Pemodelan dan Optimasi Fast-Charging Lithium-Ion Battery (LIB) Menggunakan Algoritma Quasi-Newton-Deep Neural Network (DNN) = Modeling and Optimization Fast-Charging Lithium-Ion Battery (LIB) Based on Quasi-Newton Algorithm-Deep Neural Network (DNN)

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Abstrak

Lithium-Ion Battery (LIB) masih menjadi alternatif teknologi yang efektif dalam memaksimalkan efisiensi kendaraan listrik atau Electric Vehicle (EV). Penerapan EV telah memberikan dampak yang signifikan dalam rangka mengurangi isu permasalahan global-pengurangan emisi gas karbon. Mekanisme pengisian LIB dengan metode fast-charging menjadi alternatif pengaplikasian EV dalam skala yang lebih masif. Namun, adanya dinamika pada baterai dimana fungsi kerja baterai dapat mengalami penurunan dari waktu ke waktu akan mempengaruhi kinerja baterai. Selain itu, upaya pengisian fast-charging pada LIB dengan kecepatan maksimum memberikan dampak resiko peningkatan suhu baterai dan adanya celah yang semakin besar terjadinya degradasi baterai. Pada penelitian ini diusulkan penerapan algoritma Deep Neural Network (DNN) untuk optimasi fast-charging Lithium-Ion Battery (LIB) sebagai solusi pendekatan yang inovatif dalam menanggulangi dinamika fast-charging LIB yang kompleks. Penelitian ini mengembangkan pendekatan yang integratif dengan mengombinasikan metode Quasi-Newton Limited-memory Broyden–Fletcher–Goldfarb–Shanno Bound (L-BFGS-B) dan algoritma DNN. Hasil penelitian menunjukkan bahwa metode Quasi Newton L-BFGS-B mampu menemukan solusi awal arus pengisian optimal. Metode ini mampu mempertahankan kesehatan baterai (SoH) dan kapasitasnya dengan hanya mengalami penurunan SoH sekitar 2% serta kapasitas baterai dipertahankan 98% dari kapasitas awal. Pengembangan algoritma DNN juga mampu memprediksi arus pengisian optimal berdasarkan input dari hasil optimasi Quasi-Newton L-BFGS-B. Namun, model DNN yang diterapkan menunjukkan adanya overfitting yang perlu ditangani lebih lanjut.
......Lithium-Ion Battery (LIB) is still an effective alternative technology in maximizing the efficiency of electric vehicles (EV). The application of EVs has provided a significant impact in order to reduce the issue of global problems - reducing carbon gas emissions. The LIB charging mechanism with the fast-charging method is an alternative to the application of EVs on a massive scale. However, the dynamics of the battery where the battery work function can decrease over time will affect battery performance. In addition, fast-charging efforts at LIB with maximum speed have the impact of increasing the risk of battery temperature and the existence of a larger gap in battery degradation. This research proposes the application of Deep Neural Network (DNN) algorithm for Lithium-Ion Battery (LIB) fast-charging optimization as an innovative solution approach to address the complex dynamics of LIB fast-charging. This research develops an integrative approach by combining the Quasi-Newton Limited-memory Broyden–Fletcher–Goldfarb–Shanno Bound (L-BFGS-B) method and DNN algorithm. The results show that this approach can improve the speed and efficiency of fast-charging. The research shows that the Quasi Newton L-BFGS-B method is capable of finding an initial solution to the optimal charging current. This method is effective in maintaining battery health (SoH) and capacity by reducing SoH by only 2% and maintaining battery capacity by 98% of the initial capacity. The DNN algorithm development is further

capable of predicting the optimal charging current based on inputs from the Quasi-Newton L-BFGS-B optimization results. However, the implemented DNN model shows the overfitting which should be further explored.