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# The 2nd Universitas Lampung International Conference on Science, Technology, and Environment (ULICoSTE) 2021

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**Editors** • Lusmeilia Afriani, Rudy, Ryzal Perdana, Gede Eka Putrawan and Trio Yuda Septiawan

2021
2nd ULICoSTE
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# Preface: The 2nd Universitas Lampung International Conference on Science, Technology, and Environment (ULICoSTE) 2021

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# PREFACE

The Institute for Research and Community Services of Universitas Lampung was honored to host the Second Universitas Lampung International Conference on Science, Technology, and Environment (ULICoSTE) 2021. As a result of the COVID-19 pandemic, we were dealing with a paradigm of entirely online-organized event utilising Zoom.

As the world moves toward digitalization, where technology reigns supreme, this conference is dedicated to fostering synergy in science and technology through collaborative research for digital transformation. Additionally, the pandemic has compelled us to embrace digital technology. As a result, today's digital transformation involves collaboration across numerous stakeholders via diverse research and innovation efforts. Thus, the 2nd ULICoSTE 2021 Conference served as an opportunity to explore a variety of topics linked to our Conference theme, "Promoting Synergy through Collaborative Research in Science, Environment, and Technology for Digital Transformation."

The 2nd ULICoSTE 2021 conference promised to be both stimulating and informative, with a stellar line-up of keynote speakers from Murdoch University (Australia), Universitas Lampung (Indonesia), Universiti Teknologi MARA (Malaysia), and National Taiwan Normal University (Taiwan). The conference aimed to foster relationships and exchange theoretical and practical ideas and knowledge among those interested in collaborative interdisciplinary research in the areas of sustainable development, environmental science, remote sensing and GIS, climate change, renewable energy, and other related areas. This conference featured invited sessions and panel discussions with prominent speakers on a variety of scientific and technological research issues. All presenters and participants were able to meet and engage with one another online throughout the interactive sessions.

The current issue of AIP Conference Proceedings consists of 81 articles that represent a selection of the contributions presented at the 2nd ULICoSTE 2021. The papers cover a range of topics related to the conference's theme. We consider it an honour to provide the most recent scientific knowledge and advancements in the world of science and technology. Additionally, we believe that these proceedings will serve as a valuable reference book for researchers worldwide.

The conference is the culmination of the efforts of numerous individuals. As such, we would like to extend our gratitude to the members of the organizing committee for their efforts in ensuring the conference's success on a daily basis and to the reviewers for their hard work in reviewing submissions. Additionally, we appreciate the four invited keynote speakers for sharing their perspectives and knowledge with us. Finally, the conference would not be possible without the excellent papers contributed by authors. We would like to express our gratitude to all authors for their contributions and participation in the 2nd ULICoSTE 2021.

We look forward to seeing you next year at the 3rd ULICoSTE 2022.

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# Committees: The 2nd Universitas Lampung International Conference on Science, Technology, and Environment (ULICoSTE) 2021

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# Drowsiness detection of the cars driver using the Raspberry Pi based on image processing

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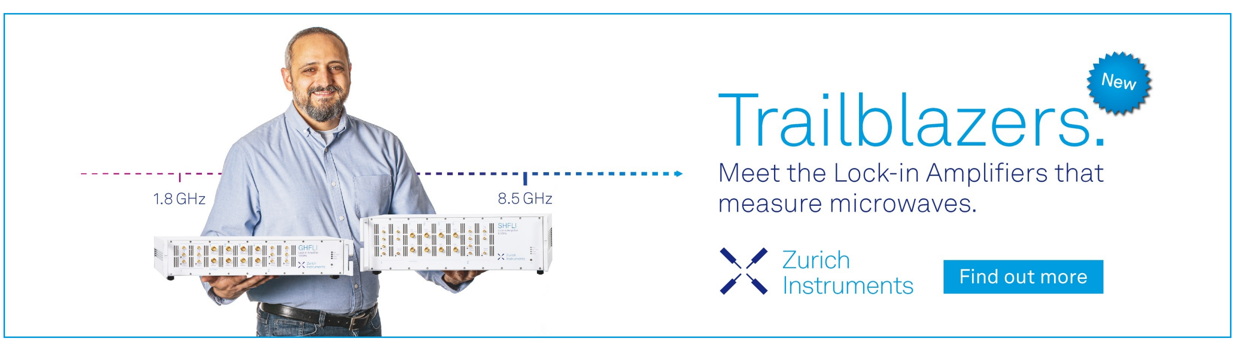

