Coal Monitoring System Using CAN

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Abstract- Based on continuous revolution of coal mining technology,this paper put forwards a technology about safety monitoring system using Controllable area network protocol.Coal mining plays very important role in most of the developing countries to meet the energy demands.But the same time mining industry is facing many problems which include the mine workers safety.Especially the underground mine environment is very complex. There is a need of continuous monitoring of temperature, emission of toxic gases like methane etc.Here we can use CAN protocol to record and transmit information about these factors reducing the use of wired technology.

I. INTRODUCTION

A mine is considered tobe a plant that produces useful mineral with a given percentage of ore and given quantity whereas the cost of mining is expected to be minimum price. Geological conditions of any mine are determinesd by nature. They are unpredictable[1]. The various environmental parameters of mine system,such as methane,carbon monoxide, tempratue,oxygen and so on are currently using the traditional cable network.This kind of network has poor performance of expansion. The cables are very easy to aging and wear, and have high incidence of failures. With the working surface expanded, a blind area for monitioring appears, and then the new cost for installation and maintance is needed. When an accident happened, especially explosion, the sensors and cables usually were damaged fatally, and couldn't provide information for rescue search and detection events.[2]. Besides this mining project activity is subject to high risks because of its size, uncertainty, complexity, high costs and mine workers safety.[3].The emission of toxic gases from coal seam in turn leads to air pollution in mine area. It sevely affect mine workers health .The deeper a mine is, the worse and more dangerous miner's work is. The high temperature of the Earth's center raises the temperature of the underground mine and it will be impossible to work. Controllable area network protiocol can solve the key issues of communication bandwidth, mobile data transmission, staff orientation, working surface real-time monitoring, synchronization monitoring and so on.

Controllable area network is widely used in automobile sectors. It was invented by Robert Bosch GmbH in 1980 for automotive applications It is basically an vehicle bus standard, designed to allow microcontroller and devices to communicate with each other within a vehicle without a host computer. The Controller Area Network (the CAN bus) is a serial communications bus for real-time control applications. CAN operate at data rates of up to 1 Megabits per second and has excellent error detection and confinement capabilities.

CAN was originally developed by the German company Robert Bosch for use in the car industry to provide a cost-effective communications bus for in-car electronics and as alternative to expensive and cumbersome wiring looms. The car industry continues to use CAN for an increasing number of applications, but because of its proven reliability and robustness, CAN is now also being used in many other industrial control applications.

CAN is an international standard and is documented in ISO 11898 (for high-speed applications) and ISO 11519 (for lower-speed applications).Low-cost CAN controllers and interface devices are available as off-the-shelf parts from several of the leading semiconductor manufacturers. Custom built devices and popular microcontrollers with embedded CAN controllers are also available. There are many CAN-related system development packages and available hardware interface cards and easy-to-use software packages that provide system designers, builders and maintainers with a wide range of design, monitoring, analysis, and test tools. The CAN protocol is defined by the

ISO 11898 standard and can be summarized like this: The physical layer uses differential transmission on a twisted pair wire. A non-destructive bit-wise arbitration is used to control access to the bus. The messages are small (at most eight data bytes) and are protected by a checksum .There is no explicit address in the messages, instead, each message carries a numeric value which controls its priority on the bus, and may also serve as an identification of the *contents* of the message. It is an elaborate error handling scheme that results in retransmitted messages when they are not properly received. There are effective means for isolating faults and removing faulty nodes from the bus.

PRINCIPLES OF DATA EXCHANGE:

CAN is based on the so-called broadcast communication mechanism. This broadcast communication is achieved by using a message oriented transmission protocol. Thus not defining stations and station addresses, it only defines message. These messages are identified by using a message identifier. Such a message identifier has to be unique within the whole network and it defines not only the content but also the priority of the message. This will be important when several stations compete for bus access.

A high degree of system and configuration flexibility is achieved as a result of the content-oriented addressing scheme. It is very easy to add stations to an existing CAN network without making any hardware or software modifications to the existing stations as long as the new stations are purely receivers. This allows the concept of modular electronics and also permits multiple receptions and the synchronization of distributed processes: data needed as information by several stations can be transmitted via the network in such a way that it is unnecessary for each station to have to know who the producer of the data is. This allows easy servicing and upgrading of networks as data transmission is not based on the availability of specific types of stations

THE CAN MESSAGES

The CAN bus is a broadcast type of bus. This means that all nodes can "hear" all transmissions. There is no way to send a message to just a specific node; all nodes will invariably pick up all traffic. The CAN hardware, however, provides local filtering so that each node may react only on the interesting messages.

