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Designing Of a Low Cost Based Alerting System to Prevent the Train Accidents Using GSM and GPS Technology

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ABSTRACT

This paper is proposed to design the rail engines with a new emergency automatic braking system called Vigilance Control Device (VCD) to prevent the train accidents due to the un-alertness of the loco pilots. The proposed system is a microcontroller based safety system which will enhance safety of the passengers by cyclically generating warnings and by automatically stopping the train if the driver is fast asleep or incapacitated or dead. This paper also gives the information to the higher authorities regarding the position of the loco crew and the position of the train where it is stopped by using Global System for Mobile communication (GSM) and Global Positioning System (GPS) technologies. If the loco pilot does not perform a regular task such as accelerating or braking for a stipulated period of time a message will be send to the Vigilance Control Officer (VCO) through GSM. After the train is stopped automatically by applying the penalty brake, its position is tracked by GPS and a message will be send to the vigilance control officer.

Keywords – Control, loco, GPS, GSM, pilot, vigilance

I. Introduction

In Indian Railways, most of the accidents have been caused due to failure of Railway staff. Under optimum field conditions and with the best of intentions, a human being is likely to commit a mistake from time to time. This is the reason why operating rules included many redundancies in safety procedures and operating practices involve number of checks and balances. More and more automation is resorted to prevent human errors. This paper provides a method to safety of the passengers in trains by alerting the driver cyclically at regular intervals. Vigilance control device plays a major role to reduce and prevent the accidents that are caused by the pilot of the train. Vigilance Control Device (VCD) is a microcontroller based safety device which will automatically apply penalty brakes in case the driver is incapacitated or dead or fast asleep. Similar operation is available in older rail engines in the form of Dead man's Lever. "The dead man's lever is a knob that has to be kept pressed at all times to keep the train running. This system was introduced to prevent accidents, even if the driver died at his controls, hence the name. Unless a certain amount of pressure is maintained on the lever, brakes get automatically activated and the train slows down and comes to a stop. Another form of driver safety system is "Dead Man System" which detects a continuous input from the driver, e.g. by application of force to a pedal or handle [1]. In this system there is no facility to inform the action of the loco pilot and the position of the train to higher authorities to take any responsible action. So in order to overcome this disadvantage and to make the loco pilot in alertness and to ensure safety to passengers the new emergency braking system is proposed called vigilance control device.

The rest of the paper is organized as follows. The proposed setup of the system i.e., the block diagram, components, interfacings and protocols are explained in section 2. Working of the proposed system is explained in section 3. Experimental results are presented in section 4. Concluding remarks are given in section 5.

II. Components and Interfacings

The proposed system shown in Fig.1 consists of different components interfacing to a microcontroller.

1. Power Supply
2. Inputs from Loco Pilot
3. MU Mode
4. 16x2 Liquid Crystal Display(LCD)
5. Flashing LED
6. Buzzer
7. Relay & DC Motor
8. MAX 232
9. GSM Modem
10. GPS Module

In this paper we are using AT89S52 microcontroller, the heart of the system. The AT89S52 is a low-power, high performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry standard 80C51 and 80C52 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system

programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

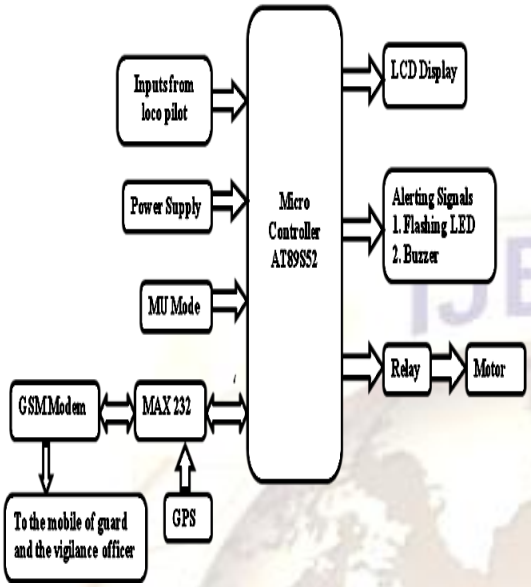

Fig.1: Block Diagram

2.1. Power Supply

The input to the proposed system is applied from the regulated power supply. The A.C. input i.e., 230V from the mains supply is step down by the transformer to 12V and is fed to a bridge rectifier. The output obtained from the rectifier is D.C voltage. So in order to get a pure D.C voltage, the output voltage from the rectifier is fed to a filter to remove any A.C components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a pure constant dc voltage. We are using an IC 7805 as voltage regulator to get a 5V output Voltage.

