Experimental Study On Eog Signal Processing For Drowsiness Divination

K.Suresh, A.Sangeetha, P.Pradeepa, S.Vijayprasath

Abstract : The mounting numbers of traffic accidents all over the human race are owing to driver fatigue. Observing the driving personal state of alertness and fatigue is exclusively significant to lessen the amount of traffic calamities. For that reason a system that can detect looming driver drowsiness in prior and issue timely warning could help to prevent many accidents. In this proposed work, a new EOG signal processing algorithm to determine the state of drowsiness was developed. The proposed method relies only on derivative and amplitude level of received EOG signal. Based upon the different ocular movements, algorithm was tested in LabVIEW for determining drowsiness.

Index Terms: Biosensors, Electrooculography, Biomedical signal processing, Fatigue, Signal processing algorithms, Vehicle safety.

1. INTRODUCTION

Driver fatigue is a noteworthy factor in a large number of vehicle accidents. According to an estimate provided by the National Highway Traffic Safety Administration (NHTSA) annually 1,500 fatalities and 71,000 injuries [21] are attributed to fatigue related crashes [4]. In an article in mint daily on 24.07.2012, it is stated that fatalities due to road accidents in India are on the rise and in the year 2011, 11.8 persons died per lakh of population compared to 11.4, 10.8 and 10.5 in 2010, 2009 and 2008 respectively. Within the country, highest fatalities due to road accidents are in the state Goa where 23 persons per lakh die, followed by Tamilnadu (21), Puducherry (19), Haryana (19), Dadra & Nagar Haveli (18.4), Andhra Pradesh (17.9), Delhi (12.3), Maharashtra (11.6), Uttar Pradesh (11), Bihar (4.9).The advance of technologies for detecting or preventing drowsiness at the wheel is a major challenge in the field of accident avoidance systems. Due to such hazards provided by fatigue on the road, methods need to be developed for counteracting its effects. While driving a car it is hard for someone to look directly into the eyes of the driver and hence these are hidden even from the person sitting beside the driver.Drowsiness can be detected both in brain activity [14] which refers to the ability to process the information and in eyes activity which refers to the perception ability. This study focuses on the visual signs of drowsiness: blinks. Commonly few unlike methods are used to compute drowsiness movements. The detection of drowsiness based on subtraction and labelling which is very hard to put into practice, for it consumes more time in detecting.

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2 EXISTING METHODOLOGIES

Electroencephalographic (EEG) study of drowsiness indicators of drowsiness, fails in practicality because of wearing an EEG cap, head gear's while driving. Eye blink may be one of the most important actions among the eye related behaviours. This is due to its potential applications in many fields, including human-computer interface [1, 7], indicator of driver awareness [2], psychology analysis [4], and so on. Some techniques have been projected for blink analysis. In Fasel et al. [9], many open eyes and closed eyes were used to train the blink detector with a boosted cascade classifier structure.Some [8,10] tried to make use of optical flow to determine whether a blink has occurred. As for some other work [1, 7], the detection of blinking was based on observations of the correlation scores using the online or offline templates.The aim of this proposed work is to develop and test a model for detection and categorization of driver drowsiness by evaluating Electrooculogram (EOG) data from a number of test subjects, who have been driving during normal and drowsiness conditions by analysing various states eye blinks in a non-intrusive manner using LabVIEW. The leading possessions of EOG signal are labelled in Section II. Section III focuses the pre-processing methods. The algorithm to detect the direction of eye movement is established in the Section IV. The next Section describes the tests realized. Finally, in Section V the results of tests using LabVIEW are described.

3 METHODOLOGY

Here the 2 voltage points, "low" and "high", are well-defined in order to differentiate among a considered movement and a non-deliberate one. Together, both levels are recognized by a predefined level, where "value" represents an absolute value of amplitude. In broad, an event is completed using two eye movements, one is used to produce the event and the second is utilized to return a neutral position. Through these movements, three unlike steps can be renowned using EOG signals: the signal amplitude rises from the "low" level to the "high" level, then it stabilizes in the "high" level and finally, it fades until the "low" level. From this familiar dissimilar components could be identified: initial edge, final edge, area between edges and errors. This fact allows removing noise from the signals. For instance, while the 3 phases are offered during a blink, the width of area between edges is much reduced. A pulse is categorized as a blink if the width of this area is smaller than 250 ms.

