Detailed Introduction to XJTU Battery Dataset

Battery Introduction:

The object of this experiment is the 18650 nickel-cobalt-manganese (NCM) lithium-ion battery manufactured by "LISHEN". The chemical composition is $LiNi_{0.5}Co_{0.2}Mn_{0.3}O_2$. The nominal capacity of the battery is 2000 mAh, and the nominal voltage is 3.6 V. The charging cut-off voltage and discharging cut-off voltage are 4.2 V and 2.5 V, respectively. The whole experiment was conducted at room temperature.

Experimental Details:

A total of 55 batteries were included in this experiment, conducted under 6 different charging and discharging strategies. The charging and discharging platform is ACTS-5V10A-GGS-D, and the sampling frequency for all data is 1Hz. The experiment began on September 16th, 2022 and lasted until February 18th, 2023, at which point all batteries reached their end-of-life (capacity decreased to below 80% of their initial values). Although there were a few pauses in the experiment due to power outages and other issues, our publicly available data has been properly consolidated. The charging and discharging strategies for each batch are described below (represented respectively by Batch-1 to Batch-6 for the 6 experiments).

Batch-1 (8 batteries): Fixed Charging and Discharging Strategy, Fully Charged and Discharged.

The first cycle measures the initial capacity: Charging to 4.2V with a constant current of 0.5C (1A), then maintaining the voltage unchanged until the current drops to 0.02C (40mA) (also called CC-CV mode); resting for 5 minutes; discharging to 2.5V with a constant current of 0.2C (0.4A).

For other cycles: Charging to 4.2V with a constant current of 2.0C (4A), then maintaining the voltage unchanged until the current drops to 0.05C (0.1A); resting for 5 minutes; discharging at 1.0C (2A) until 2.5V; resting for 5 minutes.

Batch-2 (15 batteries): Fixed Charging and Discharging Strategy, Fully Charged and Discharged.

The first cycle measures the initial capacity: Charging to 4.2V with a constant current of 0.5C (1A), then maintaining the voltage unchanged until the current drops to 0.02C (40mA); resting for 5 minutes; discharging to 2.5V with a constant current of 0.2C (0.4A).

For other cycles: Charging to 4.2V with a constant current of 3.0C (6A), then maintaining the voltage unchanged until the current drops to 0.05C (0.1A); resting for 5 minutes; discharging at 1.0C (2A) until 2.5V; resting for 5 minutes.

Batch-3 (8 batteries): Variable Discharging Strategy, Fully Charged and Discharged.

The first cycle measures the initial capacity: Charging to 4.2V with a constant current of 0.5C (1A), then maintaining the voltage unchanged until the current drops to 0.02C (40mA); resting for 5 minutes; discharging to 2.5V with a constant current of 0.2C (0.4A).

For other cycles: Charging to 4.2V with a constant current of 2.0C (4A), then maintaining the voltage unchanged until the current drops to 0.05C (0.1A); resting for 5 minutes; discharging at x C to 2.5V (where x is cycled through values of {0.5, 1, 2, 3, 5}); resting for 5 minutes.

Batch-4 (8 batteries): Variable Discharging Strategy, Fully Charged but not Fully Discharged.

The first cycle measures the initial capacity: Charging to 4.2V with a constant current of 0.5C (1A), then maintaining the voltage unchanged until the current drops to 0.02C (40mA); resting for 5 minutes; discharging to 2.5V with a

constant current of 0.2C (0.4A).

For other cycles: Charging to 4.2V with a constant current of 2.0C (4A), then maintaining the voltage unchanged until the current drops to 0.05C (0.1A); resting for 5 minutes; discharging at a current of x C to 3.0V (where x is cycled through the values of $\{0.5, 1, 2, 3, 5\}$); resting for 5 minutes;

After each cycle, measuring the capacity by charging at a CC-CV mode with 2C (4A) to 4.2V, resting for 5 minutes, and discharging at a current of 1C (2A) to 2.5V, then resting for 5 minutes.

Batch-5 (8 batteries): Random walking discharging, Fully Charged but not Fully Discharged.

