ISSN:2348-2079

Volume-6 Issue-1

International Journal of Intellectual Advancements and Research in Engineering Computations

Battery backup management system for electrical vehicle

#1M.Bhuvaneswari,*2Dr. C.N. Marimuthu,*3Mr.S.T.Sadish Kumar
PG Scholars, *Professor & Dean,*Associate Professor
Department of Electronics and Communication Engineering
Nandha Engineering College(Autonomous),Erode.
[1]E-Mail : sugan,bhuvi13@gmail.com
[2]E-Mail : muthu_me2005@yahoo.co.in
[3]E-Mail : sadishphd@gmail.com

***Abstract*- This paper proposes a new algorithm for a real time charging recommendation for an electric vehicle (EV) driver based on an accurate real-time range indicator system to avoid range anxiety. In this algorithm the graphical user interface (GUI) of the real-time range indicator system is also used to show the driver an accurate estimation of the remaining range to destination and the current state of charge(SoC). This algorithm also calculates the minimum charging time required at the charging station to reach the destination. Charging recommendation system, electric vehicle, energy management, real-time range estimation model, state of charge estimation these are tools required for implementing this paper. The proposed system will enhance the use of electric vehicles by reducing range anxiety and reduce the necessary charging time along a route and also helps the driver to travel over a longer distance by a depleted electric battery.**

***Keywords*— Charging recommendation system, electric vehicle, energy management, real-time range estimation model, state of charge estimation.**

I. INTRODUCTION

These concerns rank even higher than the higher cost of the vehicles and batteries. Even taking into consideration the new low-cost generation of electric vehicle batteries, the range anxiety can still limit the usage of electric vehicles [4].

Recently, a great deal of research effort has been devoted to the study of reducing range anxiety in EV. The research has been mainly concentrated on improving the SoC/range estimation by taking into consideration driving environmental conditions [5]-[6], driver behavior [5] [7] [8], traffic conditions [8]-[9], and time-variant efficiency analysis of the drive system [10]-[11]. The customer adoption, however, remains relatively low. This problem can be solved by combining the research in improving the SoC/range estimation with smart communication systems [12].

The smart communication systems in the automotive industry can be categorized into three levels: i) vehicle-to-driver (V2D) ii) vehicle-to-vehicle (V2V) iii) vehicle-to-infrastructure (V2I). V2V and V2I communication systems have been well-researched due to the large investments of governments to make the road safer by using these communication systems to reduce the traffic congestion [13], to track the position of the vehicles for infrastructure assessment [14] and to prevent of collisions [15]-[16]. There is still a lack, however, of research into the effectiveness of V2D communication systems for use in EV.

This paper proposes to combine an improved SoC/range estimation published previously by the authors [11] with a state-of-the-art V2D communication system to provide charging recommendation to a driver in an EV. The novelty of the system is that it can (i) alert the driver when charging is required during the route, (ii) identify the nearest charging stations with the exact names, addresses and geographical coordinates, and (iii) provide the amount of time required to charge the EV to reach the destination using simple, accurate and intelligent model without the necessity of establishing complex information environment. All information will be automatically obtained through GPS and the mobile internet system using publicly available websites or through stored historical data requiring little or no input from the driver.

It is envisaged that with an accurate SoC/range estimation and a smart V2D communication system, the driver can be more confident that he can always reach the destination without any possibility of being stranded. This will ultimately lead to increased adoption of EV.

A review of the importance of wireless communication methods especially in intelligent transportation systems and current Internet of Things (IoT) in industries is summarized in [17]. From the paper, the number of IoT-related journals from 2009 to 2013 increased significantly which shows the importance of the research area.

The main differences between previous researches and this work are as follows:

1) The algorithm will automatically obtain the driving environmental conditions and the driver behavioral factors from previously stored information about the driver, and use the information to estimate the SoC and remaining driving range, and for the proposed charging recommendation system.
2) The proposed system does not require a complex information exchange in order to obtain the required data for the algorithm – everything is obtained through the mobile internet system using publicly available websites.
3) The proposed system will be smart enough to provide sufficient data to the driver with little or no requirement of data input from the driver during driving reducing the risk of collision with other vehicles.
4) The proposed system is designed to ensure that there is a balance between the need for simplicity and the need for accuracy and hence the proposed model will use optimized functions considering computing capability of OBUs in its algorithm. Therefore, the proposed communication system can easily be implemented in any commercially available electric vehicles.

Introducing EVs with such an intelligent wireless communication system between EVs and drivers can be of great interest to younger generation or the technology enthusiasts, who would expect this capability from their vehicles. It is envisaged that such communication systems can help to improve the penetration of electric vehicle into the transportation market.

