Alertness Detection of Driver Using MEMS & PIR Sensor

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ABSTRACT

This paper presents analysis of eye state and head pose (HP) for continuous monitoring of alertness of a vehicle driver. Most existing approaches to visual detection of non-alert driving patterns rely either on eye closure or head nodding angles to determine the driver drowsiness or distraction level. Drowsy driving has been implicated as a causal factor in many accidents. Therefore, real-time drowsiness monitoring can prevent traffic accidents effectively. However, current BCI systems are usually large and have to transmit an EEG signal to a back-end personal computer to process the EEG signal. In this study, a novel BCI system was developed to monitor the human cognitive state and provide biofeedback to the driver when drowsy state occurs. The ever increasing numbers of traffic accidents all over the world are due to diminished driver's vigilance level. For this reason, developing system that actively monitors the driver's level of vigilance and alerting the driver of any insecure driving condition is essential for accident prevention. In this project we have an alcohol sensor to detect first weather the driver is drunken or in normal state and if the driver is in normal state then the vehicle will move. While vehicle is moving an eye blinking sensor will sense the eyes of the driver that weather the eyes of the driver are blinking or not. If the sensor detects that the eyes of the driver are not blinking and the driver is drowsy then a message is sent to the authorized person that the driver is drowsy through GSM. In this with the help of MEMS we can be able to know the position of the driver in the vehicle.

INTRODUCTION

In spite of the excellent safety record of railways as a means of transportation, there have been occasions when drivers have allowed their train to pass a point where they should have stopped. Many of these incidents have resulted in collisions, some involving loss of life and most involving damage to equipment or property. Most incidents are the result of a driver failing to ensure that his train stops at a stop signal due to falling asleep or might be died etc. In India, this has become known as SPAD or Signal Passed at Danger.

Such incidents have occurred on railways ever since they began in the early 19th century and various systems have been introduced to try to prevent them. These have taken the form of both warning and train stop systems. In India, a warning system is used for providing the awaking mode for Loco Pilot. An alarm sounds in the driver's cab whenever a train approaches a caution or stop signal. If the driver fails to acknowledge the alarm, the train brakes are applied automatically. The system is called AWS (Automatic Warning System).

Taking in action all these things, we are supposed to develop a machine for detecting the real time status of the loco pilot which will capture the fatigue, motion and heartbeat rate of the loco pilot providing alertness to the driver. This technology will always make the alert system to the driver for detecting the various signals coming in front of the railway.

This paper presents analysis of head pose (HP) for continuous monitoring of alertness of a train driver. Most existing approaches to visual detection of non-alert driving patterns rely either on body motion or head nodding angles to determine the driver drowsiness or distraction level. Drowsy driving has been implicated as a causal factor in many accidents. Therefore, real-time drowsiness monitoring can prevent traffic accidents effectively. However, current BCI systems are usually large and have to transmit an EEG signal to a back-end personal computer to process the EEG signal.[1] In this study, a novel BCI system was developed to monitor the human cognitive state and provide biofeedback to the driver when drowsy state occurs. The ever increasing numbers of traffic accidents all over the world are due to diminished driver's vigilance level. For this reason, developing system that actively monitors the driver's level of

vigilance and alerting the driver of any insecure driving condition is essential for accident prevention. If the driver is drowsy then a message is sent to the authorized person that the driver is drowsy through wireless technology. In this with the help of MEMS we can be able to know the position of the driver in the train.
The main aim the paper is "To check alertness of train driver

with an analysis of head pose & to prevent accidents". This paper presents analysis of head pose (HP) for continuous monitoring of alertness of a train driver. The proposed scheme uses features such as HP to extract critical information on non-alertness of a train driver. This paper presents analysis of head pose (HP) using a Micro Electro Mechanical System for continuous monitoring of alertness of a train driver. [4]The proposed scheme finds in real time HP angles by using MEMS & IR Sensor. The proposed method brings HP together to make a decision if a driver is not alert.

Driver inattention might be the result of a lack of alertness when driving due to driver drowsiness and distraction.

