Design and Implementation of IOT based Innovative Charging Method For E-vehicles

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Abstract
The major goal of this paper is to use IoT to create a smart EV charging infrastructure. The application of IoT mesh rule-based algorithms to optimize low-carbon technologies via a single linked platform, therefore aiding in the decarburization of both energy generation and consumption. The most difficult difficulty with the EV is battery power management. Poor battery power management systems cause battery failure or damage, as well as fire mishaps. To avoid the issue of poor battery management, an IOT capable battery may be used, which will update the battery information/state of charging/healthiness to both the provider and the user. The battery management will be entirely wireless, with the ability to monitor different battery properties such as voltage, current, and temperature. Various sensors can collect data and send it to a microcontroller, which subsequently sends it to the cloud. This allows us to monitor the voltage current temperature in real time via smart phones and PCs. This paves the way for improving battery performance as well as battery life and optimizing its operation. An additional feature of web based user interface is also proposed for the better reliability.
Keywords: IoT, battery power management, real time data.

I. INTRODUCTION

The recent researches in the field EV, which attracts importance because of it is an appreciable alternative to conventional IC based vehicles [1]. These have the problems associated with EV charging is unavailability of commercialised EV charging stations[2]. Though the future vehicle industry will be ruled by the EV so the network of both charging points / station and national grid will be essential to meet the EV growth[3].

Fig. 1. Typical Fast Charging set up(Internet photo)

the peak need of clean green energy for the increasing EVs on the roads, increase the demand of charging station[4]. By monitoring the information of the charging stations and the information of vehicle needs to access the charging station based on the battery level will help to avoid crowding at charging station and locate the charging station [5]. The radio frequency identification monitoring based mesh network will be a promising solution. EM waves will be used to transmit and receive the information, which will enable us to optimize the charging infrastructure according to the requirement[6]. As part of study the usage of RFID charging monitoring and control also used for user authorisation[7]. The IoT based mesh networks will the cost effective and promising solution to identify and authorizing the vehicles at charging stations [8]. Fast charging on road charging shown in Fig..1. Charging station integrated with PV / Battery / grid tied power dispatch system for EV charging [9]. The advantage of this system is providing service for all lined vehicle a same time, especially where the charging power limited [10]. The Fig. 2 shows the information of the EVs and the charging station.

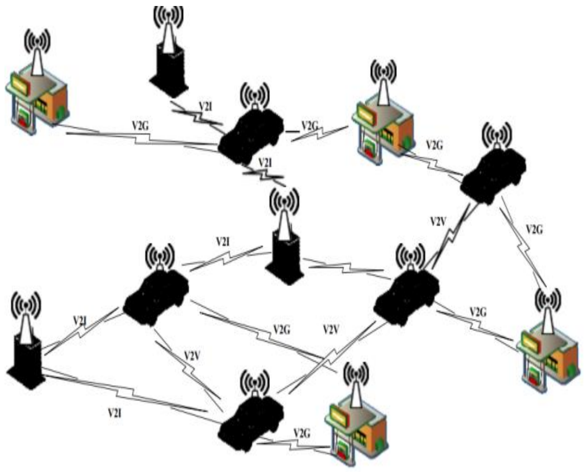

Fig. 2. Information of the EVs Connected to Cloud [9]

The group charging design study has been carried to understand the control and efficiency of the charging station. This facility can support for the cluster control over the widely connected EV group for charging[11].

The characterizes of the EV charging network business in the market and meet the environment policies of national and local. In order to meet the demand, the accurate metering and fast wireless charging of EV are looked[12]. The identification of the equipment, software required for charging station maintenance, power meters, on board and off board charging controlled charging units [13].

Berth or position allotting problem (PAP) is addressed by PAS (position allocating system) which schedule the EVs position and charging time[14]. The solution uses meta heuristics algorithm, simulating Annealing (SA) for scheduling the EVs. The design considerations are length of the vehicle for allocating the suitable position, time of charging based on the rating of the battery helps to identify the optimal solution [15]. Even all type of DC-DC converters [16-18] plays a major role in charge management as IOT involved in wireless sensor networks [19-20]. Fig. 3 shows the architecture of IOT.

