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Facial Image Processing for Sleepiness Estimation

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Abstract—Sleepiness could cause different accidents at work and in our daily lives. Activities such as driving a car, handling heavy machinery, being in charge of controlling a satellite or monitoring a nuclear plant, are activities that require short visual and motor reaction times. These reactions could be affected by sleepiness. The highest number of these accidents is related to vehicular accidents. WHO statistics show that 1.2 million people worldwide die every year due to road crashes, 50 million people are injured, and more than 3,000 people die daily from road traffic injuries. The primary objective of the present work is to develop a tool based on techniques of artificial intelligence and image processing that can detect states of sleepiness in people whose work needs the greatest attention - to avoid accidents. The idea is to develop an algorithm that can be executed on a computer and through a webcam can record the face of the person or worker to analyze the video and through facial recognition techniques can identify the eyes of the person, and thus identify eyelashes that would be an indicator of sleepiness. It is expected to have an algorithm developed in MATLAB to detect drowsiness and provide some notification.

Keywords— Sleepiness, face detection, eye detection, vehicular accident, yes-no questions.

I. INTRODUCCIÓN

ACCORDING to [1], it can be seen that sleepiness is a cause for different accidents, especially motorized accidents. WHO statistics show that 1.2 million people worldwide die every year due to road crashes, 50 million people are injured, and more than 3,000 people die daily from road traffic injuries. (World report on the prevention of road traffic injuries, WHO 2004).

Activities such as driving a car, handling heavy machinery, being in charge of moving a satellite or monitoring a nuclear plant are activities that require short visual and motor reaction times; these attitudes are affected by drowsiness.

According to [2], Peru's statistics indicate that in 2007 there were 3510 deaths due to traffic accidents and 49,857 injuries, most of them due to the tiredness of the drivers. One of the cities that suffers from these accidents due to drowsiness is Arequipa, which according to [3] is the third city with more passengers flow.

Faced with this reality, the Ministry of Transportation of Peru has created regulations that indicate that the maximum time of driving a car should be 5 hours in the day and 4 hours in the night, this is a rule that currently does not carry out in our country.

The implemented algorithm, capable of detecting the level of drowsiness of users, can prevent fatal accidents that can be more frequent due to fatigue and drowsiness.

A business model will be developed to look for a self-sustaining project. This business model would be based on giving monitoring and information gathering services.

As has been observed, drowsiness is a major cause of accidents that occur at work, especially in drivers of interregional public transportation.

In that sense, many research groups around the world work on different tools to determine the fatigue of people and give warning signals to prevent the user from sleeping.

In work [4] a system of fatigue detection is presented in the conductor through the analysis of electroencephalographic signals and using neural networks for their classification. The authors analyzed alpha, beta, delta, and theta rhythms. As a result, they achieved an 83.06% success rate in the standings.

A more recent work is presented in [5], where the authors present a method for the monitoring of driver fatigue through eye tracking. Computer vision and image processing techniques are used on images recorded by an infrared camera. In this paper, they also use a neural network for the classification of signals. The results that the authors obtained show a 97% success in the discrimination.

Based on this background we developed a drowsiness detector based on the analysis of facial images.

With the development of an algorithm with the ability to detect the face and eyes of people, and through determining the level of individuals drowsiness, it is expected to provide a tool to aid to reduce the number of workplace accidents. Likewise, with the help of the Internet and ICT, an efficient, cost-effective system with monitoring, alert, and reporting capacity will be offered.

This paper is structured as follow. Section 2 presents the methodology used in this research. In Section 3 one shows the results obtained in the testing process. Section 4 one interprets the results although the discussion and conclusion for this study.

II. METHODOLOGY

The present project seeks to develop a system for monitoring, alert, and reporting levels of drowsiness for people.

This evaluation system of levels of sleepiness is a non-invasive tool.

For this purpose, the study will consist of the following components:

- 1) Hardware.
- 2) An Algorithm for image analysis.
- 3) Development of APP for a mobile device.
- 4) Web server for data storage.

A. Acquisition of the images:

The implementation of the system with the ability to determine the degree of drowsiness of the people will be carried out using a mobile device (smartphone or tablet) with frontal camera.