HARDWARE COMPONENTS

Microcontroller (Atmega16 AVR)

- Micro Electro Mechanical System (MEMS device)
- Zigbee Module
- Buzzer
- Power supply
- PIR Sensor
- LCD Display

Proposed Hardware System:

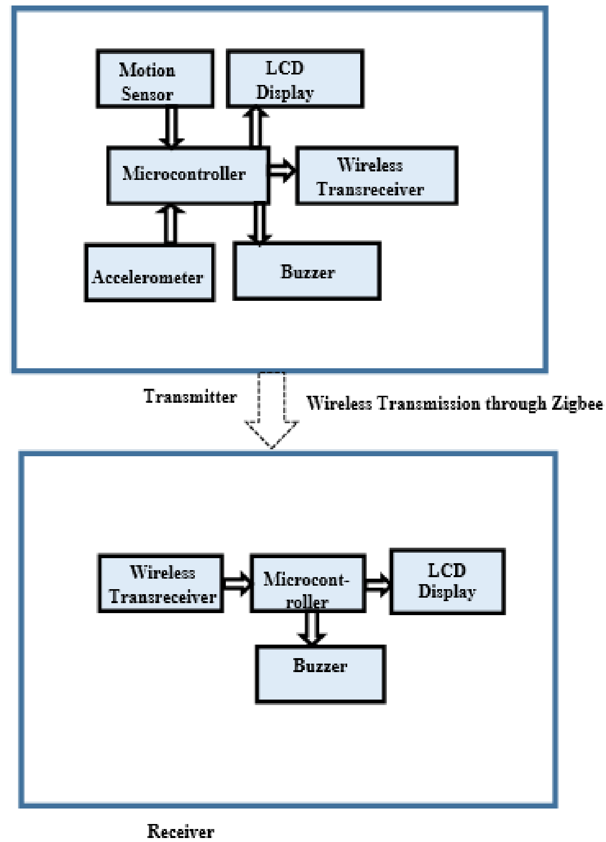

Figure 1 Block Diagram

Microcontroller ATMega16

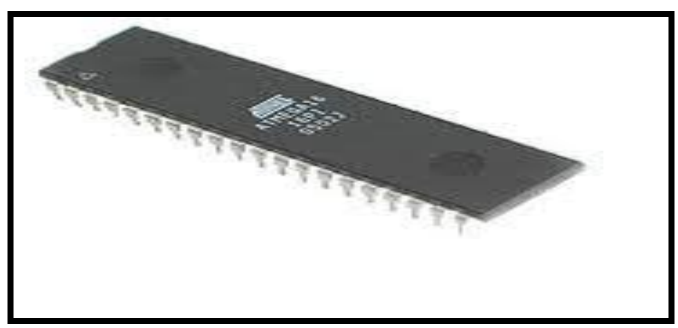

Figure 2 Microcontroller ATMega16

The ATmega16 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16 achieves throughputs

approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed.
The AVR core combines a rich instruction set with 16 general purpose working registers. All the 16 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers. Advanced RISC Architecture. Up to 16 MIPS Throughput at 16 MHz.16K Bytes of In-System Self-Programmable Flash. 512 Bytes EEPROM 1K Byte Internal SRAM 32 Programmable I/O Lines In-System Programming by On-chip Boot Program 8-channel, 10-bit ADC Two 8-bit Timer/Counters with Separate Prescalers and Compare Modes One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Four PWM Channels Programmable Serial USART Master/Slave SPI Serial Interface Byte-oriented Two-wire Serial Interface Programmable Watchdog Timer with Separate On-chip Oscillator External and Internal Interrupt Sources.

Pyroelectric Infra-Red Sensors

PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors.

