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Driver's Drowsiness Detection

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Abstract—*This work confer the development and execution of result that detects the drowsiness of driver while driving and alert them to avoid possible accidents that may occur in real time. An analysis and design of method that is used for detection of usual drowsiness through computer vision that is carried out, mainly focusing on use of various facial landmark and eye area points. Drowsiness, tiredness, distraction, over speeding as well as fatigue are one of the main causes of road accidents. Therefore an advanced driver assistance system helps in reducing these types of human errors. Here proposed a solution to locate, analyze as well as track both things that is area of driver face as well as driver's eyes using various coordinates and landmarks to detect and analyze exact results with accuracy.*

Keywords – *Drowsiness detection; Facial landmarks; computer vision.*

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I. INTRODUCTION

Human beings cause traffic accidents because they are distracted, drowsy, under psychotropic substances or simply because they are bad drivers. Despite this, the human being is the best perceptual control system [1]. Drowsiness prevents safe driving by reducing the driver's reaction speed, resulting in a 50% chance of causing death or serious injury in high-speed impacts [2].

Faced with this problem, Driver Assistance Systems (DAS) are developed, which help human beings to maintain safe driving.

The DAS informs the driver about the state of vehicle and the environment; in addition,they warn the driver about possible risks that may affect the vehicle and itself. Within the DAS, there are, for example: driving stability, automatic parking, lateral control, traction control, anti-lock system, among others. In some operations, DAS require complex processing to perform their functions, as in the case of lane change control or lane keeping support, which is why Advanced Driver Assistance Systems (ADAS) are developed. in English Advanced Driver Assistance System) [3].

This article conveys and describes the development and implementation of an ADAS, for the detection of driver drowsiness, using facial reference points. In the structure ofthe article, section II presents the background that explains the problem. Section III describes studies on methods for detecting sleepiness. Section IV presents the methodology and architecture of the system. Section V shows the preliminary results. Finally, the section VI describes the conclusions and future work.

This paper conveys the implementation of driver assistance system to detect driver's drowsiness in real time world, using various facial reference points. They are based on various facial regional area points and coordinates.

II. BACKGROUND

In Ecuador, in 2019, the number of accidents was 24,595, causing 19,999 people injured and 2,180 deaths [4]. According to statistics, the number of registered vehicles grew by 7.4% between 2017 and 2018, reaching a total of 2,403,651 vehicles nationwide. In 2018, 24.13% of accidents were due to driving inattentive to traffic conditions (cell phone, video screens, food, makeup or any other distracting element), and 1.38% to driving while drowsy or poorly physical conditions (sleep, tiredness and fatigue) [5].

There are various researches in literature that developed methods and techniques for detecting sleepiness. Some of them have focused on theirstudies on analyzing the exact facial features and the present state of the driver in real time, in case of detecting fatigue, tiredness or drowsiness, alert that allow the driverto ensure safety measures for him as well as for other drivers.

Table I shows the alarming values of injuries and deaths, per year, due to traffic accidents in Ecuador. Researchers have launched projects to avoidtraffic accidents by implementing ADAS. The DAS informs the driver about the state of vehicle and the environment.

TABLE I.ACCIDENTS IN THE PERIOD 2015-2019 IN ECUADOR

	2015	**2016**	**2017**	**2018**	**2019**
Accidents	35,706	30,269	28,967	25,530	24,595
Wounded	25,234	21,458	22,018	19,858	19,999
Deaths	2,138	1,967	2,153	2,151	2,180

III. RELATED WORKS

There is research in the literature that has developed methods for detecting sleepiness. Some have focused theirstudies on analyzing the facial features and the current state of the driver in real time, in case of detecting fatigue, tiredness or drowsiness, issuing alerts that allow the driverto establish safety measures for himself, for other drivers and for drivers. Pedestrians, in order to avoid accidents [6],[7].

Three categories of driver sleepiness measurement are presented in [8], considering vehicle driving patterns,psychological characteristics, and computer vision techniques. Driving patterns are based on monitoring the steering wheel movement, acceleration time, or lane departure. The techniques that measure psychological characteristics of the driver, focuses on electrical biosignals such as following Electroencephalography (EEG), Electrocardiogram (ECG) and Electrooculogram (EOG) data and offer an accuracy of 89.5% in detecting drowsiness. However, its development is less due to the intrusion of the various sensors that must be connected to the driver. Therefore, computer vision techniques are more popular and focus on eye closure monitoring.

