ISSN 2395-1621

IoT Based Smart Charging of Electric Vehicle

Tejal Hatim, Sakshi Agarkar, Prajakta Kadam

tejalhatim01@gmail.com
sakshiagarkar75@gmail.com
kprajkta@gmail.com

Department of Electronics and Telecommunication Engineering

Pimpri Chinchwad College of Engineering, Nigdi Pune

ABSTRACT

As more countries are moving towards pollution-free traffic, Electric Vehicles are gaining more popularity across the globe. As the number of Electric Vehicles increases, Electric Vehicle charging infrastructure will also be a basic need. An IoT enabled system will streamline the performance of EV charging and will improve city planning. Since the battery is a commonly used device for storage of energy, calculation of the State of Charge plays a vital role. The proposed method is helpful in transportation systems as it allows the charging of the batteries in an electric vehicle in a semi-autonomous way with minimal human intervention. This paper focuses on the IoT part of determining the SoC value and sending the data to 000webhost. The user can view the data in the Android App. Also, the user can locate the nearby charging station locations and transaction history on the app. Once the user knows about the status of his car battery, he can easily decide whether to proceed with the charging process by permitting to charge on the app. Once the acknowledgment is received from the user the system will perform the charging action and calculate the corresponding charges and deduct the amount from the owner's e-wallet and transfer it into the charging station owner's account. In this way Internet of Things (IoT) based smart charging has been developed to monitor the status of batteries and make the charging process semi-autonomous. The proposed system will provide a smooth charging experience and a better method to control the entire charging process.

Keywords— IoT- Internet of Things, EVs-Electric Vehicles, SoC-State of Charge.

ARTICLE INFO

Article History

Received: 14th May 2020

Received in revised form : 14th May 2020

Accepted: 16th May 2020

Published online : 22nd May 2020

I. INTRODUCTION

Most aspects of our daily life continues to transform by the digital revolution. Recently the most popular form of green transportation is (EV)electric vehicles. EVs have many advantages including that they are eco-friendlier, energy efficient, economical, and comfortable than conventional gasoline vehicles. Certainly, EV has evolved to be produced by many mainstream automobile manufacturers. Batteries play an important role in EVs because they serve the purpose of being either the primary energy source or the backup source in hybrid EV's. Battery performance is dependent on certain factors such as temperature, chemical composition, age, and rate of charge or discharge. In EV's, it is important to monitor the battery's state of charge (SoC) although this is not always easy because the characteristics of the battery itself. The boom of the World Wide Web has intensified interest in e-money that can be transferred over the internet. So, it is necessary to do the transactions for the charging of the vehicle electronically. For, that an e-wallet some form of digital payment system must be developed for faster and ease of transactions.

II. PROBLEM STATEMENT

To design and develop semi-autonomous smart charging system for Electric Vehicles wherein it can charge and display money payment transactions for an Electric vehicle with minimal user's interference with the help of IoT. To design an Android app that conveys the current State of Charge of the battery, alerts the user whenever the State of Charge goes beyond a threshold value, displays nearby charging stations and money transaction history of the whenever requested by the user.

III. REVIEW OF LITERATURE

M¨ugeKural, FatihKaanTuncer, Deniz Memis¸, M.Naci Dai developed a system for Electric Vehicles with Event

Processing. This paper is about a way to integrate the EV system and cloud. The paper uses CAN protocol to collect large data of the vehicle. Then it uses OSGI Gateway to transfer all data to the cloud and helps to process it. All the vehicle data is monitored in real time. [1]

Arunkumar P and Vijith.K developed IOT system uses a cloud platform and Android Apps for communication purposes. Internet of Things (IoT) based smart grid has been developed to monitor status of batteries in smart grid systems. The IoT which is developed here uses a cloud platform and Android Apps for communication purposes. The car user can easily check the health of his car battery and he can easily make a decision whether to take power from grid or to sell power to grid. [2]

In research paper of Mohammad Asaad, Furkan Ahmad, Mohammad Saad Alam, Yasser Rafat, Electric Vehicles (EVs) is a good prospect although the probability of damage to battery pack in case of overcharging or deep discharging situations prevails. To mitigate the danger of damage, an accurate real-time capacity determination of a battery pack is desired to increase their lifespan and to protect the equipment they power. A less complex and easy to implement algorithm i.e., coulomb counting technique is implemented in this paper and the estimated SoC along with measured parameters are made available in real time to the user on a remote basis in form of messaging communication. [3]

