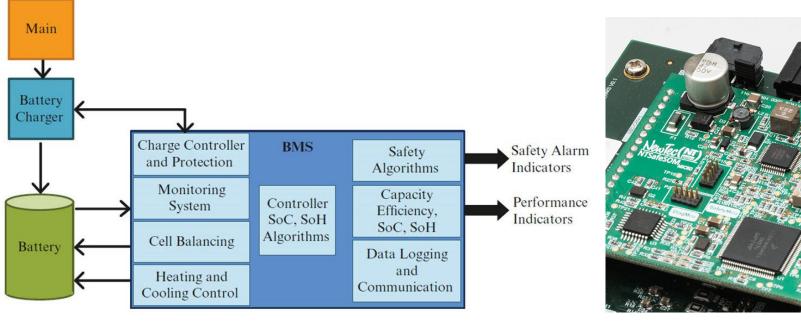
Implementation of IMM in Battery Management System

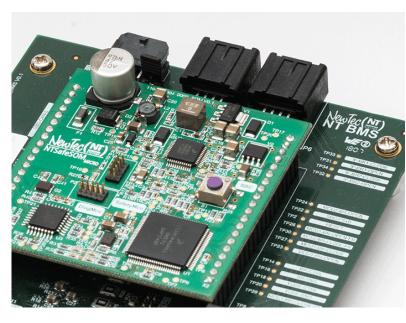
Centre for Mechatronics and Hybrid Technology Mechanical Engineering McMaster University Reza Hosseininejad, Farzaneh Ebrahimi, Saeid Habibi

EECOMOBILITY (ORF) & HEVPD&D CREATE

What IS the BMS?

The Battery Management System (BMS) ensures the safe and reliable operation of a battery pack by monitoring, predicting, and protecting against potential faults or dangerous trends in the system. It accomplishes this by processing information from monitoring sensors and communicating with other components of the vehicle.



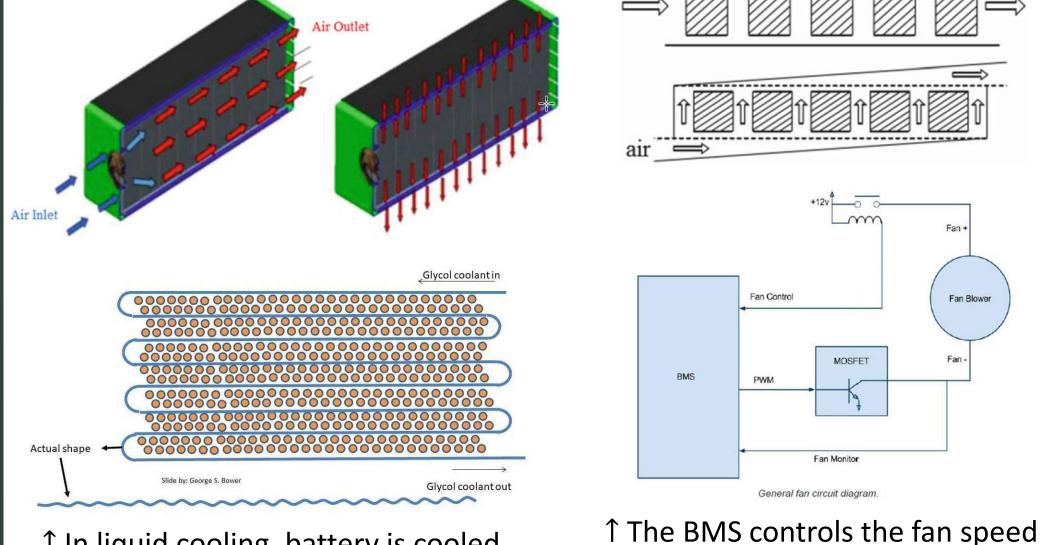


In general, there are different types of BMS: microprocessor-driven, microcontroller-operated, PLC-controlled, and LabVIEW-powered

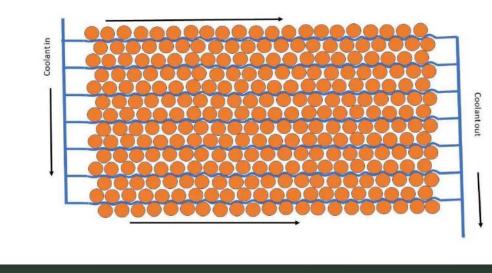
Efficiency, lifespan, and safety are enhanced by the battery management system: adjusts cutoff voltage and charging current, regulates SoC range, balances cells, and controls temperature for optimized battery performance.

