Vehicular Framework Estimation Using Controller Area Network

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Abstract

With advancements in the field of engineering, the certainty is that majority of accidents are caused by humans . To reduce the risk of accidents, Anti-lock braking system (ABS) is used to prevent slip in vehicles by reducing the breaking force. The Controller area network (CAN) is an in-vehicle communication network system and serves as the backbone of the entire system. The CAN bus is the central control through which many microcontrollers, transmit and receive the data. The Controller Area Network which serves as a serial communication protocol supporting real-time control, helps to obtain more efficiency. It also provides very high level of data integrity. The communication with the controller will be faster irrespective of its load. For example, in automotive applications, engine control units, sensor units and anti-skid systems are integrated using CAN. The CAN bus offers bit-rates up to 1 Mbit/s and is implemented into vehicle body electronics as a cost effective measure..

Keywords: *ABS, CAN.*

I. INTRODUCTION

The automotive functionalities, such as drive assistance systems, will require features, such as safety, dependability and testability. CAN protocol can increase the car safety in an effective way by several folds. Information sharing is the basic function of in vehicle network. The main challenge on a slippery road is stopping a car in a hurry. The Anti-lock braking system is an automobile safety system that depends on drive inputs and helps in maintaining tractive contact with the road surface. When brake is applied, locking up is prevented as a result of which uncontrolled skidding can be avoided. Wheel speed sensors are used to determine if the wheels are trying to lock up during the process of braking. CAN protocol is one of the vehicle bus standards which allows the microcontrollers and devices to communicate in applications where a host computer is not involved. CAN protocol transmit the data faster and hence the time delay is reduced.

The existing system uses Traction control system for actuation of electric motors and it is an effective approach to monitors the speed of each wheel to detect locking. When sudden braking is detected, it releases braking pressure temporarily and provides appropriate braking pressure to each of the wheels. Thereby, it also provides an improved ability of stopping the vehicle. The skidding of wheels during driving is prevented using a Traction control system, that uses brakes during friction to serve as actuators.

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TC and ABS functions are implemented by means of torque control of wheels. The ABS and TC performance of full electric vehicles can be enhanced at frequencies above 10 Hz as compared with conventional systems.

The paper is structured as follows. Initially, the details of CAN protocol are provided. Next, the flow of protocol within the vehicular module is presented, and the last section consists of analysis of the simulated results and proof of their credibility.

II. CAN PROTOCOL IMPLEMENTATION

A. Proposed Implementation

The CAN bus is a multi-master message based protocol with high data rate compared to USB and Ethernet. Broadcasting short messages to the entire network is done by the CAN network, which provides data consistency in every node of the system

The CAN protocol is based on the Open System Interconnection model, and it mainly uses the physical and application layer for data transmission. Figure 1 depicts the functions of the CAN network

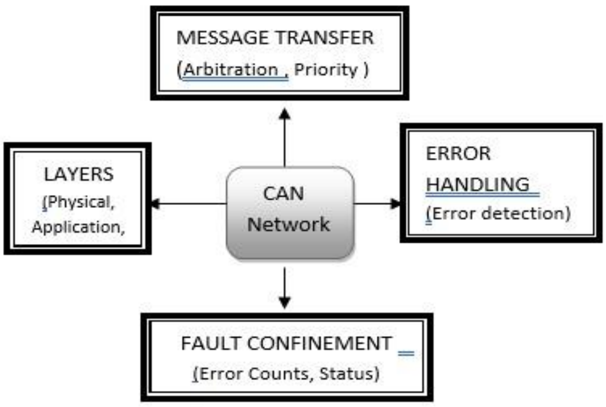

Figure 1. CAN Network

Figure 2 shows the frame format of CAN. It consists of the Identifier phase and the arbitration phase and the message is broadcast into the entire network. The main advantage of CAN is its Bit wise Arbitration strategy where the recessive bit always overrides the dominant bit that helps to avoid collision in the network

