Optimal Power Management in Plug-in Electric Vehicle and an Energy Efficient Solution for charging Station with SMART GRID technology

T.Shanthi[1], J.Divya[2]

Abstract— **this paper discusses the modeling of a charging station for plug-in Electric Vehicles (EVs) and its utilization from grid support and renewable energy resources along with the power management techniques. A smart grid puts information and communication technology into production, transmission, distribution and ends with the customer. Smart Grid which is also called intelligent grid or modern grid uses new technologies to reduce the environmental impact of power grid, energy conservation, increase efficiency and renewable energy utilization. As the essential part of grid loads in the future, the charging station load foresigting, especially the short-term load out looking, will play a very important role in manufacturing arrangement, economic consigning, and safe operation of electric power system. It is important that forecasted load must be made known to the user by means of sending the information to the navigation system of the vehicle through the communication technology that has been spreaded all over the world. By this means power management can be done through load management at the interiors of the vehicle along with the information obtained at the navigation system which facilitates the driver to reach out the appropriate charging station effectively.**

***Index Terms*— Charging Station, GPS, PIC Microcontroller, Power Management, RF, Smart Grid.**

I. INTRODUCTION

Electric vehicles (EVs) play an important role in efficient energy utilization and zero–emission when in use. Due to the high price of the fossil fuel and the aggravating environmental issues, Plug-in Electric Vehicles (PEVs) have gained high popularity recently. Nowadays, there is a conflict between the rapidly increasing demand for electricity and the requirement for reducing dependence on fossil fuel to decrease the greenhouse gas emissions. Electricity is considered as the most universal form of energy, which can be transformed from and to another form effectively.

By converting the endurable renewable energy, like solar and wind, to electricity, we can manipulate energy in a much cleaner manner. Also the utilization of energy and the management of power should be carried out in a smarter way. In this paper two things are considered,

1. Along with the Navigation system of the vehicle which facilitates the occurrence of nearby charging stations, the following can be transmitted to the user.
   - The Available energy level of each charging station.
   - The Available number of charging points that are not engaged by any other vehicle.
2. Optimal Power management in the Hybrid Electric Vehicle can be done by selecting the loads of the vehicle interiors based on the Battery level.

II. CHARGING STATION

The development of EV relies on the foundation of infrastructures, such as charging station, which is one of the most important factors of exploiting market for EV. With the worldwide large-scale construction of charging station, the wide use of electric vehicle will cause the rapid growth of the power load and cause peak power of electric power in local areas and some periods of time when all are charging.

A. Smart Grid

Electricity is the most versatile and widely used form of energy and global demand is growing continuously. Usage of natural resources like fossil fuels, however, is currently the largest single source of carbon dioxide emissions, making a vital contribution to climate change. To overcome the consequences of climate change, today's electrical system are in need to undergo significant adjustments.

A smart grid is an evolved grid system that manages electricity demand in a consistent, efficient, reliable and economic factor, built on advanced infrastructure and tuned to facilitate the integration of all involved. Smart grids possess demand response capacity to help balance electrical consumption with supply, as well as the potential to facilitate the integration of new technologies to enable energy storage devices and the large-scale use of electric vehicles.

B. Renewable Energy Sources

Most of today's generation capacity relies on fossil fuels and contributes significantly to the increase of carbon dioxide in the world's environment, with negative consequences for the climate and society in general. Renewable energy technologies are clean sources of energy that have a much lower environmental impact than conventional energy technologies. Positive environmental impact is certainly one of the top reasons. Fossil fuels when burn produce toxic greenhouse gas emissions that have significantly contributed to global warming cause.

Using renewable energy instead of fossil fuels we would significantly decrease the total amount of greenhouse gas

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emissions which would help prevent stronger climate change impact. The most common sources employed can be are solar and wind energy sources. Based on the demand the required type of energy source can be chosen and are converted to the DC line by means of the charging circuit which is then stored in the battery.

C. Battery

The current level of the renewable energy generated and the grid is monitored by the Voltage reference unit, which is then provided as the input to the microcontroller. The ADC unit which is the built-in peripheral of the microcontroller converts the analog value into the digital value that is understandable by it. The amount of energy level that is being generated at that station is transmitted by means of the RF waves in the prototype.

D. GPS

GPS is often used as a navigation system. On the ground, GPS receiver contains a computer that "triangulates" its own position by getting bearings from various satellites. The result is provided in the form of a geographic position - longitude and latitude - to, for receivers that are placed in the navigation system of the vehicle. In the designed prototype the tracked location is send through the RF transmitter which is then obtained by the RF receiver of vehicle module.

