

Vehicle Engine Vibration Monitoring System Using Real Time CAN

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Abstract

Nowadays car manufacturers use either their own or pre-built commercially available vibration testing systems, to examine every part of the car from the seats to the engine. The cost of the vibration test systems is extremely high, and the automotive industries are very keen on the research and development of new cost-effective techniques with real time monitoring systems. Based upon these requirements, we have developed a preliminary prototype system for testing the vibration of the vehicle engine, based upon the use of a Controller Area Network (CAN) system. This system can be integrated efficiently into the present vehicles' management network system. The system includes two micro controller-based boards with PIC18F4520 and ADXL335 chips. The first board has a two-axis acceleration sensor, which is mounted on a car engine for vibration testing, while the second board, communicates to the PC to simulate a car dashboard for controlling the system. The two boards communicate via the vehicle's existing data communications network (CAN bus). These micro controller-based hardware devices are driven by programs written in the C programming language, while LabVIEW provides the user-control interface. This paper will present the methodology, design approach and results of the online monitoring system.

Keywords- Controller Area Network (CAN), Vibrations, Micro-controller

I. INTRODUCTION

Nowadays car manufacturers use either their own or pre-built commercially available vibration testing systems, to examine every part of the car from the seats to the engine. The cost of the vibration test systems is extremely high and the automotive industries are very keen on the research and development of new cost-effective techniques with real time monitoring systems. This system comprises two parts, one is a micro controller-based vibrations testing board mounted on the engine (see Figure 1), and the other contains the second micro controller-based board and the PC that simulate the dashboard. These two parts communicate through a CAN bus. The micro controller chips run programs written in the C programming language. The second board communicates with the PC through a RS232 serial bus. The CAN protocol was developed by Bosch in the 1980's, and the CAN network is widely applied in many automation industries, particularly in the automotive industry [2]. It is an advanced serial communication bus system with a transmission speed from 125Kb/s to 1Mb/s, depending on the physical bus length. CAN efficiently supports distributed real time control with a high level of security [3]. There are two popular CAN specifications, 2.0A (Standard CAN message format with 11 bits identifier) and 2.0B (Extended CAN message format with 28 bits identifier) [4]. The employment of this existing data communications network in this design enables the system to integrate efficiently with the current vehicles' management network system. The vibration sensor chip, ADXL335, is a small, low cost, low power device that has three-axis accelerometers with a measurement range of $\pm 10g$. The micro controller chip, PIC18F4520, has a built-in CAN controller and controls the sensor. The second board consists of a PIC18F4520 micro controller chip, and a RS 232 driver chip (MAX 233), which drives the RS 232 communications between the board and the PC

II. LITERATURE SURVEY

Sr. No.	Reference	Purpose	Merits	Demerits
1]	Electric vehicle data acquisition system	From this paper various parameters researched and from this we research how data is transmitted and received for example research in electric vehicle driving pattern, vibration testing and fleet management. For data transmission and received CAN protocol is used.	Basic concepts of sentiment analysis explained	Only Generalized methodology explained
2]	CAN In Automation	Controller area network or CAN protocol is a method of communication between various electronic devices like engine management systems, active suspension, ABS, gear control, lighting control, air conditioning, airbags, central locking etc. embedded in an automobile. An idea initiated by Robert Bosch GmbH in 1983 to improve the quality of automobiles thereby making them more reliable, safe and fuel-efficient..	More detailed model of sentiment analysis is given	Techniques not much used
3]	Monitoring vibration of vehicle engine and various parameters	From this paper we got actual implementation of our project whose can is used, what parameter are required for input and output.	Detailed information about importing datasets,	Algorithm not much effective
4]	Analog devices	Low cost +-2 g/+10 g dual axis accelerometers with digital output ADXL210. In real time application. We use engine but for demo purpose we use ADXL210 sensor and we get information about ADXL210 sensor from this paper	Better, low cost	Methodology not Explained in detail

III. CAN (CONTROLLER AREA NETWORK)

The CAN protocol was developed by Bosch in the 1980's, and the CAN network is widely applied in many automation industries, particularly in the automotive industry. The CAN controller module is for communications between both boards. The data length of CAN transmission data is up to 8 bytes, and the transmission baud Rate is programmable up to 1mb/ps. Every CAN node in a CAN system must have a device to convert the digital signals Generated by a CAN controller to signals suitable for transmission over the bus. A CAN transceiver MCP 2551 chip is used for this purpose, it serves as the interface Between CAN controller and physical bus. Its operation speed is up to 1 Mb/s.

