ABSTRACT

Energy storage technologies are being used excessively in industrial applications and in automobiles. Battery state of charge (SOC) is an important metric to be monitored in these applications to ensure proper and safe functionality. Since SOC cannot be measured directly, this study puts forth a novel machine learning architecture to improve on the existing methods of SOC estimation. This method consists of using combined stacked bi-directional LSTM and encoder–decoder bi-directional long short-term memory architecture. This architecture henceforth represented as SED is implemented to overcome the nonparallel functionality observed in traditional RNN algorithms. Estimations were made utilizing different open-source datasets such as urban dynamometer driving schedule (UDDS), highway fuel efficiency test (HWFET), LA92 and US06. The least Mean Absolute Error observed was 0.62% at 25 °C for the HWFET condition, which confirms the good functionality of the proposed architecture.

Generative deep learning techniques are being used excessively in machine learning applications. Ongoing research in this field has been amped up by many players in the consumer market because, none of the other deep learning method can synthetize high fidelity data that can be used to improve other algorithms. In this study a combination of BLSTM SOC estimator and CGAN are used to lower the estimation error. The high-fidelity data generated is fed into the SED BLSTM SOC estimator for training and testing is carried out using the actual LA92 dataset to provide an accurate SOC estimate. Two cases are established for testing and highest accuracy was observed while using LA92 25°C data. The major contributions of this dissertation are:

1. Proposed a new SOC estimation technique using stacked Encoder-decoder Bi-LSTM network that provides an improved accuracy over pre-existing machine learning SOC estimation techniques.
2. A generative SOC estimation approach that uses conditional GAN to generate synthetic battery data that can be used to train the proposed SED SOC estimator to improve the versatility of the estimator.
3. High fidelity battery drive cycle data can be synthetized using this architecture for use in different applications.