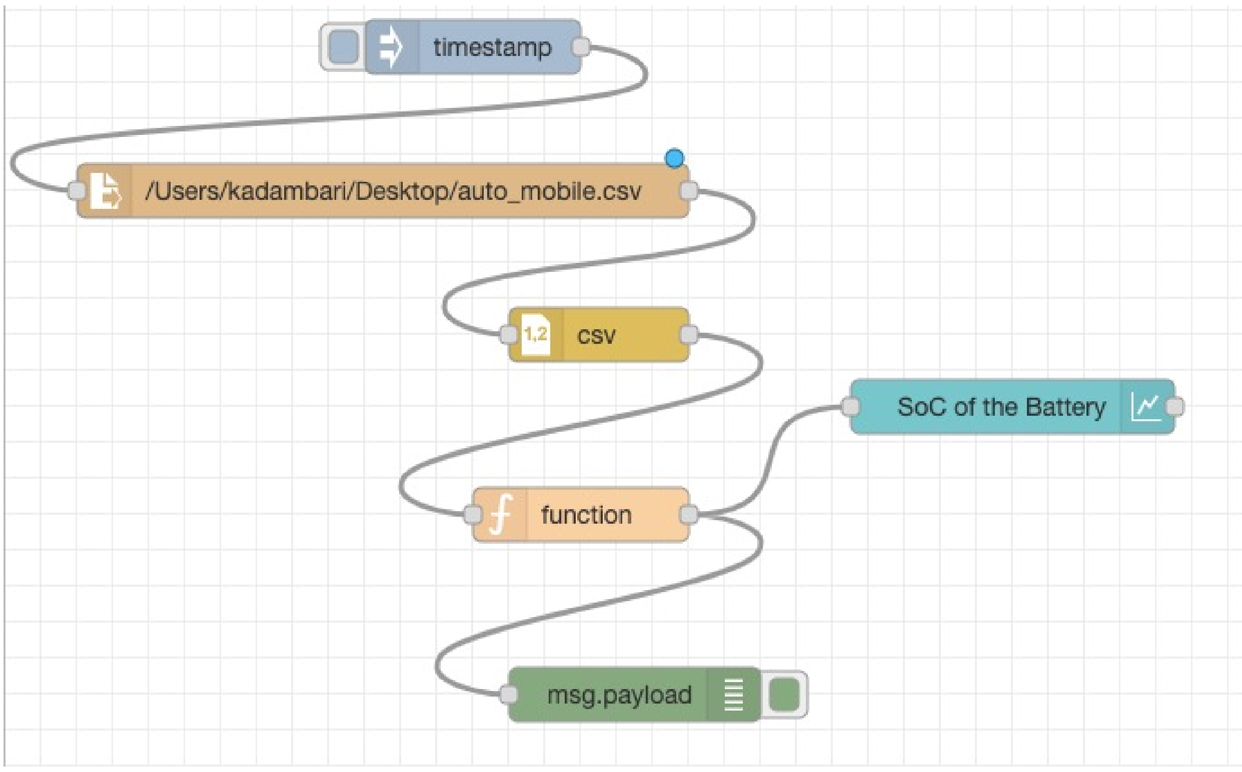

Figure 13: Node-RED INTERFACE

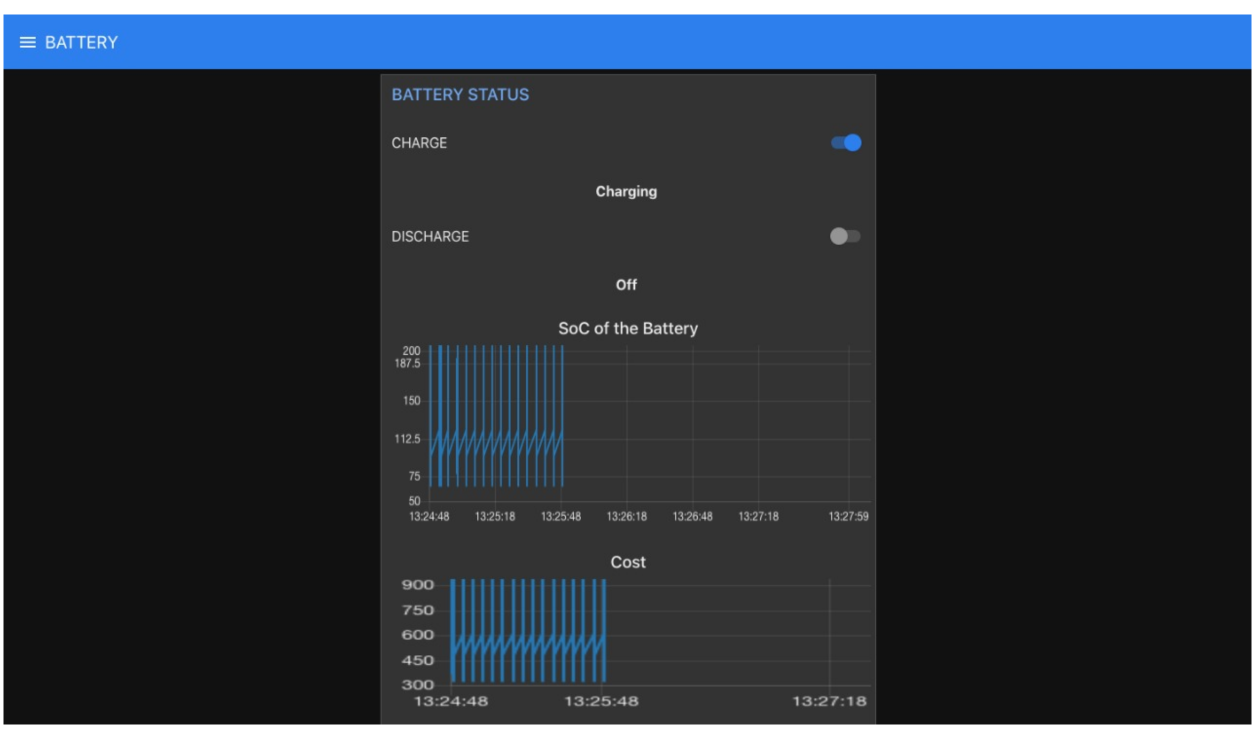

Figure 14: Node-RED User Interface Screen

I. Result and Analysis

We have successfully created the charging and discharging circuit for Electric Vehicle on MATLAB Simulink. We have created our user interface on NodeRED for visualization. We faced problems during integration of NodeRED with MATLAB Simulink. We tried various protocols like MQTT, HTTP, TCP/IP, etc but we did not get the desired output. Thus we decided to store the output obtained from Simulink in a csv file and read the csv file in NodeRED. For the future scope of the project we intend to work on the communication between MATLAB Simulink and NodeRED. We can also develop an app for the same purpose.

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