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DETECTION OF EYE BLINK USING DL Techniques

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ABSTRACT:

The execution of monotonous tasks that require high levels of attention is increasingly common due to automation and technological development. When such tasks have critical roles in guaranteeing the safety of work environments – such as in industrial control rooms and airport traffic control towers –, it is essential that operators retain adequate levels of alertness, so that demands for action are fulfilled. This paper presents a model for the detection of drowsiness based on processing video streams of a person's face. Different from intrusive methods based on biological approach Drowsiness detection relies on automatic face detection and evaluation of the Eye Aspect Ratio, which allows monitoring user's alertness state by classification with Support Vector Machine

INTRODUCTION:

In recent times, human reliability has been extensively studied due to the risks imposed by human errors in industrial scenarios and the great potential of loss involved [1]. Specifically, there is a global growing concern with the consequences of performance breakdown by operators in safety-critical task environments, since a distraction or inattention could damage the entire system, including the integrity of the people in it. Despite the increasing automation, the human operator has a critical central role in the execution of these complex tasks. Additionally, high demands in life outside ofwork – as sleep disturbances and stress – present a cumulative challenge that allows humans to both respond effectivelyto new challenges and to reduce engagement with demands whenever stability is threatened by impending fatigue [2]. Operator monitoring can be employed as an attempt to ensure the correct performing of tasks and can be done with theaid computer vision. This computer vision technique aims to extract visual fatigue related characteristics in real-time using image/video processing [3]. Robust object detection is one of the most developed research domains in the field of computer vision and pattern recognition. It has been used in different useful applications in all the possible domains, likesecurity and surveillance, industrial control, robotics, smart objects, semantic search, video-stream analysis, among others [4]. The same concept is also used to track human body (e.g. eye, mouth, arms), recognizing its shape and movement, creating diagnosis and also inferring future human behavior.

RELATED WORKS:

As explained by , there are two major ways to detect blinking and, specifically, detect drowsiness: 1. By biological approaches such as electrooculogram (EOG) (as in ref.), electroencephalogram (EEG) or electrocardiogram (ECG) readings; 2. By image processing and computer vision methods. In this section, a few scientific papers will be presented, mainly related with the second category [5]. depicts an interesting review of the role of computer vision technology appliedto the development of monitoring systems to detect distraction. Authors explain the main methods for face detection, face tracking and detection of facial landmarks, as well as the main algorithms for biomechanical, visual and cognitive distraction [6]. Additionally, there are some algorithms detecting mixed types of distraction and the relationship between facial expressions, key points for the development and implementation of sensors and test and training to driving monitoring systems are summarized. A real-time algorithm to detect eye blinks in a video sequence from a standard

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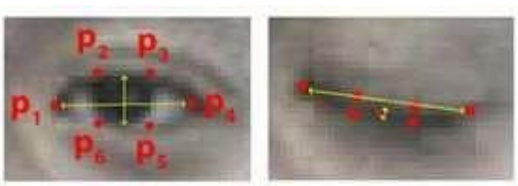
camera is proposed in [7]. They show that recent landmark detectors, trained on in-the-wild datasets, exhibit excellent robustness against a head orientation with respect to a camera, varying illumination and facial expressions, being sufficiently precise to reliably estimate the level of the eye opening. Also, they use a SVM classifier to detect eye blinks as a pattern of EAR values in a short temporal window [8]. In , a blinking detection method is proposed, based on Gabor filters by measuring the distance between the two arcs of the eye. First, the eye is detected by Viola-Jones' method. Next, the Gabor filter extracts the pattern of the eye based on orientation angle. They apply a connected labeling method to detect the two arcs and measure the distance between them compared to a threshold [9].

