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COMPARISON OF ROBUSTNESS TEST RESULTS OF THE EYE ASPECT RATIO METHOD AND IRIS-SCLERA PATTERN ANALYSIS TO DETECT DROWSINESS WHILE DRIVING

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Abstract

Traffic accidents caused by driver drowsiness are a leading factor in fatal road incidents. This study introduces a computer vision-based drowsiness detection system utilizing two methods: Eye Aspect Ratio (EAR) and Iris-Sclera Pattern Analysis (ISPA). The EAR method measures the eye aspect ratio to determine whether the eyes are open or closed. This involves calculating the vertical distance between specific landmark points on the eyelids and comparing it to the horizontal distance between points on the eye. A decrease in this ratio serves as an early indicator of drowsiness. The ISPA method employs symmetry analysis between the iris and sclera. This approach relies on the visual pattern formed when the eyes are open, where the sclera appears symmetrically distributed around the iris. During this process, eye images are processed to extract iris and sclera features, which are then analyzed for symmetry to detect signs of drowsiness. The study evaluates the reliability of both methods under varying conditions, such as changes in lighting, viewing distances, head movements, and the use of eyeglasses. The results show that the EAR method achieved an accuracy of 83.33% in distance testing, indicating its effectiveness in stable lighting environments. In contrast, the ISPA method achieved an accuracy of 59.25% under low and variable lighting conditions and proved more reliable for detecting the eyes of users wearing glasses.

Keywords: *Drowsiness Detection; Eye Aspect Ratio; Iris-Sclera Pattern Analysis; Road Safety*

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1. INTRODUCTION

Traffic accidents caused by drowsy drivers are one of the biggest threats to road safety. According to data from Integrated Road Safety Management (IRMS), throughout January 2024 there have been 11,565 traffic accidents. Fatigue and drowsiness while driving are the leading causes of fatal road accidents, leading to many losses, including death, serious injury, and material loss [1].

Drowsiness can cause drivers to lose control of their vehicles, increasing the risk of life-threatening accidents for drivers and other road users, with a variety of consequences. The risk of experiencing fatigue while driving can increase due to things such as high work pressure, lack of rest, and certain medical conditions. In addition, long travel times and long-distance travel can also exacerbate this condition.

Computer-based drowsiness detection can be done by a variety of methods. Some approaches use physiological sensors such as electroencephalogram (EEG), electrooculogram (EOG), and heart rate measurement. However, these methods tend to be invasive, inconvenient to use in the long run, and expensive to implement in public transportation. Therefore, more practical, non-invasive, and computer vision-based approaches have begun to be developed, one of which is the analysis of driver's eye images. This technology can detect signs of drowsiness by monitoring physical changes in the eyes, such as decreased blink frequency, length of time the eyes are closed, and eyelid movements.

Two popular methods for detecting sleepiness based on eye images are Eye Aspect Ratio (EAR) and Iris-Sclera Pattern Analysis (ISPA). Both methods aim to detect open or closed eyes and provide an indication of whether the driver is showing signs of drowsiness. However, there are fundamental differences in the way the two methods work, efficiency, and robustness. Therefore, a comparative analysis between these two methods becomes important to understand which is more effective and reliable in a real environment, especially in challenging situations such as lighting variations, head movements, or the use of glasses[2].

Detecting driver drowsiness using computer vision technology faces various challenges. One of the biggest challenges is lighting variability. Lighting conditions inside a vehicle can vary greatly, especially when the vehicle is moving from a bright area to a dark area or vice versa, or when dealing with direct sunlight. Methods that are not robust to lighting changes can provide inaccurate detection results, potentially jeopardizing safety[3].

Another challenge is head movement and eye position. This change in head angle can interfere with the accuracy of detection of open or closed eyes if the method used cannot adjust to the change in viewing angle[4].

Facing these challenges, a comparative analysis between the EAR and ISPA methods is very important. Although both methods aim to detect open or closed eyes for the purpose of detecting drowsiness, each has advantages and disadvantages that affect their performance in real-life situations[5].

According to previous research for the detection of eight-way eye gaze with the characteristic excitation of corner triangle similarity and eye aspect ratio, the results of the study showed that mentioning that the eye aspect ratio can be used to detect eye gaze, the results obtained an accuracy value of 88%, precision of 89%, recall of 88%, and f1-score of 87% [6].