The remainder of the paper is organized into four sections. Section III presents the proposed real-time range indicator model with recommendation system. In Section IV, the details of the proposed GUI will be discussed. Section V summarizes the results of this work; and Section VI concludes the findings and identifies future works to be done.

II.RELATED WORKS

There have been a lot of work done on electrical vehicle system. New algorithms and implementation techniques and different methods are introduced in the electric vehicle system to avoid the anxiety.

2.1"Future vision for reduction of range anxiety by using an improved state of charge estimation algorithm for electric vehicle batteries implemented with low-cost microcontrollers," [1]

The fear of being stranded by a depleted electric vehicle (EV) battery is commonly referred to as ‘range anxiety’. This study explores a future vision for a comprehensive driver alerting algorithm to reduce the range anxiety by increasing the accuracy of the EV range estimation method. The key piece of information required to achieve this is an accurate battery state of charge (SoC) estimation. This study proposes an improved SoC estimation algorithm for implementation using low-cost microcontrollers. A method by which this improved algorithm can be implemented in a distributed battery management system is presented. The improved SoC estimation can be used to provide an enhanced range estimation method that can take into consideration a variety of environmental and behavioural factors. The proposed range estimate is more accurate than when only SoC is considered and can be implemented as part of a comprehensive driver alerting system to alert the EV driver of the expected energy required to reach the destination, the expected range with current SoC, an advisory if charging will be required prior to reaching the destination and the suggested duration of the charging required. By reducing the uncertainty surrounding EV range, it is hoped that the uptake of EVs can be improved.[1]

2.2 “Driver alerting system using range estimation of electric vehicles in real time under dynamically varying environmental conditions,"[2]

As the technology supporting electric vehicles (EVs) is rapidly progressing and the cost of EV components is reducing, EVs are becoming more feasible for use in Australia and in many countries around the world. However, the public perception of EVs and their perceived limitations result in a slow uptake of the technology, partially because of the uncertainty regarding the ability of an EV to meet the driving needs of the general population. Range anxiety is a particular concern with drivers having fear of being stranded by a depleted EV battery. This study explores means of reducing range anxiety by taking into account a variety of environmental and behavioural factors. By considering such factors and implementing it in conjunction with a recently proposed improved state of charge (SoC) estimation method by the authors, a range estimate can be produced that is much more accurate than the conventional methods which consider the SoC and vehicle efficiency alone. This range estimate can be used to inform the driver of the capabilities of the EV and advise if a recharge is required to reach the intended destination.[2]

2.3"Breadth-First Search-Based Remaining Range Estimation and Representation for Electric Vehicle,"[3]

This paper proposes a state-of-the-art algorithm for a real time charging recommendation for an electric vehicle (EV) driver based on an accurate real-time range indicator system to avoid range anxiety. The charging recommendation algorithm alerts the driver when charging is deemed required for the selected route. This algorithm determines the nearest charging location obtained using GPS based on an accurate estimation of SoC at the destination and when charging determines the optimum charging time required by the battery to have sufficient energy to reach the destination. The graphical user interface (GUI) of the real-time range indicator system is also used to show the driver an accurate estimation of the remaining range to destination and the current state of charge (SoC). The results from simulations of a range of routes validate the proposed algorithm.[3]

2.4"Real-Time Prediction of Battery Power Requirements for Electric Vehicles,"[4]

In this paper, we propose an efficient way of predicting the power requirements of electric vehicles (EVs) based on a history of their power consumption, speed, and acceleration, as well as the road information from a pre-downloaded map. The predicted power requirement is then used by the BMS to prevent the damage of battery cells that might result from high discharge rates. This prediction also helps BMS efficiently schedule and allocate battery cells in real time to meet an EV's power demands. For accurate prediction of power requirements, we need an accurate model for the power requirement of each given application. We generate this model in real time by collecting and using historical data of power consumption, speed, acceleration, and road information such as slope and speed limit. By using this information and the operator's driving pattern, the model extracts the vehicle's history of speed and acceleration, which in turn, enables the prediction of the vehicle's (immediate) future power requirements. That is, the power requirement prediction is achieved by combining a real-time power requirement model and the estimation of the vehicle's acceleration and speed. The proposed approach predicts closer to the actual required power than a widely used heuristic approach that uses measured power demand, by up to 69.2%.[4]

2.5"Review of driving conditions prediction and driving style recognition based control algorithms for hybrid electric vehicles",[5]

