Enhancing CAN Bus Transmission Efficiency in Electric Vehicles through Data Speed Optimization

Umar Jamil, Jonghoon Kim
Energy Storage Conversion Lab., Chungnam National University

ABSTRACT

In battery management systems (BMS), the conventional approach in controller area network (CAN) bus protocol for transmitting current and voltage information in 64-bit data frame packets which requires significant bandwidth and power consumption. By focusing on these challenges, this paper proposes a novel approach by introducing the delta encoding technique which transmits only the difference in data earlier packets rather than full data set. Through implementing this approach in battery parameters, reduces the size of the data packets to be transmitted over CAN bus. The impact of this reduced size compensates for more data sets in one transmitting packet which improves the transmission speed and BMS performance. The experimental results demonstrate the effectiveness in enhanced data transmission speed, highlighting the delta encoding as an effective strategy in data transmission reduction while keeping the data integrity. The data transmission speed gets improved by two times through following this approach of transmission.

1. Introduction

In electric vehicles (EVs), CAN buses are used for communication between the Electronic Control Units (ECUs) responsible for various vehicle functions. These include the Battery Management System (BMS), charging scheme, motor movement, sensor commands, etc. The data communicated via the CAN bus is called a packet or frame, which contains information to be transmitted between the ECUs. CAN bus packets contain various fields before and after the data set. These fields include frame start (SOF), identifier (ID), control field, cyclic redundancy check (CRC) field, approval (ACK) field, and end of frame data (EOF). The CAN bus provides a maximum communication speed of 1 Mbit/s within 40 meters [1]. According to the ISO 11898-2 high-speed CAN bus standard, the ECU must be within 30 cm to deliver a message fully without losing packet data. In CAN bus transceivers can enter low-power standby mode, but they typically maintain their connection to the bus. In present CAN bus architecture assigns two bytes for each parameter of voltage and current which collectively consists of six bytes per data frame. However, the CAN bus gives the space of eight bytes per frame, so limiting the data that can be transmitted within one transmission cycle. The CAN bus gives the maximum 1Mbit/second so it's required to a make a unique algorithm to increase the CAN bus transmission speed so that large volume of data can be transmitted within the available bandwidth. Through this way, the data throughput can be increased by enhancing the number of battery cells for data collection through CAN bus. The data optimization and technique can facilitate the transmission efficient of more data while keeping the conventional CAN bus protocol in the EV systems. The algorithm protocol follows to minimize the transmission latency and reduces the packet loss during the communication with the MCU of the EV [2].

2. Proposed Hardware approach

In this paper, a new algorithm is proposed which focuses on data collection and develops a packet-setting algorithm for CAN buses. The entire data of current and voltage is shared with CAN buses each time, which is more time and power-consuming in terms of communication. Here, instead of transmitting the entire eight-byte dataset, we present a unique algorithm that uses an optimized dataset consisting of 3 bytes to transmit the same dataset. In this way, more data can be transmitted in one packet. We obtain the difference between the previous and current values and map them to a defined range to facilitate transmission. This method allows two data to be processed cooperatively within one transmission cycle of CAN buses. Fig. 1 shows CAN bus packet transmission distribution in which the eight bytes of the data are reserved for the data. Hence, the Eq. 1 presents the Δv as change in voltage, $v(t)$ is present voltage and $v(t-1)$ is the past voltage. In Eq. 2, the ΔI is change in current, $I(t)$ is present current and $I(t-1)$ is past current amperes. The CAN bus data is given in Eq. 3, where CAN_{data} are eight bytes packet, Δv is the voltage change and ΔI is the current change.

$$\Delta v = v(t) - v(t-1) \quad (1)$$
$$\Delta I = I(t) - I(t-1) \quad (2)$$
$$CAN_{data} = \Delta v + \Delta I \quad (3)$$

3. Experimental results

The experiment was carried out to make the new data for the CAN bus packet to compensate the four data sets instead of two