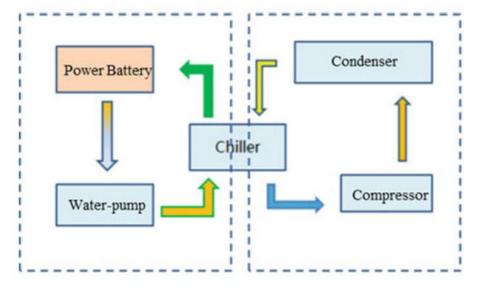
Thermal control

There are air cooling, liquid cooling and cooling using PCM. Air cooling and liquid cooling are commonly applied.



1 In liquid cooling, battery is cooled by oil, water etc. Liquid cooling efficiency is higher than air cooling due to the larger heat capacity for liquid than air ↓





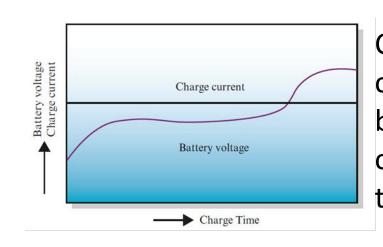
via PWM signal with respect to

warming up or cooling the pack

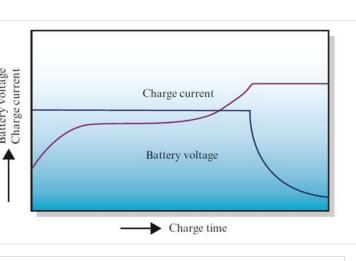
cell and ambient temperature for

Charging Modes

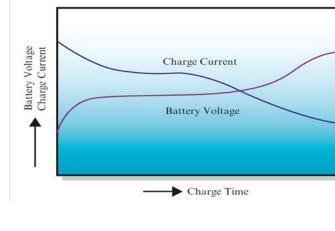
Battery charging optimized with BMS: constant current and voltage techniques used for efficient and safe charging.



Constant current charging is an easy way to characterize the battery behavior The battery behavior remains uniform as the coulombic charge is forced at a constant rate throughout the charging process

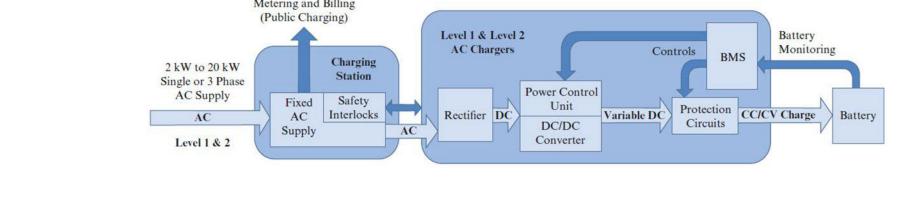


Constant voltage: It is used as a saturation charging step. The method mainly prevents overcharging with a carefully selected threshold voltage.



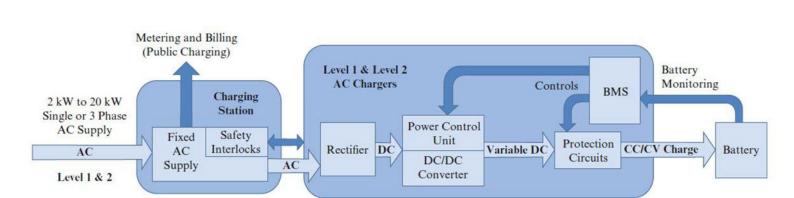
Semi-constant current method uses impedance of the circuit to control the charging current. As the voltage of the battery increases with charge, the current starts to decease.

Based on the infrastructure and power capacity, battery chargers are categorized in three levels.





