Team 05: Battery Management System (BMS): Online Battery Fuel Gauge Indicator

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Abstract

Battery fuel gauge (BFG) is the most important part of a battery management system. The BFG estimates the state of charge (SOC), and time to shut down (TTS) of a battery based on three measured quantities from battery; voltage, current and temperature.

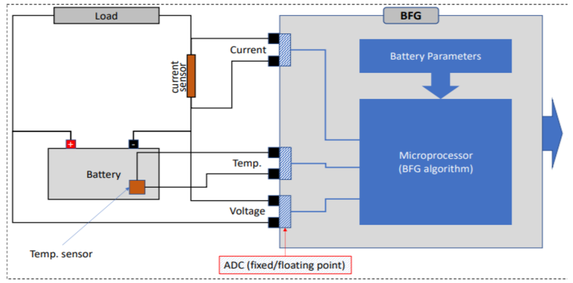

Figure 1: Block Diagram of Battery Fuel Gauge

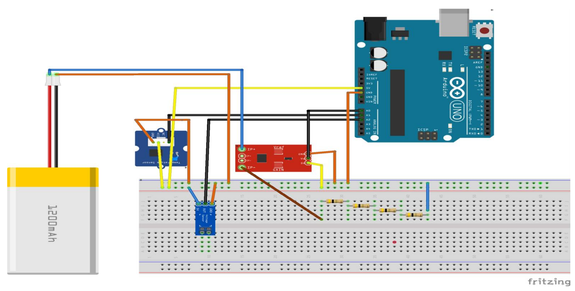

Figure 2: Schematic of Proposed Solution

Introduction

A battery management system (BMS) is a system that manages the rechargeable batteries. The BMS consists of three main elements which include battery fuel gauge (BFG), optimal charging algorithm (OCA) and cell balancing circuitry (CBC). In this project, we have designed the battery fuel gauge (BFG), it is a primary component of BMS, which estimates the state of charge (SOC), and time to shut down (TTS) of a battery. LiTh ion batteries are used everywhere, and it is essential to know its SOC and TTS. This project demonstrates how the results were obtained and used to calculate the parameters.

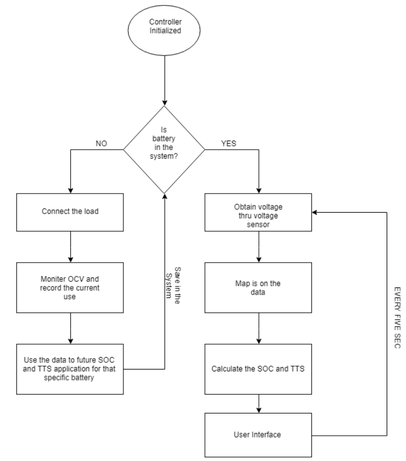

Figure 3: Battery Fuel Gauge Flow Chart

Deliverables

A battery fuel gauge (BFG) estimates the following important quantities in a battery.

- State of charge (SOC). The SOC is specified in percentage; 0 & SOC indicates empty battery and 100% SOC implies battery is full.
- Time to shut-down (TTS). The TTS tells how much time is left on the battery. This also depends on the type of load. In lithium-ion batteries, it tells in how much time the battery will shut off.

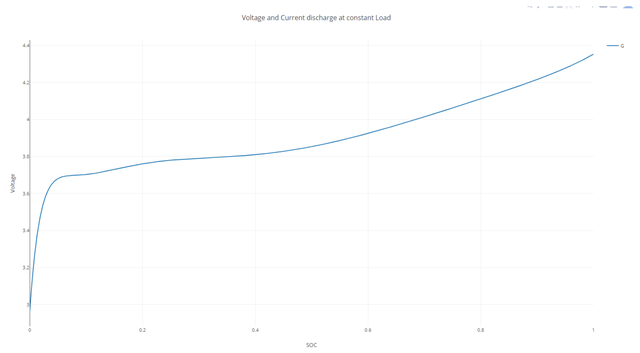

Figure 4:Theoritical Data

Results

Several batteries were used to obtain the state of charge. The figure 5 shows the graph between open circuit voltage and state of charge. One can see from the figure that as the voltage decreases the state of charge decreases. The results were taken in real time and were logged online using raspberry pi. The Arduino was used as a microcontroller and current, voltage and temperature sensors were used to measure the current, voltage and temperature of the battery.

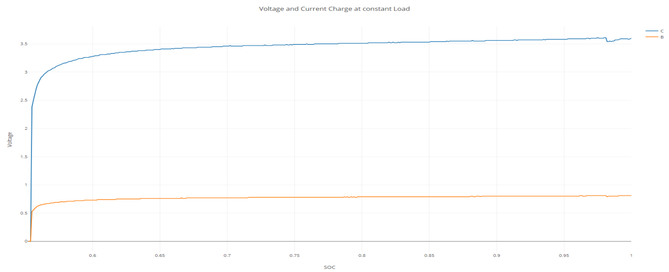

Figure 5: Perturb and Observe Algorithm

Conclusions

The battery fuel gauge was successfully build. The results were plotted and it can be seen that results obtained as shown in figure 5 are close to the expected results. It can be seen that battery drops at 3.0V significantly. The results then were used to calculate the TTS and SOC and shows to user in real time. Hence the project was successful.

Future Work

For this project we worked on battery fuel gauge. For the future work, the BMS can be further improved in following ways:

- Improve the algorithm and have proper OCV testing performed on battery to make efficient fuel gauge system
- Add circuitry to make sure the battery is not over discharge and over charge (part of BMS)

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