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Driver Drowsiness Detection Based On Novel Eye Openness Recognition Method Using Image Processing

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Abstract:
In this paper, we proposed a driver drowsiness detection method for which only eyelid movement information was required. The proposed method consists of two major parts. 1) In order to obtain accurate eye openness estimation, a vision based eye openness recognition method was proposed to obtain an regression model that directly gave degree of eye openness from a low-resolution eye image without complex geometry modeling, which is efficient and robust to degraded image quality. 2) A novel feature extraction method based on unsupervised learning was also proposed to reveal hidden pattern from eyelid movements as well as reduce the feature dimension. To develop such a system we need to install some hardware components like camera inside the vehicle, which can capture the image of the driver at a fixed interval, and an alarm system, which will alert the driver after detecting his/her level of drowsiness and in the next level it will stop the vehicle automatically. Now apart from these hardware components, we need a software part also, which can detect the level of drowsiness of the driver and is the main concern of our paper. In this paper, we develop a drowsiness detection system that will accurately monitor the open or closed state of the driver's eyes in real-time. The proposed method was evaluated and shown good performance.

Keywords: Image, Pixel, Image resolution, Image processing, Image restoration, sampling, Image coding.

1. Introduction

Driver drowsiness is one of the biggest safety issues facing the road transport industry today and the most dangerous aspect of driver fatigue is falling asleep at the wheel. Fatigue leads to sleep, it reduces reaction time (a critical element of safe driving). It also reduces vigilance, alertness and concentration so that the ability to perform attention-based activities (such as driving) is impaired. The speed at which information is processed is also reduced by sleepiness. The quality of decision-making may also be affected [1-3].

Driver falls in micro sleep, results in collision with object or vehicle, or they cannot recognize that he or she has drifted into a wrong lane. The consequences of a drowsy driver are very dangerous and lead to loss of lives, casualties and vehicle damage. As the most important safety factor, it is necessary to make some serious measures, in order to improve working conditions of drivers [4-10].

so that negative consequences subjected by a drowsy driver can be minimized. Computer Science and Engineering contributes their responsible role for development and betterment of society by providing their valuable services in various fields belong to different aspects of life. Driver drowsiness detection system is such an example that can be used as a security measure that alerts the drowsy driver while driving, in order to safeguard himself as well as others [11-15].

A few systems already had been created, in light of recording of head developments, movement of steering wheel, heart rate variability or grip quality.

Systems that utilize a camera for the tracking of eye movements have already been created. In any case, so far no framework has turned out to be adequately reliable. Previous method relies on the LED's and multiple cameras to estimates the facial expressions however moving vehicle introduces new difficulties like variable lighting and running backgrounds. This paper presents a solution for minimizing the road accident caused by the drowsiness of driver by alerting through a single camera placed on the dash board of vehicle. Smart vehicle vendors have developed this technology by applying different techniques.

The algorithm of eye detection system integrated with hardware to develop the smart vehicles, which can implement nationwide to avoid the road accidents. Microcontroller and camera are used to make and intelligent hardware and software integrated system. The purpose of this study is to build up a model of Drowsiness Detection System. The system will precisely check in real time, the open or close condition of the eyes of driver. By checking the driver's eyes, the indications of driver drowsiness can be identified in the beginning to protect from vehicle accident [15-19].

In this paper we proposed a driver drowsiness alert system. It is non-intrusive system for monitoring driver drowsiness based on open and close conditions of eyes. Eye behaviour provide significant information about driver’s alertness and that if visual behaviour can be measured then it will be feasible to predict driver’s state of drowsiness, vigilance or attentiveness. The power electronic converters and renewable eneegy systems are discussed in [20-67].

2. Image

An image is an array or a matrix of square pixels arranged in columns and rows. An image is an artifact, for example a two-dimensional picture that has a similar appearance to some subject usually a physical object or a person.

2.1. Characteristics

Images may be two-dimensional, such as a photograph, screen display, and as well as a three-dimensional, such as a statue or hologram. They may be captured by optical devices such as cameras, mirrors, lenses, telescopes, microscopes, etc. and natural objects and phenomena, such as the human eye or water surfaces. The word image is also used in the broader sense of any two-dimensional figure such as a map, a graph, a pie chart, an abstract painting. In this wider sense, images can also be rendered manually, such as by drawing, painting, carving, rendered automatically by printing or computer graphics technology, or developed by a combination of methods, especially in a pseudo-photograph.

