14thAnnual International Conference on Industrial Engineering and Operations Management
Dubai, United Arab Emirates (UAE), February 12-14, 2024
Publisher: IEOM Society International, USA
Published: February 12, 2024 DOI: 10.46254/AN14.20240451

Charging Planning Model for Electric Vehicles Based on Range Prediction

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Abstract

Range anxiety continues to be one of the most important factors negatively affecting the transition to electric vehicles (EVs). However, range anxiety can be reduced if the EV driver knows where to stop for charging on the route according to the range information remaining at the beginning of the journey. Although EVs can access real-time data, it cannot be expected that the created charging plan will reduce range anxiety unless range prediction is made considering the conditions of the determined route. The aim of this study is to determine where and how much the EV should be charged for minimum travel time or cost by creating a charging plan based on real-time range prediction for a specified route. The deep neural network model was trained by using the inputs of the static features and dynamic features of the journey in the range prediction model. The amount of energy consumed between the nodes is obtained by the range prediction model. Within the scope of charging planning, a mixed integer programming model is developed that consider nonlinear charging times, dynamic charging prices, vehicle to the grid, multiple charger with different power levels and their availability. Since the developed mathematical programming model was insufficient in terms of the solution time, a matheuristic is proposed. Test results on 32 various problems indicate that the matheuristic approach outperforms the metaheuristic and heuristics for both minimum travel time and cost.

Keywords

Electric vehicles, range prediction, charge planning, mixed integer linear programming, matheuristic, genetic algorithm

Acknowledgements

I wish to express my gratitude to Prof. Dr. Betül Yağmahan for her guidance and support during my doctoral studies, which played a crucial role in my academic development. Additionally, I appreciate the contributions of Prof. Dr. Erdal Emel and Prof. Dr. Gürkan Öztürk, who provided valuable insights and suggestions for my thesis. I also acknowledge the Council of Higher Education (CoHE) of Türkiye for their financial support through the 100/2000 scholarship program.

Biography

Hilal Yılmaz is an accomplished scholar and researcher with a focus on Industrial Engineering, particularly in Intelligent Transportation Systems. Graduating with honors from Karadeniz Technical University in 2016, Yılmaz pursued an integrated PhD at Bursa Uludag University, supported by the Turkish Council of Higher Education's 100/2000 Doctorate project in January 2017. Yılmaz completed her PhD in December 2022. Beyond research, Yılmaz gained leadership experience in the research group on autonomous vehicles at Bursa Uludag University named OTAGG as a project manager. Currently, Yılmaz is also team member in the software department at OTAGG. Yılmaz is currently an Assistant Professor at Bursa Technical University in the Department of Industrial Engineering.