# Drowsiness Detection of the Cars Driver Using the Raspberry Pi Based on Image Processing

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**Abstract.** Drowsiness while driving is one of the biggest factors causing traffic accidents. To prevent this, it is necessary to make an automatic system that can detect the drowsiness of vehicle drivers. In this research, the driver's face and eye positions were detected using a camera and processed using a Raspberry Pi. The position of the face and eyes was obtained using the Viola Jones method and then continued with determining the condition of the driver's eyes. The number of frames processed per second is set to 5 frames, so as not to burden the computation. The research was conducted on the object of the driver with glasses and without glasses by placing the camera at a distance of 20 to 80 cm from the driver. The study was conducted indoors and in the car cabin with lighting intensity between 0 to 100 Lux. In this study, eye position detection reached 100% at an illumination intensity of 20 to 100 Lux with a camera distance of 20 to 80 cm for drivers without glasses and an illumination intensity from 20 to 60 for drivers with glasses. Drowsiness condition is determined if three consecutive frames are detected when the eyes are closed.

## INTRODUCTION

Definition of drowsiness, in general, is a condition when a person feels like sleeping. Usually, this is due to lack of sleep or fatigue, but it can also be caused by other things. Other causes include medical disorders, psychiatric disorders, psychological disorders, and metabolic disorders. This drowsiness if it occurs at the wrong time will be very dangerous for example driving a vehicle.

Drowsiness occurs in the driver's usually because of the condition of the driver's stress, drugs taken, and lack of sleep [1]. The drowsiness, felt by the driver of the vehicle is one of the causes of accidents. According to previous research, 25 percent of the causes of serious traffic accidents are drowsy drivers. Drivers who drive long distances are at high risk of experiencing drowsiness if they do not rest regularly [2]. This drowsiness causes the driver to lose concentration on the environment around his vehicle and lose control of his consciousness. Therefore, prevention is necessary by detecting drowsiness experienced by drivers early on.

This study proposes an early detection of drowsiness and provides a warning in the form of sound by a buzzer to the driver. This study proposes a method of detecting the face and eye condition of a driver using the Viola Jones method and determining drowsiness conditions based on the duration of the blinking of the driver's eyes. Based on the duration of the blink, eye conditions can be divided into 3 types, namely; below 400 ms in normal conditions, between 400 - 800 ms in drowsiness conditions, and above 800 ms in sleep conditions [3]. The Viola Jones detection method is a detection method that has a detection speed process about 0.067 seconds and an accuracy rate of 93.7% [4]. This

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method has a fairly fast processing speed, so this method can be applied for real time processing, besides that this method is quite accurate in recognizing the position of the face, eyes, nose, and mouth [5,6].

Preliminary research before research on the detection of drowsiness has been done. Research on face detection, challenges in face detection, applications, and techniques have been carried out previously [7]. Research on eye detection in color images has also been done previously [8]. This study is based on detecting skin areas by modeling skin color to provide candidate's faces. Previous studies have stated that the accuracy of detecting sleepiness is more influenced by the level of light intensity than camera resolution [9]. The other studies have been conducted using artificial intelligence and computer vision to perform face tracking, eye detection, and eye tracking at different light intensities, light intensity disturbances, background changes, and vibrations [10].

This study proposes the use of a Raspberry Pi as a data processor and controller, a Raspberry Pi camera V1.3 as a visual sensor, and an active 5V buzzer as an alarm to warn the driver in the form of sound if drowsiness occurs. To reduce the computational load, in 1 second only 5 frames are processed to determine the driver's eye condition. In addition, it was also tested on drivers with glasses and not, different light intensities, and varying face angles.

## METHOD

In this study, a visual sensor in the form of a camera is used to capture the image of the driver. The captured image is processed using a Raspberry Pi to determine the face position, eye position, and eye condition of the driver. If drowsiness is detected, the alarm will sound as a warning to the driver. The block diagram of the sleep detection system in this study is shown in Figure 1.

