Human's Fatigue Detection System Based on Eyelid Blinking

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Abstract*:*

This paper describes method for detecting the early signs of fatigue in person. As soon as the person is falling in symptoms of fatigue immediate message will is transfer to the supervisor in any place due to any sever medical problems. The fatigue system is detected based on eyelid blinking. The mechanism is based on detects face, eyes and tracks the eyes for the person. Based on eyelid blinking, along with templates that monitor how long the eyes are open or closed. Tests of the approach were run on many persons to find its potential and its limitations. The system is very efficient to detect the fatigue. The results confirm that our method is able to measure human fatigue and show the validity of the proposed approach. Moreover; it can be used for vehicles driver and medical area.

Keywords: Fatigue, Human's drowsiness, Driver fatigue.

Introduction

The word fatigue is used in everyday living to describe a range of afflictions, varying from a general state of lethargy to a specific work-induced burning sensation within one's muscles. Fatigue is a phenomenon that influences a person's ability to perform a task on various levels. Fatigue defined as a state in which performance capabilities are temporarily impaired by continual activity demands which exceed the ongoing capacity to restore performance capabilities. [1] Fatigue can be defined as the feeling of tiredness, exhaustion or lack of energy to perform tasks in an efficient manner. This can further be categorized as physical or mental fatigue. Although physical fatigue can

be addressed by refraining from performing the strenuous activity, the onset of mental fatigue is hard to detect. Table 1 lists the different types of fatigue detection methods that can help in these situations. [2]

Table 1: Classification of fatigue detection methods.

S.NO	Method type	Measured quantity	Applicability
1	Visual detection using camera	Eye closure and head motion	Driving or other operations that requires worker to be seated in constant position such as in cranes , etc.
2	Heart rate based methods	ECG	Generic
3	Muscle activity based methods	EMG,EOG	Worker performing physically intensive tasks
4	Brain wave based method	EEG	Generic
5	Psychomotor monitoring based methods	Movement of hand or limbs while performing tasks such as driving	Driving can be adopted to other operations were motion parameters can be monitored

When a worker is tired or deprived of sleep, there is natural tendency for the eyes to close. This can be analyzed using a camera. Active illumination imaging system is used to measure the eye closure in day light and dark conditions. The face region is analyzed to detect closure of eyes to estimate PERCLOS measure which gives an indication of fatigue. The cost of fatigue is of increasing concern to organizations across the globe as fatigue-related accidents and losses are extremely high. [3]

When a person's alertness is affected by fatigue, his or her performance on the job can be significantly impaired. Impairment will occur in every aspect of human performance (physically,

emotionally, and mentally) such as in decision-making, response time, judgments, and countless other skills. The threat to safe aviation operations arises from the impairment to alertness and degradation of performance. [4]

This paper presents a system that measures the fatigue in human based on eyelid blinking. The system works with inexpensive USB cameras and runs at a frame rate of 30 frames per second. To prove this system's features, usability evaluation have been done through a laboratory experiment design. The experimental results have demonstrated feasibility of the concept and system. Therefore, this research will be a solution to address some human's fatigue problems such as vehicles accident and heavy transportation driver such as pilot.

The paper is organized as follows: section II is about the related work which summarizes previous researches on the fatigue techniques. Moreover section III provides more information about proposed system concept design and implementation. Section IV about evaluation where section V describes results and discussion. Section VI presents the conclusions.

Related work

The word fatigue is used in everyday living to describe a range of afflictions, varying from a general state of lethargy to a specific work-induced burning sensation within one's muscles [2].

Several of fatigue detection and monitoring system have been proposed, each has its own features.

This section analyses previous work on face and eye detection, eye tracking and eye state classification area.
Possible techniques for detecting fatigue in person can be broadly divided into four major categories:
• Methods based on human's current state, relating to the eye and eyelid movements [5].
• Methods based on human performance and human behavior [6].

• Methods based on physiological signals [7].
• Methods based on combination of the multiple parameters [8].