2.2. Inputs from loco pilot

The inputs from the loco pilot are the mechanical inputs which are discussed in this paper by using switches. The inputs are Horn, Brake, Gear 1, Gear 2, and Reset.

2.3. MU Mode

Mu mode is multiple unit mode to support the efficiency of the second engine.

2.4. Liquid Crystal Display (LCD)

Liquid Crystal Display (LCD) screen is an electronic display module and find a wide range of applications. A 16x2 LCD means 16 columns and 2 rows i.e., it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Data and Command. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The interfacing of LCD with microcontroller is shown in Fig.2.

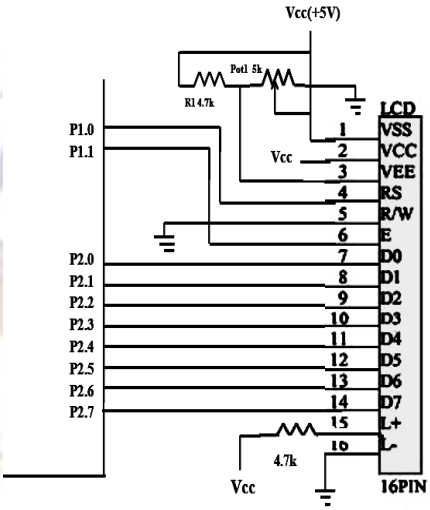

Fig.2: LCD interfacing

2.5. Flashing LED

Light emitting diodes (LEDs) are semiconductor light sources. They are manufactured in different shapes, colors and sizes. Based on semiconductor diode, LEDs emit photons when electrons recombine with holes on forward biasing. The forward voltage of LED (1.7V-2.2V) must be lower than the voltage supplied (5V) to drive it in a circuit. Using an LED as such would burn it because a high current would destroy its p-n gate. Therefore a current limiting resistor is used in series with LED. The LED is interfaced to the output port of micro controller as the first indication to alert the loco pilot.

2.6. Buzzer

Buzzer is an audio signaling device, which may be electronic, mechanical or electro-mechanical that sounds a warning of continuous or intermittent sound. It is compact and produces high sound pressure levels with minimal power consumption. The range of operating voltages is from 1 to 30V whilst sound output may be as high as 75 dB at 1m. Normally, buzzers operate a buzzing noise in the frequency range 300 to 500 Hz. This is used to alert the driver. The buzzer is connected to output port as a second indication to driver.

2.7. Relay & motor

A relay is an electrically controllable switch widely used in industrial controls, automobiles and appliances. A relay is able to control an output circuit of higher power than the input circuit. Relays are devices which allow low power circuits to switch a relatively high Current/Voltage ON/OFF. For a relay to operate a suitable pull-in & holding current should be passed through its coil. Generally relay coils are designed to operate from a particular voltage often its 5V or 12V. DC (direct current) motors convert electrical pulses to mechanical movement. Maximum speed of DC motor is indicated in RPM. The RPM is reduced when moving a load and it decreases as the load increases. The permanent magnet DC motor can be modeled as a device that produces torque proportional to the current flowing through it. It also produced a voltage proportional to the rotational velocity. The RPM of a motor is proportional to the voltage across its terminals. The motor will spin up in speed until the generator portion of the motor model matches the supply voltage. At that point no more current will flow into the motor and it will produce zero torque. The interfacings of relay and motor are shown in Fig.3.