METHODOLOGY:

This paper methodology is based on three main parts: (1) real-time eye detection, (2) SVM Classification and (3) Drowsiness detection and warnings. Real-time Eye Detection To construct our real-time drowsiness classification model, it is necessary to identify the operator's eye on the image. Based on it, we build a blink detector to recognize every blink and distinguish it from a nap or drowse. Unlike traditional image processing methods for computing blinks, which typically involve some combination of: (1) eye localization, (2) thresholding to find the whites of the eyes, (3) determining if the "white" region of the eyes disappears for a period (indicating a blink), we use a metric called eye aspect ratio (EAR), introduced by . Furthermore, we use a weighted average eye aspect ratio from a neutral face and a smiling face. This procedure is done to capture one's natural EAR and subtle changes when facial expression varies; this will be discussed in The eye detection is performed with facial landmarks. Our goal is to detect important facial structures on the face using shape prediction methods [10]. We use the dlib library for facial landmark detection based on , which uses Histograms of Oriented Gradients and Linear Support Vector Machines in the procedure [11]. The library provides landmarks for the entire face, displayed as light green dots in Fig. 1. The landmarks are adaptive to recognize the shape of distinct human faces.

SVM Classification In this part, only the landmarks related with the eyes are used. First, the proportion between width and height of the eye, based on its landmarks, is calculated [12]. This is called EAR. Fig. 2 depicts the landmarks using inthe procedure.



In order to detect eye blynk two methods of classification were applied, based on the approach proposed by ref. [10]. The first approach is here called threshold model. A threshold was considered so that if the user's EAR becomes lesser than this threshold for a number of frames (e.g. three consecutives frames), a blink is then detected. However, a

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single threshold is not adequate for every user, since each person has his own 'natural EAR' due to his face features [13]. Thus, it was not possible to set a universal threshold, being necessary the calibration for every user. Also, even after calibration, this approach leads to many false positive alerts, once natural expressions such as talking or smiling tended to decrease

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the EAR. A second approach was considered, where the EARs from 15 consecutive frames were concatenated to createa user's state feature. This feature could be classified in three categories: open eye, blink or closed eye (0,1 and 2, respectively). Specifically, the state feature is considered a blink only when the touch of eyelids occurs in the seven central frames of the state feature (i.e. from the 5th to the 11th frame). This procedure was adopted to avoid counting the same blink twice or more when running the detection model. Therefore, the model uses the fifteen-dimension input (15 consecutives EARs) and returns a scalar (state feature) [14].

Support Vector Machine (SVM) was used as the classification learning algorithm, once it presents the advantage that previous knowledge about neither the function behavior nor the relation between input and output are required. The problem could be seen as follows: there exists a mapping function = (), unknown, of real values and, possibly, non-linear between an input vector and an output scalar and the only available information is the data set , called training data. This corresponds to solving a convex and quadratic optimization problem with the Karush-Kuhn-Tucker (KKT) conditions as necessary and sufficient to guarantee a global optimum [15]. The goal is not to look for the perfect alignment between the function () and , but the best representation for the mapping. This mapping will separate each region in the classificationproblem, i.e., delimit whether an input x (state feature) is open eye, blink or closed eye.

Blynk Detection and Warnings

Once predictions provided by SVM were considered satisfactory, real-time monitoring could be achieved. After every 7 new frames received from the video feed (approximately 0.28 seconds), a new state feature was created using the EARs from the latest set of 15 frames available, and SVM classifies this feature in one of the three classes (open eyes, blink, closed eyes). The interesting here is dealing with drowsiness detection. Thus, SVM outputs (i.e. sequence of 0, 1 and 2) are used to determine whether the user is drowsiness or not. Two different situations were considered as drowsiness states: 1. If within a period of 30 seconds, 5 or more outputs are 2 (closed eyes). This situation occurs when the user's eyes close for brief moments, i.e., a slow blink; 2. If 4 or more consecutives outputs (i.e. predictions of SVM) are 2 (closed eyes). This occurs when the user's eyes remain closed for more than a second.

CONCLUSION:

A machine learning-based algorithm to automatically classify the operator state feature was presented. The method used face landmarks to estimate the user's EAR, subsequently applying an optimized-SVM to classify the state feature. Then, a decision rule was adopted to determine whether the user/operator was drowsy or not. The application is physically non-intrusive and could be run alongside other programs in a consumerclass computer without noticeable practical performance impact. Currently, the authors are working with an independent drowsiness basis and applying the proposed methodology to in a real time experiment. AsAcknowledgements The authors thank the Brazilian research funding agencies CNPq and CAPES for the financial support in the form of a graduate scholarship and research grants.

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