There has been lots of literature on detection of fatigue effects and the person's current state specifically focused on changes and movements in the eye. Generally, eyes detection consists of two steps: Locating face to extract eye regions and eye detection from eye's windows several researches use Haar-Like feature and AdaBoost algorithm for detecting face and eyes and use PERCLOS to evaluate driving fatigue. PERCLOS (Percent Eye Closure), a video based method that measures eye closure is a reliable and valid determination of a driver's alertness level. PERCLOS is the proportion of total time that the driver's eyelids are closed 80% or more and reflects slow eyelid closures rather than blinks. For example Viola and Jones [9] have used boosted cascade of features to detect particular object. Template matching and support vector machine based approach is used to detect eye from face image [10] [11]. Eye-tracking is an area of computer vision that has been researched in the past years. The eye-tracking systems can be used for several applications. Some of them have already been implemented to conduct psychological studies about attention and interest [12]. [13] Describes the most important application of eye tracking i.e. driver drowsiness detection. In [14] float boost learning for classification is described. In [5] detected face and eyes region using Haar-Like feature and AdaBoost algorithm and used an improved template matching method to detect eye states and selected PERCLOS to evaluate driving fatigue. They used the transition of eyes state to detect eyes' blink.

DESIGN STEPS OF FATIGUE DETECTION SYSTEM

The block diagram of fatigue detection system is shown in figure 1, which illustrates the whole system. The first stage of block diagram is data input source, which are classified by two methods for data input. The first method may be video file stored in the computer for human. The second method for input data to the system is by using web camera connected directly to computer. The second block is fatigue system which constitutes form many stages. The fatigue system is based on software that will analysis data input in many steps as shown below and last stage is output result in message appears on computer as fatigue state or not.

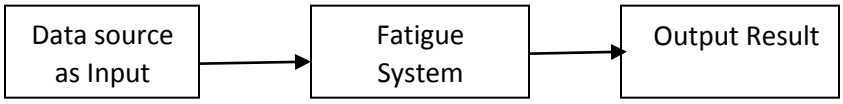

Figure 1 Shows block diagram of system

➢ PROPOSED FRAMEWORK

The construction of the framework is based on the derivation of every single component. It is done by mapping all components into a framework as illustrates in Figure 2. From Figure 2, the human's fatigue system is based on eyelid blinking algorithm. The end result will give the conclusion whether the human exhibits a fatigue or not. This systematic framework is developed as a guide to build a prototype using Matlab programming language software.

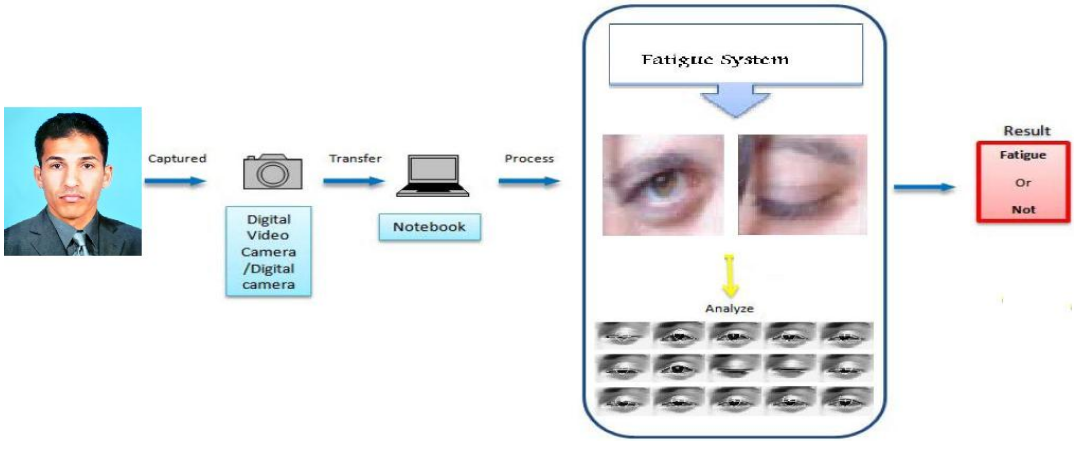

Fig 2 Framework of Human Fatigue.

➢ PROGRAMMING OF FATIGUE SYSTEM

The flow chart of basic components programming of Fatigue system are shown in figure 3 where will be discussed later in more detail for every step.