In [9], the authors describe a review of the techniques to detect sleepiness, emphasizing their analysis in investigations based on computer vision: template matching, eye blinking, PERCLOS and yawning techniques. These computer vision techniques have the advantage of being non-intrusive and easy to use, although a disadvantage is the lighting conditions.

In [10], a system is proposed that detects the drowsiness and tiredness of a human being, through the analysis of emotions using convolution neural networks and eye tracking. The system monitors the activity of the person, that is, the change of emotion, through a webcam and issues an alert in the event of abnormal behavior.

The system proposed in [11], measures the time that the eyes are closed, and if they are closed for minimum at least more than 4 seconds, then the system will issue alerts to warn the driver, at the same time it issues a notification (sms) of the driver's state and particular location via GPS, to a designated emergency contact. This system is tested with a cell phone camera and concludes that the optimal distance between the camera and the driver is between 25 to 100 cm. It is also determined that the image quality should not be so high to avoid delays in image processing and algorithm response.

In [12], a driver's safety monitoring and alerting system based on Internet of Things(IoT) and computer vision is created to predict future risks. The system uses facial landmark detectors to detect the driver's face and eye frame, alerts when drowsiness is detected, and updates a database of thedriver's condition.

Various statistics indicates the need of reliable drowsiness detection systems that can alert the driver before an accident occurs. In [13] a literature review is described to determine driver sleepiness using various measures. A review of these measurements provides information about the current system, the problems happening associated to them, and improvements that need to be make an accurate robust system.

Many investigations have been tested in laboratories and not in real vehicles in motion, this due to the safety of the driver who has to be in an active state, in a drowsy state as well as in a distracted state, with the system put to the test, and it can be very dangerous . The drawback of performing the tests in the laboratory is that the challenges that the environment and the road present, such as variable lighting, background change andvehicle vibrations, are omitted [14]. In [15] an industrial model called "copilot" is presented, which has been tested by truck drivers. This system detects the eyes and calculates the percentage eye closure to measure the driver's drowsiness.

This paper presents the development and implementation of an advanced driver assistance systemto detect the driver's drowsiness in real time, using facial reference points.

IV. METHODOLOGY

For the development of the solution, it is proposed to use the Scrum methodology, which has an iterative, unique and incremental of project management method [16]. The architecture of the system is presented in Figure 1, it beginswith the image acquisition through the webcam. Image processing begins by resizing the image and changing it to grayscale. Next, the evaluation of the eye opening is carriedout, obtaining the value of the eye aspect ratio (EAR). Finally, the parameter obtained from EAR is evaluated withrespect to the minimum threshold allowed. If the value is lower during a certain time interval the alarm will sound, otherwise the algorithm will continue to process continuously.

A. Algorithm detection

The system proposed in [11], measures the time that the eyes are closed, and if they are closed for minimum at least more than 4 seconds, then the system will issue alerts to warn the driver, at the same time it issues a notification (sms) of the driver's state and particularlocation via GPS, to a designated emergency contact. This system is tested with a cell phone camera and concludes that the optimal distance between the camera and the driver is between 25 to 100 cm. It is also determined that the image quality should not be so high to avoid delays in image processing and algorithm response.

For the detection of drowsiness, the most used and precise methods were considered, such as the Viola & Jones algorithm [17]–[19]. This algorithm uses cascade classifiers based on Haar features for object detection. The functions formed from various many other images. Then it is used to detect objects in other images [20].