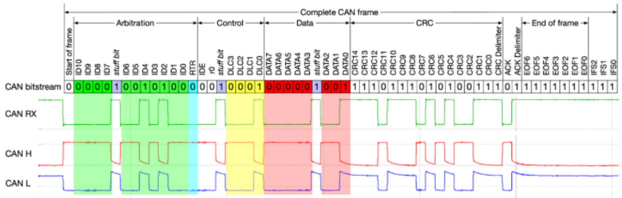

Fig.1 CAN bus packet data transmission

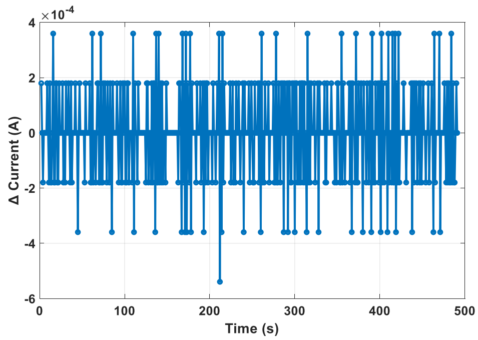

Fig.2 Change in current between present and past measured current profile

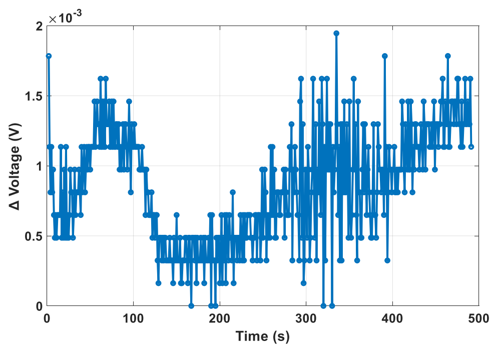

Fig.3 Change in voltage between present and past measured voltage profile

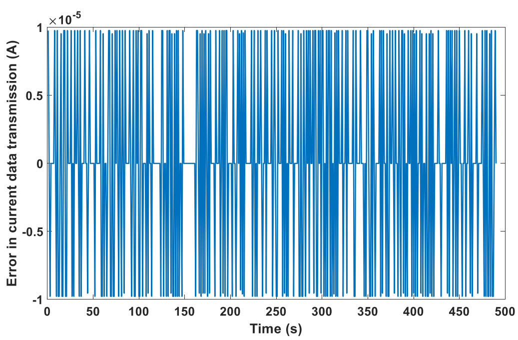

Fig.4 Error in current transmission from actual value

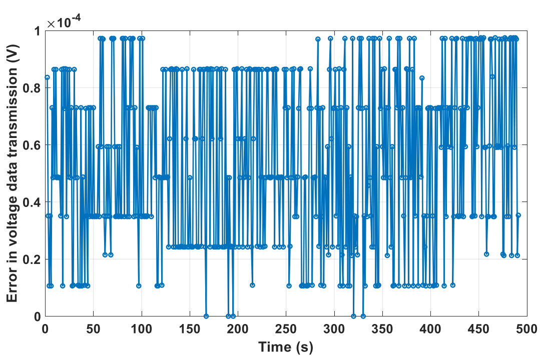

Fig.5 Error in voltage transmission from actual value

data sets. By this approach the data transmission speed improved as more data get transmitted through one transmission. The algorithm is designed to take the difference between past and new value of the voltage and current and mapped it in the character form to make it 1 byte. This will make the value in the ranges of −127 to 128 which converted to the binary form. Now with the improved algorithm compensated eight values consists of 4 bytes for the current and four bytes of voltage in CAN bus data. Fig. 2 and Fig. 3 demonstrate the current and voltage difference values which are ready to be mapped. Fig. 4 and Fig. 5 present the error in the current and the voltage value which occur while transmitting the data through the CAN bus. The CAN bus limitations for keeping the data sharing of the eight byte is overcome through the new algorithm in which the difference between the previous and the new data is shared. The mapping in the current case has a maximum error of 0.8 mV and 9 mA for the voltage and current respectively.

4. Conclusion

In this research work, propose a new method to increase the speed of data sharing by improving the efficiency of data transmission on CAN buses. In existing methods, transmitting the entire values of voltage and current could increase the amount of data and slow communication. However, in this new approach, the amount of data that needs to be transmitted can be greatly reduced by only transmitting information about the amount of change. Real-time data sharing is important in battery management systems, and faster and more efficient communication is possible by transmitting only the amount of change in data. In addition, this method has an advantage in terms of energy efficiency. Reducing the amount of data transmission also reduces the power consumption required for transmission, which can improve power efficiency and increase the sustainability of the system.

Acknowledgement

References

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