2.2. Volatile image

A volatile image is that exists only for a short period of time. This may be a reflection of an object by a mirror, a projection of a camera, a scene displayed on a cathode ray tube.

2.3. A fixed image

A fixed image, also called a hard copy, is that has been recorded on a material object, such as paper , textile by photography & digital processes.

2.4. Mental image

A exists in an individual's mind something one remembers or imagines. The subject of an image need not be real. it may be an abstract concept, such as a graph, function, & imaginary entity. For example, Sigmund Freud claimed to have dreamed purely in aural-images of dialogs. The development of synthetic acoustic technologies and the creation of sound art have led to a consideration of the possibilities of a sound-image made up of irreducible phonic substance beyond linguistic or musicological analysis.

2.5 Still image

A still image is a single static image, as distinguished from a kinetic image. This phrase is used in photography, visual media and the computer industry to emphasize that one is not talking about movies, in very precise, pedantic technical writing such as a standard. A film still is a photograph taken on the set of a movie or television program during production, used for promotional purposes.

2.6. Moving image

A moving image is typically a movie, video including digital video. It could also be an animated display such as a zoetrope.

3. Pixel

Image processing is a subset of the electronic domain where in the image is converted to an array of small integers called pixels, representing a physical quantity such as scene radiance, stored in a digital memory and processed by computer or other digital hardware. For the moment, lets make things easy and suppose the photo is black and white. that is lots of shades of grey, so no colour. We may consider this image as being a two dimensional function, where the function values give the brightness of the image at any given point.

We may assume that in such an image brightness values can be any real numbers in the range 0.0 (black) to 1.0 (white). The ranges of x and y will clearly depend on the image, but they can take all real values between their minima and maxima.

A digital image differs from a photo in that the x, y, and f(x,y)values are all discrete. Usually they take on only integer values, so the image shown in figure 1.2 will have x and y ranging from 1 to 256 each, and the brightness values also ranging from 0 (black) to 255 (white).

A digital image can be considered as a large array of discrete dots, each of which has a brightness associated with it. These dots are called picture elements or pixels.

The pixels surrounding a given pixel constitute its neighbourhood. A neighbourhood can be characterized by its shape in the same way as a matrix. we can speak of a 3*3 neighbourhood,of a 5*7 neighbourhood it may be necessary to specify which pixel in the neighbourhood is the current pixel.

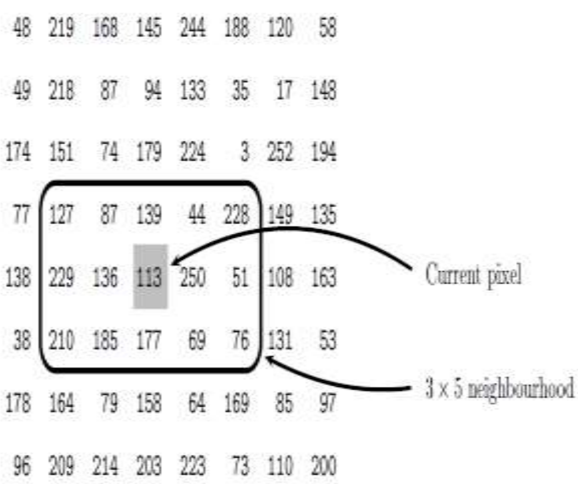


Figure3.1 Pixel representation

4. Image Resolution

Resolution is the definition of the number of pixels per square inch on a computer. Resolution allows you to transform pixels into inches and back again. Two resolution definitions are often used in place of one another. Pixel resolution is the size in bytes of your image or its appearance on a computer screen. This number is tied directly to how big your image is on your hard drive. The byte-size of the image file is directly proportional to the pixel count and its size on your computer screen, which simply displays all the pixels in a fixed one-to-one grid.

Embedded resolution is different. Embedded resolution tells your printer how far apart to spread the pixels in a printed image. It is completely independent of the pixel count ,file size of the image. A high pixel count image can have a low embedded resolution . Given the same pixel count, a high embedded resolution will result in a smaller printed image the pixels are packed together more tightly. And a low embedded resolution will result in a larger image the pixels are more spread out.

