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Fusion Drowsiness detection System

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Abstract

This paper presents Non-invasive approach for drowsiness detection. The system detects drowsiness using both Brain and Visual information. Most of the drowsiness detection systems are based on video analysis. These systems give good performance but they have a high rate of false alarms. So merging more information sources increases the reliability of drowsiness detection. The brain activity is monitored using EEG data and Visual activity is monitored through blinking detection. Both the systems are then merged using cascading decision rules. Merging both brain and visual information detects "Alert", "Drowsy" and "Eyes not detected" and reduces the chances of false alarms

Index Terms: Blinking analysis, Drowsiness Detection, EEG signal, Visual Fatigue behavior.

Introduction

Drowsiness represents an important risk on the roads, given that it is one of the main factors leading to accidents. This fact has been proven by many studies that have established links between driver drowsiness and road accidents. Currently, the traffic accidents' study is become important because they produce several died and hurt around the world. The National Sleep Foundation (NSF) also reported that 51% of adult drivers had driven a vehicle while feeling drowsy and 17% had actually fallen asleep. Drowsiness can be defined as the transition between the awake state and the sleep state where one's ability to observe and analyze are strongly reduced[1].The Consequences are an increase in reaction time as well as a decrease in driver vivacity which lead to an impairment of driving abilities.

Drowsiness detection technique

One can use a number of different techniques for analyzing driver exhaustion. One set of technique [2] places sensors on standard vehicle components, e.g., steering wheel, gas pedal, and analyses the signals sent by these sensors to detect drowsiness sensors to detect drowsiness. A second set of technique focuses on[4] measurement of Physiological signals such as heart rate, pulse rate, and Electroencephalography (EEG).EEG power of the alpha and theta bands providing Indications of drowsiness. Third set of solutions focuses [6] [7] on computer vision systems that can detect and recognize the facial motion and appearance changes occurring during drowsiness**.**

the goal of this system is to develop a real-time monitoring system that will detect driver's drowsiness and progressively warn the driver of this condition, so he/she can either correct the behavior or stop driving. it uses to detect the drowsiness using both brain and visual activity [1], [4]. the brain information is obtained by eeg signals & visual information is obtained by ir camera. most drowsiness detection system based on video analysis even if these methods demonstrate good performance still they have a high rate of false alarms so merging different sources of information increases the reliability of drowsiness detection. for eeg detection [5], a real time drowsiness detection algorithm visual detection viola & jones algorithm is proposed.

Block Diagram

This work contains detection of drowsiness using both brain and visual activity. The brain information is obtained by eeg signal emulation& visual information is obtained by web camera.

A drowsiness detection system using both brain & visual information has mainly four units.EEG Emulation unit & visual information, GUI Front end (Drowsiness Estimation unit)& voice alert.

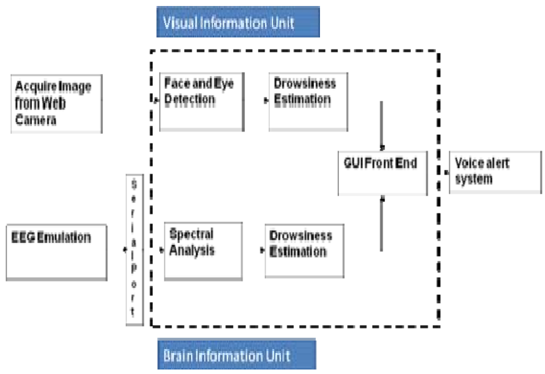


Fig. 1: Block diagram

Eeg Signal Emulation

Medical EEG hardware could not be used in this project because of high cost as well as lack of easy availability. Therefore, instead of input from the EEG equipment, it was decided to emulate the expected EEG signal from an MSP430 board. The mathematical properties of typical EEG signals for 'awake' and 'drowsy' states are well-known. Hence, in order to emulate such signals from MSP430 board, the following method was used. Signals with appropriate frequency ranges (alert: 17-22 Hz, drowsy: 8-13Hz) were generated in MATLAB.

These signals were converted into an array of PCM values, with1KSPS sampling rate. The length of this array was 512 samples, hence representing approximately 0.5 seconds of EEG signal. We have restricted the signal length in order to facilitate fast data transfer over serial port. Since the frequency range of the signal is < 25Hz, 1ksps sampling is many times the Nyquist rate, and therefore the array of 512 samples is sufficient to adequately represent the signal.

The array of PCM amplitude values was written out from MATLAB into a text file.

This array of values was used as input to program the MSP430 board with the emulated EEG signal.

The MSP430 board writes out the array of values to its serial port when the GUI requests for the values. Thus the EEG signal input to the GUI is emulated.