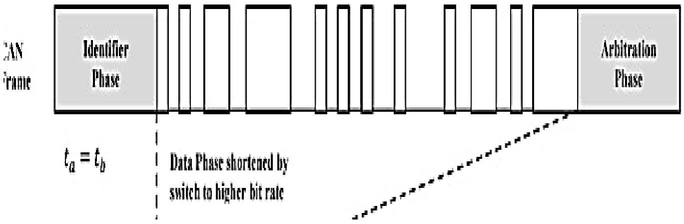

Figure 2. CAN Frame format

Errors are generated due to faults on transmitted messages, which causes the contents to corrupt and error recovery is implemented using several fault-tolerant mechanisms. This leads to delays in message delivery. Under practical requirements of these messages, these problems can affect the system performance by a drastic amount.

Figure 3 shows the proposed system that implements a CAN protocol for an in-vehicular system such as car. The various sensors and modules present in the car such as gas sensor, temperature sensor, air bag, ECU etc. are controlled using a ARM7 processor that is interfaced to the various devices using the CAN protocol.

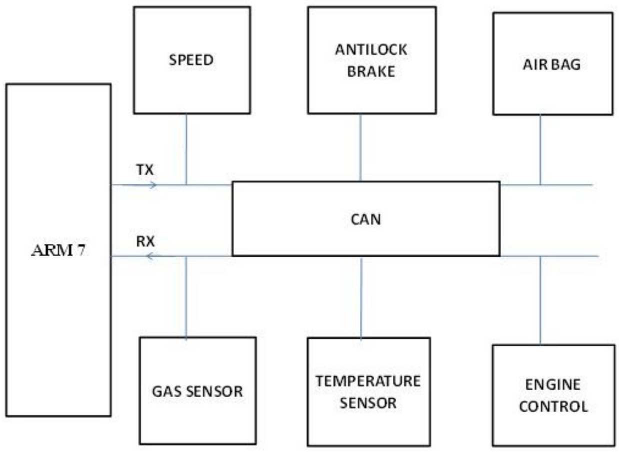

Figure 3: CAN Protocol Implementation

The CAN (Controller Area Network) protocol reduces the number of electrical lines and data connections with high reliability in rugged operating environment. Tremendous flexibility in terms of cost,

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performance, and upgradeability can be provided in system design. This reduces the complex to understand and troubleshoot the problems by using only two wires. This paper aims at the implementation of CAN protocol using ARM7 microcontroller which enables the communication between all interconnecting modules with great speed and priority. The CAN network requires two or more nodes to communicate and lossless bitwise arbitration method of contention resolution is used. For a network range below 35m , the CAN provides bit rates up to 1 Mbit/s. High speed CAN is used in industries and automotive applications. Another classification of CAN bus, fault tolerant CAN is used where nodes need to be connected together by forming groups. The operational frequency is about 16MHZ. This reduces the time delay and it is more efficient compared to other protocols.

B. Process flow of CAN

The flow diagram of the CAN based network is depicted in figure 4. Flex sensor that is built upon resistive carbon element is used in the prototype as a braking system. The flex changes its resistivity based on its bending ratio. When the sensor is bent, the resistance output produced is correlated to the bending radius. The more the bend, the resistance is also more. This resistance is considered as the brake applied, in the prototype.

Temperature sensor is used to measure the engine temperature and the cabin temperature. When the temperature exceeds a certain value, an alarm is sounded that makes the vehicle's processor to either continue its operation or adjust certain engine functions always ensuring that the engine keeps functioning.

