Passive CAN-Based Energy Monitoring for Low-Voltage Electric UGVs

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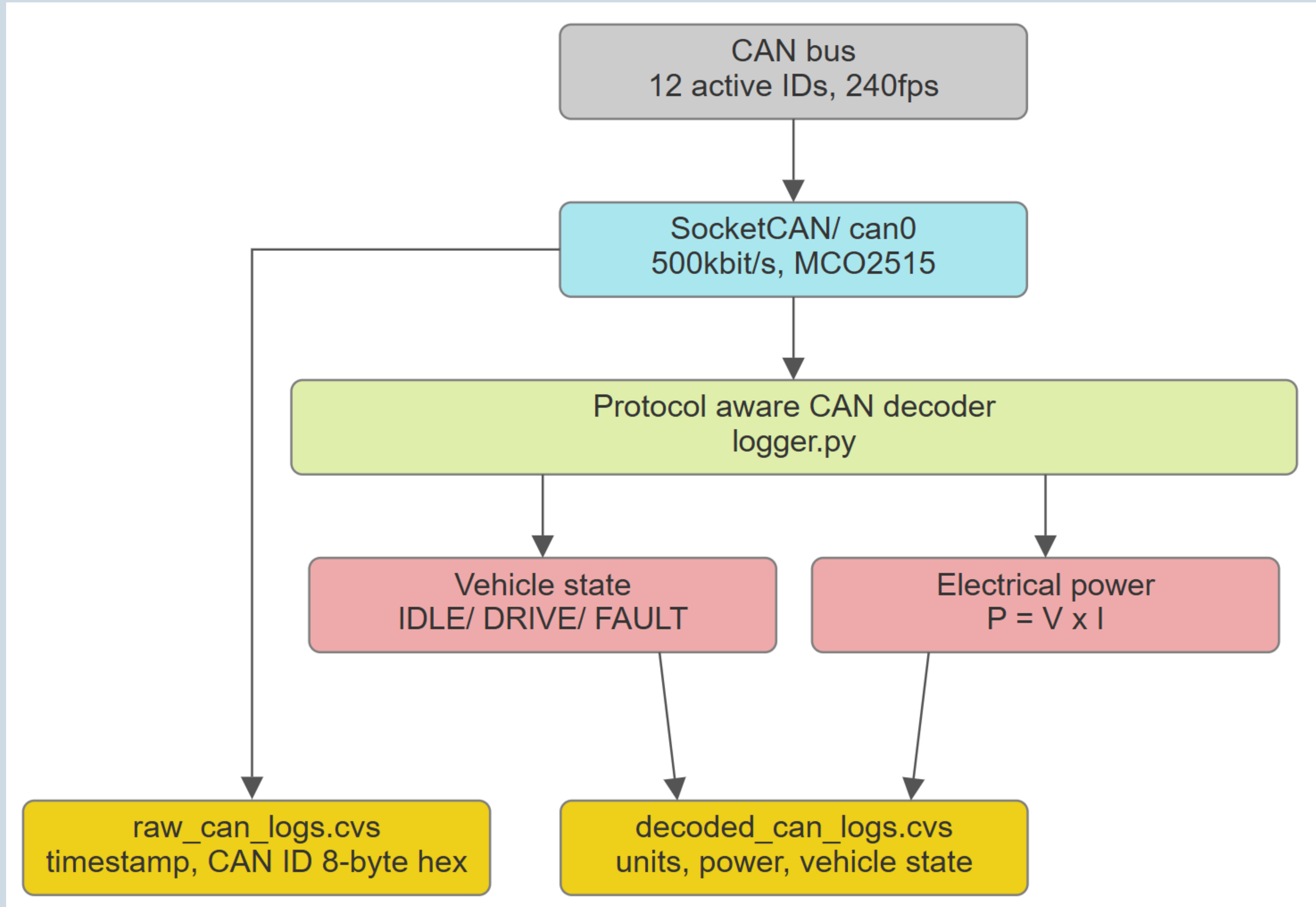
Passive CAN logging enables reliable vehicle-level energy monitoring without a VCU

- A total of 54,564 CAN frames were recorded across 12 identifiers without frame loss.
- The system operated at 240 frames per second and enabled real-time identification of vehicle states.

