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2018
MCM/ICM
Summary Sheet
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Analysis and Optimization to the Electric Vehicle Charging Station Network

Summary

In the trend of migrating transportation to electricity-based system, electric vehicles are globally produced and quickly entering the market. Requirement of sufficient power creates difficulty of its popularization since the charging stations are supposed to be reasonably located to efficiently support vehicle's cursing. Therefore, we are required to figure out key factors that influence the process of electrification and create models to design a proper network.

We developed **basic model** according to the current charging station distribution of Tesla vehicles in the USA that indicated statistical relationship between number of charging stations and population density in different area. Correlation coefficient 0.8 of number of stations and population in each state represents strong positive linear relationship. Based on statistics of average travelling and cursing distance, we fix charging requirement and hypothetical EV proportion for each state. Then the total number of stations could be determined by our model. In addition, we also plot for number of charging stations as proportion increases. From numerical analysis, we noticed that our model built up a reasonable relationship between two parameters with quadratic function. This indicates the growing charging network in the USA is related to both population distribution and vehicles coverage.

Based on previous analysis, we mainly created two models that considered population distribution, traffic network and city distance as key factors for general countries. The first one **'hinge distribution trail model (HDT)'** chooses the furthest hinge point as station relative to starting position and each temporary end point. It shows that larger the span between two cities is, the more travelling distance would be saved, compared to the highway length. The other one is '**shortest route preference model (SRP)**'. It suggests constructing charging stations along the shortest route chosen by Manhattan Distance in highway network so that vehicle could reach destination faster and with sufficient charging support.

We also create other models according to city's population density and its position. The **'neural distribution network model (NDN)'** creates network vertically by province region in neural shape and horizontally by traffic flow between two cities. The result shows that this model could also stays high effectiveness since network principle is based on different country's population and states' allocation. Another one '**population-based city model (PBC)**' is an ideal model that set stations at cities that have large population density.

Keywords: Charging Station; Distribution; Population Density; Traffic Network