The final system merges two systems i.e. Brain Information i.e. EEG Emulation unit & visual information i.e. Web Camera & these two systems evaluate the drowsiness.

Visual Information Unit

Visual information is obtained by Web Camera with the cascade detector implementation of Viola & Jones algorithm.

First Initialize cascade detector object.

The image gets acquired from the Webcam.

The cascade detector gets run on the acquired image.

Then we can detect the possible location of the eye region.

Isolate eye region from image by taking the common area between the bounding boxes for both the eyes and single eye.

We can convert the Eye area RGB image in to HSV to remove effects of slight flections' in color.

We can select only saturation plane in HSV for better visibility and isolate the S (saturation) plane because it enables easier detection of eye closure.

We can detect the edges of eye images in the saturation plane.

After detecting the Edges we can detect the row and column indexes of edge pixels.

Height= Row max- Row min

Width= Column max- column min by using these two equations we can calculate the width/Height ratio.

If the Width /Height ratio is <1.75 the eyes are open

else the eyes are closed. If eyes are closed drowsy count is incremented by one else it is set to zero.

If MSP board is connected its signal is acquired after every 20 frames. Spectral analysis is done on this signal to determine awake or drowsy state. If the MSP signal state is detected as drowsy and the drowsy count is more than 5 then the GUI is updated with a drowsy warning. If MSP is not connected the warning is generated only on basis on drowsy count from visual information.

Drowsiness Estimation

When drowsiness gets detected from both the systems i.e. EEG signal Emulation and through Web camera then and then only it displays 'Drowsy' otherwise it displays 'Alert'.

Sound Alert System

When drowsiness gets detected from both the systems i.e. EEG signal Emulation and through Web camera then the Voice alert system gets activated & gives the voice message to the driver.

Simulation Results

Eeg Signal Generation In Matlab

Medical EEG hardware could not be used in this project because of high cost as well as lack of easy availability. Therefore, instead of input from the EEG equipment, it was decided to emulate the expected EEG signal from an MSP430 board. Signals with appropriate frequency ranges (alert: 17-22 Hz, drowsy: 8-13 Hz) were generated in MATLAB as shown in figure 1

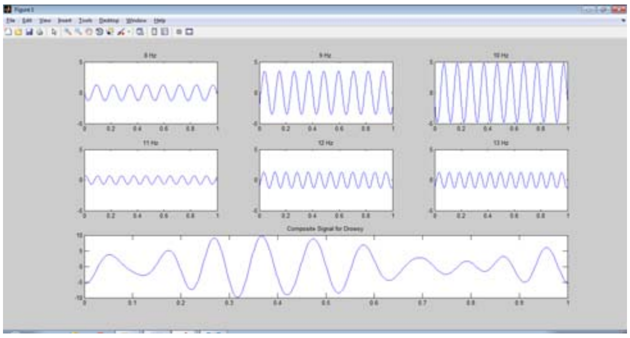


Fig. 2: Drowsy Signal Generated in the MATLAB in the frequency range of 8-13 Hz.

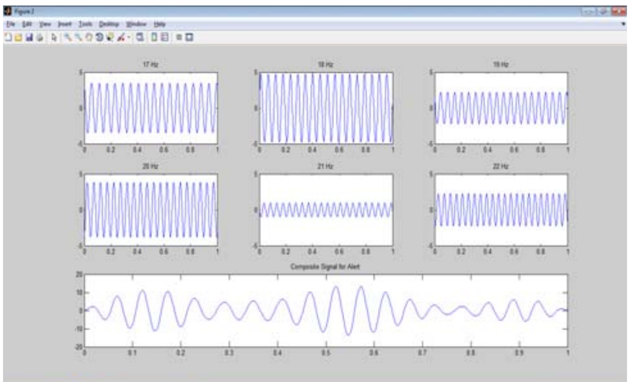


Fig.3: Alert Signal Generated in the MATLAB in the frequency range of 17-22 Hz.