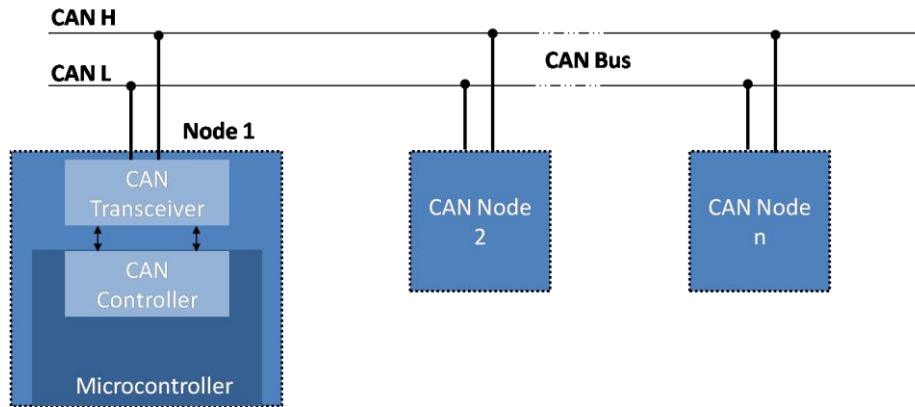


Fig.1 CAN Controller Module

V. METHODOLOGY

This system contains two boards. One is a micro controller-based vibration testing board mounted on the engine. Other contains the second microcontroller-based board and the PC that simulate the dashboard. These two boards communicate through a CAN bus. For demo, we use ADXL335 vibration sensor chip which is mounted on board 1 similarly we also test various parameters of engine like temperature, engine oil level etc. The output circuits of the ADXL 335 convert the analogue signals to duty cycle modulated digital signals whose duty cycles (ratio of pulse width to period) are proportional to the acceleration in each of the two sensitive axes. These outputs are measured directly with the micro controller counter using the CCP module. It initializes the chip, sets the timer/clock, initializes the CAN module, and captures the data from the pins of CCP module for the calculation of the duty cycle for the ADXL335 chip. There are four data outputs from this device, these are T1x and T2x (for x axis vibration), T1y and T2y (for y axis vibration). These are captured, and then sent to the Board 2 via the CAN controller and CAN transceiver. The second program is for the micro controller chip of board 2. This program initializes the chip, sets the timer/clock, captures the data from CAN bus to the buffers, initializes the UART module, and sends/receives the data to the PC via the RS 232 driver. The PC calculates the vibration results using the data collected from the micro controller-based hardware system using equation 1, and then the calculated vibrations testing results are displayed. Some of the information about the CAN communications between two boards are captured and displayed. All of the parameters for the RS 232 communications and part of the parameters for the CAN communications can be set in this user interface.

In the Board 1 design, a micro controller chip PIC18F4520, a two-axis accelerometers chip, ADXL 210, and a CAN transceiver chip, MCP 2551, are employed. In the Board 2, a PIC18F4520 and a multichannel RS232 driver chip, MAX233, are used. A 20MHz TTL oscillator is employed to clock each board. Several passive components are required for the board to operate correctly. In order that the system is able to integrate efficiently into the present vehicles, the board space is made as minimal as possible, each board takes 52mm (L) * 50mm (W) * 8mm (H) only. To make the board secure and stable, the Printed Circuit Board (PCB) technology is used. The PIC18F4520 is a flash programmable processor allowing for rapid development and prototyping, and has built in Capture/Compare/PWM (CCP), CAN controller, and Universal Asynchronous Receive and Transmit (UART) modules. The CCP module is used to capture the outputs from the accelerometer's sensor chip. This module contains a 16-bit register that can operate as a 16-bit capture, compare, or PWM Duty Cycle register. The CAN controller module is for communications between both boards, it supports both CAN 2.0 A and B. The data length of CAN transmission data is up to 8 bytes, and the transmission baud rate is programmable up to 1 Mb/s. The UART module is for RS 232 communications between the second board and the PC.