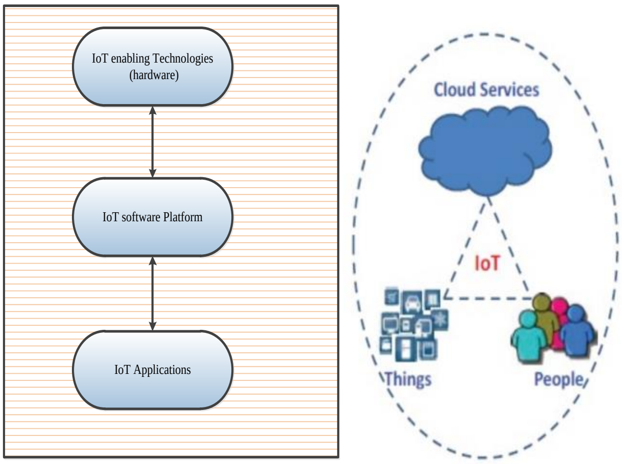

Fig. 3 Architecture of IoT [10]

The internet of things architecture is the interconnection of things information and the people and the cloud. The information or the data of the things are collected and stored in cloud that can be accessed by people at the any point of time. The IOT enabled device can connect to the cloud and update the information. The IOT enabled device an access data from cloud as well update information to the cloud its directional communication. The IOT enabled device i.e., the hardware module that cannot operate separately. It requires software and the application related to the IOT. The software for IOT enables the hardware to connect to the cloud.

The conventional IC engines energized by burning the fuels in the combustion chambers whereas the EV finds its energy from the huge batteries. These batteries act as the main source of power for the EV. These batteries used for are not a single battery instead it uses small tiny cells working together to meet the power requirement. These batteries undergo the process of charging and discharging. And the major cost of the vehicle is based on the battery and its performance. The researches in lead acid batteries makes it stable for long time source and certainly not at the time of starting. The thick plates of these lead acid batteries make these batteries as less resistant for repeated discharging and charging cycles. These types of batteries find its wide range of applications in lifts, E vehicles and E-bicycles. The fast charging depends on current flow rate between the battery and the capacitor.

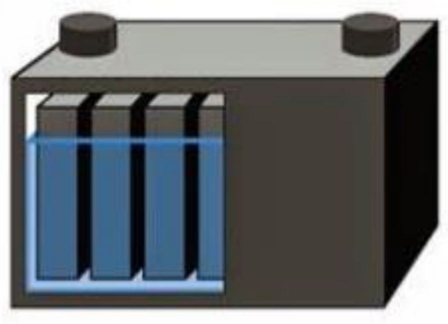

Fig. 4. Lead Acid Battery with Internal Cell Structure

The table 1 represents the Specifications for several types of batteries, per cell and Fig. 4 depicts the Internal Cell Structure for Lead Acid Batteries.

TABLE.1. VARIOUS TYPES BATTERY SPECIFICATION OF PER CELL

Battery Type	Voltage (V)	Self-discharge / month (%)	Resistance (Ω)
Alkaline	1.5	.3	.00166
Lithium	3	10	.0018
Nikal - Cadmium	1.25	20	.00133
Ni-Mh	1.25	30	.00133
Li -Po	3.6	10	
Lead-Acid	2	5	.057

The data flow diagram in Fig. 3 clearly describes the data from the physical system i.e., Battery is collected from the individual sensors meant for collecting the information of the battery like voltage current and Temperature. By the intelligent electronics device like micro controller (Arduino and many others) process the data received from the sensors and convert it as digital data through analog to digital converters, since sensors send only analog data. Through internet the information is stored in cloud. The stored data can be accessed through mobile or PC/ laptop.