The performance of a vehicle control strategy, in terms of fuel economy improvement and emission reduction, is strongly influenced by driving conditions and drivers' driving styles. The term of 'driving conditions' here means the traffic conditions and road type, which is usually indicated by standard driving cycles, say FTP 75 and NEDC; the term of 'driving styles' here relates to the drivers' behavior, especially how drivers apply pressure on acceleration and brake pedal. To realize optimal fuel economy, it is ideal to obtain the information of future driving conditions and drivers' driving styles. This paper summarizes the methods and parameters that have been utilized to attain this end as well as the results. Based on this study, methods and parameters can be better selected for further improvement of driving conditions prediction and driving style recognition based hybrid electric vehicle control strategy.[5]

2.6"Method for estimating the energy consumption of electric vehicles and plug-in hybrid electric vehicles under real-world driving conditions,"[6]

This study presents a novel framework by which the energy consumption of an electric vehicle (EV) or the zeroemissions range of a plug-in hybrid electric vehicle (PHEV) may be predicted over a route. The proposed energy prediction framework employs a neural network and may be used either 'off-line' for better estimating the real-world range of the vehicle or 'on-line' integrated within the vehicle's energy management control system. The authors propose that this approach provides a more robust representation of the energy consumption of the target EVs compared to standard legislative test procedures. This is particularly pertinent for vehicle fleet operators that may use EVs within a specific environment, such as inner-city public transport or the use of urban delivery vehicles. Experimental results highlight variations in EV range in the order of 50% when different levels of traffic congestion and road type are included in the analysis. The ability to estimate the energy requirements of the vehicle over a given route is also a pre-requisite for using an efficient charge blended control strategy within a PHEV. Experimental results show an accuracy within 20–30% when comparing predicted and measured energy consumptions for over 800 different real-world EV journeys.[6]

2.7"Comprehensive Efficiency Modeling of Electric Traction Motor Drives for Hybrid Electric Vehicle Propulsion Applications,"[7]

Extensive research done in the recent past has proven that power electronic converters and electric propulsion motors are extremely critical components for modern hybrid electric vehicle (HEV) propulsion applications. Therefore, it is essential that both the traction motor and the associated drive operate at their optimal efficiencies throughout the driving schedule. In typical HEV propulsion applications, the traction motor and the drive are used over the entire torque/speed operational range. In view of this fact, this paper aims at modeling the inverter and motor losses/efficiencies over typical city and highway driving schedules. The noteworthy losses within a typical three-phase dc/ac traction inverter, such as the switching and conduction losses for both the insulated-gate bipolar transistors and the anti parallel diodes, are modeled and simulated over the city and highway driving patterns. An induction motor (IM) is used for a medium-sized sport utility vehicle, which was modeled in the Advanced Vehicle Simulator (ADVISOR) software. The significant IM losses that were considered in the study include the stator copper losses, rotor copper losses, and core losses. Thus, the average efficiencies of both the inverter drive and the induction traction motor are evaluated and summarized under city as well as highway driving conditions. Finally, based on the individual-model-based efficiency analysis, the overall traction motor drive system efficiency is estimated.[7]

2.8"Accurate range estimation for an electric vehicle including changing environmental conditions and traction system efficiency," [8]

Range anxiety is an obstacle to the acceptance of electric vehicles (EVs), caused by drivers' uncertainty regarding their vehicle's state of charge (SoC) and the energy required to reach their destination. Most estimation methods for these variables use simplified models with many assumptions that can result in significant error, particularly if dynamic and environmental conditions are not considered. For example, the combined efficiency of the inverter drive and electric motor varies throughout the route and is not constant as assumed in most range estimation methods. This study proposes an improved method for SoC and range estimation by taking into account location-dependent environmental conditions and time varying drive system losses. To validate the method, an EV was driven along a selected route and the measured EV battery SoC at the destination was compared with that predicted by the algorithm. The results demonstrated excellent accuracy in the SoC and range estimation, which should help alleviate range anxiety.[8]

2.9"Route planning and user interface for an advanced intelligent transport system,"[9]

