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A Review on Future Challenges Of Ev Range Extension

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***Abstract*:** Due to the duo of fossil fuel demand and air pollution we are in need of alternate transportation. The acceptable transportation is electric powered vehicles. The bottleneck in this method of transportation is lack of fuel filling station and EV range. Batteries play the most important role in traveling distance as well as performance of traction motor of every electric vehicle. Noticeably, the battery has a wide voltage range from fully-charged to empty state. The range extension issues are overcome with many solutions. But each and every one has its own drawbacks. Installation of a large-capacity battery pack is a straight forward method to extend the range of battery electric vehicles (BEV or all-electric vehicles). However, at the same time, a large-capacity battery pack not only occupies a big space but also significantly increases the vehicle weight, which directly impacts the fuel economy and vehicle performance. Electric Vehicles (EV) offer a strong prospect in achieving emission- free transport. This paper will encourage the audience to invest research and come up with solutions for the problem. Automobile engineers, EV manufacturers, mechanical engineers and budding researchers will be the primary audience for this paper. This paper is divided into three parts. Staring with introduction and discuss about the various methods of existing EV range extension and finally ended with the comparison and conclusion

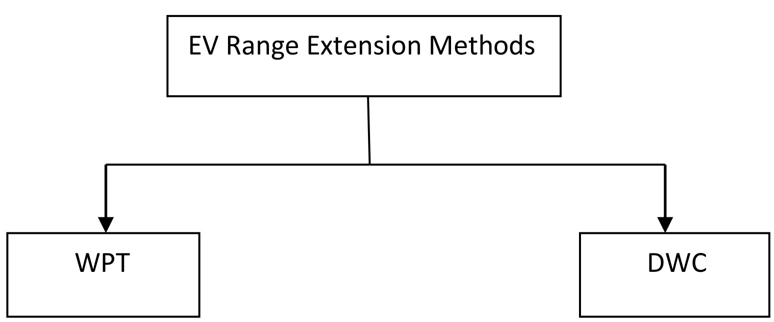
Keywords – BEV, Range Extension, Battery, Economy

I. INTRODUCTION

Currently, battery is the primary source in an electric vehicle (EV). The bigger battery, the further distance the EV can travel. In order to feed energy to the traction motor, in normal commercial EVs, the conventional inverter is used. Battery packs for electric vehicles (EVs) are created by placing numerous lithium-ion batteries in series, typically around 100 cells in series [1], to generate a high-voltage (HV) pack for energy storage. A battery pack will haveboth stronger and weaker cells, due to manufacturing impurities, temperature gradients across the pack, self-discharge rates, and mechanical constraints [2]. Major drawbacks of electric vehicles (EVs) are their limited driving range, high cost of batteries, and long charging time [3]. One way to extend the limited driving range of EVs is to increase the energy storage capacity by adding more batteries, but this adds to the weight and cost of the vehicle, adversely impacting performance and cost competitiveness. One possible way to overcome this drawback is dynamic wireless charging [4] – [6]. There are several approaches presently being considered for wireless charging and are based on: traditional inductive power transfer, capacitive wireless power transfer, magnetic gear wireless power transfer, and resonant inductive power transfer [4]. Most of theresearch efforts on wireless charging are currently focused on energy transfer between two objects through electromagnetic induction [6]. Rising mobility applications demand higher efficiency and it becomes imperative to act now in order to preserve our pristine environment [7], [8]. Electric vehicles (EV) render a feasible solution towards zero-emission transportation needs [9], [10]. Recently, SRM has become one of the most promising candidate to replace induction and permanent-magnet machines due to its robust, low-cost and simpler construction along with reliable high speed operation at increasing temperatures[11] Electric Vehicle technology has been witnessing a remarkable growth in the recent decade and is receiving immense attention from research fraternity. Along with the rest of the world, India has also been keen in embracing the EV adoption revolution over IC engine vehicles, owing to the several advantages of Indian market like abundant energy and human resources [12]. One of the major concern area in the extensive implementation of EVs is the limited driving range achievable per charge cycle for an EV. The increasing demand and the higher cost of electrical energy, improving the energy efficiency of the EVs is of prime importance in the EV technology. The problem of driving range has been addressed by improvisation of battery and charging technologies and introduction of range extenders. However, each of these techniques have inherent problems associated with the implementation in the current stage. The rapid charging technology is at infantstagewhereas range extenders calls for the retrofitting of auxiliary energy sources to the vehicle and face several safety as well as complexity issues associated with it. The range extension controllers were introduced in a later stage as a solution to avoid retrofitting and associated complexities in the drive train. One of the most explored control strategies is the torque vectoring control, where the driving torque distribution among the wheels can be controlled to improve the energy efficiency of the vehicle [13]. The driving torque, generated corresponding to driving inputs, is usually equally distributed among the front and rear wheels. This is often found to be inefficient in terms of energy consumption. By designing an optimal torque distribution controller which minimizes the energy consumption of the vehicle from the battery source, the driving range achievable per charge cycle can be increased significantly[14].

