Abstract:

A subject of great interest for energy providers is the influence that electrical vehicles (EVs) will have on the electric grid of a city, how to cope with the emerging demand, and how to plan a sufficient charging infrastructure. The goal of this work is to evaluate the extra energy demand emerging through the introduction of EVs by analysing their driving patterns in a certain city using Singapore as an example [1]. The obtained results will be incorporated into a comprehensive taxi simulation aiming at optimising charging infrastructure in Singapore. Two analysis tasks are conducted: driving profile and energy demand analysis. The driving profile unit focuses on raw GPS trajectories obtained from GPS loggers and incorporates various processing steps like filtering, map-matching, division into trips subject to vehicle’s status, route reconstruction, and statistical evaluation of driving patterns. The energy demand part aims at estimating energy consumptions of EVs for various sampling rates and various trajectory or route resolutions, suitable for a simulation context. It comprises three approaches: a static, a dynamic and an instant one of which the two first mentioned include a conceptualization of energetic databases established upon historical GPS trajectories. The driving profile analysis reveals insightful statistical evaluations combining SMRT's
logging and booking data with LTA and auxiliary data sources. The performed pre-processing and map-matching steps prepare the trajectories successfully for a satisfying energy estimation. Accordingly, the implemented energy analysis approaches perform well under given conditions employing three concepts: a static energy map of Singapore, a dynamic driving share approach, and an instant driving feature approach. Each is capable of predicting energy at the detail level or road segments. An evaluation of energetic results against the comprehensive TUM CREATE EV Model reveals considerably compliance. The dynamic driving share approach performs best with an average deviation of ±14% for the best 90% trips due to its most flexible, driving dynamics anticipating, and in-detail design. The static energy map approach yields similar findings with an average deviation of ±18%, but lacks in incorporating particular driving and traffic conditions as it merely relies on average energy values per road segment. The instant driving feature approach, levering fewest historical data inputs, produces a mean deviation of ±20% but is rather applicable for high resolution trajectories and thus inappropriate for the targeted simulation purpose.

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