https://doi.org/ 10.33472/AFJBS.6.10.2024.3879-3886

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

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

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Article History

Volume 6,Issue 10, 2024

Received:13 Apr 2024

Accepted : 05 May 2024

doi: 10.33472/AFJBS.6.10.2024. 3879-3886

Abstract:

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

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. 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. 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. 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. 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.

Literature Review:

There exist number of techniques recommended in literature and this section briefs set of methods around the problem.

An intelligent energy management system is presented in [1], to support flexible operation of grid connected solar powered electric vehicle (EV). The method uses the constraints like PV availability, grid loading and EV charging load data. The method uses a Markov decision process (MDP) to perform vehicle control. A disturbance observer (DOB)-based model predictive voltage control (MPVC) is presented in [2] to support electric vehicle. The model predict the voltage would be available in the vehicle to measure the span of the vehicle. Accordingly, the method performs directions for the vehicle.

A particle swarm optimization (PSO) based control law generation model is presented in [3], which generates maximum voltage from photovoltaic generator (GPV) and applies PSO to regulate the supply to the vehicle. The PSO is used to identify the route for the vehicle where it would get enough energy support to maximize the span of vehicle.

A multi battery block module (MBM) topology is presented in [4], to support electric vehicles which uses multi-battery block module and photovoltaic (PV) panel into an asymmetrical half-bridge (AHB) converter, to supply a multilevel bus voltage for the SRM drive. A tracking absorption strategy is presented in [5], which adjust the charging process of electric vehicle through electric vehicle aggregator (EVA) and uses soft actor-critic (SAC) algorithm in scheduling the process. By adapting this strategy, the span of vehicle has been increased for some extend.

A electric-drive-reconstructed onboard charger (EDROC) is presented in [6], which has six phase machine drive and power traction inverter to leverage the charging process. The onboard charger produces electric supply and retain the energy for some point and does not improve the span maximization. An synchronous MPPT over DPP topology is presented in [7], to facilitate more targeted decoupling and reduce the difficulty and complexity of decoupling.

A long short-term memory (LSTM) recurrent neural network (RNN) based model is presented in [8], to schedule charging and discharging of number of EVs in the model. The use of LSTM has been adapted to the power control and integrated with the RNN which support the selection of charging unit and schedule the charging point for the electric vehicles.

A three stage voltage allocation and distribution model is presented in [9], to support electric two wheelers in charging station. A power grid voltage stability analysis framework is presented in [10], which analyze power generation and load demand with Monte Carlo simulation. The driving data of Toyota prius car has been demonstrated and analyzed in [11]. An optimal scheduling model is presented in [12], which handles the distribution mobile energy storage systems. A hierarchical coordination framework is presented in [13], to manage domestic load using photovoltaic (PV) units, battery-energy-storage-systems (BESs) and electric vehicles (EVs).

A bidirectional dc converter (Bi-C) is presented in [14], to improve dynamic stability and provide a high-quality power supply for EVs.

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.

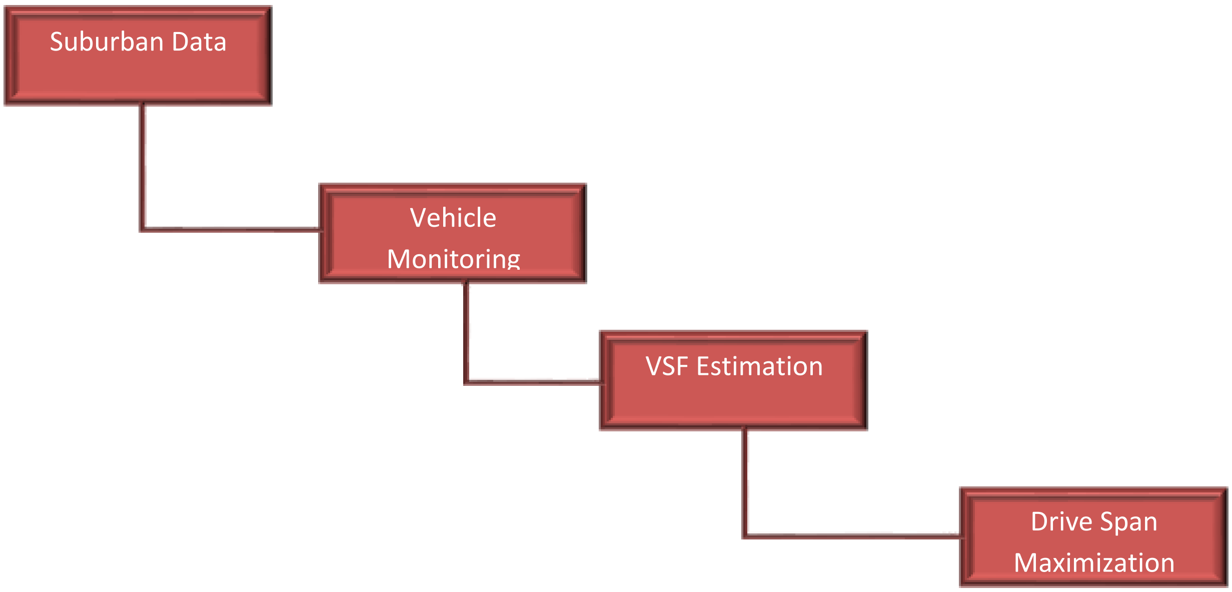

Figure 1: Architecture of proposed RVAM model

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.

Results and Discussion:

The proposed Real time Voltage Absorption Model (RVAM) has been implemented with Simulink. The performance of the model has been evaluated under various parameters and presented in this section.

