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Efficient Real Time Voltage Absorption Model for Improved Span Maximization of Electric Vehicles in Suburban

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Providing electrical support for the electric vehicles has been identified as the keen issue in suburban. As the world moves towards using electric vehicles to reduce the fuel consumption and cost, it has been a key challenge for the vehicle manufacturer now a day. To solve this issue, there are number of models being recommended by the researchers. Some of the focused on reducing the energy depletion and some of them focused on maximizing the span of vehicle. However, they suffer to achieve the goal as the vehicle moves on the suburban and they does not consider the possibility of voltage absorption in suburban sector. To handle this issue, an Real time Voltage Absorption Model (RVAM) is presented in this article. The method focused on providing effective electric support for the vehicle at the suburban area. To perform this, the method consider the vehicle speed, routes available, stations available to direct the vehicle on the speed and direction. With these factors, the method computes Voltage Support Factor (VSF) for various routes and identifies suitable routes for the vehicle and provides recommendation for them. The proposed model improves the energy utilization and span maximization.

Keywords: Voltage Absorption, Energy Depletion, RVAM, VSF, Span Maximization.

1. Introduction

The use of electricity has been identified as the most dominant factor in the energy sector. The human society utilize the electricity for various purposes and mostly depending on the energy factor[4]. The most human work is performed through the use of electricity. On the other side, the increased use of fuel like petrol and diesel claims higher cost of any country and has direct impact on the economy of the country as well. So, in order to reduce the outgoing funds, the most countries has shifted their focus towards using electric vehicles. The most countries promote the use of electric vehicle and announces various subsidies for the manufacturers. The automobile sector claims various facilities from the government and publishes various vehicles every year.

The frequency of using electric vehicles is getting increased in recent years. But the only issue is the infrastructure support required for the electric vehicles. For example, if the manufacturer is providing a span of 600 kilometer in one charge, and it would be different in on road conditions. The span of vehicle gets reduced due to the traffic and speed conditions. So, it is necessary to provide effective on road support for the users of electric vehicles. On the other side, the span of the vehicle must be increased by adapting various factors and measures. The span of vehicle can be increased by choosing efficient route for the vehicle and other factors like traffic conditions should be considered towards increasing the vehicle span.

There exist number of approaches towards maximizing the span of vehicle which consider the energy of the vehicle alone[19]. This introduces poor performance in maximizing the span of vehicle. With the consideration to increase the span of vehicle in suburban, an efficient Real time Voltage Absorption Model (RVAM) is presented in this article[20]. The method focused on providing effective electric support for the vehicle at the suburban area[2]. To perform this, the method consider the vehicle speed, routes available, stations available to direct the vehicle on the speed and direction. With these factors, the method computes Voltage Support Factor (VSF) for various routes and identifies suitable routes for the vehicle and provides recommendation for them[25]. By adapting the proposed model, the vehicle span can be increased and the model would provide good road support for the consumers. The detailed working of the model has been sketched in this part.

2. Literature Review:

There are several ways that are advocated in the literature, and this section provides a concise overview of the methods related to the topic.

In [1], a sophisticated energy management system is introduced to facilitate the adaptable functioning of grid-connected electric vehicles (EVs) fuelled by solar energy[6]. The approach utilizes restrictions such as photovoltaic (PV) availability, grid loads, and electric vehicle (EV) charging load data. The approach employs a Markov decision process (MDP) for the purpose of vehicle control. In [21], a disturbance observer (DOB)-based model predictive voltage control (MPVC) is proposed as a means of assisting electric vehicles. The model predicts the availability of electricity in the vehicle for measuring the vehicle's span. Consequently, the approach provides instructions for the vehicle.

In [27], a model is introduced that utilizes particle swarm optimization (PSO) to develop a control law. This control law aims to maximize the voltage output from a photovoltaic generator (GPV) and uses PSO to regulate the power supply to the vehicle[8]. The Particle Swarm Optimization (PSO) algorithm is utilized to determine the optimal path for a vehicle, ensuring it receives sufficient energy support to maximize its range.

The paper presents an architecture called the multi battery block module (MBM) to provide power for electric vehicles. This design combines a multi-battery block module and a photovoltaic (PV) panel in an asymmetrical half-bridge (AHB) converter. The purpose is to generate a multilevel bus voltage for the SRM drive. In [5], a tracking absorption approach is introduced. This strategy involves modifying the charging process of electric vehicles using an electric vehicle aggregator (EVA) and use the soft actor-critic (SAC) algorithm to schedule the operation. By implementing this method, the range of the vehicle has been extended to some degree.

An electric-drive-reconstructed onboard charger (EDROC) is described in [26]. It utilizes a six-phase machine drive and power traction inverter to enhance the charging process[18]. The onboard charger generates and stores electrical power without enhancing the maximum lifespan.A synchronous Maximum Power Point Tracking (MPPT) over Direct Power Path (DPP) topology is introduced in reference [7]. This topology aims to enhance targeted decoupling and minimize the challenges and intricacies associated with decoupling.