E. Microcontroller

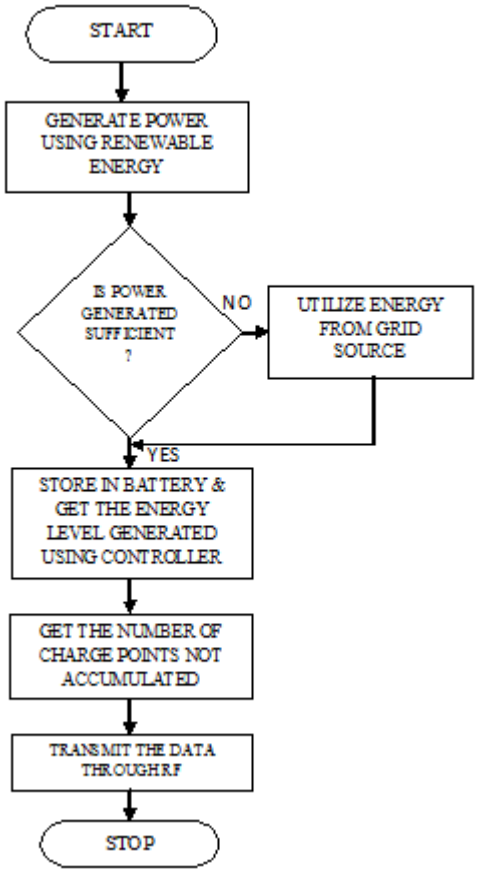
The microcontroller which acts as the core component of the system gets the information about the number of charge points that are being engaged by the user. Hence the total number of charge points that are not engaged in the charging station is calculated by the intelligent unit and it is then transmitted to the navigation system of the vehicle through means of RF transmitter**.**

The microcontroller being employed in the prototype module is PIC 16f877A which has various built-in features that facilities the working operation of this module. The same type of microcontroller can be used in the vehicle module also to carry out the power management operation along with getting the data at the navigation system to track the location of the charging station.

The microcontroller is connected to the charge point through the relay, where the 5V accepted by the controller has to converted to the appropriate voltage level used in the charge points. This is carried out by the relay unit connected in between them.

F. Flow of Operation

The flow of operation of the proposed system has been discussed as follows. The shifting between various energy levels takes place in a step by step process. The Transmission and Reception of data is carried out using RF Module.



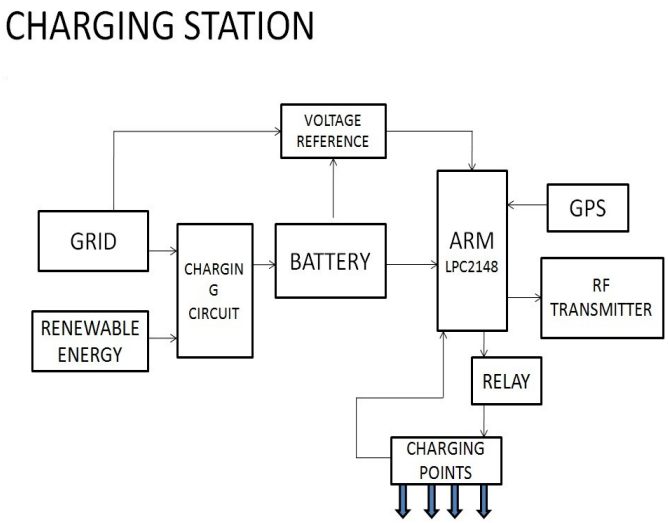


Fig. 1 Module in the charging station

III. POWER MANAGEMENT IN BATTERY

The battery is a fundamental component of electric vehicles, which represent a step forward towards consistent mobility. Battery monitoring is vital for most electric vehicles (EVs), because the safety, operation and depends on the battery system. The battery management system of electric vehicle had been designed, according to the function requirements of battery management system and the characteristics of controlled object and controller, Battery current, voltage are the major inputs of an electronic battery management system. The level of the battery is monitored by

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means of the voltage sensor in the vehicle battery unit, which gives the value as input to the microcontroller.

A. System Function and Test Analysis

Power management system in the battery for plug-in electric vehicle has following functionalities
Parameters detection
Collecting running parameters in charging and discharging process, and real-time display it. The collected data include: total voltage of the batteries, total current of the batteries.