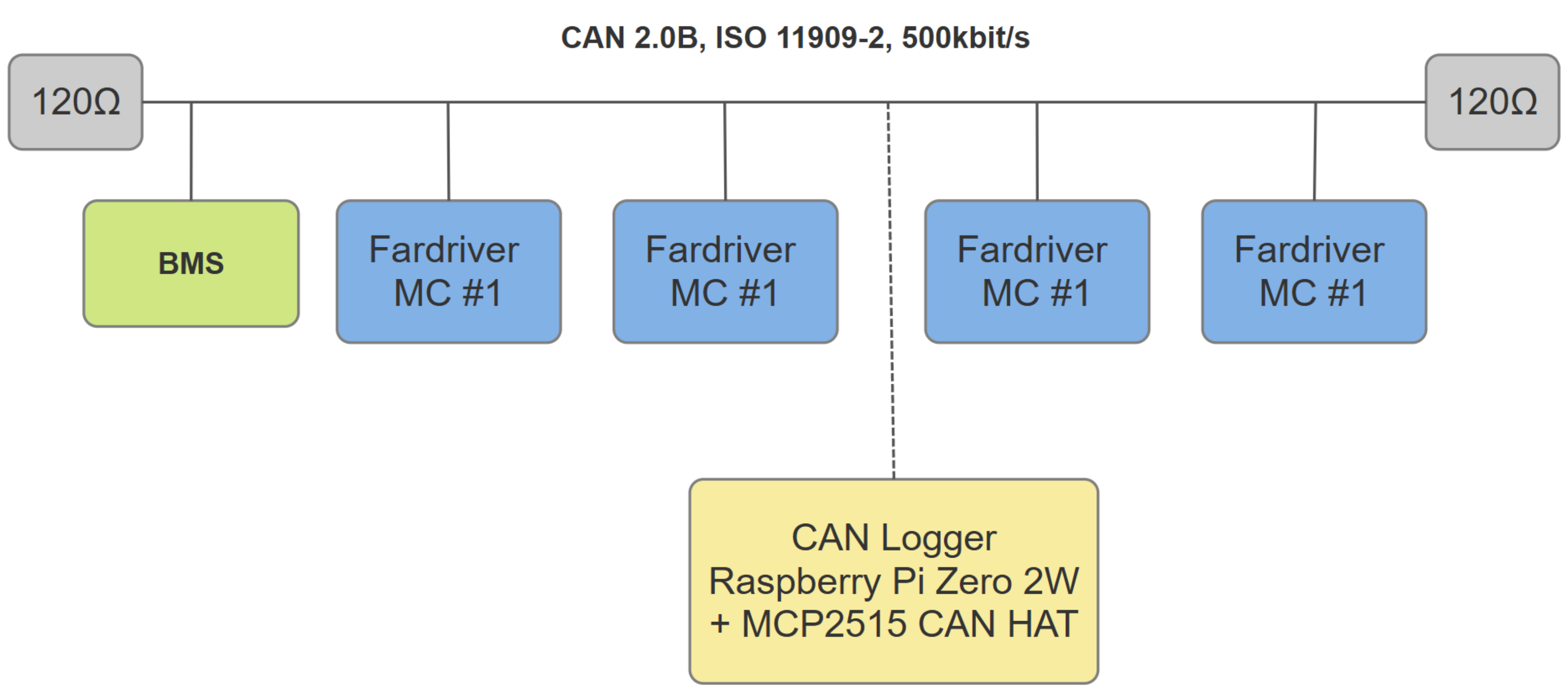


Introduction

Electric unmanned ground vehicles (UGVs) use multiple distributed controllers for propulsion.
Without a vehicle control unit (VCU), vehicle-level energy monitoring becomes difficult. Controller Area Network (CAN) provides access to real-time electrical parameters such as voltage, current, and motor speed. This work presents a passive CAN-based monitoring system for vehicle-level energy analysis in a low-voltage electric UGV.