↑ Level 1 is a slow charging system for typically home garage overnight charging or workplace charging]

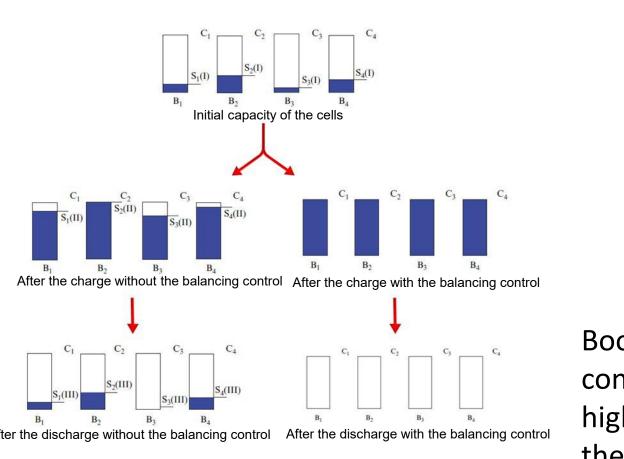


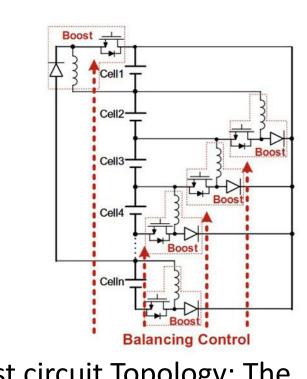
The level 3 charger uses high power. It is a threephase, AC 208 V or DC 600 V connected outlet and has a fast-charging system →



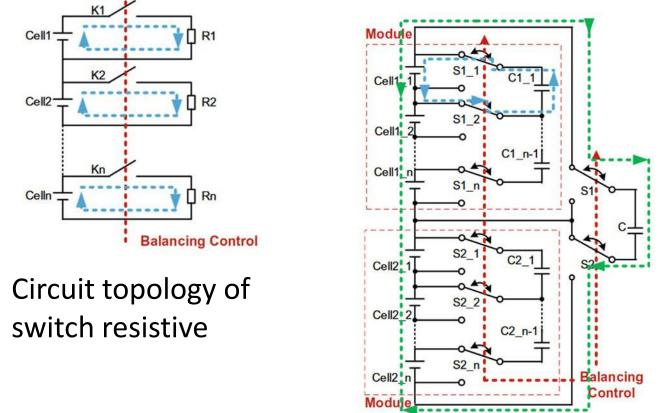
Cell Balancing

- improves the cycle life of the battery
- achieves the uniform aging of the battery pack so that the SOH of the cells is relatively close
- Cell balancing prevents under-charging of good cells and overcharging of weak cells, which increase the overall age of the pack.
- There are different types of cell balancing topologies which can be categorized as active and passive.





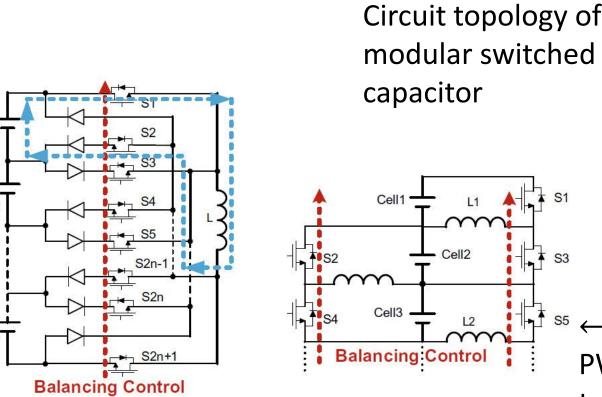
Boost circuit Topology: The control precision of Cuk circuit is high but the cost is also high as there are many elements in the



←Apart from charge transferred between cells, balancing between modules can be realized to reduce inhomogeneities inside battery packs

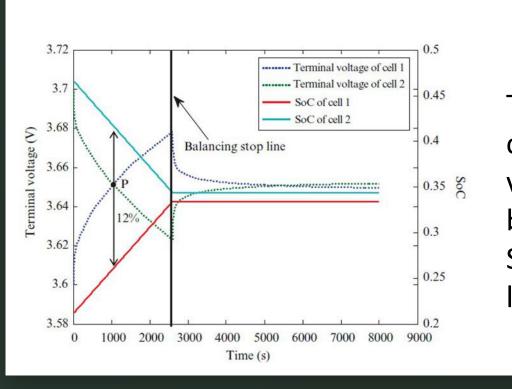
Circuit topology of

single capacitor



ss ←Switches are controlled by Circuit topology of

PWM signal and the energy transfer among different cells. For the battery pack composed multiple inductors of many cells, the balancing time is long