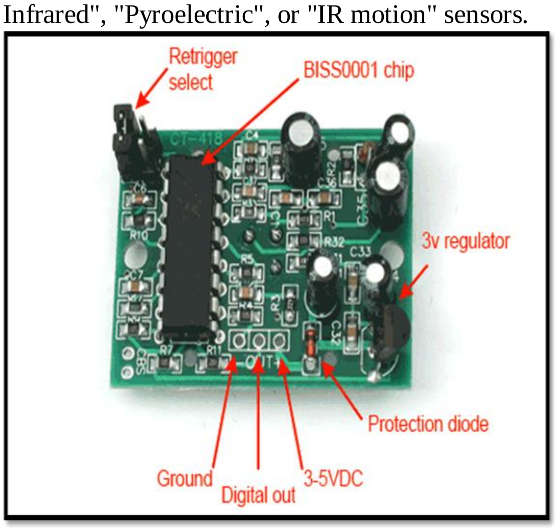

Figure 3 PIR sensor

The Passive Infrared Sensor (PIR) sensor module is used for motion detection. It can be used as motion detector for security systems or robotics. It works form 3.3V to 5V DC and gives TTL output which can be directly given to microcontroller or to relay through a transistor. It consists of pyroelectric sensor and Fresnel lens that detects motion by measuring change in the infrared levels emitted by the objects. It can detect motion up to 20ft. This module is very sensitive to change in infrared levels subjected by human movement.

Zigbee Module

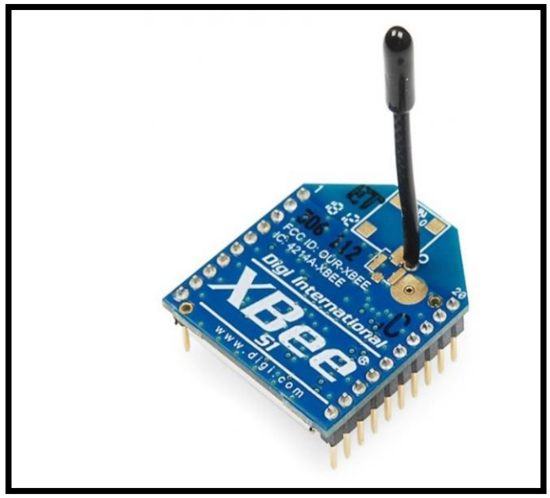

Figure 4 Zigbee Module

Provides a Zigbee node interface that can connect to or create a Zigbee network. EB051C – Coordinator Zigbee node, used to start, configure the network and allow other nodes to join.EB051R – Router / End device node, used to connect and communicate to networks started by EB051C.Zigbee is a software-based protocol that sits on top of the 802.11 RF wireless devices standard similar to Bluetooth. Unlike Bluetooth, Zigbee is capable of forming large networks of nodes and boasts advanced features such as mesh networking, simple addressing structures, route detection, route repair, guaranteed delivery and low power operation modes. The EB051 Zigbee E-Blocks are fully compliant with both the Zigbee pro (07) and ZNET (08) Zigbee standards.

The boards can be used create a network of dynamic moveable Zigbee nodes, or to interface with an existing Zigbee network. Zigbee provides a transparent layer for sending and receiving data from the network. Therefore once the module has been configured and assigned to the correct address then sending and receiving data is as simple as sending and receiving RS232 bytes through the chip’s UART. The circuit board consists of 5 digital I/O lines on a ‘downstream’ 9-way D-type plug. This routes the transmit (TX), receive (RX), clear to send (CTS), request to send (RTS) and sleep (SLEEP) lines to the XBEE Zigbee module.

Accelerometer

Micro-Electro-Mechanical Systems, or MEMS, is a technology that in its most general form can be defined as miniaturized mechanical and electro-mechanical elements (i.e., devices and structures) that are made using the techniques of micro fabrication. The accelerometer is a built-in electronic component that measures tilt and motion. It is also capable of detecting rotation and motion gestures such as swinging or shaking. The most common use for it is to activate auto screen rotation on mobile devices when the user changes their orientation from portrait to landscape or vice-versa. Another modern application for the accelerometer is to control the mobile device music player with gestures (Sony Ericsson Shake control or Samsung Motion play technologies).