3.1 Preprocessing EOG

EOG signal evidence is mostly limited in drop frequencies. So a well known band pass filter with a range between 0.1 and 30 Hz is applied. Then an average filter is kept behind in order to remove noise constituents. Then an average filter is applied in order to remove some noise components. Eye movements are noticed using an algorithm based on edge. The edges are perceived over the derivative of the EOG signal. The first pre-input of this algorithm is the derivative of EOG signal that can

have three different values: a value superior than 0, a value slighter than 0 and a value exactly fits to 0. The values that are not equal to 0 are related to initial and final edges of a pulse having positive amplitude. The value equal to 0 is associated with the area between edges (no-activity area). State transitions are led by the values of signal amplitude at current moment and previous one, and by the value of the signal derivative. Typical parameters for detection of drowsiness in

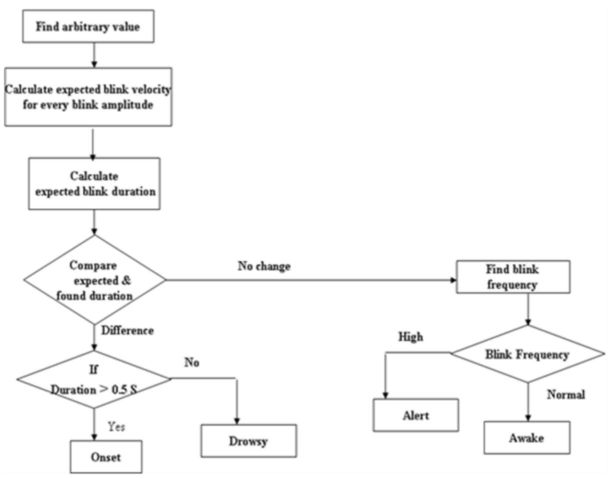

Fig 1 *Proposed methodology to predict drowsiness from EOG*

the EOG are blink amplitude, blink duration and blink frequency. In a normal state the amplitude is high and the duration short because of the sharp rise and fall. The frequency is low in normal state. This means that the eyelids are far apart before they close for a tiny moment and that this procedure is repeated with long intervals. As a person gets tired the amplitude lowers, the duration gets longer and the frequency increases. Typical samples of blink pattern describing the course of events from an alert state with short blinks to a very drowsy characterized by longer flat blinks. The method of detecting drowsiness prophecy from EOG is described in flow diagram shown below. The different stages for predicting drowsiness are explained in table 1. Since the initial stages of drowsiness include short blinking durations and the remaining long blinks, this is the criteria used to examine the signal. The blinks with normal durations should then be checked for high or low blink frequency where the first indicates a state of wakefulness and the latter a condition of low vigilance.

Table 1 Stages of drowsiness

Stages	Characteristics
Awake	Short blinking durations
Drowsy	Long blinking durations
Sleepy	Very long blinking durations or a low eyelid opening level

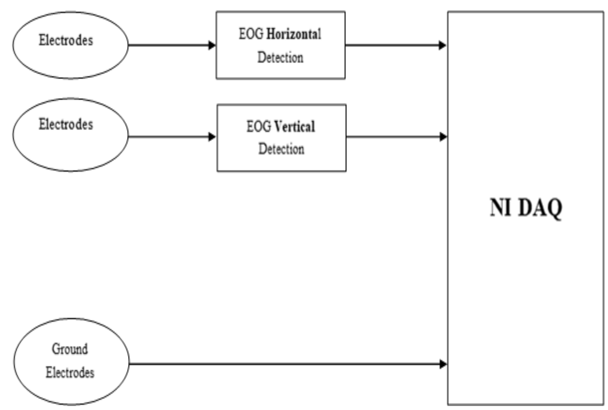

Fig 2 *Processing of EOG signal for drowsiness detection*

If the blink duration is considered as longer than normal there is a check for appearing eye closures and low eye lid opening level. If none of them come into view the subject is stated as drowsy but if either of them is present this can be an indication of sleep onset. In a real time system this would be the moment when the driver should be warned. Performance analysis on predicting drowsiness can be calculated based on the flowchart shown in figure 1.

4 RESULTS

The EOG signal analysis system was developed in LabVIEW platform. LabVIEW is a graphical user interface based virtual instrument environment which has a lot of features for signal processing applications.

4.1 Hardware description

The preliminary section starts with the location of electrodes. Stage two incorporates the popularity of horizontal and vertical movements of the attention. The hardware for the second stage contains the look of EOG bio potential amplifiers for horizontal movements and different for vertical movements. The EOG is routinely the method of alternative for recording eye movement in investigation thanks to the proportion of eye movement to eye position. The outputs of each the stages are inputted into the ultimate stage, the NIDAQ acquisition tool and then to private laptop. The location of electrodes is important for getting an honest signal kind from the eyes. For the detection of horizontal discrimination, one electrode is placed to the corner of the left eye and one to the opposite corner of the proper eye. It is important to stay the electrodes equal from the middle of the face for the EOG to be properly targeted. Similarly another set of electrodes are placed higher than the eye brow and below the eye brow. These set of electrodes area unit used for vertical detection. The electrodes were most popular with the apprehension of protective the eyes from harmful components. Thus, solid gel electrodes were selected over wet gel electrodes as a compensatory live to avert the gel from getting into the eyes. Ag/AgCl electrodes were favored since the half-cell potential was the nearest to zero.