4.1 IMAGE BRIGHTNESS

An image must have the proper brightness and contrast for easy viewing. brightness refers to the overall lightning or darkness of the image.Image brigtness is a measure of intensity after the image has been acquired with a digital camera or digitized by an analog to digital converters.

Luminance is the measurement of the amount of light emitting ,passing through or reflected from a particular surface from a solid angle. It also indicates how much luminous power can be perceived by the human eye. This means that luminance indicates the brightness of light emitted or reflacted off of a surface .

In the display industry luminance is used to quantify the brightness of displays.Illuminance is the amount of light falling onto and spreading over a given surface area. Illuminance also correlates with how humans perceive the brightness of an illuminated area.

4.2 Contrast

Contrast refers to the difference between black and white levels in images, whether on a flat panel display or a projection screen. Without good contrast, images appear to lack brightness, colour and definition.

The image contrast ratio refers to the difference between the luminance of the white part of an image, divided by the black part. So if the white part is one hundred times brighter than the black part, it will be 100:1, and so on.

5. Enhancement

Image enhancement is the improvement of digital image quality without knowledge about the source of degradation. If the source of degradation is known, one calls the process image restoration.

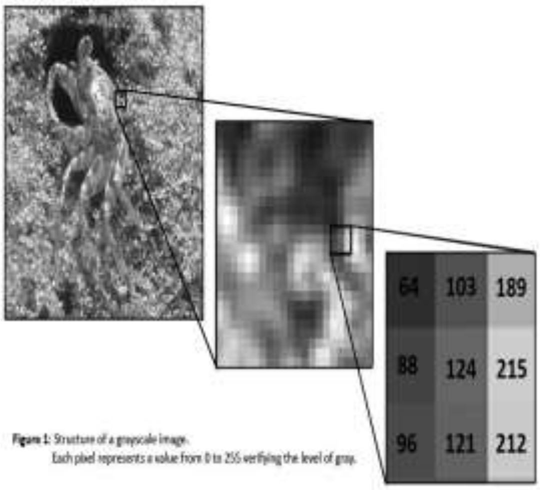


Figure 5.1 Structure of grey-scale image. in each pixel represents a value from 0 to 255 verifying the level of gray.

Many different, often elementary and heuristic methods are used to improve images in some sense. The problem is, of course, not well defined, as there is no objective measure for image quality. Here, we discuss a few recipes that have shown to be useful both for the human observer and/or for machine recognition. These methods are very problem-oriented: a method that works fine in one case may be completely inadequate for another problem.

The example in figure operates on 256 grey-scale images. This means that each pixel in the image is stored as a number between 0 to 255, where 0 represents a black pixel, 255 represents a white pixel and values in-between represent shades of grey.

These operations can be extended to colour images too

Examples of simple grey level transformations in this domain are:

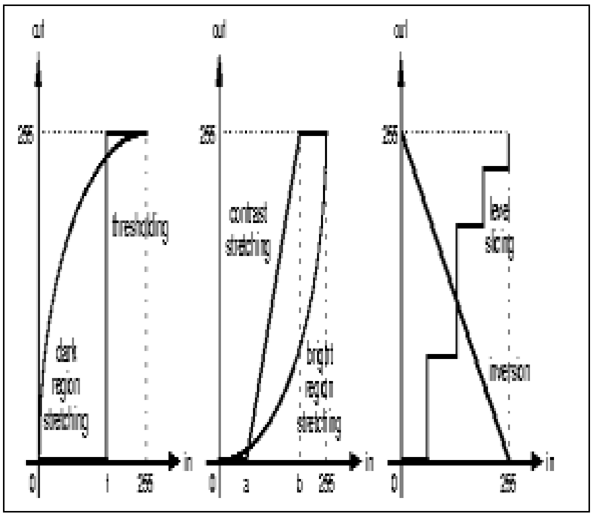


Figure 5.2: The grey value histogram

Grey values can also be modified such that their histogram has any desired shape, e.gflat (every grey value has the same probability). All examples assume *point processing*, viz. each output pixel is the function of one input pixel usually, the transformation is implemented with a look-up table:

(a) (b)