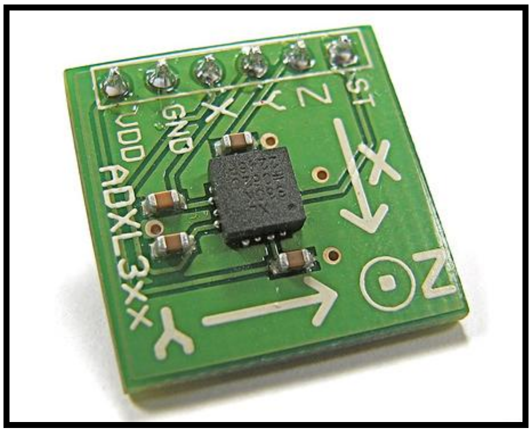

Figure 5 Accelerometer

The MMA7 660FC is a ±1.5 g 3-Axis Accelerometer with Digital Output (I2C). It is a very low power, low profile capacitive MEMS sensor featuring a low pass filter, compensation for 0g offset and gain errors, and conversion to 6-bit digital values at a user configurable samples per second. The device can be used for sensor data changes, product orientation, and gesture detection through an interrupt pin (INT). The device is housed in a small 3mm x 3mm x 0.9mm DFN package. Accelerometers are also utilized for enriching the gaming controls (navigating by tilting the device instead of by pressing keys). Another popular mobile phone feature based on an accelerometer is turn-to-mute. It allows user to mute an incoming call, silence an alarm or pause the mobile music player simply by turning the device face down.

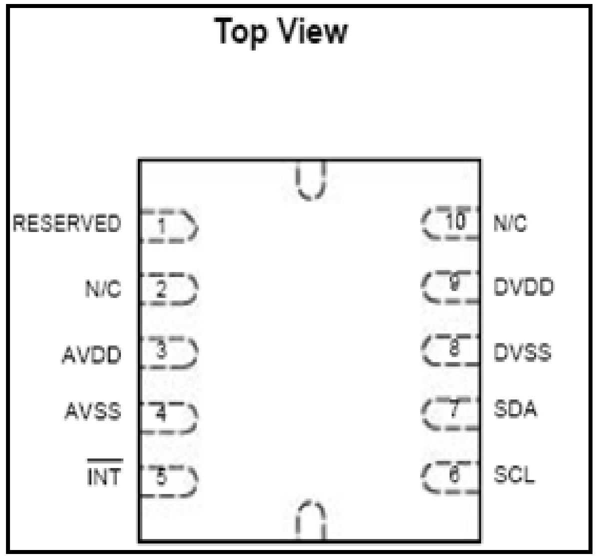

Fig.6.MEMS PIN Configuration

Fig.7.MEMS Bottom View

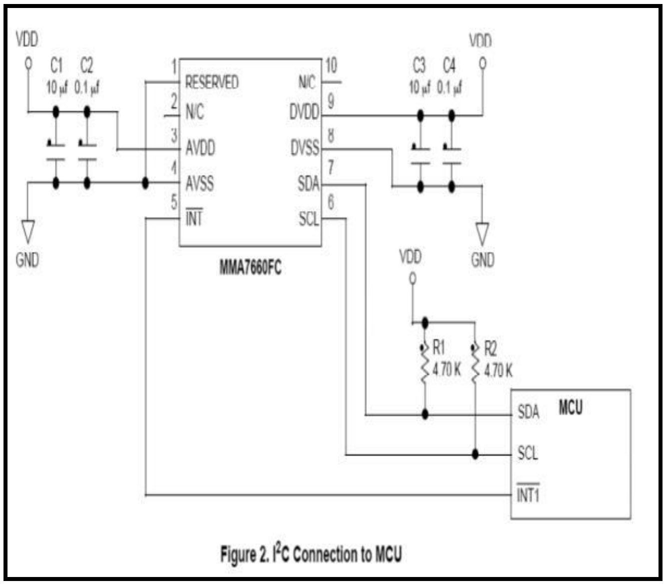

Fig.8.MEMS Device

PIN DESCRIPTION

Pin #	Pin Name	Description	Pin Status
1	RESERVED	Connect to AVSS	Input
2	N/C	No Internal Connection, leave unconnected or connect to Ground	Input
3	AVDD	Device Power	Input
4	AVSS	Device Ground	Input
5	INT	Interrupt/Data Ready	Output
6	SCL	I^2C Serial Clock	Input
7	SDA	I^2C Serial Data	Open Drain
8	DVSS	Digital I/O Ground	Input
9	DVDD	Digital I/O Power	Input
10	N/C	No Internal Connection, recommended to connect to Ground	Input