II. VARIOUS METHODS OF EV RANGE EXTENSION

To keep up with the fast-paced industry, and make EV's consumer friendly, we should come up with solutions that will help improve the range of an EV with a considerable amount. These solutions include dynamically charging the vehicle while the vehicles are moving and thereby generally extending their cruising range. This will also result in reduced range anxiety wherever such infrastructure is available[15].



2.1 Wireless Power Transfer Technologies Using Solar Power

According to [15] this solution includes hardware such as a transmitter and a receiver coil in order for the circuit to work, The requirements for the coil construction are the inductance (property of an electrical conductor to induce electromagnetic force) and capacity of the coil should meet the requirements, including the working frequency (number of occurrences over a given time) power transfer. The dimensions should be designed to fit the body or the chassis. The coil should shield electromagnetic waves from devices such as mobile phones. Lastly the construction should be durable. If these terms are met, the installation process will become convenient and practical. These coils are installed in CAM (Cement Asphalt Mortar) roads, which essentially are separate lanes that house these coils for induction of electricity. This system works on the application of mutual induction, 12 V are fed to battery by the solar panel, the voltage in the battery is stored in and in turn is given to the primary coil. At the same time the battery is connected to the 7805 Voltage Regulator (VR). The regulator steps down the voltage from 12V to 5V which is fed to an IR (Infra-red) sensor. This IR sensor in turn becomes active when something hits its rays and this sets off the output current, which energizes the secondary coil (of the vehicle) by inductive charging [15]. According to a test conducted by [15], it shows that the coil power is transmitted wirelessly and the induction is successful.

2.2. Dynamic Wireless Charging using Mobile Energy Disseminators

In order to eliminate the problem of increasing an EV's range, researchers and industries have come up with various solutions. One such solution includes DWC (Dynamic Wireless Charging) using MED (Mobile Energy Disseminators). According to [16] Here announced a new technology in which manhole covers will be used as charging stations in New York. Two OLEV (Online EV) buses are programmed to take a route on which the busses will charge during their commute, these have been put into service on roads of Gumi, a city in Korea. The power is transmitted through magnetic fields buried in the road which are nothing but electric cables under the road's surface. These create magnetic fields which induce electricity in the buses. MED is a device which can give out energy / electricity on the go. Energy exchange can be made possible by IPT or inductive power transfer, this is possible between the vehicles and installing a roadside unit for dynamic wireless charging. Buses and trucks can act as energy sources to EVs that need charging. These vehicles from now on can be referred to as MEDs. The buses can play the role of MEDs as they follow a predefined scheduled route with a good range and connectivity throughout the city. Trucks could function the same on highways. Busses can be fully charged when they are parked, prior to their trip and continuously charged during their scheduled journey by IPT stations installed at each bus stop. This is more feasible as it is easier to install these features into large public vehicles rather than individual passenger vehicles. This will work as followed, the vehicle requiring the charge will approach the appropriate truck from the front or the rear according to the construction. The truck will provide the vehicle charge by electromagnetic induction (production of electromotive force), Tesla coils or by electrically plugging in the two vehicles similar to mid-air refueling in airplanes. More vehicles could join and create a cluster head. Synchronization of the vehicles in the cluster will be determined wirelessly and mainly controlled by the bus / truck which acts as the main hub. The electromagnetic subsystems include magnetic coils which are similar to that as the primary and secondary of a transformer. These will have loose couplings and air as the medium to transfer the charge[16].

2.3 Improving the inbuilt hardware and infrastructure

In [17] is mentioned that all EV's have four main building blocks which are a battery, DC to AC converter, a motor and battery chargers. These main components function as the building blocks to the overall structure of the vehicle. We need to improve these components in order to make the vehicle better than the current iteration. To take this argument further, in [17] the following solutions are presented

2.3.1 Improved Storage Technology

Lithium-ion batteries are currently the most popular choices among charge storage as these are light and have higher capacities [4]. Ultra-capacitors can store the energy for a short time but theoretically have an infinite number of charge and discharge cycles. Another storage option is Hydrogen fuel cells, they have higher energy densities, many times higher than lithium ion batteries but have a poor response time. Ultra- capacitors have a faster response time but very low energy densities. Batteries can provide high continuous power. If we combine the benefits of all these storage technologies, overall efficiency of the EV can be significantly improved.

2.3.2 Improvement in the Motor

The electric motor is at the heart of the EV [17]. According to [17], selecting the right motor for the drive train is very important, which impacts the overall efficiency of the drive. Correct magnet arrangements on the rotor (moving part of the motor) should be evaluated for better performance. Reducing the losses in the motors can also contribute to the extension of range. There are two main types of losses which are copper losses and iron losses. If the make of the windings is improved, one can reduce the overall losses and hence improve efficiency.