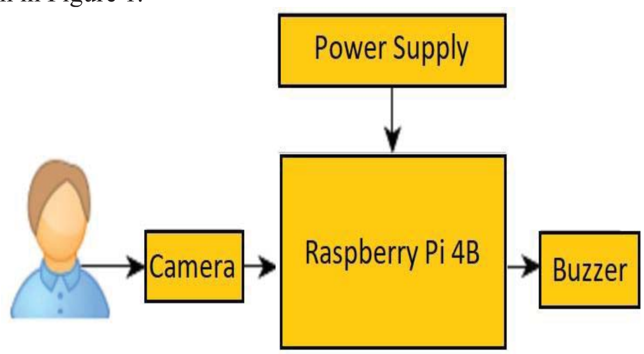


**FIGURE 1.** Block diagram of the drowsiness detection system.

From Figure 1, it can be seen that the Raspberry Pi takes the video obtained from the camera and converts it into frames in the form of images that will be processed for each image to determine the driver's eye condition. If the eye condition is detected closing on several consecutive frames and meets the drowsy condition, the alarm will sound. In this study, to reduce the computational load, the number of video frames processed is only 5 frames per second. It is known that drowsiness is determined if the eyes are closed for 400-800 ms. Using equation (1) it is found that it is said to be in a drowsy condition if in 3 consecutive frames the eyes are closed.

$$1\,frame = \frac{1000ms}{v} \tag{1}$$

Where v is the frame rate (in this study 5 frames per second).

### Preprocessing

The drowsiness detection algorithm in this study is shown through the flow chart in Figure 2. After converting the video into frames (image), preprocessing is carried out in the form of changing the color image to grayscale Converting a color image to a grayscale image using equation (2).

$$f_n(x,y) = 0,2989 f_o^R(x,y) + 0,5870 f_o^G(x,y) + 0,1141 f_o^B(x,y) \tag{2}$$

Where $f_n(x,y)$ is the degree of gray *n* at the point (*x,y*) and $f_o^R(x,y)$ is the value of the red color component at the gray degree *o* at the point (*x,y*), $f_o^G(x,y)$ is the value of the green color component at the gray degree *o* at the point (*x,y*), and $f_o^B(x,y)$ is the value of the blue color component at the degree of gray *o* at the point (*x,y*).

After the image becomes grayscale, image processing is carried out to improve image quality using histogram equalization. The purpose of histogram equalization is to improve the accuracy of face recognition by the haar cascade function. The results of converting the color image to grayscale and the histogram equalization process are shown in Figure 3.

