

Development of an algorithm to track blinks from a face video

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Aim: Blink characteristics are affected in the short term while patients wear contact lenses [1]. This paper develops an algorithm to study the comfort of patients using contact lenses.

Experimental method: The study was conducted in Matlab. First, the eye was detected using the Viola-Jones Algorithm [2]. Once the picture of the eye was cropped (Figure 1A), an averaging filter was applied to reduce the amount of intensity variation between adjacent pixels. The filter size selected was 1/10 the size of the cropped eye image to remove the noise of the image. In each frame of the video, the mean intensity value in each row of the eye picture was stored (Intensity Vertical Projection Analysis [3]). The darkest rows were, in an open eye frame, at the upper lid located in the upper side of the frame (between 0%-50% of the total vertical image size), but in the closed eye the darkest rows were located in the bottom side of the frame (between 50%-100% of the total vertical image size) (Figure 1B). Frames with the darkest row position higher than 50% were considered part of a complete blink. The threshold for partial blinks was calculated using the cumulative density function of the darkest row of each eye frame in the video, with most of them considered noise (Figure 1C). Partial blink frames were considered to have less than a 5% probability (95% of confidence interval, Figure 1F). Once the blinks were located, the duration was calculated finding the time positions at both sides with values higher than the mean value of the significant darkest row of the video graph plus the standard deviation (Figure 1D).

Results: The number of blinks and the video time when the complete and incomplete blinks were happening are shown in Figure 1C and can be seen in the

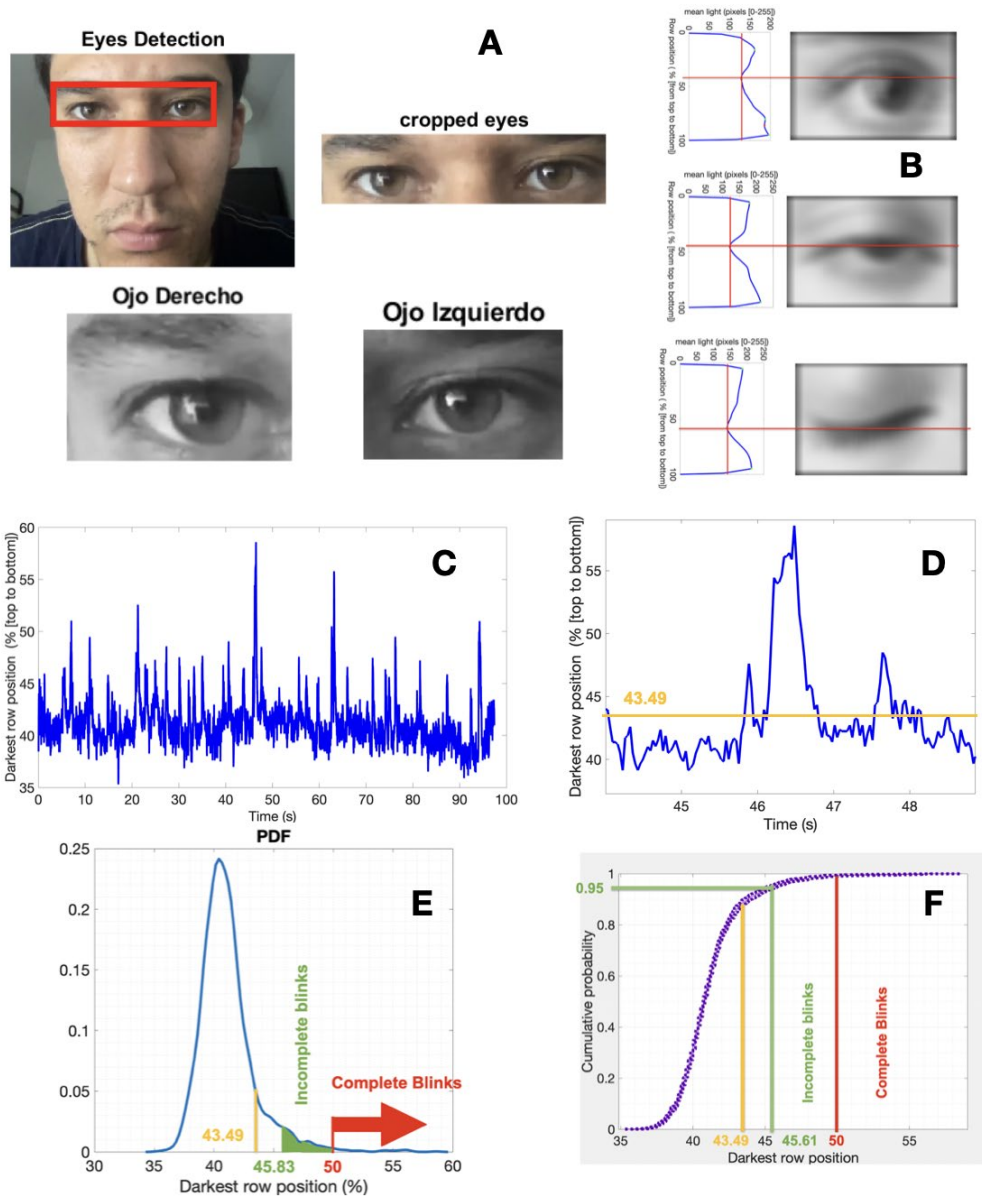


FIGURE 1. **A)** Viola-Jones Algorithm; **B)** Darkest row position; **C)** Darkest row position vs Time; **D)** Zoom in plot C; **E)** PDF of plot C; **F)** CDF of plot C.

position of the significant dark row. The peaks show a partial or complete blink depending on if it is higher than 50%. Figure 1D shows a complete blink, a zoom

of the plot in figure 1C. Figure 1E is the density of the first function. The primary valley shows the most probable position that includes all the frames where the eye is open. The secondary valley peak is due to the partial blinks in the video. In Figure 1F, the cumulative function illustrates the probability of obtaining a certain position on the frame. The result of the example tested for the complete blinks are that the duration of the blink was 0.57 s and its standard deviation was 0.23 s. The interval of the blink was 17.47 ± 11.67 s (mean \pm standard deviation). For the incomplete blinks, the blink duration was 0.29 ± 0.10 s and the blink interval was 4.3 ± 2.75 s. All the results shown were tested on other videos with different lengths and illuminations.

Discussion: The results obtained are a correct tracking of the complete blink, the mean duration and the mean blink interval and standard deviation. The blink interval result is a little bit higher than a normal blink interval due to the activity monitored during the video recording in all cases and the patient's awareness of the characteristics being studied [4]. The algorithm is robust and easy to use. The memory needed to run the program is minimal because only the mean light value of each row of the eye frame is stored (27.8 minutes are needed for a one-minute video). Other applications and programs that tracks the blink are more complex and need more time and more resources to achieve the same goal.

References

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