Materials and methods

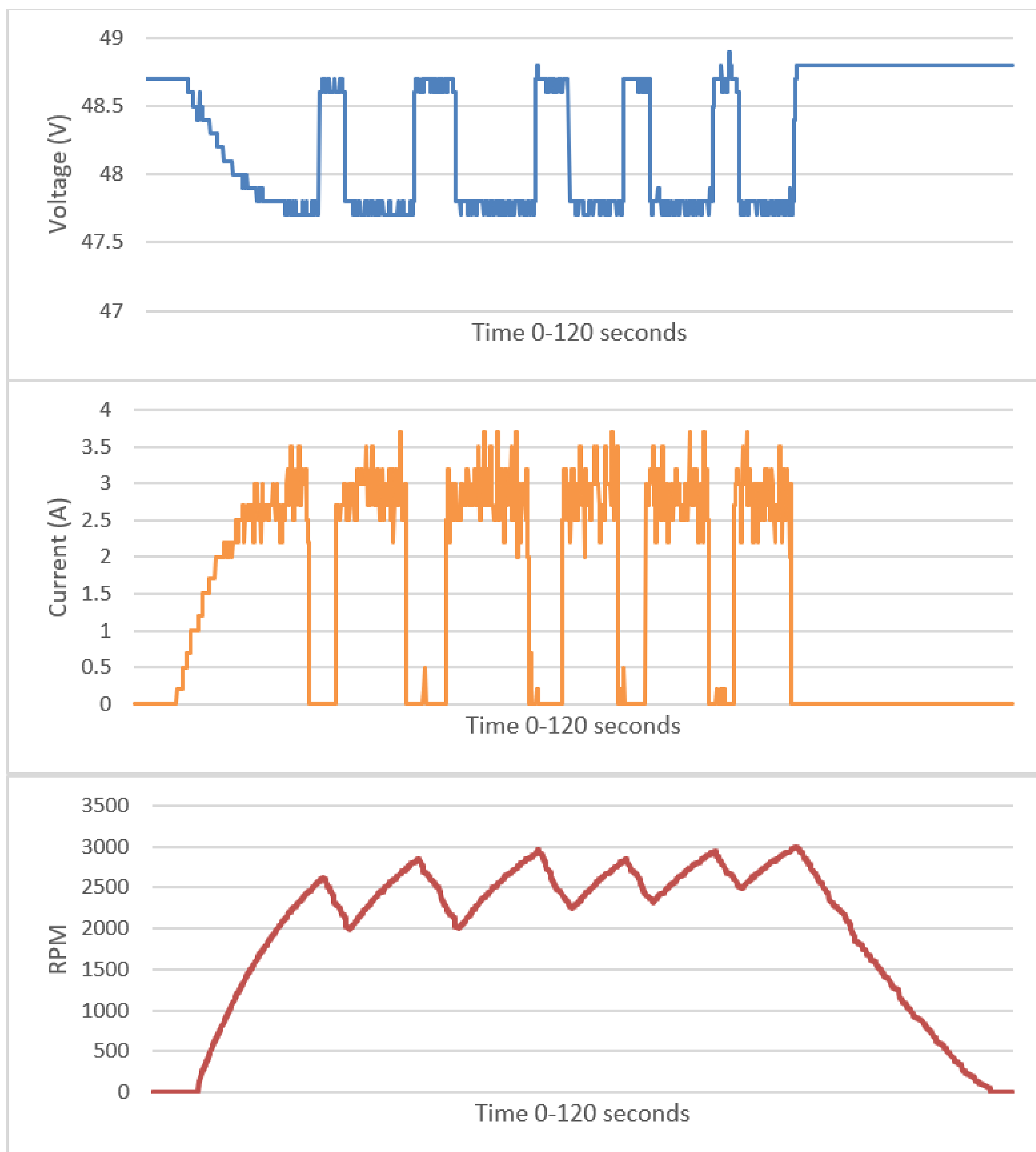
The setup consisted of a low-voltage electric UGV propulsion system with four motor controllers connected via a 500 kbit/s CAN bus. A Raspberry Pi Zero 2W equipped with an MCP2515 CAN interface was used as a passive logging node, capturing all CAN traffic without transmitting any messages. Data acquisition was implemented using SocketCAN and a custom Python-based decoding script. Both raw CAN frames and decoded electrical parameters were recorded to enable structured analysis and state identification.



Results

The system maintained stable operation at approximately 240 frames per second on a 500 kbit/s CAN bus.

Battery voltage remained stable between 47.6 V and 48.9 V, with an average value of 48.49 V. Power consumption increased with throttle input, reaching values up to approximately 506 W. The system successfully identified IDLE and DRIVE states based on decoded CAN signals. The results confirm that passive CAN-based monitoring provides consistent and reliable data for vehicle-level energy analysis under varying operating conditions.



Results decoded from raw can frames in response to throttle input (voltage, current, RPM)