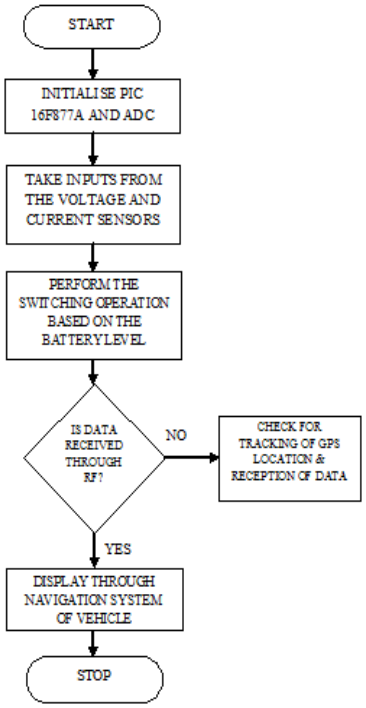
B. Load Management

In this prototype, optimal power management is carried out in the plug-in electric vehicles by means of using PIC microcontroller which automatically shutdown the loads based on the battery level of the electric vehicle. The level of the battery decreases as the vehicle is in the running mode, it is detected by the microcontroller, which shuts down the features of the vehicle like air conditioner, music player, interior lights, and usb port connectivity of the electric vehicle accordingly.

C. Navigation System

The location of the charging station which is tracked by the GPS unit is send to the vehicle's navigation system through the RF where the data about the engaged charge points are also transmitted through the RF. This is obtained at the navigation system of the vehicle and it is provided to the user through the display unit. In the prototype, the LCD module is used to display the status of the data being obtained.

D. Flow of Operation



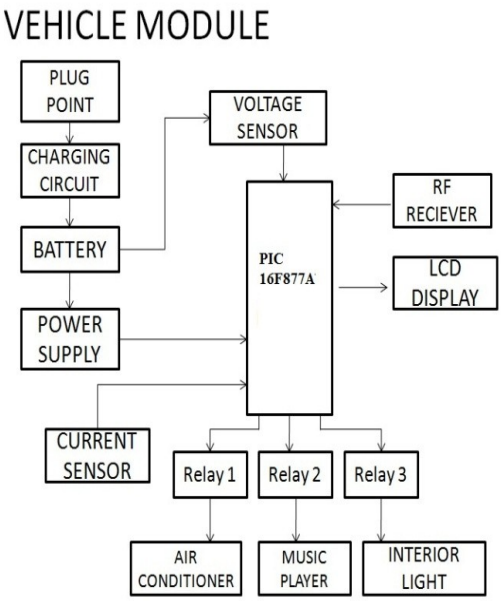


Fig. 2 Block Diagram of module in vehicle unit

IV. PROTEUS SIMULATION RESULTS

A. Battery Level Above 60%

The proposed system has been modelled using Proteus 8 Software. Here we have configured the variation in the battery level is shown by means of the variable resistance POT. When the battery level is of 60 % to 100% all the interior features of the vehicle is turned ON. In return then displayed in the LCD module to make the user understand whichever features are in ON STATE.

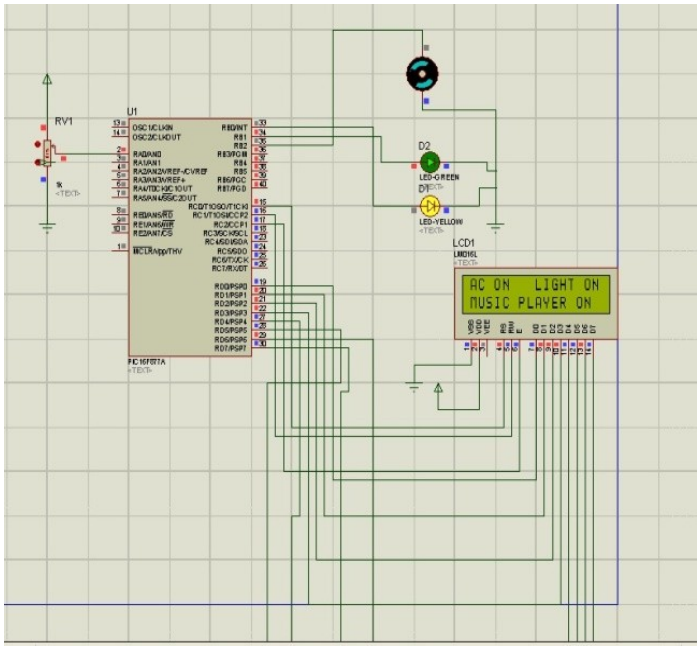


Fig. 3 Battery level above 60%

B. Battery Level Between 30% to 60%

As the vehicle is in running mode , the battery starts draining, when it is of 30% to 60% the highest power consumption feature is cut down automatically by the

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microcontroller. And it is also displayed in the LCD module.