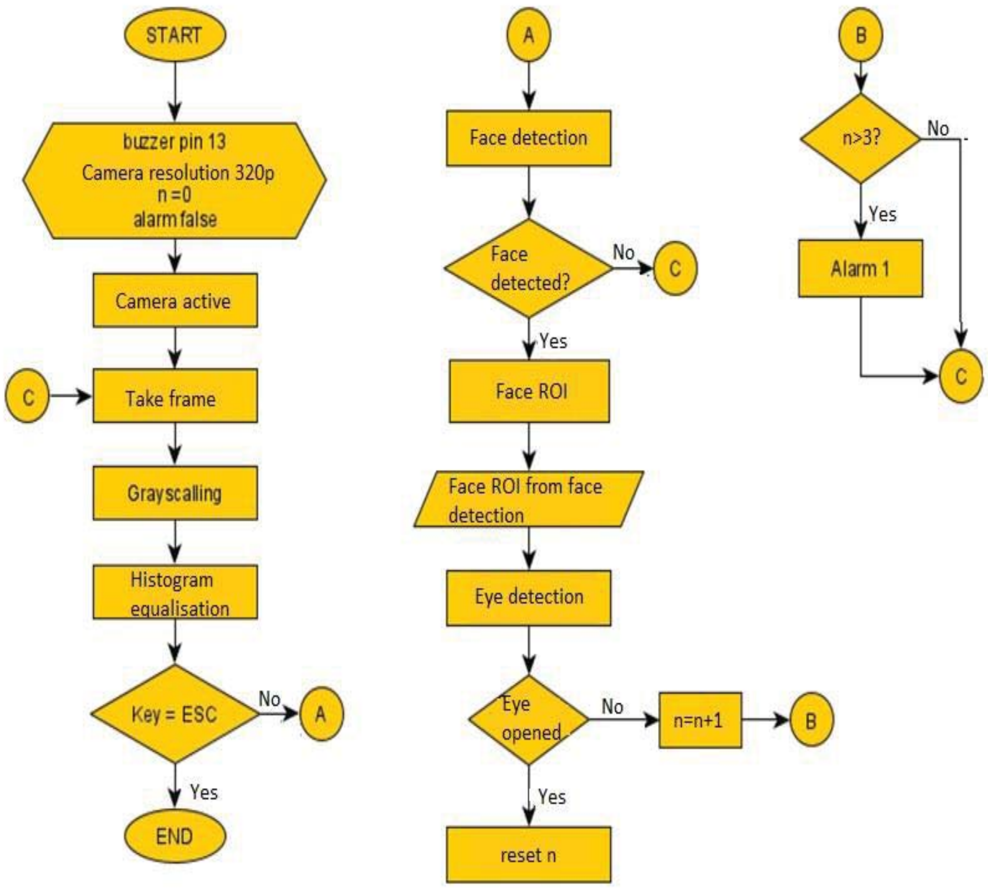


**FIGURE 2.** Flowchart of the system.

**FIGURE 3.** An example of an image frame captured by a camera. (a) Color image, (b) Grayscale image, and (c) Histogram equalization image.

## Viola Jones Method

The Viola-Jones method is an object detection method that has a fairly high level of accuracy. This method detects facial targets by classifying objects in the image based on some simple feature or feature values. In this method, 4 main keys, namely Haar Like Feature, Integral Image, Adaboost learning, and Cascade classifier are combined to obtain the best detection [4]. The sequence of the face detection process using the Viola-Jones method is shown in Figure 4.

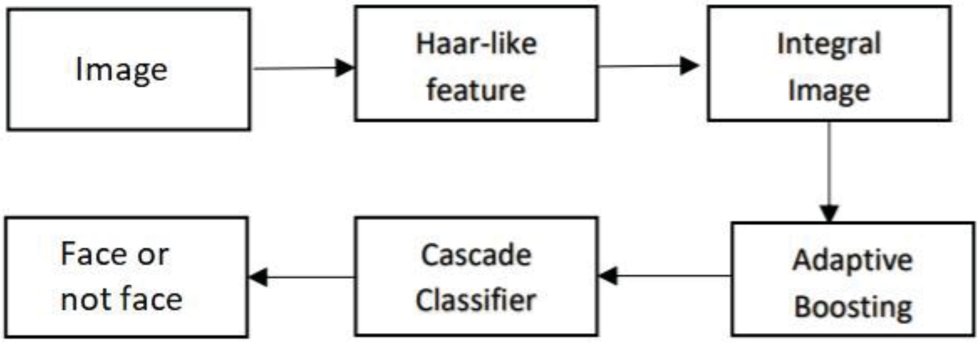


**FIGURE 4.** Schematic of the Face Detection Process using the Viola-Jones method.

Haar-like features are digital image features used in object recognition in digital image processing. The principle of Haar-like features is to recognize objects based on the difference value of the number of pixels from the area in the rectangle of the feature but not the pixel value of the object's image (equation (3)). The advantage of this method is that the computation is very fast. This is because it only depends on the number of pixels in a square not every pixel value of an image. Figure 5 is an example of a Haar Like Feature rectangular image.

$$F\left(Haar\right) = \sum F_{White} - \sum F_{Black} \tag{3}$$

Where $F(Haar)$ is total feature value, $\sum F_{White}$ is feature values in bright areas, and $\sum F_{Black}$ is feature values in dark areas. Integral Image is a technique to quickly calculate feature values by changing the value of each pixel into a new image representation, as shown in FIGURE 6. If the integral image value of point 1 is A, point 2 is A+B, point 3 is A+C, and point 4 is A+B+C+D, then the number of pixels in area D can be determined by 4+1– (2+3).