The transport of hazardous materials can have a negative impact on human health and the environment quality; therefore it represents a relevant concern for each national economy of Europe. In Italy, the Apulia Region funded a research project to face this problem. In this framework, the authors proposed a flexible intelligent transport system (ITS) designed to work in many complex situations on the road network. This ITS uses artificial intelligence methods to implement route planning. Essentially, the system specifies a route for each vehicle by optimising a multi-objective function. The objectives, which are optimised, depend on the specific application and in this work they are related to the hazardous material transport impact reduction. This goal is achieved by implementing a negotiation process among intelligent agents. The system monitors the route followed by each vehicle and verifies if it coincides with the specified route. A key element of the ITS is a flexible on-board unit mounted on vehicles. It has a modular structure that allows for a variety of sensors to be connected, depending on the application. In this case, a variety of parameters, such as the vehicle speed, position, load balance and accelerations are analysed. Using that data the system identifies some characteristics, for example, the driver behaviour and hazardous vehicle operating conditions. In order to represent this information, the authors propose a multi-level metaphor-based graphic user interface (GUI). The first level of the interface provides a quickly understood view of the situation being monitored and it is oriented towards on-site first response and route monitoring operators. The second level provides more detailed information for incident managers and other operators. This interface has been evaluated using a human panel. Each volunteer has compiled a questionnaire after that he/she has used the interface for a 30-min session. The focus of this work is to present the approaches adopted for route planning and the user interface.[9]

2.10"A mobile application to assist electric vehicles' drivers with charging services",[10]

Although electric vehicles are attracting increasing interest from consumers and automakers, the disadvantages associated with limited range and the current scarcity of public recharge stations have played a key role in limiting their large scale adoption. In this paper, we explore how information technologies might be used to mitigate 'range anxiety' and further strengthen the potential of electric vehicle integration with the renewable energy generation and storage. We motivate several mobile applications/services which would improve the ownership experience of electric vehicles and flexibility for energy providers. Our work leverages a previously proposed sensor platform for collecting travel-time and energy-usage data for a road network by a community of electric car drivers. Travel time and energy-usage on a given road segment may exhibit substantial variability due to environmental and temporal factors,e.g., congestion, road's grade, AC on/off, etc. Such variability in turn, makes it difficult to accurately predict travel-times as well as the feasible range of a car given its current energy reserves. However, by collecting statistical data using cars/mobiles as probes one can quantify such uncertainty and develop complementary algorithms to counter the anxiety and time waste associated with such uncertainty. This paper develops the necessary (routing) algorithms to support these new classes of applications/services for electric vehicles.[10]

III.RESULT AND ANALYSIS

3.1 Vehicle unit

The Figure 3.1 will shows the proteus circuit of vehicle unit for the electrical vehicle. This is the original setup for the vehicle unit at working condition.

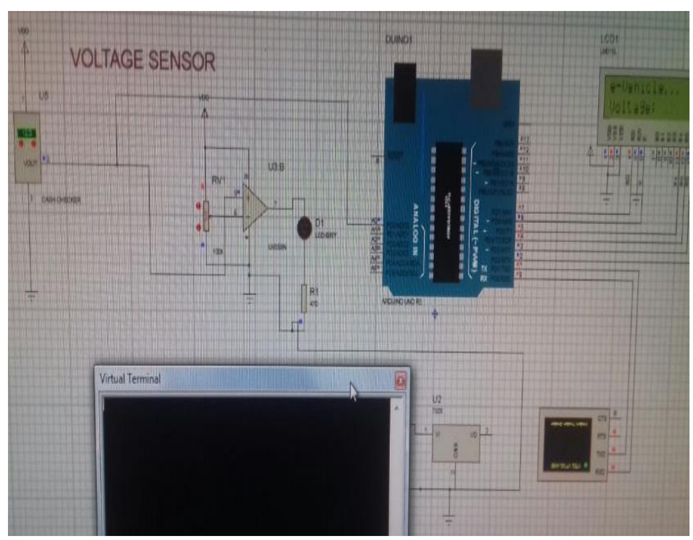

Figure 3.1 Electric vehicle unit system

This work proposes a new algorithm for a real time charging recommendation for an electric vehicle (EV) driver based on an accurate real-time range indicator system to avoid range anxiety.

The proposed system does not require a complex information exchange in order to obtain the required data for the algorithm – everything is obtained through the mobile internet system using publicly available websites.

3.1.1 GRAPICAL USER INTERFACE(GUI):

To implement the proposed range indicator system with the intelligent charging recommendation algorithm in a real electric vehicle, it would be beneficial to have a graphical view of the proposed model in the simulation environment. In order to do this, the proposed algorithm code is linked with a proposed GUI device. In the proposed GUI device, the driver enters the origin and destination names of the selected route from which the GPS will determine the geographical positions (latitude, longitude) of the beginning and ending of the route, the initial SoC, the number of occupants and also the time of day in the corresponding boxes in the GUI. The user also has the option of avoiding tolls and also considering traffic congestion along a route. To take into account of the traffic congestion along a route, Google API is used to indicate the location.

