Early diagnosis of knee-point in capacity degradation of Li-ion NCM battery using a long short-term memory model

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Accurate prediction of battery capacity fade is essential to improve the performance of the battery and ensure the safety of the users. As the lithium nickel-cobalt-manganese (NCM) batteries are put through repeated charging and discharging cyclic processes, the batteries encounter sudden degradation of capacity due to lithium plating and loss of active material. The point where the sudden degradation starts is called 'knee-point' and it is critical to recognize the knee-point as early as possible to provide instructions on when to replace the battery and prevent the battery system explodes. This study proposes a novel way to early diagnose the knee-point within capacity fade curves of NMC cells. In this study, a long short-term memory (LSTM) network is employed to detect knee-points 100 cycles before they occur. Key features characterizing battery aging status, obtained from voltage-capacity curve analysis, are used as input of the LSTM model. The model is constructed and validated using battery cell data from 12 different charging and discharging conditions.