Multi Coded XOR Masking Technique for CAN Based Distributed Embedded System for Vehicle Control

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Abstract— Present automobiles are being developed by more of electrical parts for efficient operations. The Controller Area Network (CAN) is a serial, asynchronous, multi-master communication protocol for connecting electronic control modules in automotive and industrial applications. In this paper, we explore the impact of 3 Nolte's X-OR masking techniques on the status information of vehicle to reduce jitter noise during trans-receiving a long sequence of identical bits to improve the features of CAN protocol with PIC microcontroller.

Key words: Exclusive-OR(X-OR), Controller Area Network (CAN)

I. INTRODUCTION

CAN (controller area network) is a serial communication bus protocol. This is basically implemented in the automobiles to control the mechatronic nodes. CAN allows the implementation of peer-to-peer and broadcast multicast communication functions with lean bus bandwidth use. The bit representation used by CAN is "Non Return to Zero" (NRZ) coding. If (for example) two CAN controllers are linked, then their clocks are synchronized by means of the data edges.

In recent decades, the Distributed Control Systems are preferred in industries to improve production, quality, operation control, and automatic stock registry management with cost effectiveness. Distributed system's backbone depends upon communication between central control nodes. Field bus communication is the best option to establish channels between embedded systems based central control nodes for reliable and stable network communication. CAN protocol field bus based features like collision avoidance, multi-master transmission, message filtering, variable communication speed support, stability control etc are more preferable in automobile, robotics and in different industrial applications. CAN bus communication is asynchronous type transmission which need not transmit clock pulses along with information. Because of this reason, synchronization between node clock and information bit timing is required at receiver node [2]. Due to long sequence of identical bits of information, unit-bit length time increases during transmission that affects the next bit timing as a jitter-noise. To minimize adverse effect of Data Dependent Jitter (DDJ), many researchers have developed techniques like software based Bit Stuffing and EX-OR Masking techniques [2]. In this paper we will develop an algorithm for "EX-OR masking technique" to enhance different features of CAN bus communication efficiency and reliability.

II. CONTROLLER AREA NETWORK (CAN)

Start Of frame	Arbitration field(frame identifier value)	Control field	Data field(8 Byte)	CRC field	ACK field	End of frame

Fig. 1: Frame format for CAN bus data transmission.

CAN-A Data Frame Specification format of CAN bus data transmission shown in Fig. 1, first bit start of frame field use to synchronize receiver nodes of CAN bus. Arbitration field contain eleven bits identifier for frame identification and six bits control field for data length and frame type information. Next sixty four bits (8-byte) data field carry Data/information as a payload. Followed sixteenth bits Cyclic Redundancy Check (CRC) field use to check received data sequence same as transmitted data or not. Next Two bits which are kept recessive serve as acknowledgment field and next seven bits indicates End of Frame (EOF) field Multi -master policy of CAN allows multiple nodes can be a master at the same time it can start communication but only one node can do transmission on a serial field bus at a time. When multiple nodes are ready to transmit frame at a time, the Carrier Sense Multi Access with deterministic collision resolution (CSMA) policy activates to decide priority between nodes. CSMA policy assigns highest priority to node with lowest identifier field value (arbitration field) and then it allots CAN bus to the node. CAN communication is multi node multi master based communication on Twisted pair physical link as shown in Fig. 2.

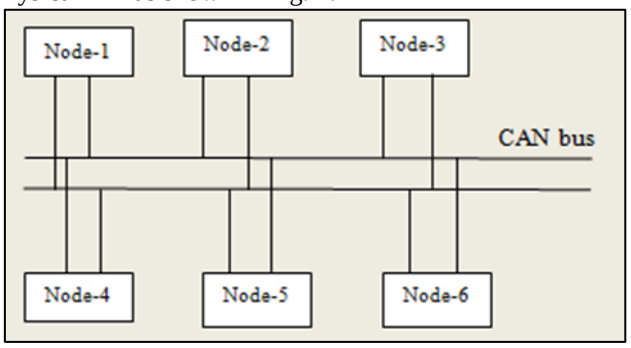

Fig. 2: Structure of Controller Area Network

III. PROPOSED WORK

In this paper our main objective is to design and implement a CAN protocol using XOR masking techniques Nolte A, Nolte B & Nolte C.