Furthermore, Another research uses a combination of haar cascade and convolutional neural network to detect drowsiness. The results of the study stated that the average accuracy in detecting open and closed eyes using CNN was 97.23% and the average accuracy in detecting drowsiness was 97.23% the same as the results of eye detection, with a computing time of 0.2075 [7].

And last research detected the activity of the eyes, mouth and tilt of the head to detect drowsiness. The results show that the use of the EAR method with characteristic extraction in the form of a blazeface can provide excellent results in detecting drowsiness while driving, with an accuracy rate of 98% [8].

It can be concluded that using this comparative analysis will focus on the robustness of the two methods under various conditions, such as lighting variations, head movements, and the use of glasses. Robustness in this context refers to the ability of a method to provide consistent and accurate detection results, regardless of changing environmental conditions. By conducting a comparative analysis between the EAR and ISPA methods, it is hoped that a more reliable and efficient method for detecting driver drowsiness will be found. The results of this analysis can be used to develop more sophisticated and reliable drowsiness detection systems, which can ultimately help reduce traffic accidents caused by drowsiness[9].

2. RESEARCH METHOD

The research framework is the stages that will be applied when conducting research. This is done so that the research stages are structured. This study uses a quantitative method because this research is mathematical and has a structure with clear stages. The stages carried out in this study are in the following Figure 1.

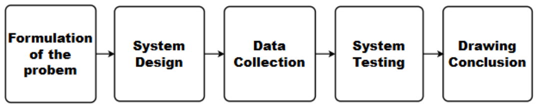


Figure 1. Research Stages

Problem formulation in research is an important blink activity in various applications such as human-computer interaction, fatigue detection, and health analysis. Two common methods for detecting blinking, namely Eye Aspect Ratio (EAR) and Iris-Sclera Recognition, have their own characteristics and advantages related to resistance to variations in environmental and individual conditions. This study aims to analyze the comparative robustness of the two methods to determine which is more reliable and efficient in detecting blinking, taking into account various external and internal factors that affect detection performance.

The application design process begins with the EAR (Eye Aspect Ratio) method where the first step is to incorporate the face detection library and facial landmark prediction into the development environment. Next, input important parameters such as EYE_AR_THRESHOLD, EYE_AR_FRAME, and Counter which will be used in the analysis of drowsiness detection. If the EAR value exceeds the threshold specified by the EYE_AR_THRESHOLD parameter, then the buzzer lights up, indicating that the driver is in an alert state. However, if the EAR value does not reach that threshold, then the counter will increase by one. The system design process can be seen in Figure 2.

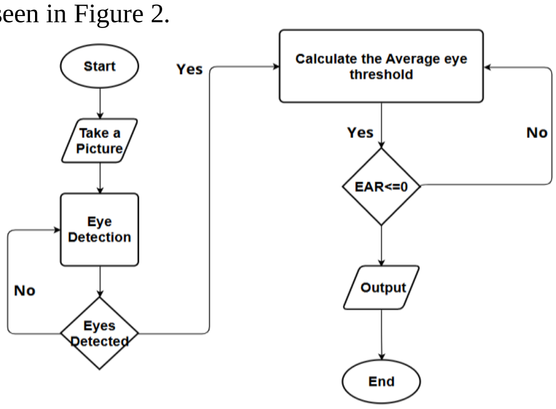


Figure 2. EAR System Design Flowchart

The next application design process is with the ISPA method which can be designed by utilizing the processing of images from real-time streaming videos captured by the camera. In this system, the camera will capture an image of the user's face, then processed using a face detection method based on the Haar-cascade classifier or similar model to detect the face and eye area. The system also implements additional logic to monitor the duration of closed eyes. If the eyes are closed for a certain duration, the system will provide a visual warning in the form of "Drowsiness Detected" text displayed on the screen. Ultimately, the system is designed to efficiently detect drowsiness by combining image signal processing techniques and analysis of eye movement patterns. Model ISPA system Design can be seen in Fugure 3.