For the first 20 cycles: charging is carried out at a constant current of 0.5C (1A) to 4.2V, then maintaining the voltage unchanged until the current drops to 0.02C (40mA); resting for 5 minutes; then discharging at a current of x A for y minutes (where x is a random integer in the interval [2, 8] and y is a random integer in the interval [2, 6]), stopping the discharge when the voltage drops to 3.0V to ensure safety; resting for 20 minutes.

Starting from cycle 21, the following operation is repeated: measuring the capacity once (by charging at a CC-CV mode with 1C (2A) to 4.2V, resting for 5 minutes, and discharging at a current of 1C (2A) to 2.5V, then resting for 5 minutes), and discharging randomly for 10 cycles (by charging to 4.2V with a constant current of 3.0C (6A), then maintaining the voltage unchanged until the current drops to 0.05C (0.1A); resting for 5 minutes; then discharging at a current of x A for y minutes (where x is a random integer in the interval [2, 8] and y is a random integer in the interval [2, 6]), stopping the discharge when the voltage drops to 3.0V to ensure safety; resting for 10 minutes).

Batch-6 (8 batteries): Simulate the charging and discharging strategy for a Geosynchronous Earth Orbit (GEO) satellite.

The first cycle measures the initial capacity: Charging to 4.2V with a constant current of 0.5C (1A), then maintaining the voltage unchanged until the current drops to 0.02C (40mA); resting for 5 minutes; discharging to 2.5V with a constant current of 0.2C (0.4A).

For other cycles: Charging to 4.2V with a constant current of 2.0C (4A), then maintaining the voltage unchanged until the current drops to 0.05C (0.1A), resting for 5 minutes, and then discharging at a constant current of 0.667C (1.334A) for a duration, as shown in TABLE I and Figure 1. The capacity is measured approximately every 5 cycles by charging at a CC-CV mode with 1C (2A) to 4.2V, resting for 5 minutes, and discharging at a current of 0.5C (1A) to 2.5V.

TABLE I The discharging strategy of GEO satellite

Cycle number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24
Discharge duration (min)	5	20	34	41	46	50	54	56	58	60	62	64	68	69	70	71	72	72	72	72	72	72	72

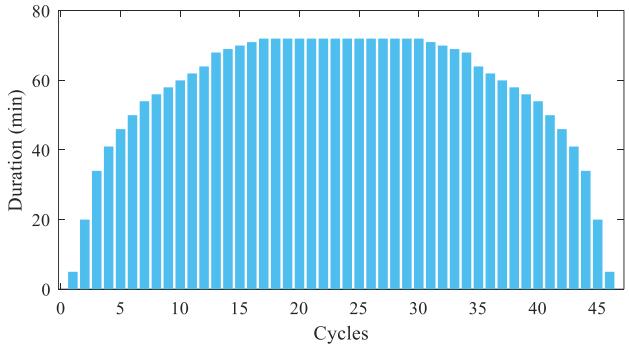

Figure 1 The diagram of cycle number and discharge duration

Supplementary

As the experiment was conducted at room temperature, there may have been some fluctuations in temperature. To provide more precise temperature information, we separately measured the temperature of the batteries in the indoor environment using a dedicated channel, without charging or discharging, for temperature compensation, as shown in Figure 2. The temperature data is saved in the Temperature_Compensation_Data.mat file.

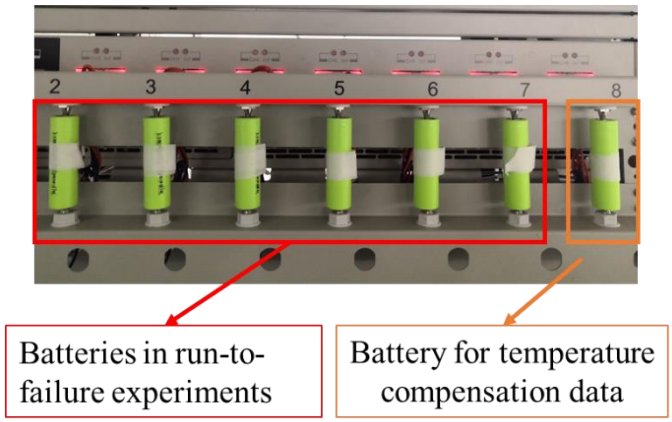

Figure 2 Schematic of the Temperature Compensation Data