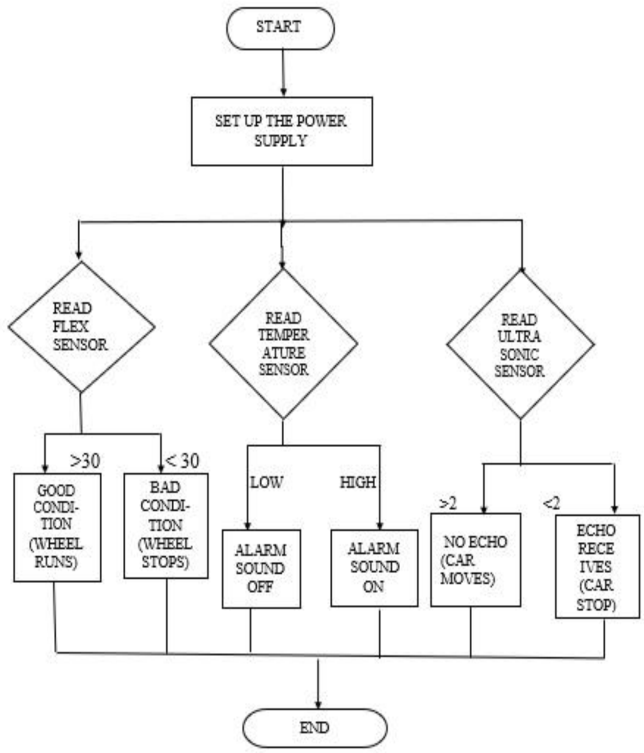

Figure 4: Flow chart of implementation

Ultrasonic sensor is used for parking assistance, maneuvering narrow situations and provides support during emergency parking situations by providing communication at high data speeds using CAN. A threshold value is set for each of the sensors connected to the processor. Figure 5 represents the threshold limit set for each sensor. When the measured value becomes lower or exceeds the threshold, then the system takes necessary action for the vehicle to operate despite varying load conditions.

SENSOR	REFERENCE VALUE
Flex	30
Temperature	10
Ultrasonic	2

Table 1. Sensor threshold limits

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III . Hardware Implementation

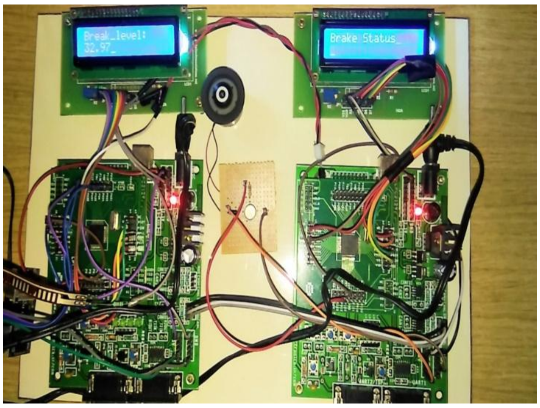

Figure 5. Hardware Layout

Under worst-case scenario, the Tindell equationis used to calculate the transmission time of messages in CAN, to the various sensors and modules present in the system

$$Cm= \left(O + 8s_m + \left[\frac{T_m + 8s_m}{5}\right]\right) T_{bit}$$

where Tbit is the transmission time of each bit, Tm is the message transmission time.

The hardware implementation is shown in figure 6 and is done as follows, two modules are separately considered, one is an in-cabin module and the other is a module that controls the ABS connected to the wheel. CAN protocol controls both the modules. For representation purpose, flex sensor is considered as a braking system, where the amount of resistance is proportional to the extent of brake applied. When the brake is applied, it is compared to the threshold limit set. When the threshold is lower than the required value, the CAN message is broadcast to the ABS and the vehicle stops with a very short delay. This shows that the data rate at which the message is transmitted is high that causes the ABS module to react immediately, with very less delay or no delay.

IV. CONCLUSION AND FUTURE WORK

This paper explored the advantages of using a CAN bus over a vehicular network. Its high data rate up to 1Mbps allowed message transfer to interconnecting modules with very less delay.

When more modules are added, or the system is modified the performance of the network is affected. To enhance this, as a part of future work CAN-FD can be used that supports many modules transmitting many messages even at high load conditions. CAN-FD can support data rates up to 8Mbps [9]. In CAN-FD the data field phase is shortened that leads to high data rate.

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