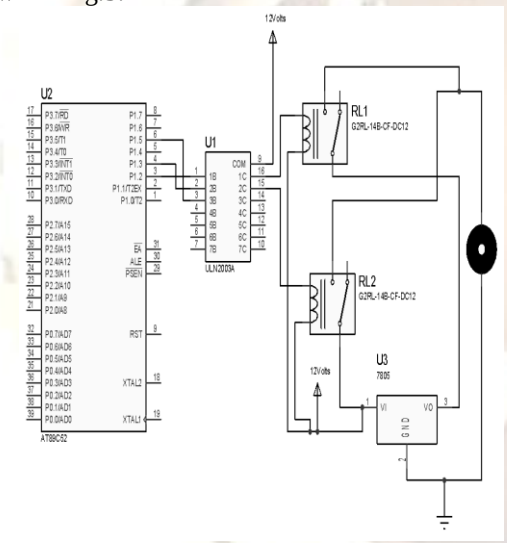

Fig.3: Relay and Motor Interfacings

2.8. MAX232

The microcontroller can communicate with the serial devices using its single serial port. The logic levels at which this serial port operates is TTL logics. But some of the serial devices operate at RS 232 Logic levels. For example PC and Smart Card Reader, GSM Modem etc. So in order to communicate the microcontroller with modem, a mismatch between the logic levels occurs. In order to avoid this mismatch, in other words to match the Logic levels, a serial driver is used. And MAX232 is a Serial Line Driver used to establish communication between modem and microcontroller. The interfacing of MAX232 is shown in Fig.4. A DB-9 connector is used for connecting the other serial devices.

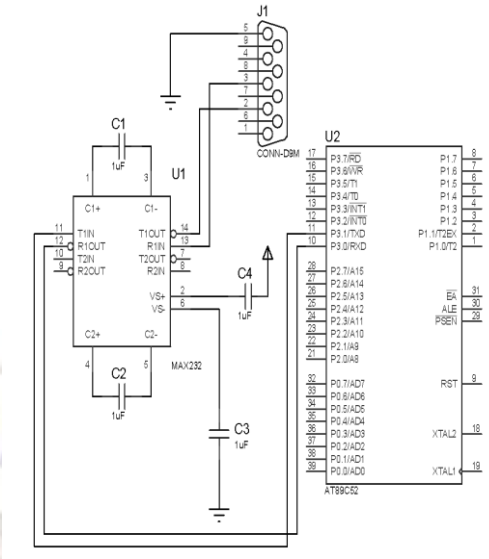

Fig.4: MAX232 Interfacing

2.9. Global System for Mobile communication (GSM)

A GSM modem is a wireless modem that works with a GSM wireless network. It operates at either the 900MHz or 1800MHz frequency band. It supports voice calls and data transfer speeds of up to 9.6kbits/s, together with the transmission of SMS (Short Message Service). The GSM Modem comes with a serial interface which the modem can be controlled using AT command interface. In this paper a GSM modem SIMCOM made SIM300 V 7.03 interfaced with the microcontroller operates in 900MHz frequency and is operated at voltage levels of 3.5 to 5V. The modem is provided with network status indication LED lamp. It is also provided with buzzer to indicate incoming call. The GSM modem prototype is shown in Fig.5.

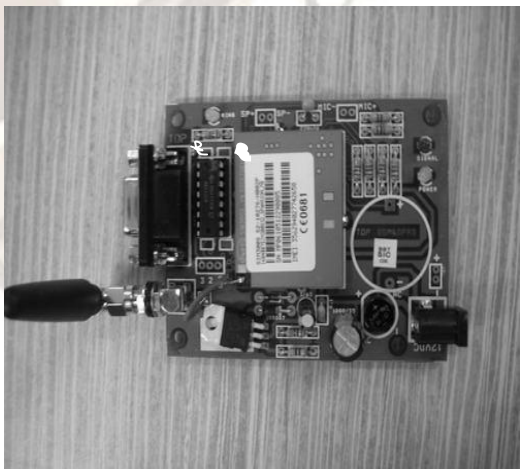

Fig.5: GSM Modem Prototype

The working of GSM modem is based on AT commands which are used to control the modems. Since one of the main objective for this

application is to show how to send the message, only a subset of the AT command set needs to be implemented which is shown in Table.1. The AT commands are given to the GSM modem with the help of PC or controller.

Table.1: Set of AT commands

Command	Description
AT	For checking communication
AT+CMGF	For setting the SMS mode (Either text or protocol data unit mode)
AT+CMGW	For storing message in the SIM
AT+CMGS	For sending message to a given phone number

2.10. Global Positioning System (GPS):

The Global Positioning System (GPS) formally known as the NAVSTAR (Navigation Satellite Timing and Ranging) is a space-based satellite navigation system that sends and receives radio signals and provides location and time information in all weather conditions, anywhere on or near the Earth. The basis of the GPS technology is a set of 24 satellites that are continuously orbiting the earth. These satellites are equipped with atomic clocks and sent out radio signals as to the exact time and location. These radio signals from the satellites are picked up by the GPS receiver. Once the GPS receiver locks on to four or more of these satellites, it can triangulate its location from the known positions of the satellites. It is a higher performance, low power satellite based model. It is a cost effective and portable system which accurately detects the location. The GPS receiver used here is Skytraq Venus 6 GPS module ST22 which is having TTL logics and also RS232 as option[8]. The interfacing of the GPS receiver is shown in Fig.6. This GPS is used to track the position of the train after the emergency brake is applied in order to avoid the accidents. This application is used only after the train is stopped either by guard or by applying penalty brake.

