INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: AN INTELLIGENT ELECTRIC VEHICLE CHARGING INFRASTRUCTURE

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SHORT ABSTRACT

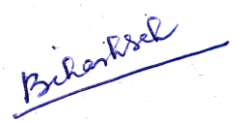
Electric vehicle charging infrastructure is the foundation for ensuring wider acceptance of electric vehicles (EVs). Governments and organisations worldwide are working on policies for deeper penetration of EVs in the transportation sector. The infrastructure comprises various stakeholder who communicates with each other. The communication ensures an optimal operation of each entity in the infrastructure, meeting the requirements of all the stakeholders. Although the present electricity infrastructure is able to support the charging of EVs, there are challenges of integrating bidirectional power flow between EVs and electric grid, developing appropriate communication infrastructure and support systems, motivating users to perform coordinated charging, and options to utilise EVs for ancillary services. Apart from the challenges in the electric grid, the requirement of fast charge with constrained battery degradation is another major challenge to persuade user acceptance. Henceforth, the work presented in the thesis proposes controllers, algorithms, estimation procedures, and techniques to develop an intelligent infrastructure that can perform coordinated charging with the least disturbances in the electric grid and meet the requirement of fast charge with constrained degradation at the user end.

The objective of developing an intelligent charging infrastructure is attempted by four major contributions described in the thesis. The potential of EVs to reduce the share of overall carbon emission by the transportation sector and provide ancillary services are best utilised in a vehicle to grid system. The vehicle to grid (V2G) system is comprised of an electric grid, controllers, aggregators, charging stations and electric vehicles as a major entity. The first two works of the thesis are focused on developing an intelligent controller to reduce the impact of any issue with the data communicated between entities in the V2G systems. A practical scenario of data being transmitted to the controller utilising different data rates and communication channels is considered. In the first work, the importance of fast and equal data rate for the data reaching the controller are determined for optimal operation. A fuzzy logic controller (FLC) is used in this work. A process to synchronise the data rate is proposed, and modifications in the FLC are discussed to ensure the best operation even at a lower sampling rate.

In the second work, an artificial neural network (ANN) and FLC based controller is designed and verified to reduce the impact of issues such as delay, error and loss of data when transmitted by a communication channel. The intelligent controller performs data integrity checks using a trained ANN and corrects based on an algorithm if required. Since the intelligent controller ensured optimal power flow between EVs and the electric grid, the next

challenge of intelligent charging infrastructure is to perform fast charge, constrain battery degradation and reduce the impact of charging in the electric grid. The battery degradation can be constrained by accurately estimating battery parameters and states during charging appropriately.

Hence, in the third work, a technique to estimate the battery parameters and states is proposed incorporating based on real-time impedance estimation. The impedance is a major parameter to interpret the ageing in EVs. Since the battery is an electrochemical device, a study incorporating electrochemistry in the development of charging techniques is necessary. Thus, the fourth work develops a new charging technique by analysing the electrochemical models and building insights on the variation of electrochemical, mechanical, and electrical parameters. The thesis concludes with the proposal of an intelligent controller for the V2G system and the development of an intelligent charger with battery-friendly charging techniques to fast charge and reduce battery degradation.



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