Testing Results

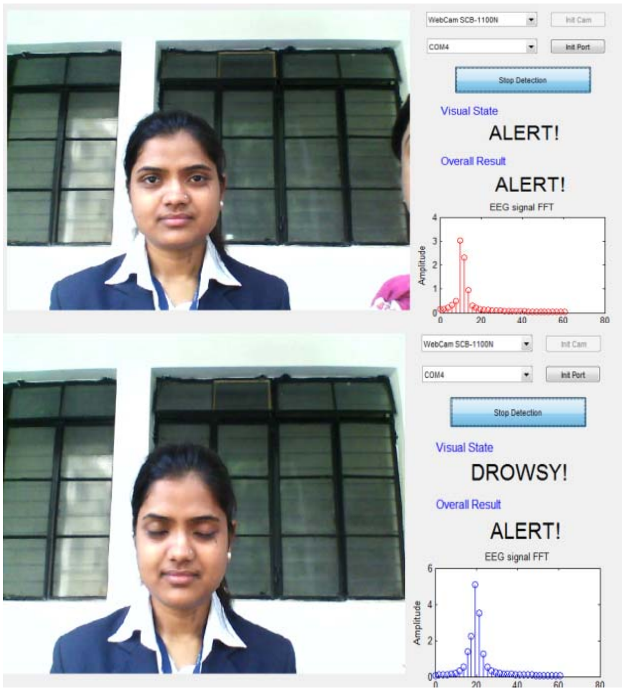
The system was tested by using different persons as specimens, normal person and in different surrounding environment conditions like low light, bright light etc. Following decision rule table are followed to take the decision about drowsiness.

By considering these decision rule decision about drowsiness is decided for following cases as shown in table 1.

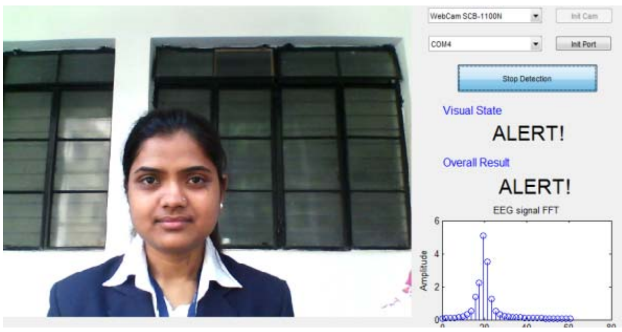
Table 1 Decision rule Table

Sr no	EEG input	Visual information unit input	Overall decision
1	Alert	Alert	Alert
	Drowsy	Drowsy	Drowsy
3	Alert	Drowsy	Alert
4	Drowsy	Alert	Alert
5	Alert/Drowsy	Eyes not detected	Drowsy

Drowsiness Detection With Normal Person (Without Specs) ---Case-1



EEG: Drowsy- Visual: Alert EEG: Alert- Visual: Drowsy



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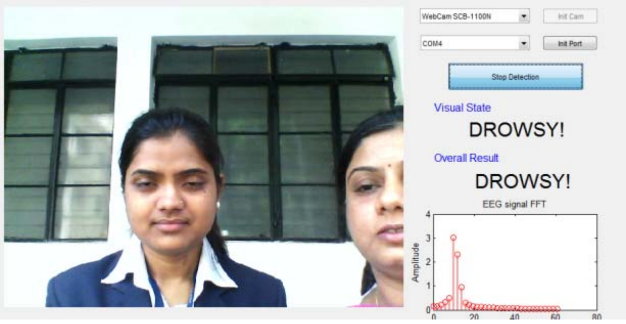
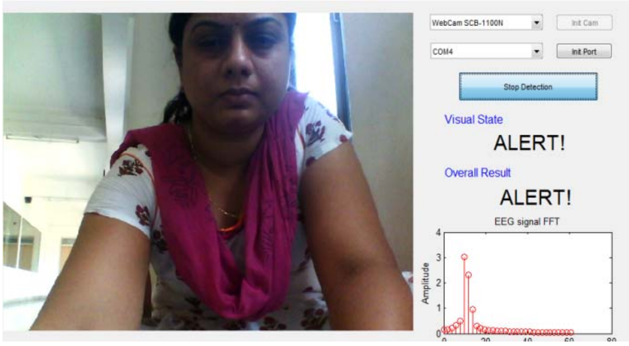


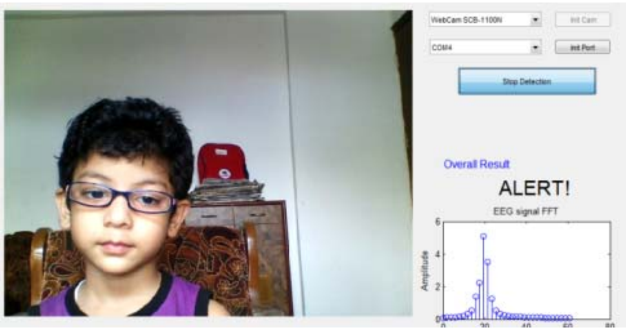
EEG: Alert- Visual: Alert EEG: Drowsy- Visual: Drowsy

