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Design and Development of Driver Fatigue detection system and control of the vehicle system

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ABSTRACT
This paper presents a method for detecting the symptoms of fatigue/drowsiness during driving. By identifying biological and environmental variables, it is possible to detect the loss of alertness prior to the driver falling asleep. From the response of the proposed technique in this paper we can detect that a particular person is able to drive or not. The biological and environmental variables like Heart rate variability (HRV), steering-wheel grip pressure, as well as temperature difference between the inside and outside of the vehicle, make possible to estimate in an indirect way the driver's fatigue level. A hardware system has been developed to acquire and process these variables, as well as an algorithm to detect beats and calculate the HRV taking into account the others aspects mentioned before. Mainly this paper proposed a technique for fatigue detection in train driver
Keywords - ECG, HRV, Inattention, Fatigue, Drowsiness

I. 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 signal coming in front of the railway.

II. FATIGUE DETECTION DURING DRIVING

The primary goal of the paper is precise and measure the development and progression of

driver fatigue and loss of alertness, and to develop countermeasures to address it, through a field study undertaken within the framework of a realistic driving environment. With the great development of the railway system and the continuous input of new technology equipments to the railway transportation safety, the workloads of the train drivers constantly strengthen. Besides, the unreasonable timetable and work environment of the train drivers will easily cause them out of order, doze off, and fatigue driving. Because of all these factors, fatigue driving is becoming a great safety problem in the railway transportation. Therefore, the guarantee and supervising system of the train drivers 'working state have be paid wider concern and attention by the public. In the project intends to develop the train drivers 'fatigue detection and recognition system.

The paper will be presents a method for detecting the early signs of fatigue/drowsiness motion and heart beat rate of the loco pilot during driving. Analyzing some biological and environmental variables, it is possible to detect the loss of alertness prior to the driver falling asleep. As a result of this analysis, the system will determine if the subject is able to drive. We are also want to developed model to acquire and process these variables, as well as an algorithm to detect fatigue and control the speed of the vehicles as per the status.

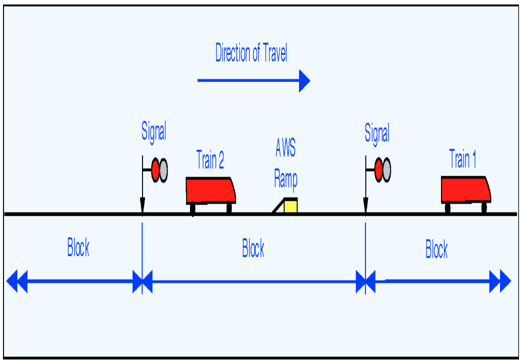

Figure1: Justification and objective of carrying out the research work.

IV. PROPOSED PLAN

There are total five modules in project hence the proposed plan can the give as for the five module.

1. Module1:Capturing the video: The development of the system to capture the video by camera and saving the video properly in the database will be covered under this module .
2. Module 2:Face Detection: The programming and designing of face detection will be covered under this module .
3. Module3:Eye Tracking: The development of eye tracking will be covered under this module .
4. Module 4:Fatigue Detection: The complete design and development along with simulation of the fatigue detection will be covered under this module.
5. Module 5 :Fatigue Alert: The design and development of the fatigue alert and the testing on the complete system will be covered under this module.

The fatigue/inattention/drowsiness are very vague concepts. These terms refers a loss of alertness of vigilance while driving. Indicators of fatigue can be found in

A. Visual Features

There is an important quantity of studies related with this area .Most of them are based on facial recognition systems to determine the position of the driver's head, the frequency of blinking, etc. This frequency and the degree of eyelid opening are good indicators of tiredness level. In a normal situation, driver blinks and moves the eyes quickly and constantly, keeping a large space between eyelids. In a sleepy state, we can appreciate that the speed of blinking and the opening decrease. With regard to the driver's head angle in a normal situation, he maintains a lifted up position and only does the typical movements related to the driving. Passing into a drowsy state implies to nod off as well as a more frequent head's position change. In fact, when it is a deep stage, the nodding off is extremely slow and the head keeps itself completely relaxing Other research lines are centered in the analysis about facial expression. In general, people are prone to have different expression depending on the alert level that show