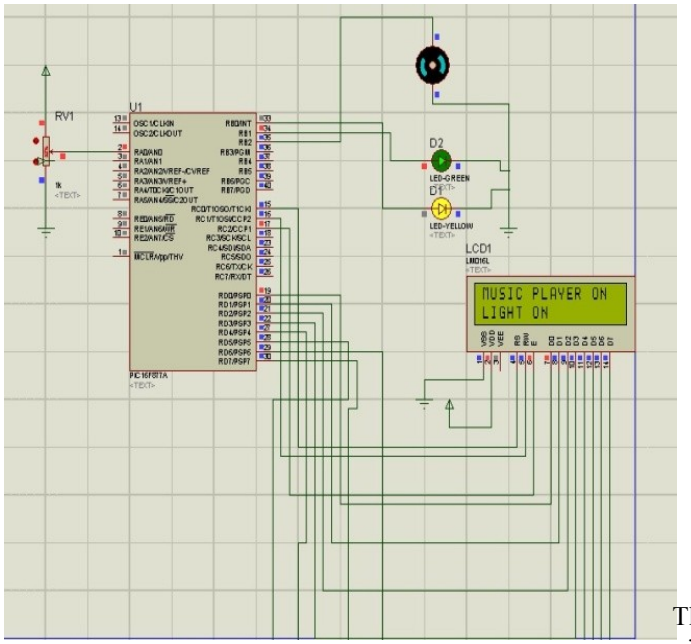

Fig. 4 Battery level between 30% to 60%

C. *Battery Level Below 30%*

When the battery level goes below 30% simultaneously the highest power consumption feature is cut down accordingly by the microcontroller based on the priority level.

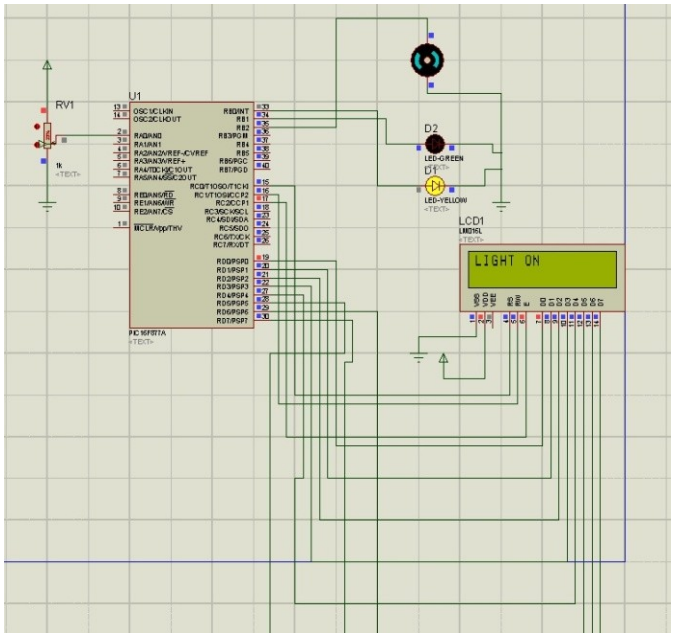

Fig. 5 Battery level below 30%

V. HARDWARE MODULE

The hardware module is constructed using PIC Microcontroller along with the necessary modules.

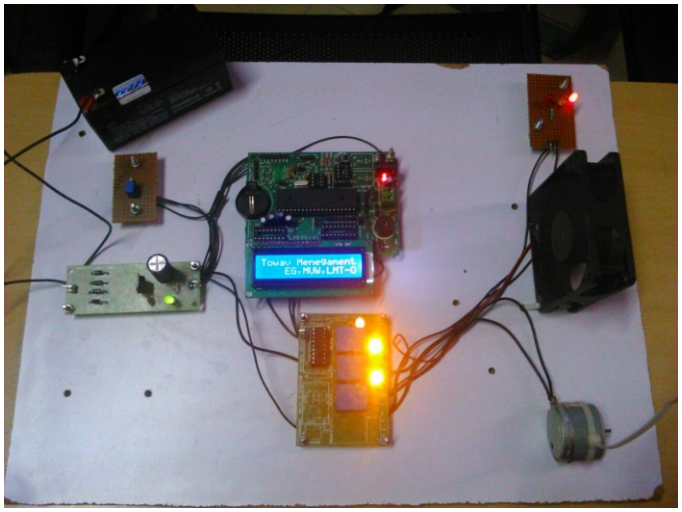

Fig.6 Hardware Module

VI. CONCLUSION AND FUTURE SCOPE

Thus through this system, power management can be carried out optimally, which helps out many vehicle users to make use of their battery level. The system will help to ensure the efficient working of battery. Through this the driving range of the vehicle can be considerably extended. The navigation system of the vehicle facilitates the user about the amount of energy level generated and the available number of charge points making the user to drive in a smarter way.

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