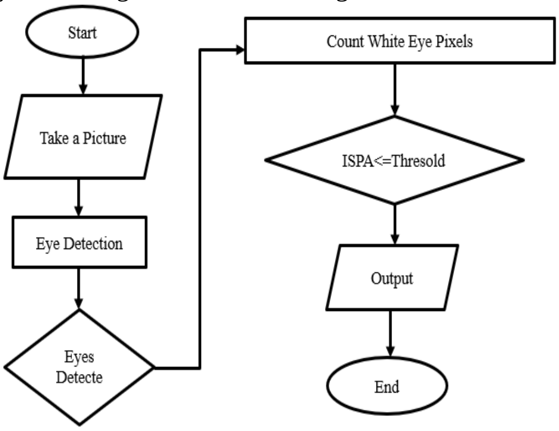


Figure 3. ISPA System Design Flowchart

Digital image data collection is carried out by taking pictures using a webcam as data input from the experiment to be carried out. Library Research which is the process of collecting information or collecting data by studying and understanding relevant data from books, theories, documents and databases of scientific journals. The data and information taken will later be used for research or study purposes.

Testing of the system will be carried out when the design is feasible. Testing will be carried out by several trials or simulations. The system will be tested with 3 experiments each in light conditions and 3 experiments each distance condition.

In this study, conclusions will be drawn after testing the system that has been made. After the experiment is carried out, the data will be used to measure how good the eye aspect ratio method is in the detection of sleepy eyes. The results of the analysis will be in the form of the percentage of success of the eye aspect ratio in detecting sleepy eyes which is tested by several factors. Such as in light or dark conditions and how far away from the range the system test is carried out.

The next application design process is with the ISPA method which can be designed by utilizing the processing of images from real-time streaming videos captured by the camera. In this system, the camera will capture an image of the user's face, then processed using a face detection method based on the Haar-cascade classifier or similar model to detect the face and eye area.

And the conclusion takes the results obtained after the process of analyzing the classification of sentiment related to electric vehicle taxes in social media X, an evaluation matrix such as precision, accuracy, recall and F1-score is obtained to assess how effective the system is in classifying data correctly.

2.1 Theory

Drowsiness while driving is a serious problem that is often overlooked but can have fatal consequences. Symptoms of drowsiness while driving vary from eyes that feel heavy and often rub their eyes, difficulty concentrating, to experiencing floating thoughts [10]. This phenomenon is the result of a variety of factors, including a lack of adequate sleep, long-distance travel without adequate rest, or driving at certain times when the body tends to experience a decrease in alertness, such as at night [11].

Robustness, or resilience, refers to the ability of a system, method, or algorithm to continue to function properly despite suboptimal conditions or encountering disturbances. In the context of drowsiness detection, robustness includes several important aspects.

Computer vision is the ability of a machine or computer to see or recognize an image in the same way or even better than what humans can see. It is known as an automated system that is used to analyze imagery and video by computers to obtain information and understanding of an object [12].

The concept of facial landmarks is an important concept in facial recognition technology, which has become increasingly important in various applications in this digital era [13]. In this study, a library of 68 facial landmarks was used as a parameter to determine the location of the eyes on the face. There are a total of 12 points that indicate the eye, namely 6 for the left eye 37-42 landmark points, while 6 for the right eye is 43-48.

OpenCV was first created in 1999 by Gary Bradski and a group of researchers at Intel. The main goal of creating OpenCV was to provide open-source software that would allow researchers and developers to use the latest advances in computer vision. The OpenCV project was founded by Bradski, a prominent computer scientist who also contributed to the field of computer vision [14]. OpenCV can be run on multiple platforms so that it can be widely applied to images or videos such as face recognition, face detection, object tracking, road tracking [15].

The Eye Aspect Ratio (EAR) is a metric used in facial analysis to measure the degree of openness or alignment of a person's eyes. This metric was first used in facial expression recognition and can provide important insights into a person's emotional state and expressions, including detecting blinking. EAR is calculated using landmark points around the eye, where the ratio between the vertical and horizontal distances between the points gives an indication of whether the eye is open or closed. Based on the above equation, the formula can be simplified into the following form of equation (1):

$$EAR = \frac{|A|+|B|}{2|C|} \quad (1)$$

EAR is the Eye Aspect Ratio, which is a measure used to detect eye conditions based on the distance between certain points. EAR is calculated from the distance at eye height, which is between the points (n-m) (A) and (j-k) (B), as well as the distance of the eye width between the points (o-p) (C). This method is often used in facial recognition analysis, specifically to detect whether a person's eyes are open or closed.