Table.1.Pin description

DESIGNING

The main intension of the proposed scheme is to design and implement a Driver alertness detection by using Head Pose. This will detects the alertness of driver based on head pose i.e., whether he is in drowsy or sleepy condition. In order to fulfill this design we have design two board hardware one is inside the train named as transmitter and another one is at control room named as receiver.

There are few steps that has been performed for design of Transmitter
The steps are as follows:
Designing of the power supply for the entire circuitry.
Selection of microcontroller that suits our application.
Selection of Micro Electro Mechanical Systems (MEMS Device).
Selection of motion Sensor.
Selection of Zigbee Module
Selection of LCD Display.
Selection of Buzzer.

TRANSMITTER

It is clear from the above block diagram that the MEMS Sensor will detect the real time status of the driver for fatigue detection and generating alarm as per the condition. There will be two types of sensors will be attached with the system containing accelerometer, Motion-PIR Sensor, which will be used for real time status of the driver. If something gone wrong then microcontroller will directly send the status message of the driver and their respective station master of the current station using wireless technology.
In this paper, accelerometer will act as a input device working on three axis, generating different voltages from its output pin. Now this input will be send to the microcontroller for its processing by executing the code embedded in the Machine.

Here Microcontroller will send a signal to the encoder for encoding it before sending to the receiver end via Transmitter Module 2.4GHz of frequency.

RECEIVER
Here the receiver will detect the radio signal coming from the transmitter and send to the decoder for decoding it into original form, which will be further processed by the microcontroller for displaying the information in the Station.

The signal coming from the transmitter will be detected by the receiver and will be decoded it into original form by the decoder. Now the decoder will send the digital signal to the microcontroller for its further processing.

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Complete studies of all the above are useful in developing this. In-order to work with any components basic requirement is power supply. In this section there is a requirement of two

different voltage levels, those are 12V DC and 5v DC. The Driver Drowsiness Detection System consists of Cortex M3 LPC 1768 Microcontroller, Micro electro mechanical system MEMS, Zigbee Technology, LCD Display. First initialize all the components by giving proper power supply to all the devices. After giving power supply first MEMS device has been initialized and then Motion sensor initialized. By using EMBEDDED programming we have programmed the predefine angle in the MEMS device i.e. 45 degrees. if the person in the train nods or shakes his head and if the angle of his head exceeds more than the predefine angle the buzzer activates and simultaneously registered user gets an SMS that the driver in the train has been non-alerting stage along with a particular location because we have kept wireless technology to get location of the train.
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The Embedded C programming language and the AVR Studio software have been used to program the microcontroller. So by this we can control the accidents occurring in our daily life by alerting driver. To avoid accidents this has been proposed.

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RESULTS

It is clear from the above description that I have successfully completed my work using Zigbee technology. Detect the real time situation of the driver fatigue and generate an alert to the station including train information. The Zigbee communication is working on 2.4GHz of bandwidth, whereas different analog sensor is used to detect the drowsiness and motion of the loco pilot. The developed device consumes less power and provide quick mode of communication between train and station.
The microcontroller used in this device is more efficient as compared to 8051 series of microcontroller.

It works on RISC architecture with 8Mhz clock frequency inbuilt and expandable up to 16Mhz using Crystal oscillator. It has 10bit ADC to PORTA which is very much valuable to read the different types of analog sensors successfully.