Figure 5.3 Image enhancement (a) original image (b) enhanced image

Physiological experiments have shown that very small changes in luminance are recognized by the human visual system in regions of continuous grey value, and not at all seen in regions of some discontinuities. A second design goal, therefore, is image sharpening. All these operations need neighbourhood processing, viz. the output pixel is a function of some neighbourhood of the input pixels:

Here is a trick that can speed up operations substantially, and serves as an example for both point and neighbourhood processing in a binary image: we number the pixels in a 3x3 neighbourhood like:

5. Image Compression

Compressing an image is significantly different than compressing raw binary data. Of course, general purpose compression programs can be used to compress images, but the result is less than optimal. This is because images have certain statistical properties which can be exploited by encoders specifically designed for them. Also, some of the finer details in the image can be sacrificed for the sake of saving a little more bandwidth or storage space. The objective of image compression is to reduce irrelevance and redundancy of the image data in order to be able to store or transmit data in an efficient form.

Lossy And Lossless Compression

Image compression may be lossy or lossless. Lossless compression involves with compressing data which decompressed, will be an exact replica of the original data. This is the case when binary data such as executables, documents etc. are compressed. They need to be exactly reproduced when decompressed. On the other hand, images and music too need not be reproduced exactly. An approximation of the original image is enough for most purposes, as long as the error between the original and the compressed image is tolerable.

230	229	232	234	235	232	148
237	236	236	234	233	234	152
255	255	255	251	230	236	161
99	90	67	37	94	247	130
222	152	255	129	129	246	132
154	199	255	150	189	241	147
216	132	162	163	170	239	122

In a (8-bit) greyscale image each picture element has an assigned intensity that ranges from 0 to 255.

6.2 Methods for lossy compression

Reducing the color space to the most common colors in the image. The selected colors are specified in the color palette in the header of the compressed image. Each pixel just references the index of a color in the color palette. This method can be combined with dithering to avoid posterization.

Transform coding. This is the most commonly used method. A Fourier-related transform such as DCT or the wavelet transform are applied, followed by quantization and entropy coding.

A grey scale image is what people normally call a black and white image, but the name emphasizes that such an image will also include many shades of grey.

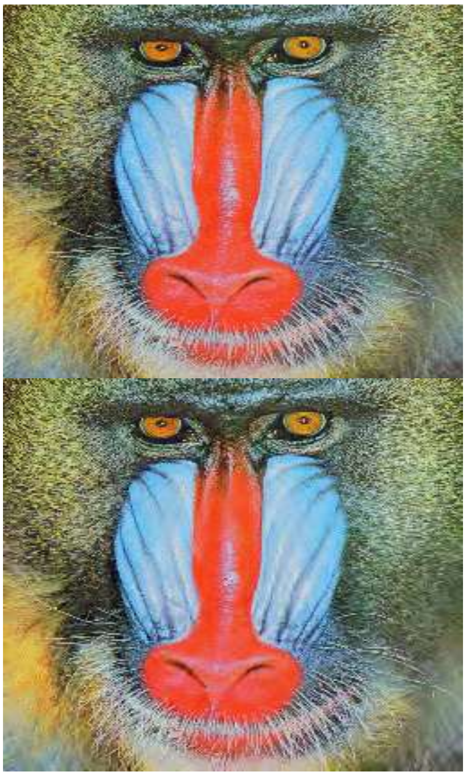


Figure 6.1 Image compression(a) original image (b) compressed image

The best image quality at a given bit-rate is the main goal of image compression, however, there are other important properties of image compression schemes:

6.3 Scalability

Scalability generally refers to a quality reduction achieved by manipulation of the bit stream or file without decompression and re-compression. Other names for scalability are progressive coding or embedded bit streams. Despite its contrary nature, scalability also may be found in lossless codes, usually in form of coarse-to-fine pixel scans. Scalability is especially useful for previewing images while downloading them (e.g., in a web browser) or for providing variable quality access to e.g., databases.

6.4 There are several types of scalability:

Quality progressive or layer progressive: The bit stream successively refines the reconstructed image.

Resolution progressive: First encode a lower image resolution; then encode the difference to higher resolutions

Component progressive: First encode grey; then color.

6.5 Region of interest coding. Certain parts of the image are encoded with higher quality than others. This may be combined with scalability encode these parts first, others later.

