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A COMPREHENSIVE DATA MONITORING AND LOGGING SYSTEM FOR LITHIUM-ION BATTERY PACKS IN AGRICULTURAL ROBOTICS

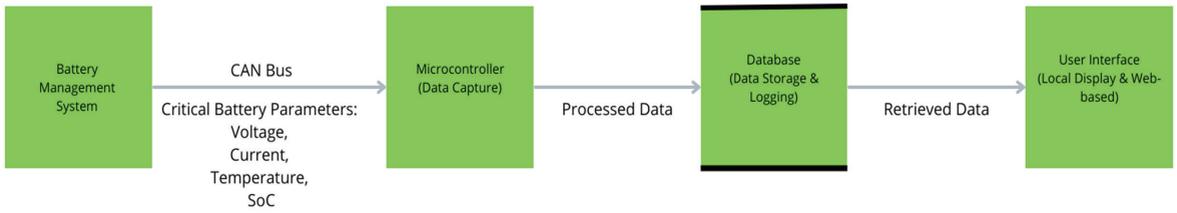
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Abstract – This paper presents the development and evaluation of a monitoring and data capture system designed to track critical parameters of a lithium-ion battery pack used in an agricultural robot. Agricultural robots rely heavily on battery performance to operate efficiently and reliably in the field. As a result, ensuring that the battery is well-managed and monitored can significantly improve the robot's operating time, reduce downtime, and extend overall battery life. Given the growing emphasis on energy efficiency in modern agricultural practices, optimizing battery usage and storage plays a crucial role in reducing energy waste and improving sustainability. Our approach integrates both hardware and software elements to collect, store, and present key battery parameters. We utilize a Battery Management System (BMS) that communicates vital data such as voltage, current, temperature, and State of Charge (SoC) through a Controller Area Network (CAN) bus. A dedicated microcontroller reads and processes these signals, and then transfers them into a central database for long-term logging and analysis. This enables precise tracking of battery health and performance, ultimately supporting more energy-efficient robotic operations. To make this information accessible to users, we developed a clear and intuitive interface. Operators can view the data on a built-in display located directly on the robot, as well as remotely through a web-based interface and an API. This dual-access approach supports on-site monitoring during field operations, as well as remote diagnostics and decision-making. Such flexibility aids in timely maintenance, better charging strategies, and overall improved resource management – key factors in maximizing energy efficiency and minimizing unnecessary power consumption. Preliminary tests performed under realistic field conditions indicate that our system reliably captures and records the critical battery parameters. The data collected facilitates early detection of potential issues, preventing unexpected breakdowns and saving valuable time and costs. In future work, we plan to implement advanced analytics and machine learning algorithms to predict battery failures and optimize charging schedules. By providing a robust and accessible tool for battery management, this system contributes to more efficient, sustainable, and productive agricultural robotic operations while reinforcing the importance of energy storage and utilization in modern farming.

Keywords – *Cell-level management; condition tracking; Controller Area Network (CAN); diagnostics; energy storage device; Graphical User Interface (GUI)*



Data Flow Diagram of the Battery Monitoring and Logging System

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