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

Table 1: Experimental Details

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

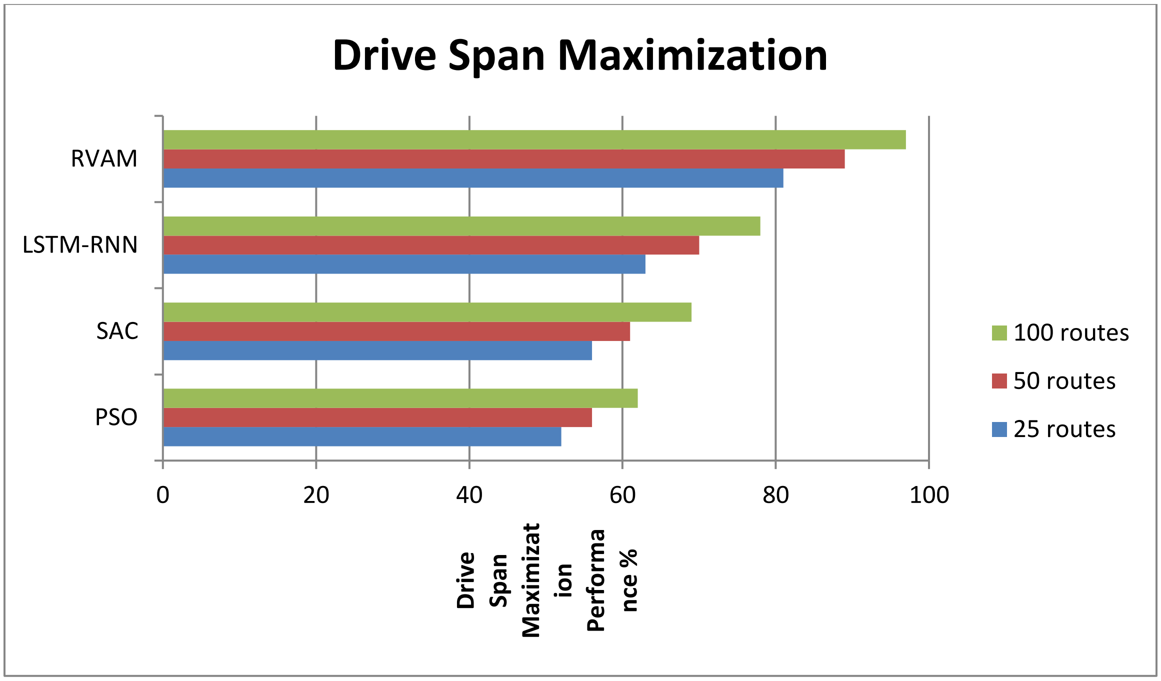

Figure 2: Drive Span Maximization Performance

The performance of method in drive span maximization is measured and presented in Figure 2. The RVAM model introduces higher performance than others. The performance of drive span maximization has been measured with number of routes available. In each case, the proposed RVAM model has produced higher performance than others.

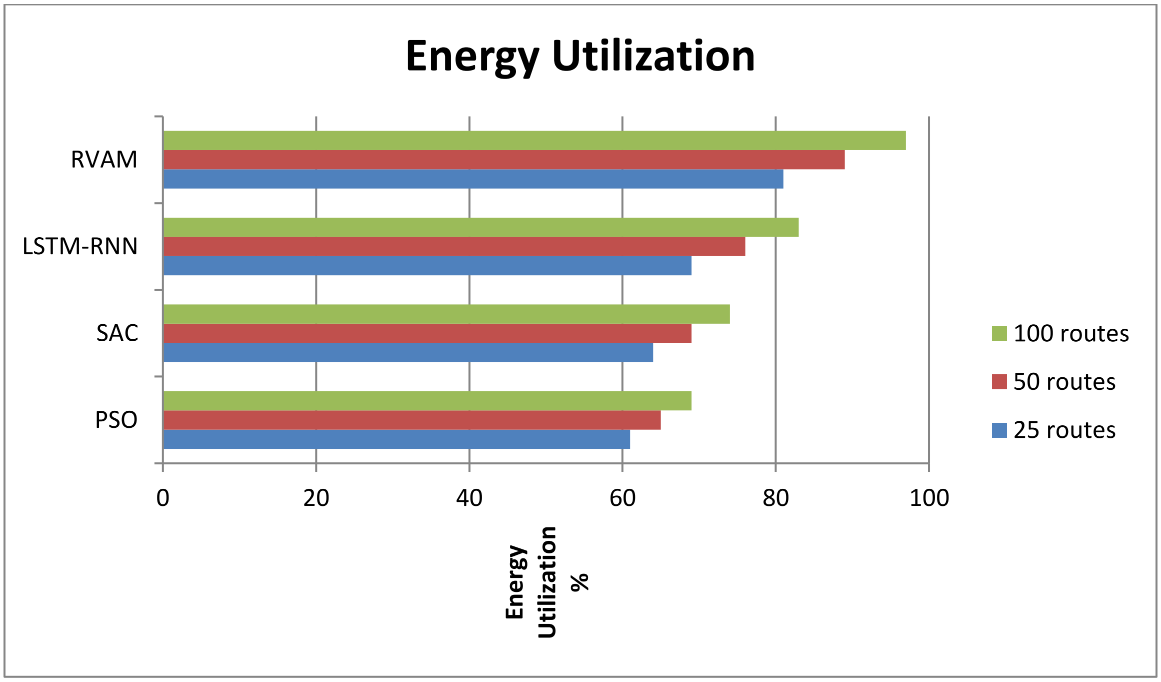

Figure 2: Energy Utilization Performance

The performance of methods in voltage regulation is measured and presented Figure 3. The proposed RVAM method produces higher voltage regulation performance than others. The energy utilization is measured according to the number of routes available and in each case, the proposed RVAM model has produced higher performance than others.

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. 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.

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