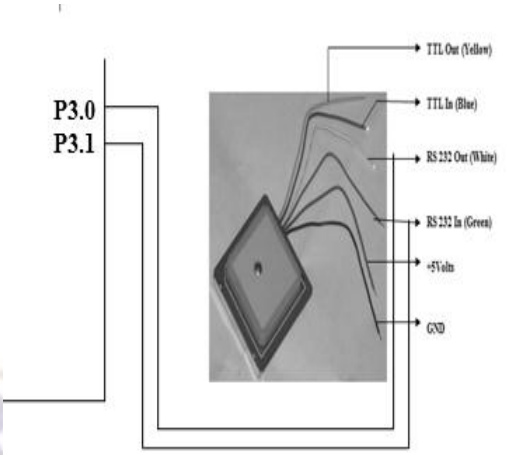

Fig.6: Interfacing of GPS receiver

III. Working of the Proposed System

The proposed system Vigilance Control device (VCD) is a microcontroller based equipment designed and manufactured to enhance the safety of the locomotive operation by ensuring the alertness of the loco crew all the time. The system operates in a fail-safe manner. VCD will generate cyclic warnings to the loco pilot. Based on the loco pilot's reaction to these warnings (in terms of pre-defined set of actions to be done by the loco pilot), the system will automatically reset the vigilance cycle. The flow chart of the proposed system is shown in Fig.7.

The loco pilot operates controls for increasing and decreasing locomotive power application or releasing the breaks or operating the horn of the locomotive. The VCD monitors whether these controls have been operated by the loco pilot in a particular time period. In case the loco pilot has not operated any controls, the VCD gives a visual warning by activating a flashing light for 8sec. If acknowledgement is not received the counter gets incremented and an additional audio alarm is given for 8sec. If the loco pilot further fails to acknowledge the alarm, a message is send to guard and to the vigilance control officer through GSM modem as "DRIVER IS NOT ALERT", here guard is provided with break to control the VCD. If guard is not applying break within 8 sec then message is sent to vigilance control officer as "DRIVER AND GUARD ARE NOT ALERT" and VCD will initiate the automatic application of brakes i.e., the penalty brake and the train is stopped automatically and t informs the position of the train where it is stopped in the form of latitude and longitude through GSM by using GPS module.