In [23], a model is introduced that utilizes a long short-term memory (LSTM) recurrent neural network (RNN) to efficiently manage the charging and discharging of several electric vehicles (EVs). LSTM has been applied to power control and combined with RNN to facilitate the selection of charging units and scheduling of charging points for electric vehicles.

In [22], a model is proposed for power allocation and distribution in charging stations to facilitate the charging of electric two wheelers. The model consists of three stages. In [10], a framework for analyzing the stability of power grid voltage is described. This framework utilizes Monte Carlo simulation to examine the power generation and load demand[15]. The driving data of the Toyota Prius vehicle has been showcased and examined in reference [17]. A scheduling methodology that is highly efficient is introduced in reference [12], specifically designed to manage the allocation of mobile energy storage devices[3]. In [24], a hierarchical coordination structure is proposed for managing residential demand by utilizing solar (PV) units, battery-energy-storage-systems (BESs), and electric vehicles (EVs)[16].

In [26], a bidirectional dc converter (Bi-C) is introduced with the aim of enhancing dynamic stability and delivering a high-quality power supply for electric vehicles (EVs) [9].

3. Methods:

Real time Voltage Absorption Model (RVAM):

The proposed real time voltage absorption model (RVAM) maintains the data about the road conditions and the infrastructure data. The method focused on providing effective electric support for the vehicle at the suburban area. To perform this, the method consider the vehicle speed, routes available, stations available to direct the vehicle on the speed and direction. Any route would contain number of charging units in various locations and by considering the above mentioned factors, the method would identify a most optimal route for the vehicle to maximize the span of vehicle. With these factors, the method computes Voltage Support Factor (VSF) for various routes and identifies suitable routes for the vehicle and provides recommendation for them.

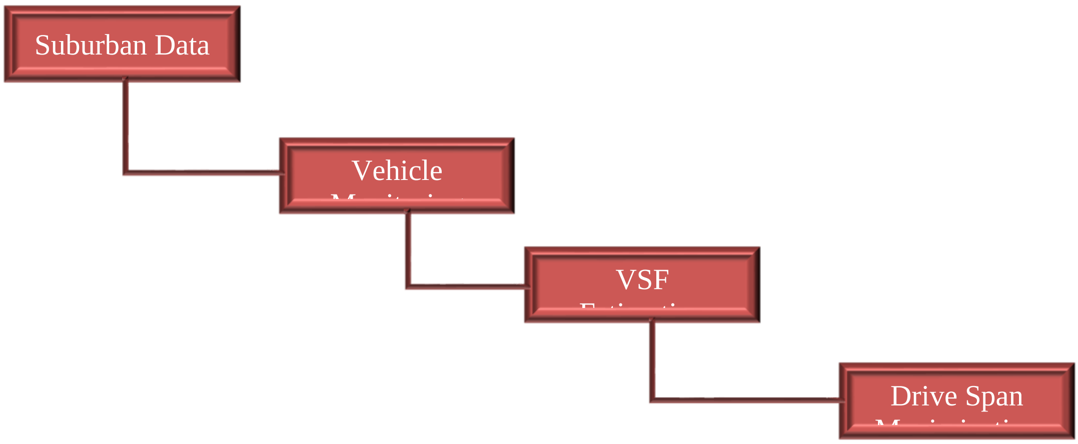

Figure 1: Architecture of proposed RVAM model

The functional architecture of proposed RVAM model has been presented in Figure 1, where the functions of the model have been discussed in detail in this section.

Vehicle Monitoring:

The proposed model RVAM monitors the vehicle condition at all the seconds. The model monitors the vehicle speed, direction, residual voltage and destination. At each time stamp, the method monitors the vehicle condition and produces a feature vector to support vehicle span maximization.

Algorithm:

Given: Road Data Rd

Obtain: Feature Vector Fv

Start

Read Rd

While true

Monitor vehicle Ev.

Speed s = Ev.Speed

Direction D = Ev.Direction

Energy E =Ev.Energy

Destination De = Ev.Destination

Feature vector Fv = {Ev, s, D, E, DE}

Perform VSF Estimation

Perform Drive Span Maximization

Wait for next cycle

End

Stop

The vehicle monitoring algorithm monitors the conditions of the vehicle and produces a feature vector to support drive span maximization.

Drive Span Maximization:

The proposed RVAM model performs drive span maximization according to the road conditions and energy of the vehicle. The model monitor the vehicle and fetches various data about the vehicle. Using these features, the method identifies the set of routes in the road map and for each of them the method computes the value of VSF. According to the value of VSF, the method identifies the optimal route to reach the destination.

Algorithm:

Given: Road data Rd, Feature Vector Fv

Obtain: Null

Start

Read Rd and Fv.

Identify route set Rs = $\sum_{i=1}^{Size(Rd)} Rd(i).Destination == Fv.De$

For each route R

Compute VSF = $\frac{R.Distance}{R.No\ of\ Charging\ Hubs} \times \frac{Fv.Energy}{Fv.Speed}$

End

Route R = $\underset{i=1}{\overset{Size(Rs)}{Max}}(Rs(i).VSF)$

Divert vehicle through the route R.