Every CAN node in a CAN system must have a device to convert the digital signals generated by a CAN controller to signals suitable for transmission over the bus. A CAN transceiver MCP 2551 chip is used for this purpose, it serves as the interface between a CAN controller and the physical bus. Its

operation speed is up to 1 Mb/s. The physical CAN bus is a two-wire bus, which are known as CAN High and CAN Low and in their inactive state they normally sit at 2.5V. The CAN bus has two states (see Figure 3): Dominant state occurs when the CAN High voltage is higher than CAN Low voltage, and Recessive state occurs when CAN High and CAN Low voltage are at the same level.

The programs for the PIC18F4520 chips are written using CCS PICmicro C compilers. This C compiler utilizes a Windows Integrated Development Environment (IDE), which makes the programs more straight forward to create. A development programmer, PICSTART Plus, with the software of MPLAB IDE is employed to program the micro controller chips.

The GUI was created using the LabVIEW programming language. The PC calculates the vibration results using the data collected from the micro controller-based hardware system using equation 1, and then the calculated vibrations testing results are displayed. Some of the information about the CAN communications between two boards are captured and displayed. All of the parameters for the RS 232 communications and part of the parameters for the CAN communications can be set in this user interface.

Inside the ADXL335, two-axis acceleration sensor is a surface micro machined poly silicon structure. Ploy silicon springs provide a resistance against acceleration forces. The deflection of the structure is measured using a differential capacitor. Acceleration will deflect the beam and unbalance the differential capacitor, resulting in an output square wave whose amplitude is proportional to acceleration. The output circuits of the ADXL335 convert the analogue signals to duty cycle modulated digital signals whose duty cycles (ratio of pulse width to period, see Figure 4) are proportional to the acceleration in each of the two sensitive axes. These outputs are measured directly with the micro controller counter using the CCP module [Analog Devices, Inc., 2005].

In order that the vibrations testing results can be displayed and the user can control the system on the PC, the RS 232 driver chip, MAX 233, on Board 2 is connected between the pins of the UART module of the PIC18F4520 and the RS 232 serial bus.

In the CAN Communication Information page, the information about the CAN communications between two boards, such as the CAN module initialization state (success or fail), the micro controller's buffers state, the transmitted message number, the baud rate, the data length, the CAN formats (standard or extended), and the CAN ID are displayed. Some of the parameters for both the RS 232 and the CAN communications are available for the user to set in the Parameters page. There are COM1 and COM 2 ports selections, data bits, stop bits, buffer size and baud rate for RS232 communication. The baud rate and CAN message formats can be set as well. In the Block Diagram (see Figure 8), which contains the codes to control the objects of the Front Panel (GUI). There are many SEQUENCES, CASE, FOR, and WHILE programming loops employed in the program. Three main items (.vi) are used for RS232 serial communications.

These micro controller-based hardware devices are driven by programs written in the C programming language, while LabVIEW provides the user-control interface. This paper will present the methodology, design approach and results of the online monitoring system.