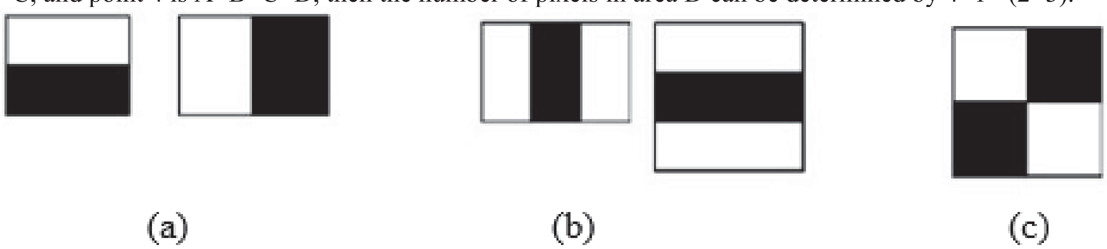


**FIGURE 5.** Haar feature example. (a) Edge features, (b) Line features, and (c) Four Rectangle features.

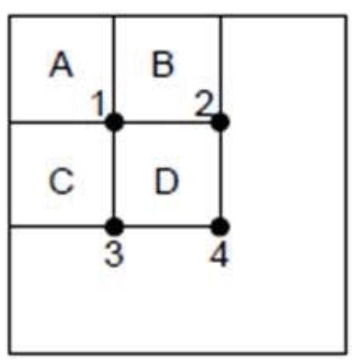


**FIGURE 6.** Ilustration of Integral Image

An Adaboost learning algorithm, is used to improve classification performance with simple learning to combine many weak classifiers into one strong classifier. The weak classifier is a correct answer with an inaccurate level of truth [4]. A strong classifier is expressed by equation (4).

$$f\left(x\right) = \sum_{t=0}^{T} \alpha_t h_t\left(x\right) \quad (4)$$

Where $f(x)$ is the strong classification, $\alpha_t$ is the adaboost weight value, and $h_t(x)$ is the result of the weak classification. Cascade classifier is a combination of all the powerful classifications that have been obtained with Adaboost efficiently in a cascade system.

## Eye Detection Process

When the detected object in the image is a face object, it is marked with a square function that serves to focus the detected area called ROI (Region of Interest). After the ROI image of the face is obtained, it continued with the eye Haar Cascade process to determine the position of the eye on the face image. The sequence of the eye detection process using the Viola Jones method from face detection, making face ROI, and eye position detection is shown in Figure 7. If the object is not detected or detected but gives a notification (when checking) with eyes closed, then the value of n is changed to n=n+1 for each frame. If these conditions occur consecutively without any changes occurring in 3 frames, the alarm will activate indicating the driver is in a drowsy state. However, if the eye is detected and gives an open eye notification, the value of n is reset back to its initial value of 0.

**FIGURE 7.** The eye detection process using the Viola Jones method.

To execute a Haar Cascade algorithm, we need training data that serves as a reference for Haar Cascade to detect the object. This study uses training data that have been provided by OpenCV. The training data used each contain 5000 positive samples and 5000 negative samples [11].

## RESULT AND DISCUSSION

Retrieval of image data in this study conducted at two different locations. First, the data was taken at an indoor location, and second, the data was taken on location in the actual conditions, ie in the car cabin. The light intensity at both locations was set between 0 to 100 Lux. Similarly, the slope of the position of the driver's face is also set on the normal conditions (0°) to 30°. This study also tested the effect of video resolution at program execution time. The distance of the camera placement in the driver's face is also tested to get the most appropriate distance in placing the camera. This drowsiness detector was also tested on drivers without glasses and drivers with glasses. The effect of light intensity on the success of detecting drowsiness is shown in Table 1.