The above paper State-of-Charge Estimation with Open-Circuit-Voltage for Lead-Acid Batteries by C. S. Moo ; K. S. Ng ; Y. P. Chen ; Y. C. Hsieh is about estimation of State o charge with open circuit voltage. The state of charge is checked under different dynamic conditions. The open circuit voltage is plotted against different values of SOD. [4]

IV. PROPOSED METHODOLOGY

OPERATION OF THE PROJECT CAN BE DIVIDED INTO 4 MODULES:

- Electric Vehicle
- Webserver
- Charging Station
- Android App

Working of Electric vehicle:
Constantly monitoring of SoC and uploading the data into the SoC database. When the charge message is received from the webserver, sense the charging station on its route with the help of IR sensor and stop the vehicle in front of the charging station. When the charger is disconnected, it will continue to travel on its own route.

Working of Webserver:
It can be considered as the ultimate controller of the entire system. It stores the details of the following in the SQL database:

- The SoC of the battery.
- The registered vehicle numbers and RFID details.
- The times charging started and ended. Money transaction details on the vehicle side as well the charging station side using dummy bank accounts.

It monitors the SoC received from the EV and when it goes below a predefined value it sends alert message to the user. When the user sends charge command it sends the enable RFID and IR sensor's command to charging station. On receiving the information about the RFID tag it checks in its database whether vehicle is registered or not. When the matching details of the vehicle are found it sends start charging command to the charging station else it aborts the process and the user won't be able to charge. While the EV is charging, if the SoC reaches an upper threshold value it sends stop charging command to charging station. It deducts the total charging cost from the user account's database and sends it to the charging station's database. With the help of the charge timing table stored in the database, it calculates the total cost based on the following formula,

Total Cost = (Start time - End time) * Cost of charge per unit time.

Working of charging station:
On receiving enable message from the webserver, it enables the RFID reader and IR sensor. When the EV stops in front of the charging station, it identifies the vehicle using RFID Tag and Reader. It sends the information of the vehicle to the webserver and checks whether the vehicle is registered on the Android App. After authentication and recognition of the vehicle it waits for the webhost to send the start charging command and on reception of the start charging command it start the charging process by connecting the charger to the EV.As soon as the charging begins it sends the details of the start of charging time to the webhost and continues charging the vehicle until it receives stop message from the webhost. On receiving stop message it records the end of charging time and sends the information to the webhost and disables the power supply. Also, it disconnects the charger from the EV which is now free to travel.

Working of Android Application:
It displays the alert message whenever the SoC goes below the predefined value. It consists of Check Level button where the current SoC will be displayed. It consists of nearby charging station button displays the nearby charging stations by making a link to the Google Map. It consists of a charge button on which the user will send charge command. It also consists of History button which will fetch the transaction history from the webserver.

V. EQUATIONS

Open Circuit Voltage Method
There is approximately a linear relationship between the SOC of the lead-acid battery and its open circuit voltage (OCV) given by

$$V_{OC}(t) = a_1 * SOC(t) + a_{0,}$$

where SOC(t) is the SOC of the battery at t, a_0 is the battery terminal voltage when SOC = 0%, and a_1 is obtained from knowing the value of a_0 and Voc(t) at SOC = 100%. By, the estimation of the SOC is equivalent to the estimation of its OCV. The OCV method based on the OCV of batteries is proportional to the SOC when they are disconnected from the loads for a period longer than two hours. However, such a long disconnection time may be too long to be implemented for battery.

