Consider a battery with N cells connected in series, as demonstrated in Fig. C.1. Due to manufacturing and operation variations, each cell can have different parameters. For this project, we assume that the cell capacities are slightly different from each other. Therefore, the cell SOC can be different from one another. To maintain a balance of cell SOC, a power converter can be used to transport charge from one cell to another, as illustrated in Fig. C.1.

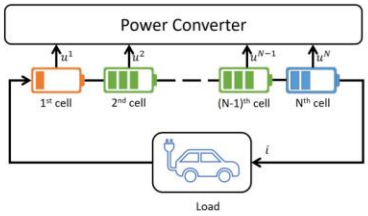

Figure C.1: Structure of series connected battery cells with balancing current.

$$x_{k+1} = Ax_k + Bu_k$$

$$u = \begin{bmatrix} u^1 & u^2 & \cdots & u^N \end{bmatrix}^T$$

$$A = I = \begin{bmatrix} 1 & 0 & \cdots & 0 \\ 0 & 1 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 1 \end{bmatrix}, \qquad B = \begin{bmatrix} -\frac{1}{3600C^1} & 0 & \cdots & 0 \\ 0 & -\frac{1}{3600C^2} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & -\frac{1}{3600C^N} \end{bmatrix}$$

Where "A" is just the identity matrix, "B" is a diagonal matrix consisting of cell capacities C^i. The assumption here is that the sampling time Δt = 1 second, and each cell's Coulombic efficiency η_0=1. We can change these if we really want to.

- We will ignore the alpha terms from the paper as we are not going to worry about relaxation and terminal voltages. Because of this, we can also ignore matrices "C", "D", and measurement equations all together.
- We also ignore the physics of the equalization circuit. We will only use the model to update the SoC based on whatever the RL agent decides to make the balancing currents u_k.
- We will declare the physical constraints of the system (0 <= SoC <= 1, delta u <= 0.05, abs(u) <= 0.3, and sum(u) = 0).

Policy Gradient…let's talk more about this. If we decide that we want to do the implementation from scratch in MATLAB, then I found a couple of resources for

policy gradient reinforcement learning. This is very new to me, so bear with me as I learn about this new topic.

- Article.
- https://youtu.be/cQfOQcpYRzE?si=ch3RYjlskePO-0J0