Iris-Sclera Pattern Analysis (ISPA) is a method used in image analysis to detect patterns between the iris (the colored part of the eye) and the sclera (the white part of the eye). Then the Eye is carried out a filtering process, where in this study will use a Median filter which will later reduce noise in the eye area and will make it easier to detect eyes. The following is stated in equation (2) below:

$$I'(x,y) = median(W(x,y)) \quad (2)$$

The above formula explains that the pixel intensity value where I'(x,y) is calculated as the median of the set of pixel values W(x,y). This filter is used to reduce noise in the image.

In this study, the Python programming language uses the VSCode application. Many libraries will be used in this study such as numpy, cv2, and dlib. The application of the EAR and Sclera Recognition formulas will later be converted into the Python programming language syntax for use.

3. RESULT AND DISCUSSION

Some of the stages that will be discussed in this study are related to problem formulation, system design, data collection, system testing, system testing, and conclusion drawn.

3. 1 Data Analysis

The research of the drowsiness detection system using the Eye Aspect Ratio (EAR) and Sclera Recognition methods involves analyzing videos or images of faces from various angles and lighting conditions to test the robustness of the system. EAR detects sleepiness through changes in the aspect ratio of the eye, while Sclera Recognition analyzes the white part of the eye (sclera) to complete detection, especially when the EAR is less sensitive. The performance tests are carried out under challenging conditions such as poor lighting, tilted head positions, and variations in facial expressions, with the aim of developing systems that are accurate and resistant to interference, for applications in the transportation and security industries.

3. 2 Data Representation

In this section, there are stages that will be used to represent the data, including Data Preprocessing Analysis, EAR Method Process, Implementation of the EAR method.

Pre-Processing Data Analysis

The process begins by taking a picture or video frame from a relevant source. This source can be a live camera (real-time video), a previous video recording, or a set of static images. The Acquisition image is shown in Figure 4. Once an image or video frame has been taken, the first step in preprocessing is usually to convert the image from color format (RGB) to grayscale. This conversion is done because color information is not required for facial feature detection, and working with grayscale images can speed up the processing process because it reduces the amount of data that must be analyzed. Suppose we have a 7x7 RGB image with RGB color intensity as follows:

Figure 4. Face Image

The image acquisition results were then subjected to RGB feature extraction as the extraction results are shown in Figure 5.

100, 150, 200	120, 180, 240	80, 120, 160	60, 90, 120	50, 75, 100	30, 60, 45	10, 15, 20
200, 100, 50	180, 90, 45	160, 40, 80	140, 70, 60	120, 60, 30	100, 50, 25	80, 40, 20
255, 100, 200	230, 180, 135	210, 160, 120	190, 140, 105	170, 120, 90	150, 75, 50	130, 80, 60
25, 50, 75	50, 100, 150	75, 150, 225	100, 200, 200	125, 200, 225	150, 200, 275	175, 200, 225
0, 255, 0	0, 200, 0	0, 150, 100	0, 100, 0	0, 50, 0	0, 25, 0	0, 0, 0
255, 0, 255	200, 0, 200	150, 0, 150	100, 0, 100	50, 0, 50	25, 0, 25	0, 0, 0
0, 0, 255	0, 0, 200	0, 0, 150	0, 0, 100	0, 0, 50	0, 0, 25	0, 0, 0

Figure 5. Imagery with RGB values

In Figure 5 it can be seen that in the first row pixel (1,1) has a value R = 100, G = 150, B = 200, pixel (2.1) R = 120, G = 180, B = 240, pixel (3.1) R = 80, G = 120, B = 160, pixel (4.1) R = 60, G = 90, B = 120, pixel (5.1) R = 50, G = 75, B = 100, pixel (6.1) R = 30, G = 45, B = 60, pixel (7.1) R = 10, G = 15, B = 20. With the RGB to grayscale conversion formula, the value of the pixel pixel will be calculated using the formula:

$Kolom\ 1$
$RGB\ (100, 150, 200)$:
$Grayscale = 0.2989 \times 100 + 0.5870 \times 150$
$+0.1140 \times 200 = 140.74$
$Kolom\ 2$
$RGB\ (200, 100, 50)$:
$Grayscale = 0.2989 \times 200 + 0.5870 \times 100$
$+0.1140 \times 50 = 124.18$
...
$Kolom\ 7$
$RGB\ (0, 0, 255)$:
$Grayscale = 0.2989 \times 0 + 0.5870 \times 0$
$+0.1140 \times 255 = 29.07$

RGB image with the results shown in Figure 5. Then converted to Grayscale, as the results of the value extraction from grayscale are shown in Figure 6.

141	168	112	84	70	49	14
124	112	80	90	74	62	50
158	190	171	151	131	94	93
56	106	144	180	196	212	224
150	117	88	59	29	15	0
183	137	103	68	34	17	0
29	23	17	11	6	3	0

Figure 6. Image of RGB to Grayscale Conversion

Implementation of the EAR Method

Facial Landmarks will be placed on the face image that has been detected using the library available on Dlib. This library has 68 sides that represent the human face such as the jaw, chin, eyebrows, lips, nose and eyes. The results are shown in Figure 7.

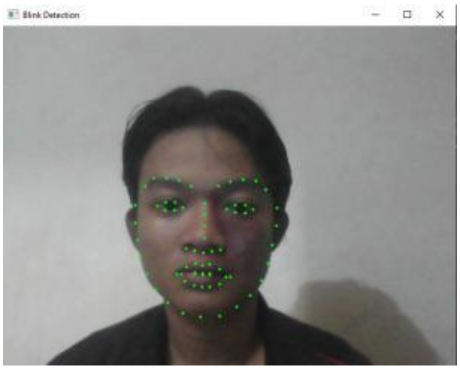


Figure 7. Faces With Landmark Points

These points will later be used to determine the ROI of an eye that will be detected how changes occur when the eye is open and closed. The points around the eyes will later be used as a reference for the calculation of the Eye Aspect Ratio method used. An example of a manual calculation of the Eye Aspect Ratio is as follows, given several coordinate points that represent the eyes as shown in Table 1.

Table 1. Eye Coordinates

No.	X	Y	Eye
P1	261	296	Left
P2	272	293	Left
P3	283	294	Left
P4	293	301	Left
P5	282	303	Left
P6	270	302	Left
P1	341	304	Right
P2	352	298	Right
P3	364	298	Right
P4	374	303	Right
P5	364	308	Right
P6	352	307	Right

The first step in the calculation process of the eye aspect ratio method is to calculate the distance between the eyes based on Equation 1. The eye is divided into 2 coordinates, namely vertical and horizontal. Suppose the eye coordinates as shown in the table, Based on Equation 1, the vertical distance of the left eye is as follows:

$D_{2,6} = \sqrt{(272 - 270)^2 + (293 - 302)^2}$
$D_{2,6} = \sqrt{4 + 81} = \sqrt{85}$
$D_{3,5} = \sqrt{(283 - 282)^2 + (294 - 303)^2}$
$D_{3,5} = \sqrt{1 + 81} = \sqrt{82}$
The Horizontal Distance of the left eye is as follows:
$D_{2,6} = \sqrt{(261 - 293)^2 + (296 - 301)^2}$
$D_{2,6} = \sqrt{1024 + 25} = \sqrt{1049}$

After the value of the vertical and horizontal distance between the left eye is obtained, the next step is to find the value of the eye aspect ratio according to Equation 3.

$$EAR_{kiri} = \frac{\sqrt{85+82}}{2\left\|\sqrt{1049}\right\|} = \frac{18.28}{64.8} = 0.282$$

Next, calculate the vertical and horizontal distances of the right eye according to Equation 1.