VI. SIMULATION AND RESULTS

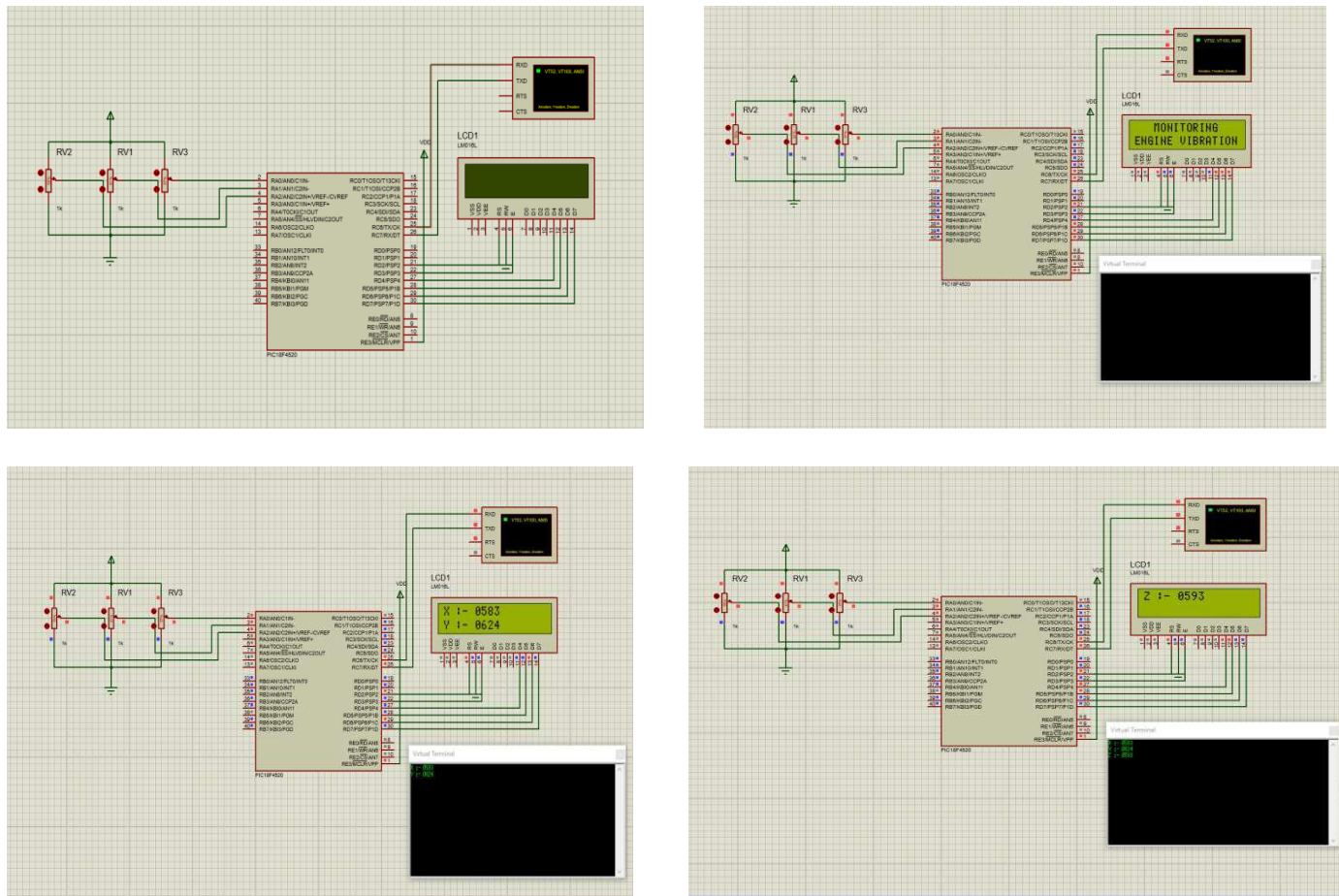


Fig.2 Monitoring the vibration results of ADXL335 in X,Y and Z direction

Whatever the values will be received from ADXL335 (from X, Y & Z directions) are further passed to the Car dashboard by using CAN Network.

VII. CONCLUSION

This CAN bus based low cost vibration testing system can be Integrated into the management network system of current vehicles very efficiently due to its flexibility and extensibility. The test of this system is very stable and successful and the system is ready to deliver to the industry. Future development of the system will involve building more boards with CAN nodes for capturing data from the different sensors used in this project and communicating with the simulated dashboard (main control board) using can bus. This data will include carbon monoxide, nitrogen monoxide, nitrogen dioxide, Sulphur dioxide and hydrocarbons sensor outputs.

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