Chapter 6
Review Work on Machine Learning Approaches for Predicting the Remaining Lifespan of Lithium-Ion Batteries

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ABSTRACT

Lithium-ion batteries play a crucial role in storing energy for electric vehicles, and their reliability is of paramount importance. These batteries are widely used in various appliances for energy storage, catering to specific appliance requirements. Understanding the battery's reliability is essential, given its vital role in energy storage. Even when fully charged to 100%, the battery's capacity undergoes changes as the number of usage cycles increases. Once the capacity surpasses limit of acceptable performance, it leads to a depleted battery incapable of retaining a charge. As a result, the concept of remaining service life (RSL) becomes pivotal in battery management systems (BMS) for both industrial purposes and scholarly investigations. This chapter delves into the appropriate method for predicting RSL, incorporating the implementation of machine learning techniques.

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1. INTRODUCTION

One possible approach to tackle the expanding issue of exhaustion of fossil fuels is to consider the implementation of electrifying. Energy storage devices such as batteries contribute significantly to enabling the seamless transformation of energy throughout the process of electrification (Shabarish, Aditya, Sai et al, 2020). Concurrently, in the realm of Industry 4.0, a domain witnessing significant growth, Machine Learning has become a prominent factor (Reddy et al., 2021). Electrical power has become a fundamental part of our everyday existence. However, a substantial hurdle currently faced pertains to the effective electrical power storage. Batteries offer an immediate solution to combat issues related to energy shortage or outages, but their standalone application is hindered by various protection concerns such as temperature conditions or impact. Consequently, the Battery Management System (BMS) emerges as a critical element to safeguard the battery's lifespan and ensure additional safety features. BMS has become a focal point of study in both industrial and academic domains (Duraisamy & Kaliyaperumal, 2021; George et al., 2019; Prabhakar et al., 2016).

In the field of Battery Management Systems (BMS), a critical area of study involves the Remaining Service Life (RSL) assessment of a battery. Assessing the RSL stands as essential task towards determining battery's reliability considering its continuous exposure to electrolyte breakdown and lithium deposition during operations (Shabarish, Krishna, Prasanth et al, 2020). RSL refers to the operational life period prior to the end of a battery reaching its end of life, encompassing the duration from the ongoing evaluation period until the End of Life (EOL) (Ma et al., 2020). The service life of a battery effectively concludes when the capacity of it diminishes to one-fifth of its initial value (Liu et al., 2020). This paper explores various Machine Learning (ML) approaches employed for predicting the RSL of batteries, emphasizing the identification of the most efficient technique for accurate RSL prediction.

2. APPLICATION OF MACHINE LEARNING FOR FORECASTING THE REMAINING SERVICE LIFE (RSL)

In the past few years, the domain of Machine Learning (ML) has witnessed substantial expansion, presenting numerous techniques relevant to predicting the Remaining Service Life (RSL) in batteries, as detailed in references (Khumprom & Yodo, 2019; Liu et al., 2017). To employ ML methods, it is imperative to extract crucial raw data from batteries, encompassing variables like current (I), voltage (V), and temperature (T), which demonstrate fluctuations throughout the battery's aging progression.

Figure 1. Data processing flow (Jin et al., 2021)

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