CAN uses short messages - the maximum utility load is 94 bits. There is no explicit address in the messages; instead, the messages can be said to be *contents-addressed*, that is, their contents implicitly determines their address.

MESSAGE TYPES

There are four different message types (or "frames") on a CAN bus:

The Data Frame

The Data Frame is the most common message type. It comprises the following major parts: The Arbitration Field, which determines the priority of the message when two or more nodes are contending for the bus. The Arbitration Field contains: For CAN 2.0A, an 11-bit Identifier and one bit, the RTR bit, which is dominant for data frames. For CAN 2.0B, a 29-bit Identifier (which also contains two recessive bits: SRR and IDE) and the RTR bit. The Data Field, which contains zero to eight bytes of data. The CRC Field, which contains a 15-bit checksum calculated on most parts of the message. This checksum is used for error detection. An Acknowledgement Slot; *any* CAN controller that has been able to correctly receive the message sends an Acknowledgement bit at the end of each message. The transmitter checks for the presence of the Acknowledge bit and retransmits the message if no acknowledge was detected.

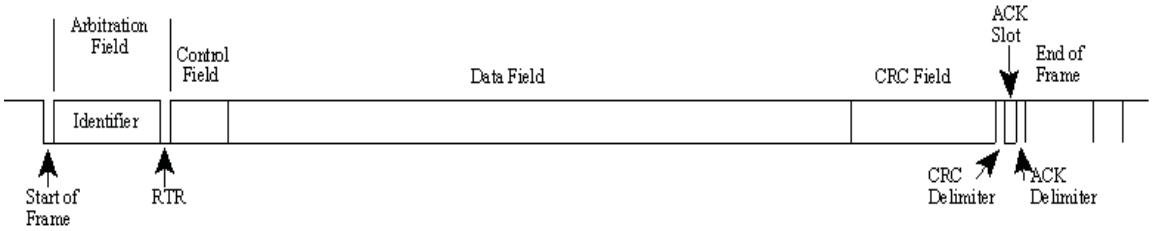

Fig 1: A CAN 2.0A ("standard CAN") Data Frame

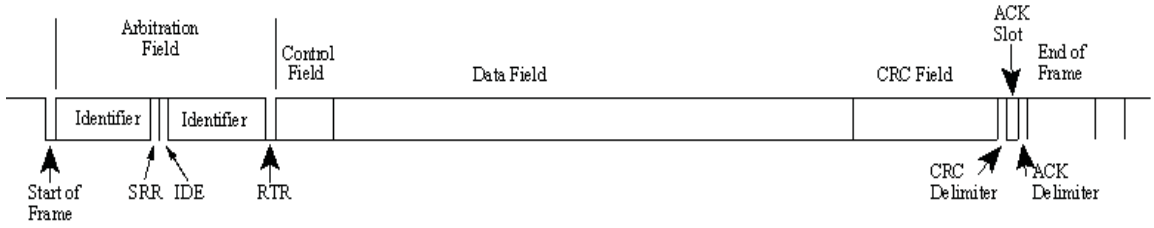

Fig 2: A CAN 2.0B ("extended CAN") Data Frame

The Remote Frame: The Remote Frame is just like the Data Frame, with two important differences: It is explicitly marked as a Remote Frame (the RTR bit in the Arbitration Field is recessive), and there is no Data Field. The intended purpose of the Remote Frame is to solicit the transmission of the corresponding Data Frame. If, say, node A transmits a Remote Frame with the Arbitration Field set to 234, then node B, if properly initialized, might respond with a Data Frame with the Arbitration Field also set to 234.Remote Frames can be used to implement a type of request-response type of bus traffic management. In practice, however, the Remote Frame is little used. It is also worth noting that the CAN standard does not *prescribe* the behavior outlined here. Most CAN controllers can be programmed either to automatically respond to a Remote Frame, or to notify the local CPU instead.

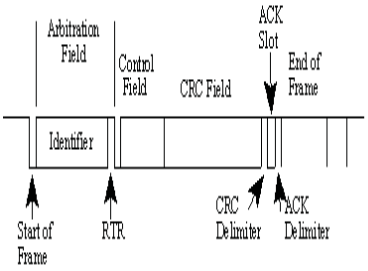

Fig 3: A Remote Frame (2.0A type)

The Error Frame**:**Error Frame is a special message that violates the framing rules of a CAN message. It is transmitted when a node detects a fault and will cause all other nodes to detect a fault - so they will send Error Frames, too. The transmitter will then automatically try to retransmit the message. There is an elaborate scheme of error counters that ensures that a node can't destroy the bus traffic by repeatedly transmitting Error Frames.