II. METHODOLOGY

Fig. 5 shows the flow of information of the vehicle battery to the cloud and then to the consumer. With the system proposed the energy consumption can be optimised, so that the vehicle operation can be altered for the efficiency operation by adjusting speed of the vehicle. The EV s can be fast charged by using the capacitor bank system. The parameters of the battery like voltage, current and temperature are monitored using the appropriate sensors and the information received from the sensors are processed and stored in the cloud using IoT (Internet of Things).

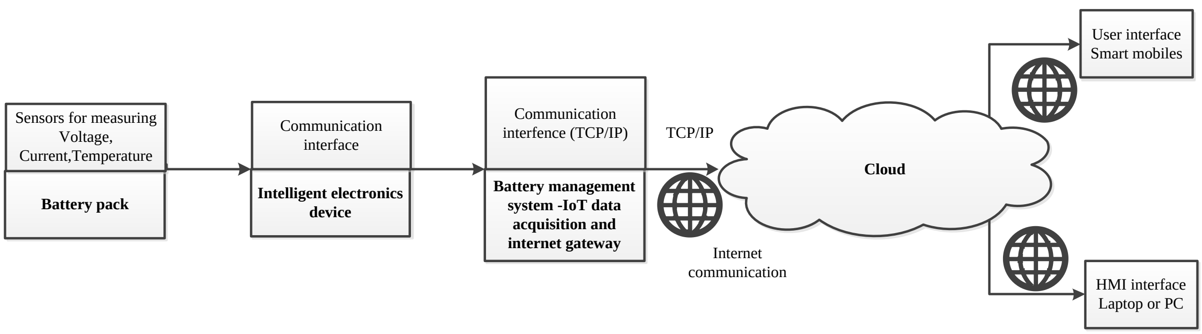

Fig..5. Flow of Data

The block diagram of the IOT based system is presented in Fig.6. The battery management system based on the sensors of the battery in the EV. The sensor like voltage, current and temperature sensor continuously monitor the battery voltage, current and Temperature of the battery in EV and continuously sends the data to the microcontroller like Arduino which process the data received from the sensors like conversion between analog to digital. The processed data are sent to the cloud by the attached Wi-Fi module and the data stored in the cloud can be accessed by the internet enable devices like PC/laptop or android mobile using the proper software application. EV charging requires the internet for the two-way communication. If any adverse condition of the EV battery is noticed then the alert system makes the alerts to the HMI. To safe operation, the alerts can be helpful. The vehicle can be turned off under the worse situation.

A. IoT system design:

Energy management system monitoring carried out using IoT system, which has one way communication using the web interface. The date from the vehicle to the cloud can also be monitored for the safety related matters. This stage two-way communication allows user to able to monitor the state art of energy. Perform voltage, current and temperature sensors will be sent through the monitoring system of the vehicle.

B. Testing of voltage sensor:

The voltage sensor ZMPT101Bis used to monitor the voltage status of the battery. The output of the sensor is sent to the microcontroller which will transfer the data to the cloud using the Wi-Fi module. When the sensor sends the weak signal or it contains the interference noise which may affect the sensor value. Table 1 displays the trial's outcomes. The table shows that the batteries were a mixture of new and old batteries, which causes the readings to vary. The results show that the accuracy of voltage measurements made with a voltage sensor and measurements made with a multi-meter are quite close. The accuracy rate for each battery that was measured was almost 92-95%. Therefore, it can be said that the voltage sensor provides precise measurements of the battery parameters.

TABLE 2.VOLTAGE MEASUREMENTS.