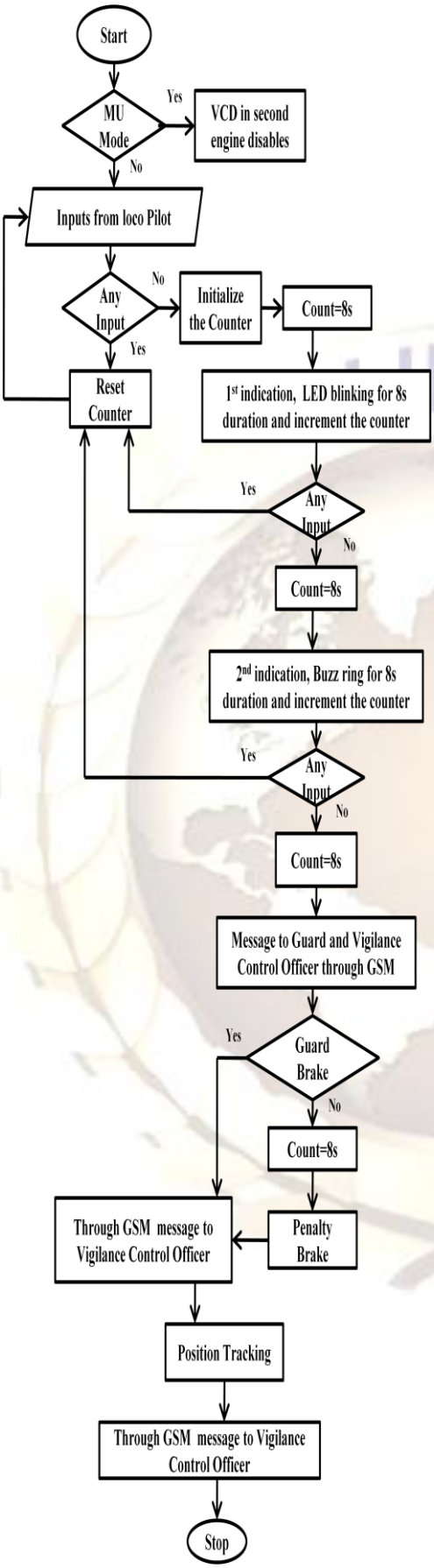

Fig.7: Flow Chart of the proposed system

MU mode is the multiple unit mode used when the efficiency of the single engine is not sufficient for pulling the trains in hilly areas so second engine is provided. So for utilizing the efficiency of the second engine it is required to operate in mu mode. When VCD is operated in MU mode the above operation of the VCD cycle should not be activated in the second engine that is the loco pilot is provided only in one cabin so it is programmed that when VCD operates in MU mode the entire VCD cycle in the second engine should not be activated.

IV. Experimental Results

The flow chart shown in Fig.6 gives the clear explanation of the working of the vigilance control device. By using this flow chart the source code is developed. The source code is written in embedded C language and the circuit is designed and the results are tested using the Proteus software as shown in Fig.8(a). The hardware implementation of the proposed system is shown in Fig.8(b).

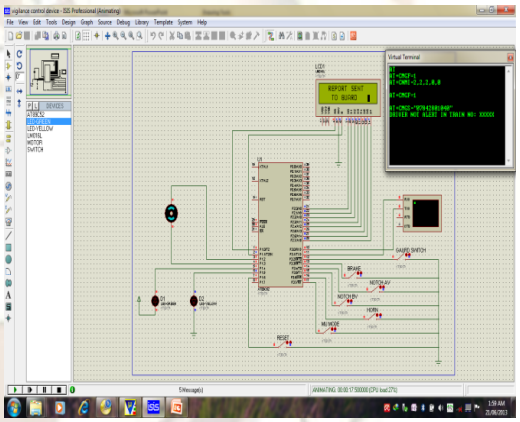

Fig.8(a): Designing of the circuit by using Proteus Software

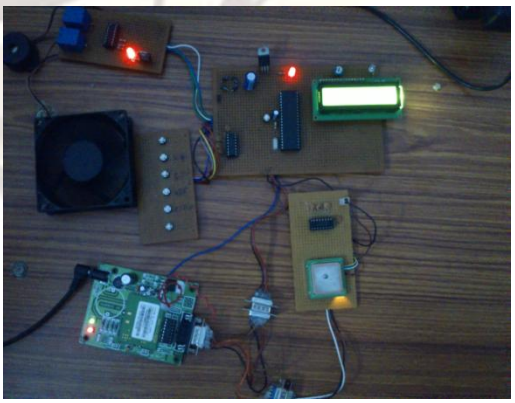

Fig.8(b): Hardware Implementation of the proposed system

The first indication of the vigilance control device is given if the loco pilot does not operate any controls. The LED blinking and the LCD displaying the action are shown in Fig.8(c).

Fig.8(c): First indication (LED Blinking) of the system

If the loco pilot fails, the guard must apply the brake or if the guard also fails a penalty brake must be applied. In these both cases the train is stopped and the information regarding the position of the train is given in terms of latitudes and longitudes as shown in Fig.8(d).

Fig.8(d): Position Tracking

V. Conclusion

This paper discusses and implements the design of an alerting system using GSM and GPS technologies. Many people travel in trains rather than the buses and other vehicles, and the number of people travelling in trains is more when compared to any other transporting system. In this paper the vigilance control device improves the alertness and provides warnings and brake application signals in a predefined manner. So with the use of this proposed system safety to passengers can be ensured. With this system we can analyze that whether the accident is due to loco pilot i.e., engine driver or due to failure of locomotive i.e., the rail engine and also we can inform the action of loco pilot to the higher authorities if he fails to respond the cyclic warnings and also the position of the train can also be tracked to avoid the accidents. The higher priority is given to the lives of people. Hence this paper provides a feasible solution to reduce accidents due to human failure.

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