The algorithm of the image acquisition applies a pre-processing step for the improvement of the picture contrast.

B. Image Analysis:

For the image analysis, we will use algorithms that were already used for other applications such as [6]. Likewise, feature extraction and classification algorithms are implemented.

The entire process of image analysis begins with face detection. Face detection is performed using the Viola-Jones algorithm [7]. The next step is to recognize both eyes; this step is also done using the Viola-Jones algorithm. Finally, the task is to identify the eyes individually, separating the left eye from the right eye. To be able to detect the eyes correctly, they must be open. In that sense, if the algorithm fails to detect the eyes could be because, in the frame (image) that we are analyzing, the eyes are closed, which would imply that the person is blinking.

The classification stage is the final task of the entire process. As the entry to the algorithm of classification or discrimination we have the set of features and the output is the level of drowsiness detected, among them, one can mention:

- K-NN (K-nearest neighbor)
- K-means
- Artificial Neuronal Network
- Support Vector Machine
- Linear Discriminant Analysis

C. App for Mobile Devices:

It is also planned to develop an application (app) for mobile devices, which should be installed on the user's cell phone. This smartphone, using its front camera, will acquire the images and send the information through the internet to a server initially located in the Image Processing Research Laboratory (INTI-Lab) at Universidad de Ciencias y Humanidades (UCH).

Likewise, the application to be developed will be connected to the GPS service of the same mobile phone, to be able to provide such information for the reports that will be elaborated.

D. Web server for data storage

The server as information technology will allow storing text files that contain the personal data of each user,

and other details that may be important to generate statistics and make correct decisions. This aspect will ensure an accurate monitoring and control of each user. Also, this information can be distributed to interested state entities to generate statistics such as the Ministry of Transport and Communications.

The server will be implemented with the algorithms for the data processing.

III. RESULTS

Figure 1 shows the application of the presented methodology. In front of an image that includes the user's face, the algorithm first detects the face, then both eyes and finally the detection of the right eye and left eye separately. This situation is possible thanks to the person's eyes are open

In the case of Figure 2, since the person has their eyes closed (possibly by blinking), the algorithm only recognizes the eye and the two eyes together without identifying the right eye and the left eye Independent.



Figure 1: Cascade detection when user's eyes are open

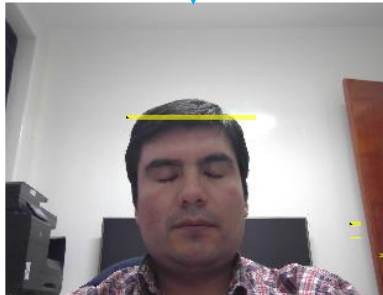


Figure 2: Cascade detection when user's eyes are close

IV. DISCUSSION

The project will contribute to the improvement of specialized technical capabilities for biomedical signal analysis in general.

Among the applications and uses of this project, we can mention mainly the interprovincial transport companies. These companies could begin to monitor the fatigue of their drivers and have a tool to alert the drivers themselves to wake up or change drivers.

Likewise, another possible use and application would be through the Ministry of Transport and Communications, who could apply this tool to monitor transport companies, also to have better statistics, and try to enforce established standards.

In general, the companies, which in their production processes include tasks where it is needed a high concentration of the worker, could also make use the resulting prototype to avoid accidents due to the fatigue of its operators.

The present project will have a critical technological impact for our country (Peru) since it would be the first time that a system of monitoring, warning and reporting of levels of drowsiness in people to prevent accidents will be developed.

With the advancement of technology and the lowering costs of the materials used in the proposed prototype, it could even have an industry oriented to the commercialization of these systems. In this way, the country's economy could become more dynamic, establishing a self-sustaining business model.

The social impact will be imperative for this project, as it is expected to significantly reduce the number of accidents (often with human losses) caused by the fatigue and fatigue of people in dangerous jobs and who need high concentration. The society will be the primary beneficiary of the results of the present work.

The realization of this project will not cause any harmful impact on our ecosystem.

According to the results found, the efficiency of the algorithm of drowsiness estimation is enough to be able to use it in real conditions.

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