Volts-based voltage measurement results		**Accuracy In Percentage**
Multi-meter value	**Voltage Sensor values**	
3.5	3.71	94.3
9.1	9.5	95.7
8.1	8.6	94.1
1.31	1.42	92.2
3.5	3.81	91.8

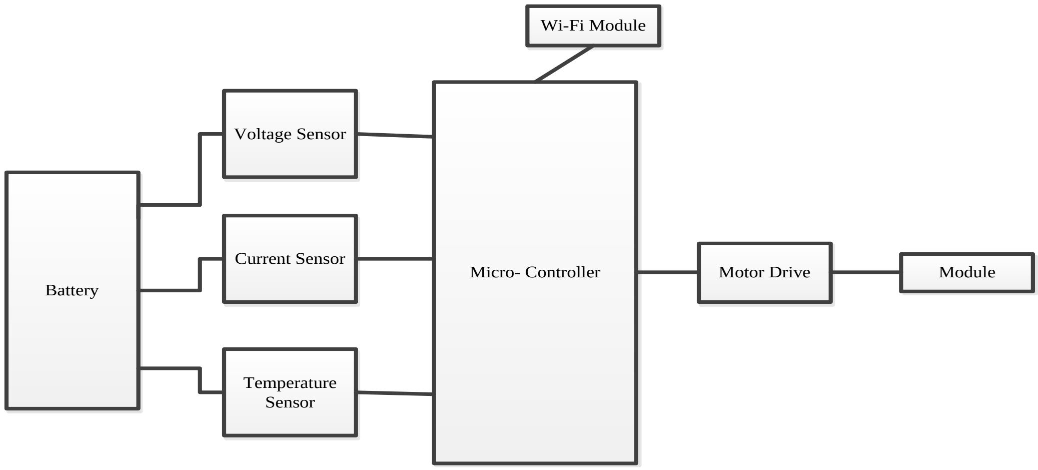

Fig. 6 Block Diagra the Proposed BMS

C. Testing of current sensor:

These miss data may lead to false conclusions of the state of battery terminal voltage. Fig. 6 shows the block diagram of the battery power management system.

The pictorial representation of the algorithm for the IOT enabled battery management system is shown in fig.7. The algorithm steps are as follows:

- Initialize the sensor inputs.
- Take the input from the sensors of the voltage, current and temperature.
- Convert the sensor Analog to digital,
- Monitor the value of the sensor.
- Display the values obtained.
- Check the temperature of the battery goes beyond threshold value.
- If the threshold value is less then the repeat the above procedure.
- If the threshold value is high then stop the vehicle.

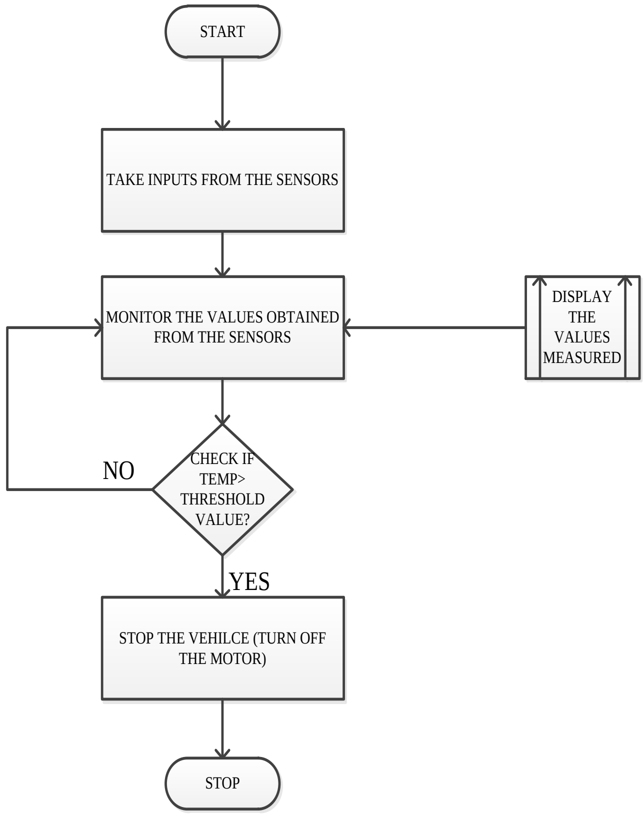

Fig. 7. Flow Chart of the Algorithm.

