A Brief Summary of Using Machine Learning to Predict the Degradation of an Ni-MH Battery

Massachusetts Science and Engineering Fair First Place 2023

Ritika Roy

Manufacturing and disposal of rechargeable batteries pose a significant environmental risk. Repurposing old batteries for less intensive usage can reduce their environmental impact. Since batteries lose their ability to retain charge with usage, predicting the remaining capacity of batteries aids with repurposing.

The Experiments:

Autodesk Fusion 360 was used to design an electromechanical system consisting of electric motors and friction pads. During each experimental cycle, frictional work drained the fully charged batteries.

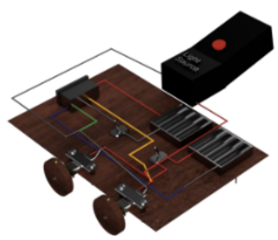

Figure 1: CAD Model of Experiment

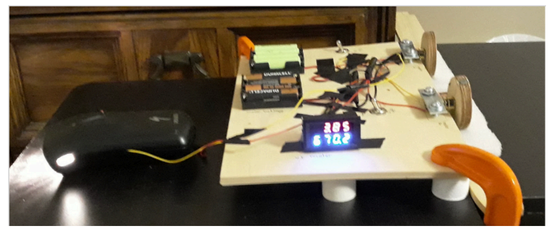

Figure 2: Experiment Set up

The voltage, current, and surrounding temperature were measured every minute during each experiment cycle. The batteries were recharged and the experiment was repeated. Over 2800 data points were generated during 3 months of experimentation.

Data preparation:

A trapezoidal-rule-based numerical integration program was coded to calculate the total energy capacity of the batteries delivered in each cycle. The time required to drain the batteries completely decreased by 42%, and the battery capacity dropped by approximately 0.7% between experimental cycles.

Machine learning models:

The data was split into training and test sets. Linear, quadratic, and cubic linear regression machine learning (ML) models were trained using the computed capacity and temperature data in the training dataset. Given the number of usage cycles and the surrounding temperature, the ML models predict the remaining battery capacity. The cubic ML model had the lowest mean squared error for the test dataset and is the most accurate of the three ML models in predicting the remaining battery capacity. This ML model can be used to repurpose Ni-MH batteries, lessening their environmental impact.

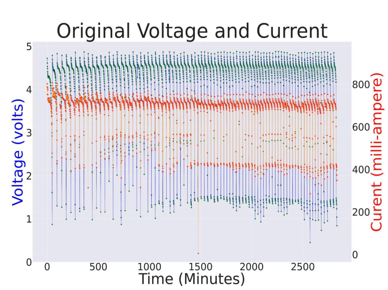

Figure 3: experimental data

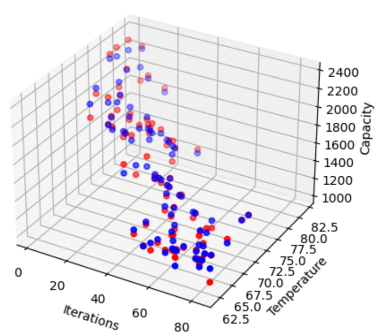

Figure 4: predicted vs actual data for cubic model

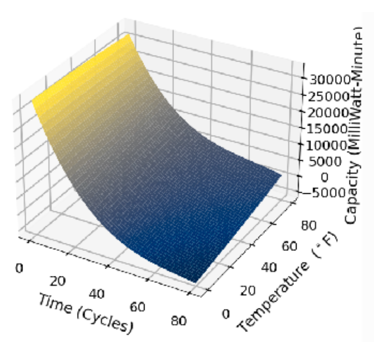

Figure 4: cubic ML model