6.7 Meta information. Compressed data may contain information about the image which may be used to categorize, search, or browse images. Such information may include colour and texture statistics, small preview images, and author or copyright information.

6.8 Processing power. Compression algorithms require different amounts of processing power to encode and decode. Some high compression algorithms require high processing power.

The quality of a compression method often is measured by the Peak signal-to-noise ratio. It measures the amount of noise introduced through a lossy compression of the image, however, the subjective judgment of the viewer also is regarded as an important measure, perhaps, being the most important measure.

6.9 Error Metrics

Two of the error metrics used to compare the various image compression techniques are the Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR). The MSE is the cumulative squared error between the compressed and the original image, whereas PSNR is a measure of the peak error. The mathematical formulae for the two are

$$MSE = \frac{1}{MN}\sum_{y=1}^{M}\sum_{x=1}^{N}\left[I(x,y) - I'(x,y)\right]^2$$

$$PSNR = 20 * \log10\,(255 / \mathrm{sqrt}(MSE))$$

where I(x,y) is the original image, I'(x,y) is the approximated version (which is actually the decompressed image) and M,N are the dimensions of the images.

A lower value for MSE means lesser error, and as seen from the inverse relation between the MSE and PSNR, this translates to a high value of PSNR. Logically, a higher value of PSNR is good because it means that the ratio of Signal to Noise is higher. Here, the 'signal' is the original image, and the 'noise' is the error in reconstruction. So, if you find a compression scheme having a lower MSE (and a high PSNR), you can recognise that it is a better one.

7. Image Restoration

The purpose of image restoration is to "compensate for" or "undo" defects which degrade an image. Degradation comes in many forms such as motion blur, noise, and camera misfocus. In cases like motion blur, it is possible to come up with an very good estimate of the actual blurring function and "undo" the blur to restore the original image.

In cases where the image is corrupted by noise, the best we may hope to do is to compensate for the degradation it caused. In this project, we will introduce and implement several of the methods used in the image processing world to restore images.

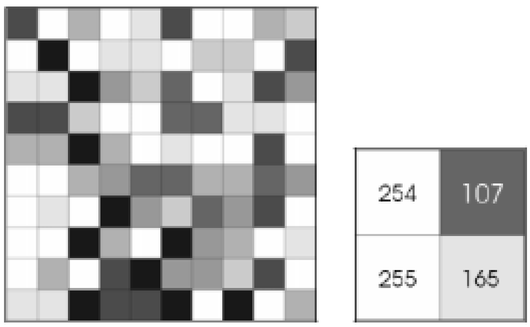


Figure 7.1 Different shades of grey

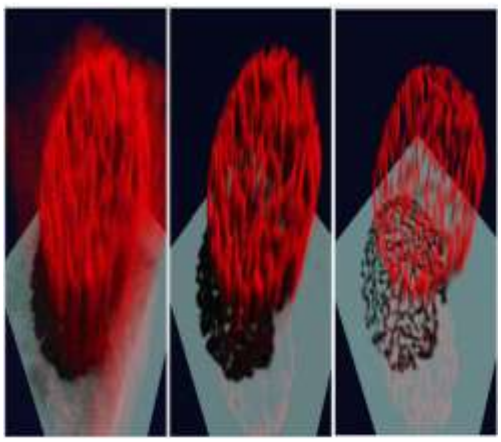


Figure 7.2 Image restoration:original image, partially restored image, fully restored image

8. Image Measurement Extraction

The example below demonstrates how one could go about extracting measurements from an image. The image at the top left of shows some objects. The aim is to extract information about the distribution of the sizes (visible areas) of the objects. The first step involves segmenting the image to separate the objects of interest from the background. This usually involves thresholding the image, which is done by setting the values of pixels above a certain threshold value to white, and all the others to black. Because the objects touch, thresholding at a level which includes the full surface of all the objects does not show separate objects. This problem is solved by performing a watershed separation on the image

