Velocity and Energy Consumption Prediction in Electric Vehicles

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To make a precise prediction of how far one can travel on the remaining fuel in a car, a model predicting the driver's future behaviour is used. The driver model can be improved with information from a navigation system and access to driver-specific historical data.

In this master's thesis it has been shown how historical data for a driver can be processed, such that an energy estimation can be done via predicting the velocity along a known route. The historical data has been driver specific, giving information on how the driver behave in different situations. Furthermore, with access to the navigation system, information about the upcoming roads such as speed references and inclination on the road was known. The results also indicate that a driver model can be individualized, such that the energy estimation becomes worse if someone borrows a car, which will make a prediction based on the owner's historical behaviour.

An accurate distance to empty estimation would be beneficial especially for electric vehicles. This since the range one can travel with the energy in the battery often is shorter than it is for conventional cars, contributing to people hesitating to use a more environmentally friendly car. With a personalized energy estimation, the driver will have a more accurate estimation of when to pause and recharge the battery and get rid of his or her range anxiety.

Five different driver models were implemented, whereof four take advantage of a driver's historical behaviour. Three out of four history based driver models use theory regarding Markov chains and the fourth frequency analysis. The purpose of the fifth model is to have a standard model that will be the same for all of the drivers that are investigated in this thesis.

The results show that the Markov based driver models perform the best predictions when both investigating how well the velocity is imitated and how much energy that is consumed per unit distance. It is also shown that one can gain most out of the individual driver model the higher the reference speed gets. This is probably due to that the traffic pattern in cities are highly influenced from pedestrians, traffic lights, stop signs and so on. Gladly, it is neither the most time or memory consuming model that is the best.

In some cars today, the distance to empty is estimated by only considering the mean fuel consumption during the last 30 kilometers. I.e. such a model does not consider any future changes in speed reference and could be used as a comparison for how well a more advanced driver model performs. In Figure 1, it is illustrated how the estimation may differ from the actual distance one can travel by using this model. In the figure this curve is referred to as $SOC_{\Psi30}$. Compared to the driver model performing the best results according to our investigation, SOC_{GMM}, it can be seen that with access to future speed references and road inclination, a state of charge curve similar to the real one can be estimated.

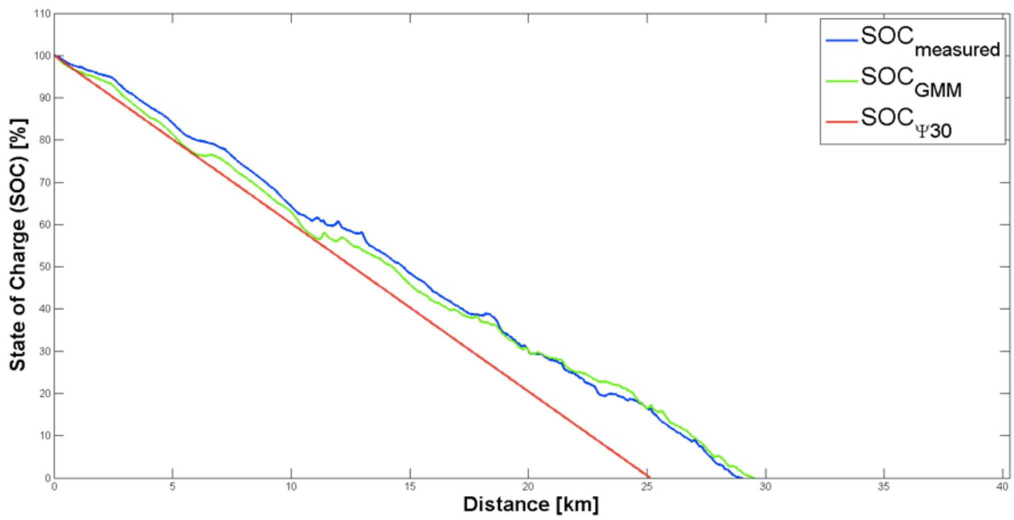

Figure 1: Illustrating distance to empty by using the state of charge in the battery.