4.2 Simulation Results

Ordinary spontaneous blinks are the blinks that can be used to measure the driver's drowsiness state. Normal blinks in EOG data usually appears as a sharp pulse with fast down phase eyelid movement and relatively slower up phase eyelid movement in vertical channel. The horizontal channel doesn't have any significant change. This kind of EOG signal patterns sometimes also appears in other eye movement signals, which means a blink is accompanied with the movement.

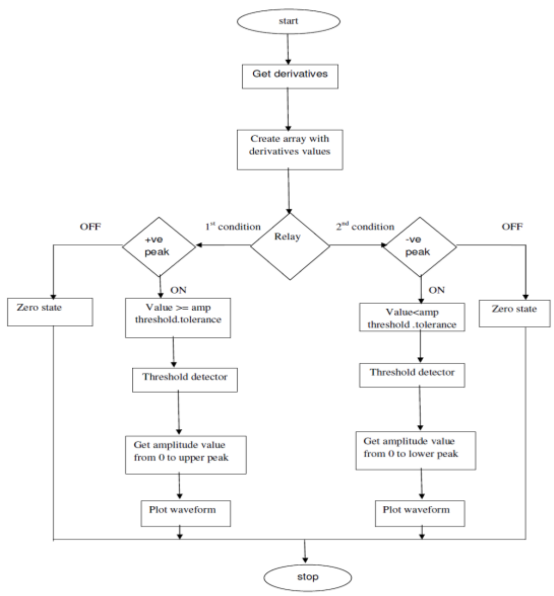

Fig 3 *Flow diagram for determining peaks in LabVIEW*

EOG signal is simulated by reading the data from an array. Data is manually extracted from the EOG recordings obtained from the derivative values. The data acquisition starts the acquisition of data, stores the data in the respective file locations and also online plotting of the data. The report module retrieves the stored data for the purpose of analysis. The front panel in a virtual instrument (VI) resembles the user interface of a physical instrument. Two channels ch0 and ch1 were used for horizontal and vertical detection. The VI equates the magnitudes of each signal to a definite predetermined value in order to determine whether the user is blinking or not. The biomedical signals necessitate preprocessing before they can be analyzed. These biomedical signals, being awfully small in amplitude, are susceptible to being flabbergasted by noise. To fight this, it is indispensable to run the acquired signal through a set of filters. Yet, after the signal ranges the program, it can still hold noise. Alternative way to solve the noise problem is to use the digital filters provided with LabVIEW. The data from each channel can be recovered separately and studied. Samples from the vertical and horizontal index arrays were then run through a series of assessments. The magnitudes of each of the samples were compared to the threshold value resolute when the EOG circuits were tested with electrodes. Figure 3 shows the block diagram of the proposed system. Signal peak values are measured using the waveform measurement features and peak values are displayed. The final part of the LabVIEW encoding constituent, is the graphical display that provides asimulation for the peak detection.

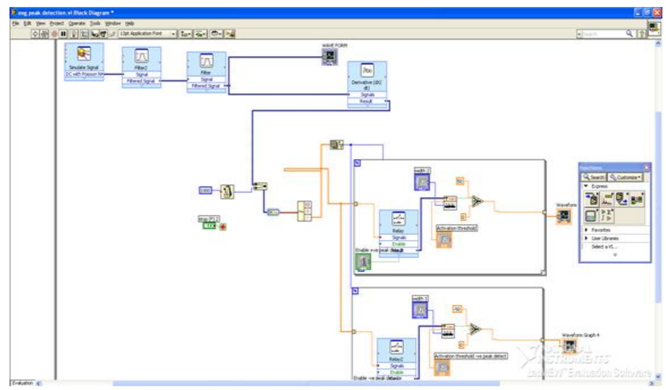

Fig4 *Front panel design*

Fig 6 *Positive peak detection*

6 CONCLUSION

Drowsiness is characterized by increased blink duration, decreased blink amplitude and increased blink frequency and EOG can be used to measure changes in these parameters. We have developed a model for predicting peaks from EOG signal obtained from different test cases and fault tolerance was around 5%. With the above obtained results we are developing a new model for determining drowsiness as shown in figure 6. The expected duration needs to be calculated and the difference between measured and expected duration can be compared to the boundary set in the program to determine if the blink duration was high enough to be classified as drowsy. The same procedure was done for each blink frequency and blink amplitude; the program compared each blink frequency and blink amplitude with the boundaries set in the program to determine if they were exceeded. The boundaries were based on mean values and standard deviations of the variables in the alert condition as this was thought to be a measure of the individual differences in the development of drowsiness. The program then examined for ten blinks at a time to see how many of the blinks that were exceeding the boundaries. We are also developing a simple hardware design based upon the validated results. Using data acquisition board (DAQ) the signal can be acquired and once after predicting drowsiness, alert signal to driver is produced through the programmed Microcontroller and the same information is transmitted to stop the motor of the wheel through RF transmitters thereby providing almost safety.

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