$D_{2,6} = \sqrt{(252 - 352)^2 + (298 - 307)^2}$
$D_{2,6} = \sqrt{0 + 81} = \sqrt{81}$
$D_{3,5} = \sqrt{(364 - 364)^2 + (298 - 308)^2}$
$D_{3,5} = \sqrt{0 + 100} = \sqrt{100}$
The Horizontal Distance of the right eye is as follows:
$D_{2,6} = \sqrt{(341 - 374)^2 + (304 - 302)^2}$
$D_{2,6} = \sqrt{1089 + 1} = \sqrt{1090}$

After the value of the vertical and horizontal distance between the right eye is obtained, the next step is to find the value of the eye aspect ratio according to Equation 3.

$$EAR_{kanan} = \frac{\sqrt{81+100}}{2\left\|\sqrt{1090}\right\|} = \frac{19}{66} = 0.288$$

So, the calculated EAR value for both eyes is around **0.28**, which corresponds to the data in Table 1.

ISPA Implementation

The first step in eye segmentation is to separate the eye from the image of other features present on the face. In this study, it will focus on the eyes only. For this reason, in order to get good results and minimal computing, segmentation will be carried out to determine the eye area. For the segmentation itself, 68 facial landmarks will be used. Once the eye area is obtained, it will make it easier to calculate the system. Steps that can be taken to separate the eye area, especially the sclera (the white part of the eye), from other areas around the eyes such as the iris, pupils, and eyelids. as shown in Figure 8. This process is typically done using image-based segmentation algorithms such as thresholding or edge detection to highlight color and texture differences between the sclera and other parts of the eye.

Figure 8. Grayscale Eye Image

Next, the eye image that has been converted to grayscale is extracted. The pixel value results are shown in Figure 9.

141	168	112	84	70	49	14
124	112	80	90	74	62	50
158	190	171	151	131	94	93
56	106	144	180	196	212	224
150	117	88	59	29	15	0
183	137	103	68	34	17	0
29	23	17	11	6	3	0

Figure 9. Eye Grayscale Value

Next we will remove the noise, noise will usually appear and can interfere with the eye pattern recognition process, then the median filter process will be used to remove the noise. Suppose we have an image with a size of 7 x 7 pixels. And we will do a median filter with a 3 x 3 kernel then it will be as follows. Specify a 3 x 3 (kernel 3) window on a 7 x 7 pixel. Figure 10 is a 1:1 pixel that will have its noise removed.

141	168	112
124	112	80
158	190	171

Figure 10. Pixel 1.1

After the 5 x 5 window is obtained, then arrange the pixel values in ascending order, for example as follows. The pixel values of the 5 x 5 window are arranged in ascending order so it will be as follows {80, 112, 112, 124, 141, 158, 168, 171, 190}.

Because it uses kernel 3, the number of pixel values is 9, the median value is the value that is in the middle of the set of values. In the order of the sorted data, the 5th value, which is 141, is the median value. Next, we will change the value at the center of each kernel window that has been filtered, then the value will be changed according to the provisions of the median filter. The results are shown in Figure 11.

141	168	112	84	70	49	14
124	158	112	90	74	70	50
158	124	144	151	131	94	93
56	144	144	144	131	94	224
150	117	106	88	59	29	0
183	117	68	34	17	6	0
29	23	17	11	6	3	0

Figure 11. Median Filter Value

Thresholding application After performing the median filter process, the next step is to apply the thresholding method to the masked area. Using the binary treshold method, the system will distinguish between the sclera (white) and other parts of the eye such as the iris (which is darker). A specific color intensity threshold will be specified to separate pixels that fall within the sclera area (rated 1) from pixels that fall within the iris or pupil (rated 0). The results can be seen in Figure 12.

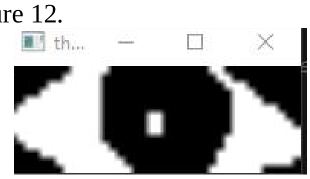


Figure 12. Eyes After the Treshold Binner Process

Then the value of white pixels will later be calculated per pixel, if the white value is below the threshold then the eyes are said to be in a sleepy position and if the eyes are in a white position greater than the threshold then the eyes are in an open condition.

3. 3 Testing

The next stage carried out in this study after the prototype of the drowsiness detection system has been completed and can be run, then the test results from this study will be obtained. The following is a list of test scenarios for distances in Table 2.

