Facial Image Processing for Sleepiness Estimation

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Introduction

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). 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 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. 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 and prevent fatal accidents that can be more frequent due to fatigue. Likewise, with the help of the Internet and ICT, an efficient, cost-effective system with monitoring, alert, and reporting capacity will be offered.

Methodology:

The 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. Also, this information can be distributed to interested state entities to generate statistics.

Results:

For the validation of the proof of concept we test the algorithm developed in a laboratory environment with some researchers belonging to our laboratory. Some images of the tests can be observed.

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

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 iris. This situation is possible because the person's eyes are open
In the case of Figure 2, since the person has their eyes closed (by blinking), the algorithm only recognizes the eye and the two eyes together without identifying the iris.

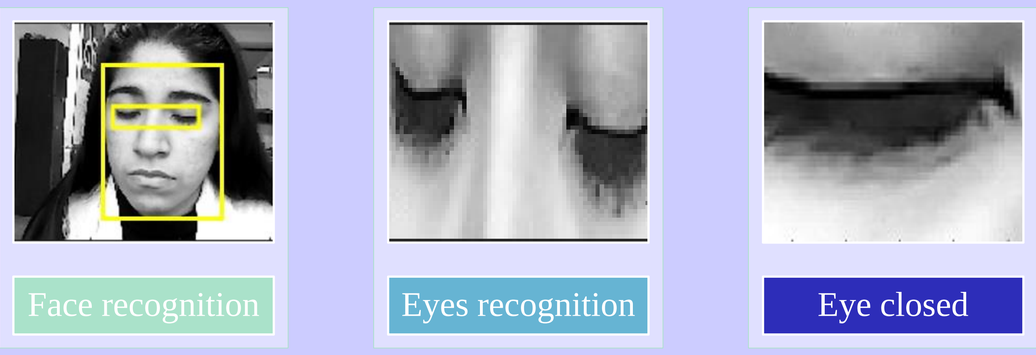

Figure 2: Cascade detection when user's eyes are close

After the stage of recognition of both states: open eye, performing a correct recognition of the iris, and closed eye, the algorithm developed performs a count of both states to identify the frequency of the blink in the individual, after based on that result we can determine if the person is drowsy.
It is worth noting that a flicker frequency in an individual without drowsiness is 15 blinks per minute, higher values indicate the presence of drowsiness in the subject.
Because the propose system has not considered the issue of the correct lighting that should have the device, for perform a correct recognition of the eyes, we consider this aspect as a consideration to take into account later. In addition, the distance and the correct angle of placement of the camera of the device must be considered, in order to perform a correct face detection.

Conclusions

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

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