The Error Frame consists of an Error Flag, which is 6 bits of the same value (thus violating the bit-stuffing rule) and an Error Delimiter, which is 8 recessive bits. The Error Delimiter provides some space in which the other nodes on the bus can send their Error Flags when they detect the first Error Flag.

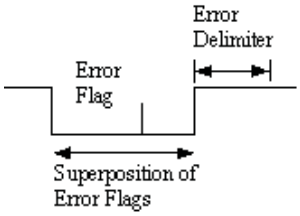

Fig 4: Error Frame

The Overload Frame:

The Overload Frame is very similar to the Error Frame with regard to the format and it is transmitted by a node that becomes too busy. The Overload Frame is not used very often, as today's CAN controllers are clever enough not to use it. In fact, the only controller that will generate Overload Frames is the now obsolete 82526.
THE CABLE **:**The ISO 11898 prescribes that the cable impedance be nominally 120 Ohms, but an impedance in the interval of [108..132] Ohms is permitted. There are not many cables in the market today that fulfils this requirement. There is a good chance that the allowed impedance interval will be broadened in the future. ISO 11898 is defined for a twisted pair cable, shielded or unshielded. Work is in progress on the single-wire standard SAE J2411.

At a speed of 1 Mbit/s, a maximum cable length of about 40 meters (130 ft.) can be used. This is because the arbitration scheme requires that the wave front of the signal can propagate to the most remote node and back again before the bit is sampled. In other words, the cable length is restricted by the speed of light.

II. Proposed Algorithm

A.Objectve of project

This system can be used for monitoring of different physical/environmental parameters involved in the chemical processes in textile and polymer fabrication such as humidity, temperature etc, also in coal mines for continuous monitoring of environmental conditions to avoid the hazards and active power dissipated across the connected load by using multiple CAN nodes. The host controller collects these parameters from sensors and transmits them to the distant location that is receiver.

The primary objective of the project is to implement the physical layer of Controller Area Network (CAN). Actually this project is research based i.e. main aim of the project is to implement the wireless CAN bus accompanied with reducing EMI losses to reduce the wire harnessing in automobiles to meet their future developments. Though the CAN was merely implemented for use in automotive applications, it can also be implemented in other industries for speedy monitoring of essential parameters.

B.Algorithm

Transmitter:

1. Disable the analog comparator and enable the ADC.
2. Initialization of SPI control and status register.
3. Initialization of timer registers to set timer0 compare match ISR at 500 Hz and timer2 compare match ISR every 1 msec.
4. Enable the interrupts.
5. Initialization of MCP2515 in normal mode and load the standard identifier in it.
6. Set filters to block transmitters from receiving any packets.
7. Read the content of ADC register and store it into array.
8. Load the data into data field of CAN frame through the SPI interface.
9. If the external interrupt is occurred then the special CAN frame is transmitted on the bus.

Receiver:

1. Initialize the external interrupts in the falling edge.
2. Initialization of SPI control and status register.
3. Assign the ports for LCD and initialize it.
4. Enable the interrupts.
5. If interrupt is occurred about message reception then read the message from MCP2515.
6. If the message about detection of methane gas then display the message about detection. Otherwise display the node no. and relative data.

III. Experiment and Result

The testing results of different sensors we have used in our project is given below.

SR.NO	Temperature	Output voltage(mv) theoretically	Output voltage(mv) practically
1	32	320	324
2	35	350	363.2
3	36	360	383.4
4	40	400	407.5
5	42	420	428.1
6	45	450	437.6
7	50	500	483.3
8	60	600	595.1
9	65	650	643.4
10	70	700	705.5
11	75	750	745.5
12	80	800	834.2

Table 06: Temperature sensor (LM 35 readings)

IV.CONCLUSION

Our project is a hardware plus software project, which aims at collecting the various physical parameters from the sensors and transmitting these collected parameters through, CAN bus from the different transmitters to the receiver. Basically our system is used in the coal mines for data monitoring of physical quantities like temperature, humidity, & methane gas, these parameters monitoring is essential for safety of miner's life. The transmitter is located at the distinct locations to collect these parameters and transmits to the receiver at the control location. As CAN provide a data transfer rate of 1Mbps it will collect the parameters with high speed.

The advantages are as 1)This is more flexible and can avoid the trouble of rewiring 2)It will greatly improve the performance and efficiency of data transmission of the coal mine safety system and reduce the costs of extending the system**.**

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