The details of each option are fully discussed in this paper, the pessimistic option is used for the calculation of vehicle SoC and total travel time. By pressing the "Get Route Data" button, the range indicator algorithm will extract all necessary real-time data from various sources. The Google direction API, Google elevation API, Google matrix distance API, WUI API, and Google places API are used for the real-time data extraction.

3.2Vehicle unit (at Low voltage)

This diagram will shows that when the battery getting low voltage, In this Figure 5.2 the LCD display will displays the battery percentage and also display LOW VOLTAGE.

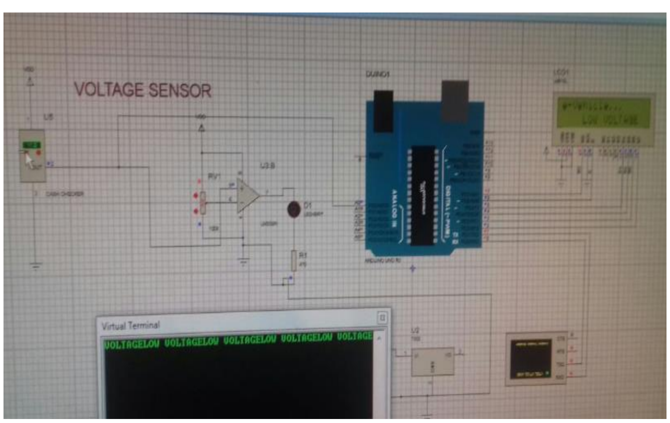

Figure 3.2 Electric vehicle unit system(at Low voltage)

In this simulation, in order to increase the possibility of finding charging station points near to the vehicle position along a route, some petrol stations in Australia have been added to the charging stations presented in figure 3.2.

3.3 Charging unit

The Figure 3.3 shows that charging unit of the electrical vehicle system. In this system when the battery has an low voltage the nearest power station will be displayed in vehicle and the vehicle select the particular station and go to charge the battery.

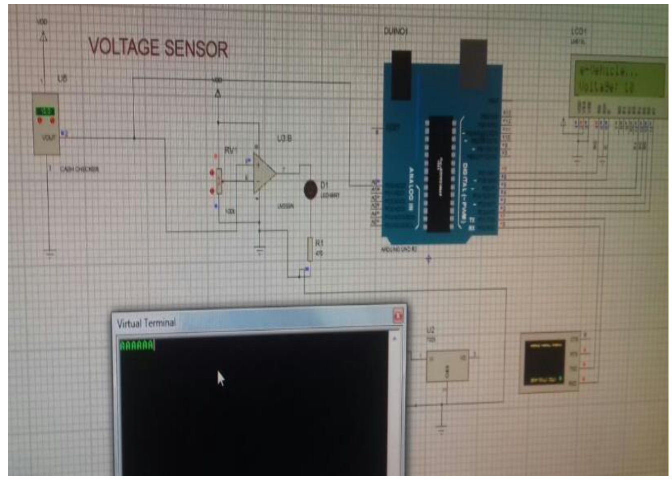

Figure 3.3 Charging unit system

Charging unit sends the reply message to the vehicle for the purpose of charging the car battery. The car automatically select the nearest charging unit for charging. We go the particular selected power station and then charge the car battery.

IV. ADVANTAGES

4.1 Advantages

There are many advantages in this process that are given below,

1) The system monitors the route followed by each vehicle and
verifies if it coincides with the specified route.
2) Collecting travel-time and energy-usage data for a road network by a community of electric car drivers.
3) High spatial resolution and high inspection performance while operating on vehicles driving at regular highway speed.
4) combining a real-time power requirement model and the estimation of the vehicle's acceleration and speed.
5) an accuracy within 20–30% when comparing predicted and measured
Energy consumptions for over 800 different real-world EV journeys.

V.CONCLUSION

An intelligent recharge alerting system are proposed in this work to reduce the driver range anxiety. Here the Arduino (Atmega328) is the main part of our project. With the help of the arduino the vehicle and charging unit where functioned and the battery getting charged. In this project we using the algorithm which is Graphical User Interface algorithm. By using this algorithm the battery will be charged and it will helps to driver to reach the destination. In this algorithm the charging cost and timing is very low comparing to other circuit.

Further research work will need to include the development of an actual real-time range indicator system with an actual GUI device. It is envisaged that the system can also automatically detect if the recommended charging station is available or not and if it is available to reserve a charging session. If it is not available, then the vehicle can select another nearby charging station that is available for use.

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