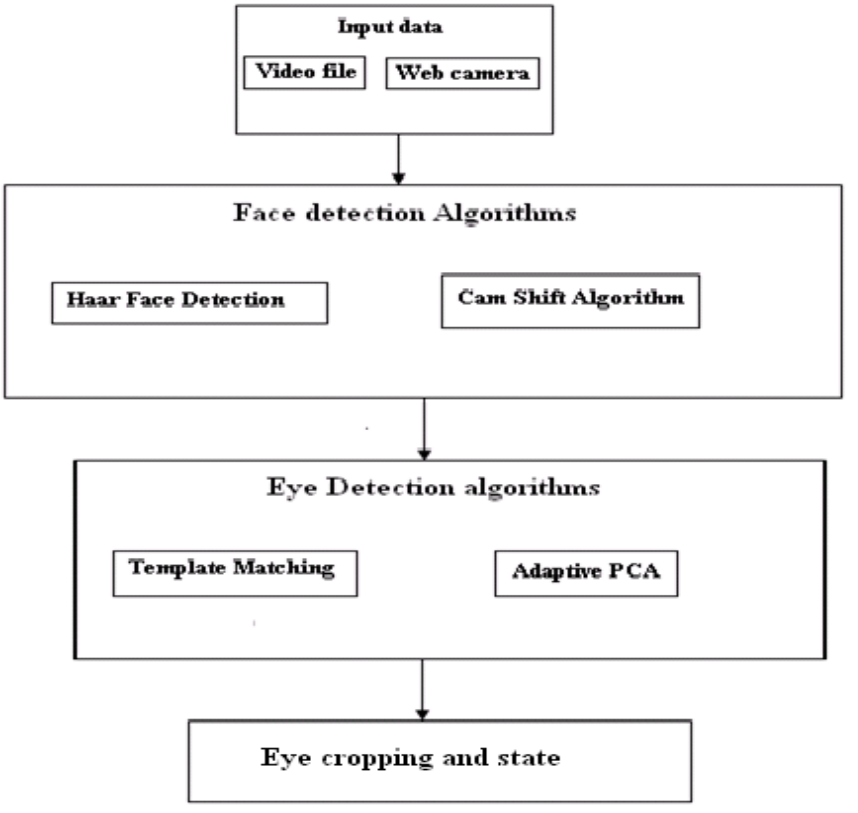

Figure 3: Block diagram of Fatigue system

➢ Face detection algorithms

The main working of the system is when the system gets started it firstly recognize the region of face which includes eye lids and eye ball positioning. Under supervision user of the system through graphic user interface it must be applied one algorithm as shown in figure 4. There are two algorithms used to detect face *Haar Cascade Classifier algorithm* and *Cam shift algorithm.*

For face detection it preferred to use Haar classifiers algorithm. These classifiers are based on features extraction, which are found to be contrast in variation inside a set of pixels making two distinguish areas, darker and lighter shades. The classifiers are prepared with two groups of images, good and bad examples of the specific features. To increase the accuracy of the system the proposed algorithm uses different Haar filters

which make the face detection step more robust. For the purpose of minimizing the chances of errors and reduce processing time, relevant regions are cropped for further processing.

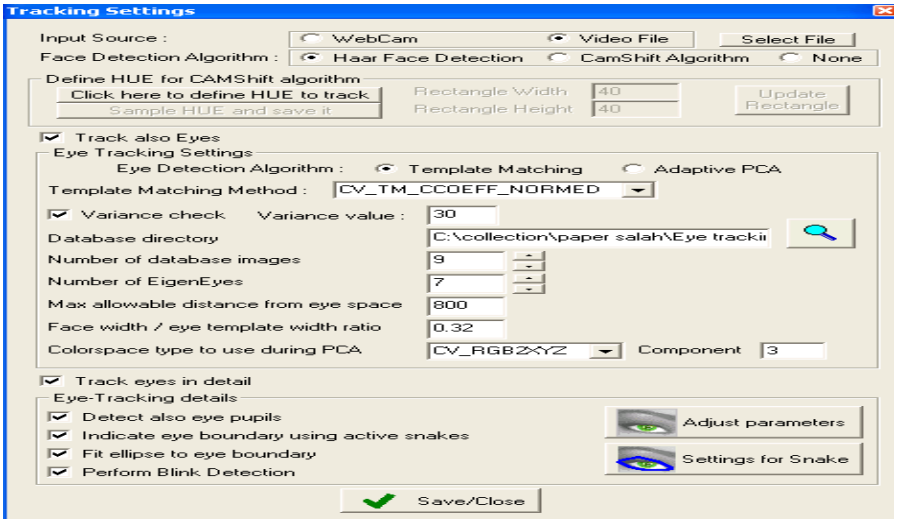

Figure 4 Shows Tracking setting configuration

➢ Eye detection algorithm

There are two algorithms for eye detection and tracking, where these algorithms are template matching and adaptive principle component analysis (PCA). Under supervision user of the system through graphic user interface it must be applied one algorithm as shown in figure 4. When chosen template matching for eyes detection and tracking in the option of GUI then the choice gives option to choose one of known standard template. The result of this choice is shown in Figure 7.