A. Nolte-A:

In this technique, all data bytes are EX-ORed with 10101010 binary bits pattern. This technique is simple and all 8-byte data space of CAN frame is used for Data purpose i.e. no bandwidth loss in Nolte-A technique [2, 3].

B. Nolte-B:

In this technique, checking for sequence of five identical bits from data field of CAN frame on the basis of byte by byte. If any data byte of frame found sequence of five identical bits then set '1' (one) in second bit of first byte of data field. Whereas all other bytes are EX-ORed with data pattern 10101010 bit pattern otherwise set zero in second bit of first byte and send data without doing any EX-OR operation [2]. At transmitter node single encoding bit is indicate frame is EX-ORed or not i.e. No bandwidth loss in this technique [2, 3].

C. Nolte-C:

This technique, checks sequence of five identical bits byte by byte if any sequence available in data field of frame then first byte's second no bit is set if not found then it will reset second bit. Last byte of data field is reserve for 6-bit encoding information i.e. If byte -2 is found 5-bit sequence of identical bit then last byte's 2nd bit become one otherwise zero i.e. if 2nd byte and 5th byte content have 5 sequential identical bit then do EX-OR operation of only 2nd and 5th byte content with the binary code 10101010 and make 2nd no bit and 5th no. bits one in the last byte and all other bits of last byte become zero [2, 3].

At receiver side node will extract second bit of first byte, if second no. bit status is one then it means last byte of data field have decoding information and frame is masked by EX-OR code 10101010. Status of bit position of last byte is use to do EX-OR operation with particular byte. When status of bit is '1' then do EX-OR operation with 10101010 code otherwise keep byte data as it is [2, 3].

IV. BLOCK DIAGRAM

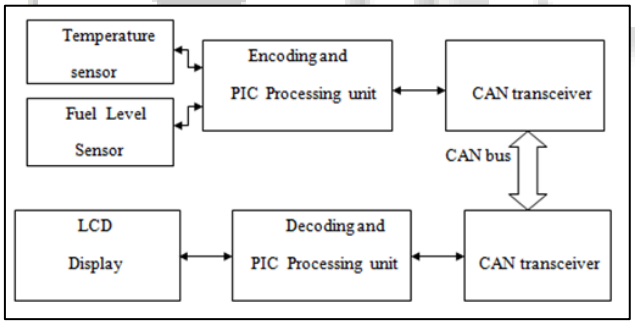

Fig. 3: Block Diagram of Proposed Work

A. Block diagram description:

Fig. 3 shows the block diagram of CAN vehicle control system. It consists of input nodes and LCD Display. CAN with PIC is used as nodes to receive the inputs of vehicle status. In this project we are using a temperature sensor as one node (A) & fuel level sensor as another node. Which are connected to CAN through PIC. The communication between these sensors is done by using CAN controller. Input from sensor is encoded and processed and then it is transmitted through CAN bus. At receiver side is decoded and displayed on LCD.

In this system, an algorithm for EX-OR masking has been developed and then it is implemented using two Free scale Demo boards. These demo boards contain CAN trans-receiver module and PIC controller. The Algorithm performs EX-OR operation to convert the message in to a form having a sequence of the maximum of four identical bits followed by a complemented bit appears in the new sequence of the message. The proposed technique can improve data quality by reducing DDJ jitter-noise and sequence of identical bits with respect to Data pattern.

V. RESULT

Transmitter Side	Receiver Side		
Temperature (˚C)	Nolte A	Nolte B	Nolte C
32	30	31	32
34	32	33	34
27	25	26	27

Table 1:

Above table shows the different temperature status of vehicle. This data is transmitted to receiver side by applying Nolte A, Nolte B & Nolte C X-OR masking techniques. Above result shows that Nolte C has higher accuracy than other two techniques.

VI. CONCLUSION

This EX-OR masking technique will reduce jitter noise and drift during trans-receiving a long sequence of identical bits. Also using this technique we will reduce the number of stuff-bits inserted by the CAN protocol.

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