Stop

The proposed model identifies the optimal route for the vehicle according to the value of VSF and vehicle has been diverted through the route identified.

4. Results and Discussion:

The Real-time Voltage Absorption Model (RVAM) has been implemented using Simulink. The model's performance has been assessed across multiple parameters and is presented in this section.

Table 1: Experimental Details

Parameter	Value
Tool Used	Simulink
No of routes	100
Time	10 minutes

The experimental details used towards performance analysis are presented in table 1.

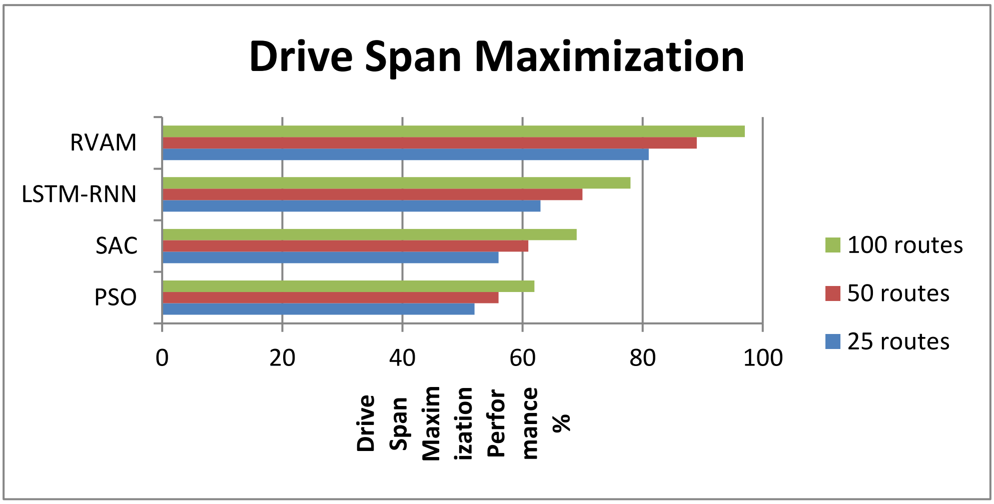

Figure 2: Drive Span Maximization Performance

The efficacy of the drive span maximization method is assessed and displayed in Figure 2. The RVAM model exhibits superior performance compared to other models. The performance of driving span maximization has been evaluated based on the number of possible routes. The proposed RVAM model has consistently outperformed alternative models in every situation.

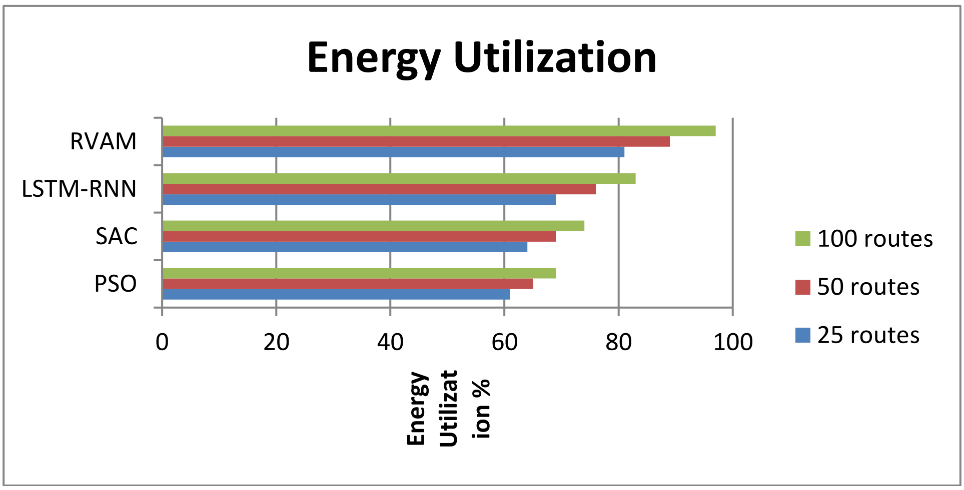

Figure 2: Energy Utilization Performance

The efficacy of voltage regulating methods is evaluated and displayed in Figure 3. The RVAM approach has superior voltage regulation performance compared to alternative methods. The energy utilization is quantified based on the number of available routes, and in every scenario, the suggested RVAM model has consistently demonstrated superior performance compared to alternative models[13].

5. Summary:

This paper presented a novel Realtime Voltage Absorption Model (RVAM) towards maximizing the span of electric vehicles. The proposed real time voltage absorption model (RVAM) maintains the data about the road conditions and the infrastructure data. The method focused on providing effective electric support for the vehicle at the suburban area. To perform this, the method consider the vehicle speed, routes available, stations available to direct the vehicle on the speed and direction. Any route would contain number of charging units in various locations and by considering the above mentioned factors, the method would identify a most optimal route for the vehicle to maximize the span of vehicle[11]. With these factors, the method computes Voltage Support Factor (VSF) for various routes and identifies suitable routes for the vehicle and provides recommendation for them. The proposed method improves the performance of drive span maximization and energy utilization[14].

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