**TABLE 1.** The Success of Detecting Drowsiness is Based on Changes In Light Intensity.

| No | Drivers | Light intensity (Lux) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 1. | Not wearing Glasses | N | N | D | D | D | D | D | D | D | D | N |
| 2. | Wearing Glasses | N | N | D | D | D | D | D | N | N | N | N |

Where N is not detected and D is detected. From Table 1, it can be seen that the best intensity for drivers with glasses and without glasses is between 20-60 Lux. The intensity of the bright light causes the reflection of light on the glasses so that the drowsiness detector cannot determine the position of the eyes and the condition of the eyes. Table 2 shows the effect of the driver's face tilt on the success of detecting drowsiness. The maximum facial tilt that can be recognized for their eye condition for both those with glasses and those without is between 0° and 20°. The tilt angle of the face for drivers without glasses is not a problem, but for drivers with glasses, it is a problem because the eye position can be covered by the glasses frame. How to determine the tilt of the driver's face is shown in Figure 8.

**TABLE 2.** The Effect of Face Tilt on the Success of Drowsiness Detection.

| No. | Drivers | Head Tilt | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0° | 5° | 10° | 15° | 20° | 25° | 30° |
| 1. | Not wearing Glasses | D | D | D | D | D | D | D |
| 2. | Wearing Glasses | D | D | D | D | D | N | N |

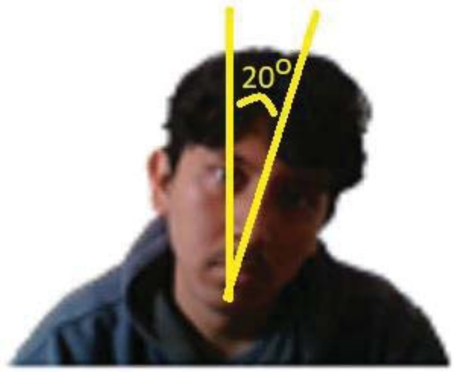


**FIGURE 8.** The inclination of the driver's face is 20$^o$.

The effect of distance on the success of detecting drowsiness is shown in Table 3. For drivers without glasses, the camera placement with a distance of between 20 to 80 cm can detect well, but for drivers with glasses, the camera placement can only be placed at a distance between 20 to 60 cm. The placement of the camera too far makes it difficult to detect the eye position of the driver that using glasses. This is due to the presence of glass that blocks the reflection of light from the eye being received by the camera.

**TABLE 3.** Effect Of Camera Distance on The Success of Detecting Sleepiness.

| No. | Drivers | The distance of the camera to the driver | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 20 | 30 | 40 | 50 | 60 | 70 | 80 |
| 1. | Not wearing Glasses | D | D | D | D | D | D | D |
| 2. | Wearing Glasses | D | D | D | D | D | N | N |

In this study, testing was carried out for 3 video qualities, namely 360p, 480p, and 720p. This quality is related to the image size of each video frame. The higher the progressive scan value, the larger the image size or resolution also. Tests are carried out to determine the time required to process one image frame. The smaller the time required, the more frames that can be processed in one second. From the test, it is found that the time required to process one frame of 360p video is 0.04 seconds, while one frame of 480p video is 1.45 seconds, and 720p video is 2.85 seconds. This means that for 360p videos, this drowsiness detection method can process as many as 25 frames per second.

In this study, when the frame is detected that the eyes are closed, the counter starts counting to mark the first frame. If the next frame is still closed, then this frame is marked as the second frame. The next frame is detected again to determine whether the eye is still closed or open. If it is still closed, then the frame is marked as the third frame and an alarm sounds as a warning that drowsiness is detected, but if not, then the frame is reset back to zero. The warning system on this drowsiness detector works well, namely sounding an alarm when three consecutive frames are detected when the eyes are closed.

## CONCLUSION

The drowsiness detection system works well for drivers without glasses in conditions of illumination intensity between 20 to 90 Lux, with a face tilt from 0$^o$ to 30$^o$, when the camera is placed 20 to 80 cm from the driver. As for the driver wearing glasses, the system works well in conditions of illumination intensity between 20 to 60 Lux, with a face tilt from 0º to 20º, and a camera placement distance from 20 to 60 cm. In 360p video, the system works quite fast at 0.04 seconds so that it can be applied to real time systems.

Future research is to use this method to detect sleepiness at a video speed of 25 frames per second. At this speed, the detection result is more accurate because it requires 10 consecutive frames to indicate a drowsy condition. In future work, additional image preprocessing can also be carried out in order to get better detection capabilities for drivers who wear glasses. It is necessary to consider using a night vision camera for detection in low light conditions.

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