Table 2. Distance Test Scenario Table

No.	Distance Testing Scenarios	Distance Testing Sub Scenario	Lots of Testing
1	Eyes with close range (S1)	Eyes closed >3 seconds	3x
		Using transparent glasses	3x
		Using sunglasses	3x
		Using a hat on the head	3x
		The head moves left and right	3x
		Head facing down	3x
2	Medium-distance eyes (S2)	Eyes closed >3 seconds	3x
		Using transparent glasses	3x
		Using sunglasses	3x
		Using a hat on the head	3x
		The head moves left and right	3x
		Head facing down	3x
3	Eyes with a distance (S3)	Eyes closed >3 seconds	3x
		Using transparent glasses	3x
		Using sunglasses	3x
		Using a hat on the head	3x
		The head moves left and right	3x
		Head facing down	3x

The next stage carried out in this study after the prototype of the drowsiness detection system has been completed and can be run, then the test results from this study will be obtained. Then in conducting the test, it will be calculated by measuring the level of accuracy. Light intensity testing ranging from light, medium, and dark. The following is a list of test scenarios against distances in Table 3.

Table 3. Light Test Scenario Table

No.	Light Testing Scenarios	Light Testing Sub Scenario	Lots of Testing
1	Bright eyes (S1)	Eyes closed >3 seconds	3x
		Using transparent glasses	3x
		Using sunglasses	3x
		Using a hat on the head	3x
		The head moves left and right	3x
		Head facing down	3x
2	Eyes with medium light (S2)	Eyes closed >3 seconds	3x
		Using transparent glasses	3x
		Using sunglasses	3x
		Using a hat on the head	3x
		The head moves left and right	3x
		Head facing down	3x
3	Eyes with low light (S3)	Eyes closed >3 seconds	3x
		Using transparent glasses	3x
		Using sunglasses	3x
		Using a hat on the head	3x
		The head moves left and right	3x
		Head facing down	3x

Based on the above test scenario, it was carried out 3 times. In the results of this test, a table consisting of 5 columns is needed, namely s (test scenario), ss (test sub-scenario), r2 (average of each test sub-scenario), r1 (average of 3 tests in each test sub-scenario). successful (if 1 means the detection is correct, and 0 means false), and j (the number of detections is correct. Here are the results of the test scenarios on each test.

Eye Aspect Ratio Scenario

Based on the distance experiment using the eye aspect ratio method in the table above using a video of the experiment which was carried out 54 times with the criteria for close, medium and far distances, the success results of the 54 experiments were 45 with an accuracy rate of 83.33%. Some samples in this experiment are shown in Table 5.

Table 4. Eye Aspect Ratio Method Distance Testing Scenario

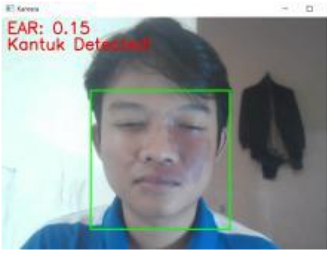
No.	Sub Scenario	Succeed			Sum
1	Ss1 	1	1	1	3
2	Ss1 	1	1	1	3
3	Ss1	1	1	1	3

	
Accuracy = 83.33%	Total = 54

Light Test Scenario of Eye Aspect Ratio

Based on the light experiment with the eye aspect ratio method in Table 5 below using a video experiment conducted 54 times with the criteria of close, medium, and far distances, the success results of the 54 experiments were 45 with an accuracy level of 83.33%. The accuracy obtained is the same as the test results in the first scenario, namely the Eye Aspect Ratio Scenario. the test results of several samples are shown in Table 5.

Table 5. Light Test Scenario of Eye Aspect Ratio Method

No.	Sub Scenario	Succeed	Sum
1	Ss1 	1 1 1	3
2	Ss1 	1 1 1	3
3	Ss1 	1 1 1	3
	Accuracy = 83.33%	Total = 54	

From the distance test scenario and light test in the table, conclusions can be drawn from the table

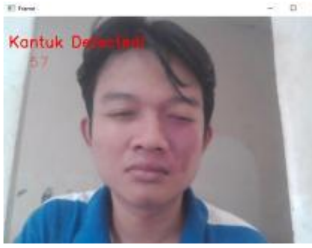
Table 6. Robustness Test Results

Test Scenario	Accuracy	Number of successful tests	Number of failed tests
Distance Testing	83.33%	45	9
Light Level Testing	83.33%	45	9

ISPA method testing scenarios

Based on the distance experiment with the ISPA method in Table 7 below using the experimental video conducted 54 times with the criteria of close, medium and far distances, the results of the 54 trials were 45 with an accuracy level of 83.33%. The test results of several samples are shown in Table 7.