B. Non-visual Features

Driver's concentration can be affected by environmental factors, therefore it would be interesting to sensorize the cabin. Diverse studies analyze the concentration of carbon monoxide and oxygen in air. An intelligent gas sensing system offers an added security in the vehicle, warning when the concentration is higher than tolerable levels (CO of 30 ppm and oxygen levels below 19.5%) .Other non-visual features are physiological variables. Gripping force gives us an idea about driver's attention level, and body temperature is an important physiological parameter that depends on driver's state too: body temperature increases due to infections, fever, etc. reflecting the autonomic responses and the activity of a human's autonomic nervous system. Electroencephalogram gives a lot psycho physiological information about stress state, drowsiness or emotional reactions .Nevertheless, electrocardiogram and heart rate variability are ones of the most important variables. In fact, power spectrum can be calculated as a Fourier discrete transform of the HRV, and, knowing the relation between the person's state and his/her spectrum, determine the driver's psycho physiological conditions. The parameters of interest are the total power (from 0.03 to 0.4 hertz), low frequency power (from 0.05 to 0.15 hertz) and high frequency power (from 0.15 to 0.4 hertz) .The acquisition of the HRV has been made amplifying and filtering an ECG signal, with the purpose of detecting to QRS complex and calculating the time between consecutive R waves. When the separation between R waves is obtained, this could be represented in function of the beat graphically. In our case, it is interesting to calculate the histogram and the frequency response. The heart rate variability gives us some information about the respiratory system (increase in respiration and decrease in exhaling), vasomotor system, temperature changes (causes little changes in HRV) and central nervous system, that is in direct relation with the person's emotional state. Finally, not only physic but also mental state can influence in the way of driving. The biggest automakers focus their efforts in this direction. Citroen has elaborated a system that detects the step of a line (continuous or discontinuous) when the indicator has not been activated. Moreover, abrupt direction changes, variations in the way of the brake or in the driver's body position (evaluated through pressure sensors in the seat) are others relevant parameters to take into account for the analysis of the driver's alert state.

III. HARDWARE IMPLEMENTATION

It is necessary an adequate hardware to obtain the biological variables that the algorithm needs for its processing.

The developed system is made up of an analogical subsystem and other digital. The first one of them does an adaptation of the signal to acquire it through an analogical to digital converter. The second one filters and processes the resulting signal that it was gotten in the analogical phase. Furthermore, the digital system is able to send information in a wireless way using Bluetooth or zigbee.

A. Analog Subsystem

This subsystem the pressure that driver exerts over the steering-wheel of the vehicle, the electrocardiographically signal coming from some ECG electrodes, as well as the pulse through a commercial cardiothoracic belt (figure).

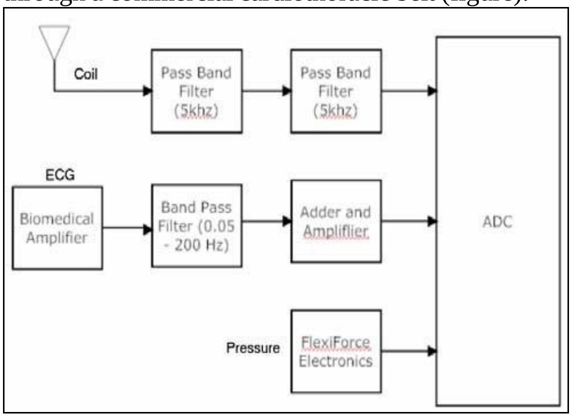

Figure: Analog subsystem

Some piezoresistive force sensors Flexi Force are used to measure a voltage which is proportional to the applied force. Using an appropriate electronic that the manufacturer prescribes us, we can get a signal which is limited between zero and five volt that will be acquired by the ADC of the microcontroller. Electronics were adjusted to achieve an adequate sensitivity level for our necessities. Thus, when the driver is holding the steering-wheel, the resulting voltage is higher than the established threshold previously. Electrocardiographically signal is gotten by ECG electrodes, a circuit based on a precision instrumentation amplifier INA114 and a band-pass filter to remove both high frequency and continuous component. Next, adaptation electronics were added to set the signal inside the dynamic range of the ADC. Although the pulse could be calculated by the ECG signal, other possibility has been added to receive this pulse signal using a commercial cardiothoracic belt utilized by sportsmen. To make this possible, a receiver has been implemented to work at the same frequency that the belt emits (5 kHz). Its circuit is made up of an amplifier and a band-pass filter. When cardiothoracic belt detects a pulse, it emits a sinusoidal wave at 5 kHz. The microcontroller detects this sinusoid, and therefore the pulse, and is able to calculate the HRV directly.