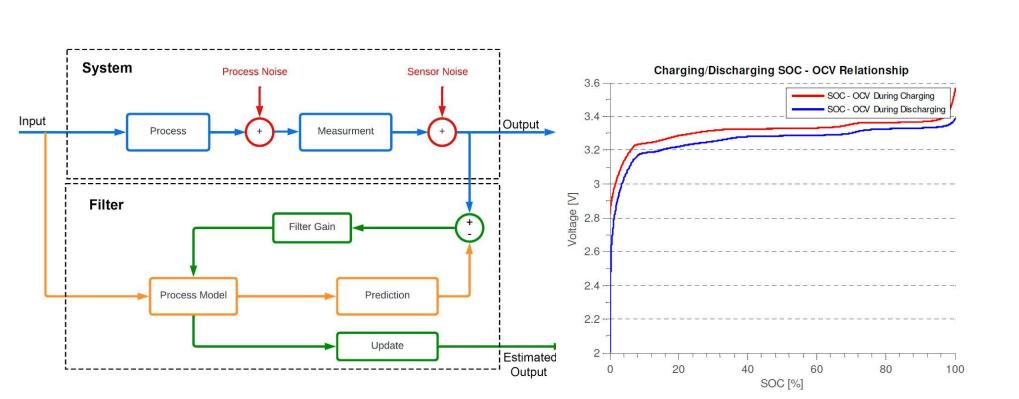
Circuit topology of

single inductor

The energy is transferred from cell 2 to cell 1 by the active method. If terminal voltage is the balancing criteria the balancing will stop at point P, else if the SOC is the criteria, balancing will stop later at the stop line

Battery States Estimation

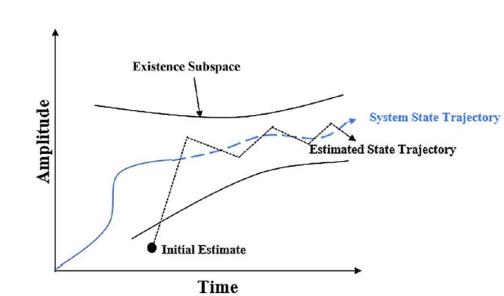
Flat region in SOC curve →battery model → model and process uncertainties → estimator-model combination ✓



Kalman Filter

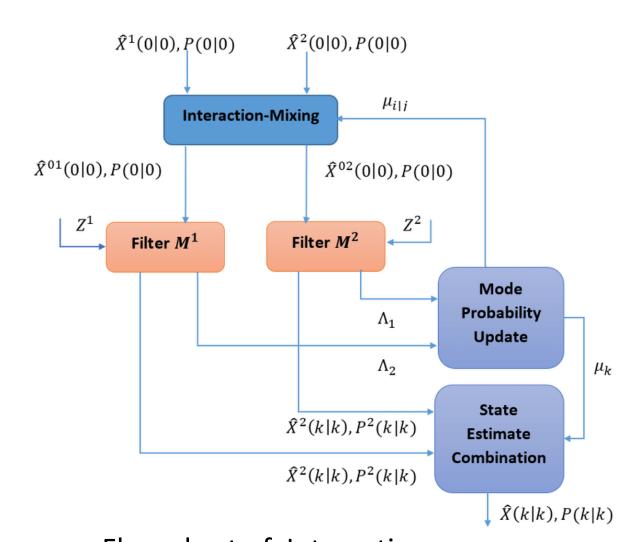
- 1. Prediction phase \rightarrow The system states are estimated based on the previously available data
- 2. Correction phase \rightarrow The prediction phase output is updated with respect to new data (to reduce the estimation error as much as possible)

SVSF is a non-linear robust filter that follows a predictorcorrector form with a gain formulation based on sliding mode control such that to keep the estimated state close to the true trajectory



chattering may occur, but this can be resolved by using a smoothing boundary layer

Multiple Interacting Model (IMM) strategy models and facilitates using different models for different SOH of the battery. Integrating this provides estimation of the SoC, internal resistance, and SoC bias of a battery.



Flow chart of Interacting multiple model filter

References

Available at:

https://github.com/Rezahnd/Poster_2022/blob/main/referen ces.md