➢ Eye Cropping and state

After successfully detection eye, now the software system will crop an eye from detected image in separate windows as shown in figure 8. The detection of eyes status is very important. It is done by another small program out the software system. To measure the state of eye use algorithm implemented in Math Lab. In the Matlab software, the process begins with Image processing eye extracted from software system. The process is converts the grayscale image to binary image. The binary image consists of only two gray levels, where"0" represents Black and "1" represents White as shown in figure 9. In this the object eye balls are

assigned white pixel value and background is assigned with black pixel. The number of white pixels is counted by program. If the value exceeds some fixed value then eyes are open otherwise eyes are closed, after that the end result will visualize whether the human is fatigue or not.

Results and Discussion

The system is tested on Video captured through USB camera. The graphic user interface GUI for the software system after tested is shown in figure 5.

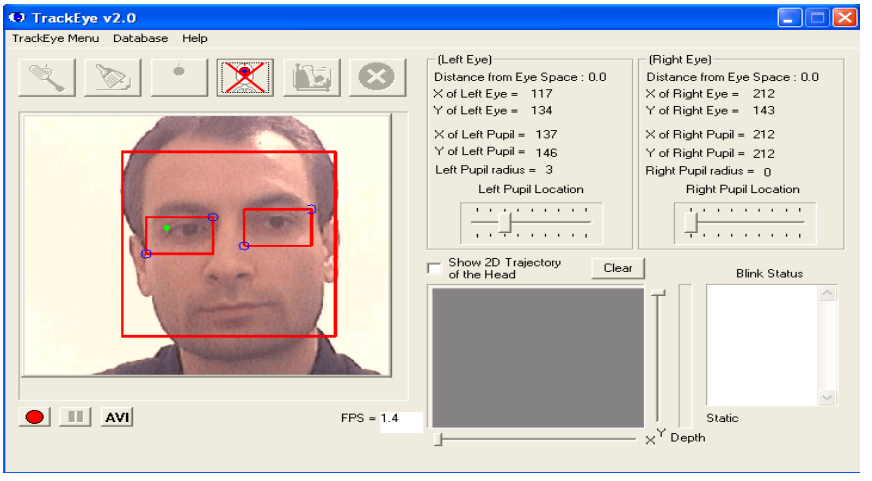

Figure 5 shows the GUI of the application where applied in the project.

The results are from software system. Use Haar classifier as face detection From GUI for the system and template matching for eye detection. This software system can detect the face, track the eyes. For functional testing, there is setting in coding for compute state of eye that if expected output of number of white pixels comes within range then it can be output state of person otherwise having functional fault. These settings of data can be varied for different persons.

Figure 6 shows result of face detection by Haar algorithm

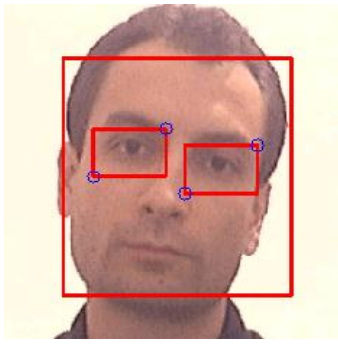

Figure 7 shows result of eye detection by template algorithm

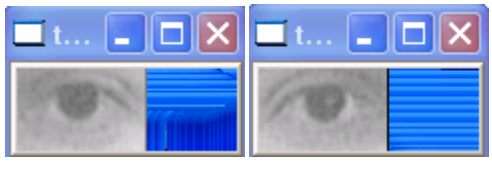

Figure 8 shows result of eye cropping

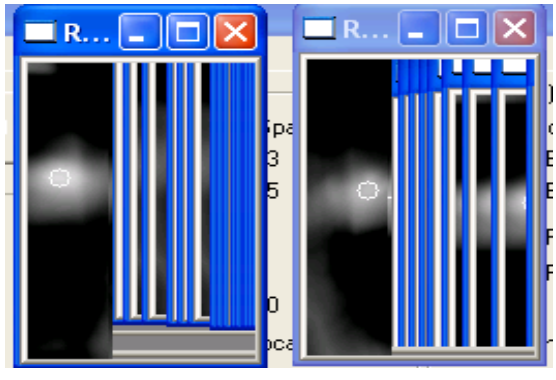

Figure 9 Shows results of Binary eye image

Conclusion and Future Work

A technological solution in human's life is important to address some human's behavior such as fatigue. In this paper, a framework for measurements of human's fatigue level by using one factor is proposed. This framework is more accurate measurement of human's fatigue level instead of another method based on medical instrumentation.

Based on this framework, the developed simulation can measure the human's fatigue level using eyelid blinking. Once the simulation has been developed, it can be adopted to develop a prototype via FPGA. The prototype can be used for accident prevention and safety for transportation and also for educational area.

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