Bayesian Neural Network Based Virtual Health Indicators for Early Lithium-Ion Battery Fault Detection

Sungeu Chae[1], Sukjoo Bae[1]

[1]Department of Industrial Engineering, Hanyang University, Republic of Korea

Lithium-ion batteries (LIBs) play a crucial role in electric vehicles (EVs) and energy storage systems. However, they are susceptible to premature degradation, mostly caused by lithium plating. This degradation not only impairs the operation and dependability of these systems but also poses substantial safety hazards. This paper presents a state-of-the-art Bayesian Neural Network (BNN)-Autoencoder methodology for virtual health indicators for quickly recognizing abnormalities in LIBs, addressing the need for enhanced diagnostic techniques. This study highlights the insufficiency of exclusively depending on normal distributions for latent variables in diverse applications. Hence, we investigate other probability distributions for latent variables, such as the Laplace and Student's t-distributions, to assess their potential in enhancing the identification of abnormalities. The efficacy of this innovative method is demonstrated by comparing it with convolutional autoencoders and variational convolutional autoencoders. The analysis utilizes data from EV LIB test benches and benchmark datasets from NASA, which closely simulate real-world settings. The efficiency and precision of our approach are outstanding, particularly due to the incorporation of specialized distributions for Bayesian neural network priors. This methodology enables the prompt identification of abnormal LIB behavior during the initial cycles. This study highlights the significance of investigating various hidden patterns in order to improve the safety and longevity of LIBs used in important applications.