D. Testing temperature sensing:

The temperature sensor attached to battery senses the temperature of the battery. The temperature sensor used is DHT11, which will sense the temperature of the battery and sends the sensed signal to the microcontroller and then to the cloud using the Wi-Fi module. The temperature rise is immediately sensed and alert can be created so that the hazards fire accidents avoided. By the output of the temperature sensor the over charging and under charging can be detected by proper programming.

E. SoC:

Calculation of status of charge (SoC) which tells status of charger defines the remaining power and time required to charge the battery.

Status of charge = Initial SoC – Nominal capacity of battery

The lithium -ion battery uses 12V, 7Ah the current sensor used LTS25NP is used. The computed data will send through ESP8266 Wi-Fi module for Analog signal transfer.

Ada fruit is the android application used for real-time voltage current and temperature monitoring of the EV battery. Fig. 8. Shows electrical design of the proposed system. Arduino microcontroller is used for the hardware model. The Wi-Fi module is used to transmit to the cloud.

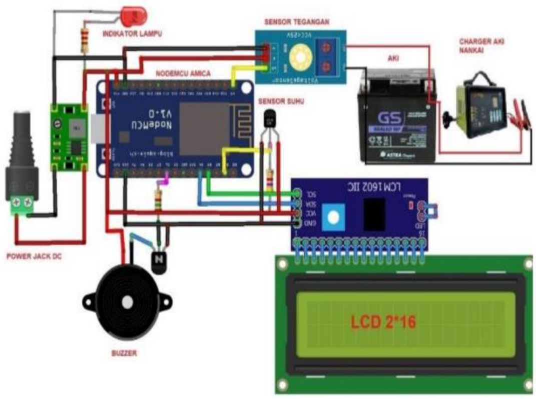

Fig.8. Electrical Design.

The main challenges identified are

1) The system should able to withstand all weather conditions (rainy, sunny, foggy etc.)

2) Internet connectivity cover range and speed on all climatical changes.

3) Lack of standardized wireless charging stations

4) Capability to handling large data

5) Maintenance cost of IoT devices is high.

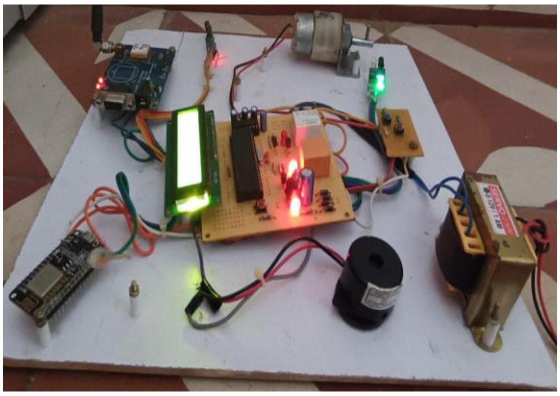

Fig. 9. Developed Prototype of the Proposed System.

Figure 9 represents the real time prototype design of proposed electrical design including all the components.

F. Web based User Interface:

An additional feature of battery monitoring system is web-based. The user interface tracks battery state and monitoring device locations. The user interface has been changed to monitor several battery states. Figure shows the web-based UI homepage. Before using the interface, users must log in. The login page ensures safe data management by requiring a username and password. The Web based interface is shown as in figure 10.

Fig.10..Additional user Interface.

III. Conclusion

IoT is used to power the link between the user and the electric vehicle. The management of the battery is analysed based on the current condition of the battery using the information supplied by the sensors. The idea that was presented in this article will reduce the amount of hassle experienced at charging stations. The user is able to make use of the data that is available about the battery of the EV through the sensors in order to take note of the state and healthiness of the EV battery in order to guarantee that the operation is carried out in a safe manner. The data that has been stored may be retrieved via the cloud using any software programmes, such as adafruit or MQTT board, and with this information, a determination regarding whether to continue travelling or locate a charging station can be made. The user can view the data stored with Adafruit for up to 30 days after it has been stored there. The current status of the battery's state of charge can be displayed on the display unit. In order to further improve the system's dependability, a web-based user interface is also suggested as an extra feature.

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