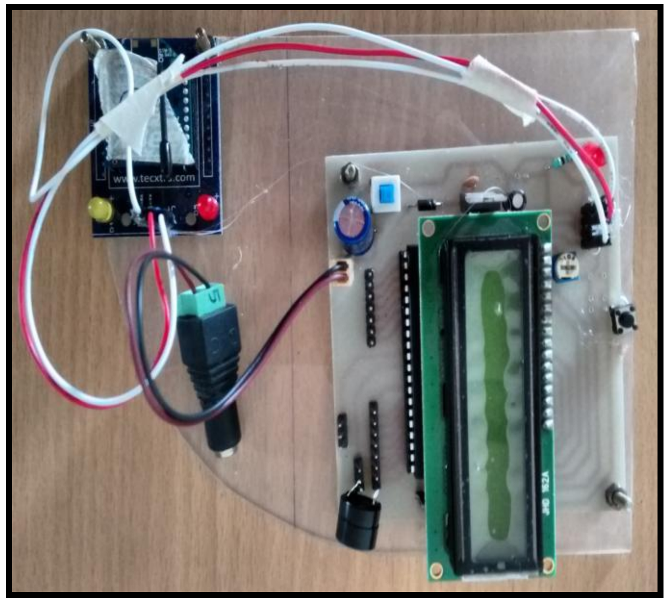

Figure 9 Receiver

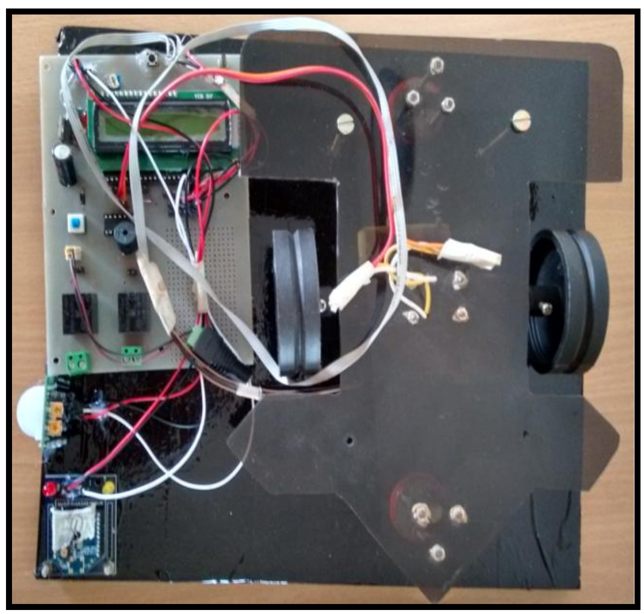

Figure 10 Transmitter

Case1- When PIR senses motion, MEMS senses no sudden head fall

1. Pilot is awake, no emergency
2. Train continues to move in normal speed
3. No SMS is sent

Figure 11 Motion & fatigue detected

Case2- When PIR senses no motion, MEMS senses sudden head fall

1. Pilot is drowsy
2. Train stops
3. Alarm is sounded to alert the Loco-Pilot

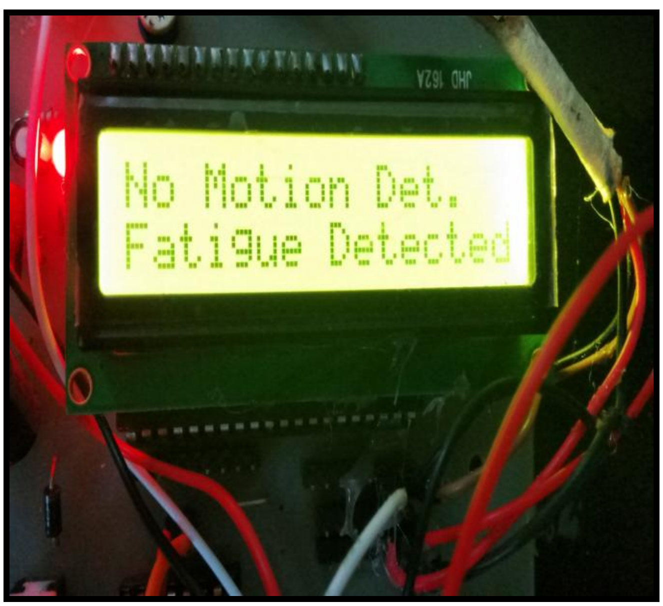

Figure 12 No motion & fatigue detected

Case3- When PIR senses motion, MEMS senses Sudden head fall

1. Pilot is drowsy
2. Train's speed is normal
3. Alarm is sounded to alert the Loco-Pilot

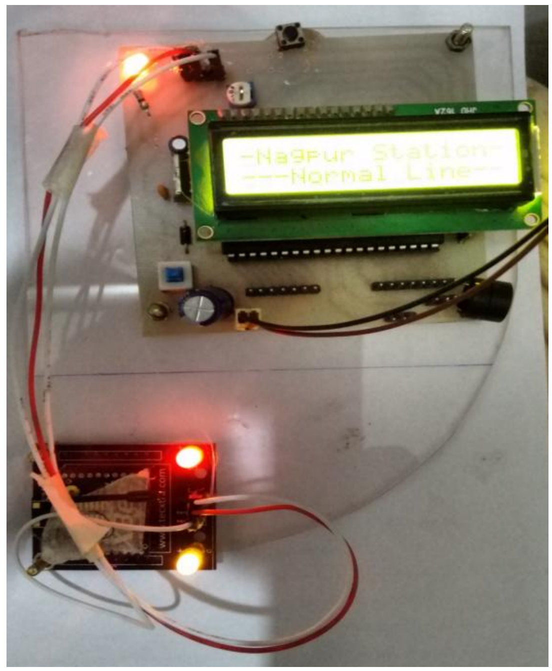

Figure 13 No fatigue detected

Case4- When PIR senses no motion, MEMS senses no sudden head fall

1. Train speed is stopped
2. Alarm is sounded to alert the Loco-Pilot, and an SMS is sent to the base station

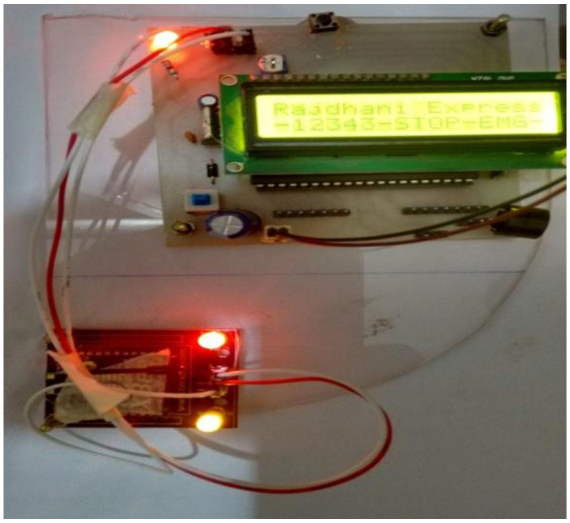

Figure 14 Fatigue detected

Conclusion

We are sure at last we can come over the solution with perfect status detection system for the driver of the train decreasing the accident level happens due to less alert by the loco pilot. It is due to the driver's condition, accidents keep with a yearly increasing of a high rate. This project shows. The new affirm of detection technique using motion sensor. In proposed system has advantages over existing system and they are compactness, configurable and driver state can be identified easily using sensors if abnormalities in the sensed values are detected and it will alert the driver due to buzzer.

Future Scope

In future we can use the GPS system for detecting the real time position of the train with containing the video footage of the driver situation, sending via GPRS system to their respective locations.

An increasing number of railways around the world are provided with automatic train protection. ATP provides a either a continuous or regular update of speed monitoring for each train and causes the brakes to apply if the driver fails to bring the speed within the required profile or if the status of the driver will not good as per the required status. This technology brings the new generation of research based application for providing the safety mechanism to the driver by providing life security to all the passengers. Also these technologies will bring a new dimension of technological development towards railway automation system.

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