A normal greyscale image has 8 bit colour depth = 256 greyscales

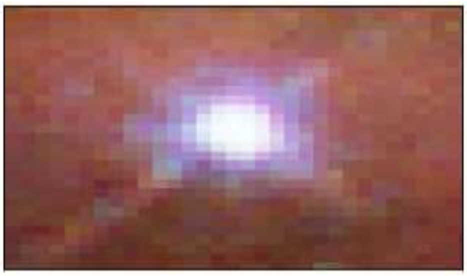
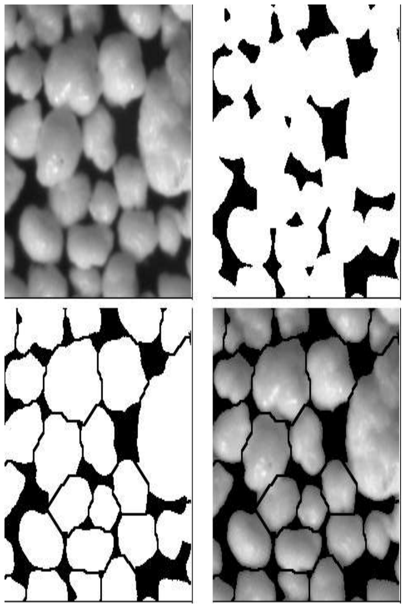
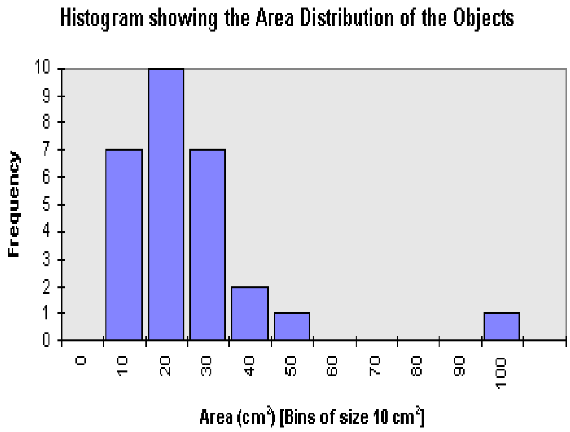


Figure 8.1 Colour image

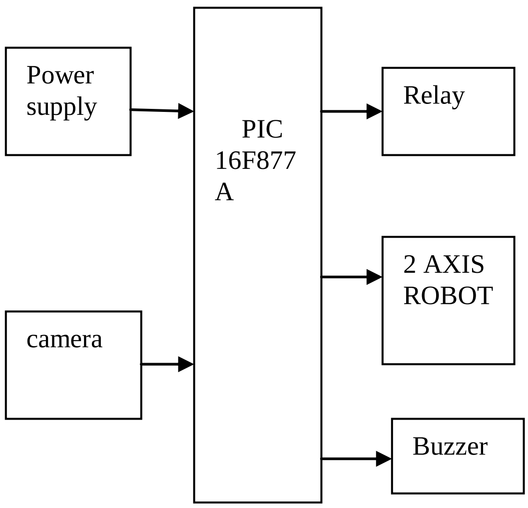
A "true colour" image has 24 bit colour depth = 8 x 8 x 8 bits = 256 x 256 x 256 colours = ~16 million colours.

The image at the lower right of figure shows the result of performing a logical AND of the two images at the left of Figure. This shows the effect that the watershed separation has on touching objects in the original image.





9. Working Principles



In this project, driver's eye drowsiness is detected and alert the driver, also stop the vehicle automatically if the driver does not give response to the alert. For this, the camera is fixed on the vehicle that focuses straight towards the face of driver and checks the driver eyes with a specific end goal to recognize drowsiness using Matlab. A buzzer is issued to caution the driver, in such situation when drowsiness is recognized. If a driver does not give response to the buzzer means then the controller will stop the vehicle. For this pic microcontroller is used.

10. Simulation Output

11. Conclusion

Eye Drowsiness Detection was built to help a driver stay awake while driving in order to reduce car accidents caused by drowsiness. During the experiment the system has the capacity to choose whether the driver's eyes are opened or closed. At the point when the eyes are close for a really long time, warnings sign i.e. buzzer is issued to driver and also stop the vehicle if the driver does not response the buzzer. Also, throughout observation, the framework has the capacity suddenly identify any eye confining error that may have happened. If there should arise an occurrence of this kind of error, the system has the capacity to recover and accurately localize the person eyes. Image processing accomplishes greatly precise and trustworthy finding of sleepiness, a drowsiness detection system which judges the alertness level of driver on the basis of nonstop eye closures. The proposed system can be used for driver’s safety and its consequences.

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