B. Digital Subsystem

Digital system acquires the signals of the analogical to digital converter and processes them according to the developed algorithm. This system is based on an Atmel ATMega16 microcontroller that has eight channels of high-accuracy 10 bit A/D Converter and high-speed program execution (16 MHz) that is enough for the application. Figure 2 shows this subsystem.

a) Heart beat Sensor

Heart beat sensor is designed to give digital output of heat beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse. For further information please refer to its datasheet.

Features

- Microcontroller based SMD design
- Heat beat indication by LED
- Instant output digital signal for directly connecting to microcontroller
- Compact Size
- Working Voltage +5V DC

Applications

- Digital Heart Rate monitor
- Patient Monitoring System

- Bio-Feedback control of robotics and applications
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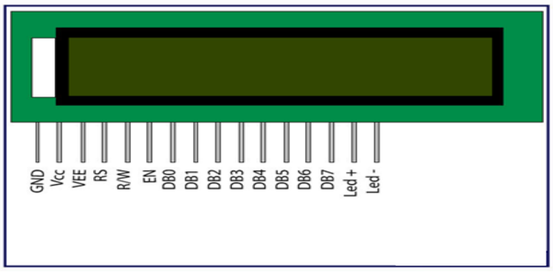
- b) ATMega16:

- 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.

c)16x2 Lcd display:-



LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A **16x2 LCD** means 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, Command and Data.

IV. SOFTWARE IMPLEMENTATION

Software used to develop the system are:

- Language use: Embeded 'C'
- AVR Studio for writing the program
- PROGISP is used for burning the program into the microcontroller.
- Matlab

Our system uses two types of software: one for the microcontroller ATmega16, and another one for the computer with a wireless link among both devices using Bluetooth or Zigbee. In a global way, in figure the flow diagram of the complete application is shown. The software has been implemented to carry out the following real time functions:

1) Signals acquisition coming from the sensors.
2) Signals filtering.
3) Signals processing.
4) Analysis of the results in a combined way to detect the first symptoms of fatigue.

The pulse measuring stage is very important for the HRV calculation that is the main parameter in which our study is based. Hence, and as we already mention previously, we use two different methods to detect the beats with in order to implement a more robust algorithm that, before any unexpected event, allow to detect those correctly. The algorithm is based on a dynamic threshold since the QRS complexes cannot present the same amplitude in different people. Previously, it has been necessary to filter the obtained signal with a pass band digital filter and to derive the filtered signal.

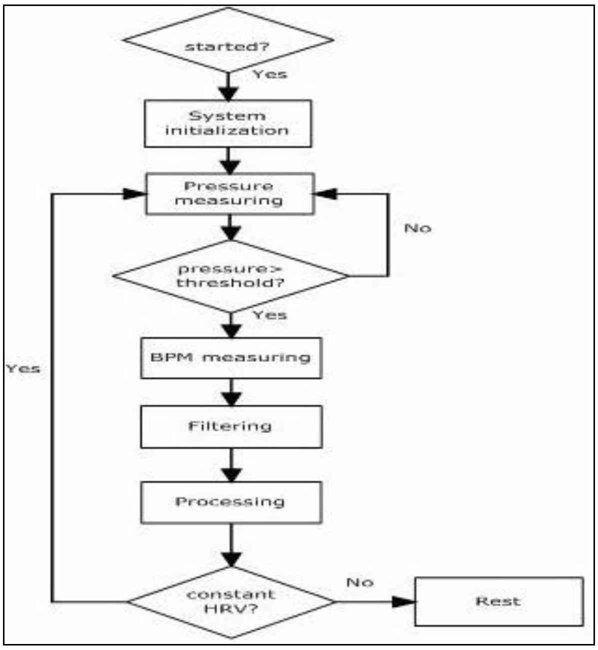


Figure: Software's flow diagram

V. CONCLUSION

In systems which are based on the study of the heart rate variability, in the power spectrum and in the histogram, it is necessary a minimum number of samples to obtain valid results. Hence, it is required to obtain a minimum number of beats before considering these data as valid. That requires a minimum time before the obtained results are reliable.

Our objective is to combine this information with visual information and with the driving environment (road conditions, climate, etc) to detect the drowsiness during the conduction and in this way to reduce the risks and dangers for the drivers.

These systems are not only useful for the driver's security also they are the base to develop register devices that make easy the reconstruction and investigation of accidents storing driving related data, state of the driver and driving environment.

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