2.3.3 Using wind Energy to Increase the Driving Range

A small wind turbine can be placed on the body of the vehicle; this turbine in turn will be connected to the battery. When the wind strikes the turbine, it can trickle charge the battery during motion [17]. This energy created by the turbine can be used in conjunction with the ultra-capacitors for quick charge and discharge cycles. This can also result in improving the vehicles range. In [18] an iteration of the following apparatus has been developed which is called as a Portable Wind Power apparatus for EVs. The device includes a wind turbine positioned on the vehicle's roof and a generator which is positioned within the vehicle that connects the turbine and the power systems of the vehicle.

2.3.4 Impact of Driving Behavior

It is stated that driving style has a lot of impact on the range of the vehicle. Driving range can be improved by about 30% by following practices like reducing the difference in acceleration and deceleration, avoiding high and steep accelerations and by reducing aggressive driving.

2.4 Bidirectional Quasi-Z-Source inverter

By using Bidirectional Quasi-Z- Source inverter instead of conventional one. Applying this solution, the vehicle can take advantage of full voltage range of the battery while still keep the performance of the motor at the highest level.

2.5 Hardware - efficient battery balancing

This balancing circuit for electric vehicle batteries that uses the low-voltage battery as a convenient source and sink for balancing. Compared to existing techniques, the proposed topology strikes a balance between the current industry standard of passive balancing and high component-count, high-cost solutions. For a battery pack consisting of n cells in series with in m modules, the proposed design uses (n + 1) bilateral switches for cell selection, and m low-voltage isolated dc/dc converters for cell balancing. Balancing can occur quickly during driving as the circuit can transfer energy between non adjacent cells concurrently throughout the pack. It Presents the design, control, simulation results, and experimental results of the proposed architecture. Furthermore, system-level vehicle modelling shows an increase in driving range of 1.8%–20.1% for different balancing parameters on repeated Urban Dynamometer Driving Schedule and Highway Fuel Economy Driving Schedule cycles for an end-of-life pack, compared to passive balancing, which does not charge cells while driving.

2.6 Propulsion assisting roads (PARs) for electric vehicles (EVs)

Concept of propulsion assisting roads (PARs) for electric vehicles (EVs) which can be considered as an alternative to the dynamic wireless charging technology. While both concepts of PARs and dynamic wireless charging pursue the goal of extending the driving range of EVs and utilize the same principle of energized coils embedded under the surface of the road, the concept of PARs is based on direct conversion of electrical energy into kinematic energy for propelling the vehicle in the fashion of linear electrical motor operation. A real time optimal driving torque distribution strategy for an electric vehicle (EV) with independently driven front and rear wheels. The proposed optimal torque distribution strategy among the front and rear wheels, improves the overall energy efficiency of the vehicle, thereby increasing the driving range achievable per charge cycle of the EV. The torque is optimized with the objective of minimizing the energy consumption during driving as well as maximizing the regenerative energy recuperation during the braking. This is realized by minimizing the losses during traction and regeneration by expressing the losses as a function of torque and optimized using Particle swarm optimization (PSO). Here, a real time torque distribution control system is proposed which can realize optimal distribution of driving-braking torque corresponding to the driving commands, for constant speed driving, acceleration, braking and grade climbing driving modes. The optimal torque distribution ensures minimal energy consumption, thus improving the energy efficiency of the EV. By reducing the energy consumed the driving range achievable per charge cycle is improved, realizing range extension of EV.

III. CONCLUSION

This paper has examined what solutions are currently viable in order to increase the range of EVs. There are many more solutions that are being currently pursued by researchers and engineers except these ones. The solutions stated in this paper are a few of the prominent ones that have a solid foundation and results. These solutions which include solar technology, MEDs and improving the current generation of EV's using improved hardware are the ones which are the most practical and viable options with current infrastructure. All of the three solutions are viable, each one has their drawbacks. It is clear that integration of all of the solutions will be the best to significantly improve the range. The most feasible one of them is to improve the current generation of EV's using improved hardware. This can be done with ease and won't be costly. It is strongly recommended that researchers and car manufacturers implement these technologies with each iteration of vehicles that come out in the market. EV's are the future as they are efficient, cheap and are eco-friendly as they emit nearly zero compared to ICE's. Producing electricity is cheaper too with renewable options such as solar energy, wind energy and thermal energy whereas petroleum is a fossil fuel which is not in abundance. Companies such as Tesla, BMW and Chrysler are shifting focus from ICEs to EVs and thus influencing the automotive industry. During this shift, newer technologies that make EVs reliable and better than current generations of vehicles should be implemented so that they become Consumer friendly and not just a gimmick.

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