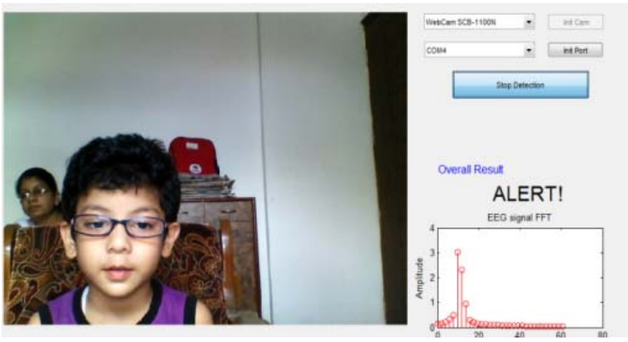


EEG: drowsy- Visual: drowsy

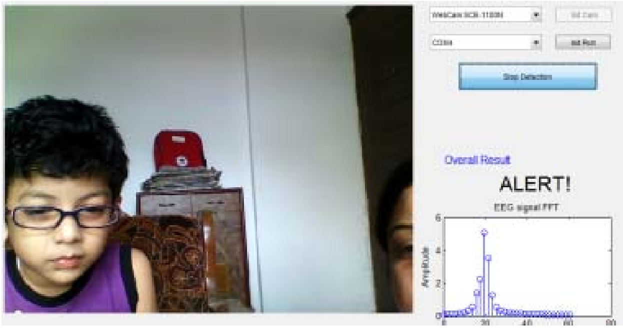
In this case EEG signal is drowsy and visual information unit displays drowsy. Eyes are becoming drowsy but overall system detects 'Alert' .It displays false result because of position of a person and insufficient light.

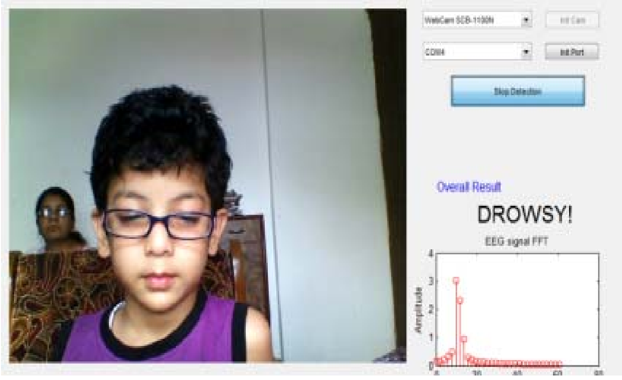
Drowsiness detection with Person wearing specs





EEG: Alert - Visual: Alert EEG: Drowsy- Visual: Alert





EEG: Alert- Visual: Drowsy EEG: Drowsy-Visual: Drowsy

Sno	Case no	Actual state of person	State detected by the system			Result
			EEG	Visual	Overall result	
1	A	Alert	Alert	Alert	Alert	True
		Alert	Drowsy	Alert	Alert	True
		Drowsy	Alert	Drowsy	Alert	True
		Drowsy	Drowsy	Drowsy	Drowsy	True
		Alert	Alert/Drowsy	Eyes not detected	Drowsy	True
2	B	Alert	Alert	Alert	Alert	True
		Alert	Drowsy	Alert	Alert	True
		Drowsy	Alert	Drowsy	Alert	True
		Drowsy	Drowsy	Drowsy	Drowsy	True
		Drowsy	Drowsy	Drowsy	Alert	**False**
3	C	Alert	Alert	Alert	Alert	True
		Drowsy	Alert	Drowsy	Alert	True
		Alert	Drowsy	Alert	Alert	True

Table 3 Result data table with different persons wearing spec

Sr no	Case no	Actual state of person	State detected by the system			Result
			EEG	Visual	Overall result	
1	A	Alert	Alert	Alert	Alert	True
		Alert	Drowsy	Alert	Alert	True
		Drowsy	Alert	Drowsy	Alert	True
		Drowsy	Drowsy	Drowsy	Drowsy	True
2	B	Alert	Alert	Alert	Alert	True
		Alert	Drowsy	Alert	Alert	True
		Drowsy	Alert	Drowsy	Alert	True
		Drowsy	Drowsy	Drowsy	Drowsy	True
		Alert	Alert	Eyes not detected	Drowsy	**False**
3	C	Alert	Alert	Alert	Alert	True
		Alert	Drowsy	Alert	Alert	True
		Drowsy	Alert	Drowsy	Alert	True

$$\%Accuracy = \frac{Total\ cases - fault\ result\ cases}{Total\ cases}$$

%Accuracy of person without specs = (13-1/13)*100 = 92.30%

%Accuracy of person with specs = (12-01/12)*100

= 91.66%

Conclusion

The system was tested by using different persons as specimens and in different surrounding environment conditions like low light, bright light etc. Following conclusions are derived based on the testing results and subsequent observations: The system will detect the drowsiness of drivers & improve safety on roads by giving the alert message to the driver. This fusion system may increase the reliability of the system & may detect drowsiness more accurately. It may reduce the high number of false alarms.

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