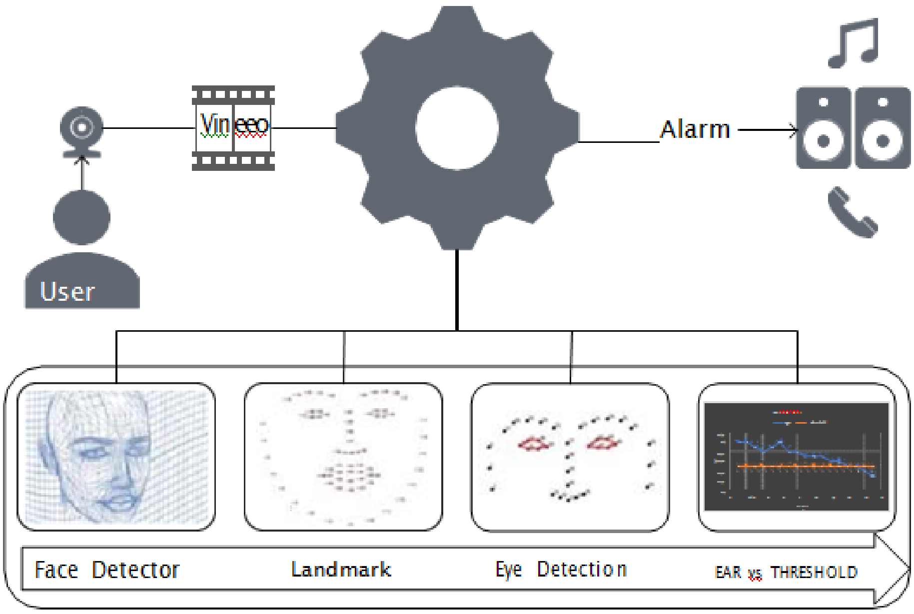

Figure 1. Architecture

Figure 2 presents the result of testing a HaarCascade algorithm for face detection, followed by a HaarCascade algorithm for eye detection. On the other hand, when carrying out some tests with a webcam and an external camera, unsatisfactory results were obtained, possibly dueto the variation in light. In particular, the green boxes should only locate the eyes, but it presents errors, therefore, it was decided to use facial reference points.

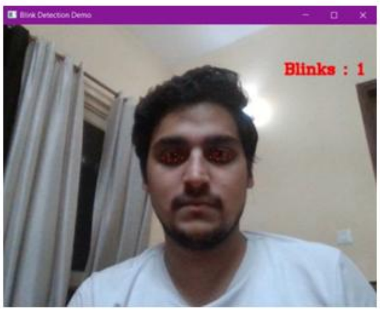

Figure 2. Test of the Viola & Jones algorithm

B. Detection of facial region landmarks

Many landmarks of face are used to detect and locate and representsregion of facial part.

Figure 3. Facial landmarks [21]

Figure 3 shows the indices of the coordinates (x, y)that are assigned to the facial structure region on the face.

Various facial landmarks has been successfully applied to face alignment, head posture, number of blink detection, and many other aspects also for various results. [12]. The pre-trained facial point detector within the dlib library (python) is used to estimate the location of the coordinates.

C. Eye detection

By detecting facial landmarks, landmarks are only extracted from the eyes (see Figure 4). Each eye is represented by various minimum 6 (x,y) coordinates that is starting from the left eye corner, and then working clockwise aroundthe rest of the region [22].

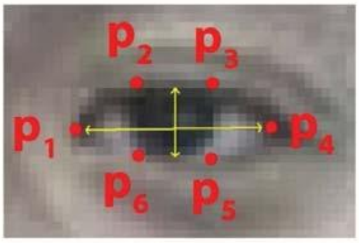

Figure 4. Landmarks of the eye [21]

There is a relationship between aspect width is to height of the coordinates. In [22] an equation is derived that reflects the exact aspect ratio of the EAR eye. According to the results, limits of the EAR value can be determined to know ifa person is sleepy.

D. Evaluation of algorithms

For the evaluation of algorithms. The algorithms were implemented and evaluated in Python 3.6, for which it was necessary to implement several libraries such as OpenCVand imutils. In addition, Visual studio code was used for code editing.

The system was developed on an Asus i7 laptop. The built-in webcam worked on the same level as an Acti View camera, ie both gave the same results.

The work environment was in a study room, at different times of the day, but maintaining an almost regular lighting environment, although with the ActiView camera the intensity of light increased, the results remained the same. It is expected to test the system in an external environment inside a vehicle at different times of the day and evaluate the results.

V. RESULTS PRELIMINARY

The results obtained evaluating the detection of drowsiness through facial reference points reflect an accuracy of 87%. The algorithm supports face and eye movements in different ways without lowering the qualityof their detection. Figure 5 shows the result of a person therefore, an alarm is activated to wake up the driver.

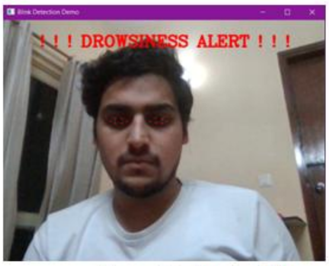

Figure 5. Landmarks of the eye

VI. CONCLUSIONS

The proposal for development of advanced driver assistance system for the drowsiness detection is presented,where the algorithm based on facial reference points constitutes a given reference that supports the movements of the person.

The results of the preliminary tests carried out in various environmental conditions are satisfactory and reflect an accuracy of 87%.

The proposed system will allow detecting when a driver is drowsy, thus reducing the number of traffic accidents.

As future work, the drowsiness detection system will be implemented in a real environment inside a vehicle, in addition, the detection of driver distraction will be implemented in real time.

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