VI. BLOCK DIAGRAM

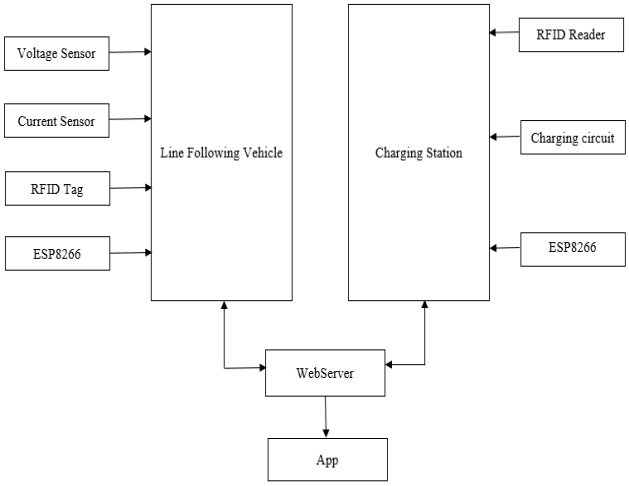

FIG 1. Block Diagram

VII. SOFTWARE REQUIREMENT SPECIFICATIONS

The proposed system application is created based on the java programming language. Arduino programming was used to program the microcontrollers Arduino uno and ESP8266 and the sensors and remaining hardware part of the system. User data and charging station owner's data is stored in sql database which is provided by 000webhost..

VIII. CONCLUSION

The proposed system accurately performs the charging of an EV without any human intervention. In this project we have designed an autonomous charging system with the help of IoT and android application which is able to uniquely identify the EV, charge the EV and accordingly generate bill for the amount of charging done. Hence IoT can revolutionize the way the system interact and respond for variety of applications in case of EV charging.

IX. ACKNOWLEDGEMENT

I wish to express my profound thanks to all who helped us directly or indirectly in making this paper. Finally I wish to thank to all our friends and well- wishers who supported us in completing this paper successfully I am especially grateful to our guide, Mr. M. M. Narkhede for his time to time, very much needed, valuable guidance. Without the full support and cheerful encouragement of my guide, the paper would not have been completed on time.

X. FUTURE SCOPE

The future scope of this project is to train the vehicle to predict the distance that it can travel based on various conditions like different driving patterns, type of roads, atmospheric conditions and most importantly State of Health of the battery. A machine learning algorithm can be developed for the determination of the distance that can be travelled with the amount of charge present. Also, we can develop self-power generating charging stations that can deploy power through solar, wind energy, etc.

Instead of charging the batteries at the charging station replace the existing batteries from the electric vehicles with the fully charged batteries in order to save the waiting time required to charge the battery at the charging station. Instead of using voltage and current sensors to identify SOC, a highly accurate algorithm for identification of SOC can be used. Identify the traffic at various charging stations and notify the users about the charging station that has minimum traffic.

Thus, there is wide scope of this project where it could be implemented for the various electric vehicles as well as for all other devices that are required to be charged from the charging station. Electric vehicle owner will soon be able to book time slot at charging station through mobile application and book them online and it will enable advance remote of charging slot.

REFERENCES

[1] M. Kural, F. K. Tuncer, D. Memiş and M. N. Dai, "A Smart Mobility Platform for Electric Vehicles with Event Processing," *2019 IEEE 5th World Forum on Internet of Things (WF-IoT)*, Limerick, Ireland, 2019, pp. 480-484. doi: 10.1109/WF-IoT.2019.8767225

[2]Arunkumar P, Vijith.K, "IOT Enabled smart charging stations for Electric Vehicle" International Journal of Pure and Applied Mathematics

[3] Mohammad Asaad, Furkan Ahmad, Mohammad Saad Alam, Yasser Rafat, "IoT enabled Electric Vehicle's Battery Monitoring System", The 1st EAI International Conference on Smart Grid Assisted Internet of Things, At Sault Ste. Marie, Canada,2017,doi: 10.4108/eai.7-8-2017.152984

[4] C. S. Moo, K. S. Ng, Y. P. Chen and Y. C. Hsieh, "State-of-Charge Estimation with Open-Circuit-Voltage for Lead-Acid Batteries," *2007 Power Conversion Conference - Nagoya*, Nagoya, 2007, pp. 758-762. doi: 10.1109/PCCON.2007.373052 System", The 1st EAI International Conference on Smart Grid Assisted Internet of Things, At Sault Ste. Marie, Canada,2017,doi: 10.4108/eai.7-8-2017.152984

[5] C. S. Moo, K. S. Ng, Y. P. Chen and Y. C. Hsieh, "State-of-Charge Estimation with Open-Circuit-Voltage for Lead-Acid Batteries," *2007 Power Conversion Conference - Nagoya*, Nagoya, 2007, pp. 758-762. doi: 10.1109/PCCON.2007.373052*Business*, Como, 2011, pp. 158-165.doi: 10.1109/ICMB.2011.48