Table 7. ISPA Method Distance Testing Scenario

No.	Sub Scenario	Succeed	Sum
1	Ss1 	1 1 1	3
2	Ss1 	1 1 1	3
3	Ss1 	1 1 1	3
	Accuracy = 83.33%	Total = 54	

.

ISPA Method Light Testing

Based on the light experiment using the ISPA method in Table 8 below using videos of experiments carried out 54 times with the criteria for near, medium and far distances, the successful results from 54 experiments were 32 with an accuracy rate of 59.25%.

Table 8. ISPA Method Light Testing Scenario

No.	Sub Scenario	Succeed	Sum
1	Ss1	0 1 1	2

	 Ss1				
2	 Ss1	1	1	1	3
3		1	1	0	2
	Accuracy =59.25%		Total = 54		

From the distance test scenario and light test in the table, conclusions can be drawn from Table 9.

Table 7. ISPA Robustness Test Results

Test Scenario	Accuracy	Number of successful tests	Number of failed tests
Distance Testing	83.33%	45	9
Light Level Testing	59.25%	32	22

3. 4 System Evaluation

Based on the results of the tests on the EAR method test table, from 2 scenario tests obtained from the results of close, medium, and far range tests, a total of 45 tests obtained an accuracy result of 83.33% where from these results it can be evaluated that from this distance the system is able to detect quickly and accurately, according to the time and accuracy obtained. Furthermore, from the light level test starting from bright, medium and dim light, a successful number of 45 tests were obtained that obtained an accuracy of 83%. Where from the results of the light level test, it can be evaluated that the system is able to detect light properly and accurately.

Meanwhile, for the ISPA method, at the same distance, 45 tests were successful with an accuracy of 83.33%, and in the same light conditions, only 32 tests were successful with an accuracy rate of 59.25%.

4. CONCLUSION

This study aimed to compare the robustness of the Eye Aspect Ratio (EAR) method and the Iris-Sclera Pattern Analysis (ISPA) method in detecting drowsiness while driving. Based on the robustness test results, the EAR method achieved an accuracy of 83.33% across both distance tests (close, medium, far) and variations in light intensity (bright, medium, dim). This indicates that the EAR method can detect drowsiness quickly and with reasonable accuracy under various distance and lighting conditions.

However, the accuracy of 83.33% did not exceed 90% due to several limitations, such as the system's sensitivity to significant head position changes and the presence of accessories like sunglasses. Additionally, the EAR method relies on detecting changes in the eye aspect ratio, which can be affected by image noise or low camera resolution.

Meanwhile, the ISPA method achieved only 59.25% accuracy in light-intensity tests, although it demonstrated the same accuracy as the EAR method (83.33%) in distance tests. The weaknesses of the ISPA method were evident in its inability to reliably detect iris and sclera patterns under dim lighting conditions, reducing its reliability in varied environmental environments.

In conclusion, the EAR method is more robust to variations in distance and lighting compared to the ISPA method. However, to improve overall accuracy, further research is required, including optimizing the detection algorithm, using higher-resolution cameras, or integrating both methods to leverage their respective strengths.

5. REFERENCES

[1] S. Djaja, R. Widyastuti, K. Tobing, D. Lasut, and J. Irianto, "Situasi Kecelakaan Lalu Lintas Di Indonesia, Tahun 2010-2014," *J. Ekol. Kesehat.*, vol. 15, no. 1, pp. 30–42, 2016, doi: 10.22435/jek.v15i1.4436.30-42.

[2] C. W. Chuang and C. P. Fan, "Deep-learning based joint iris and sclera recognition with yolo network for identity identification," *J. Adv. Inf. Technol.*, vol. 12, no. 1, pp. 60–65, 2021, doi: 10.12720/jait.12.1.60-65.

[3] A. K. Biswal, D. Singh, B. K. Pattanayak, D. Samanta, and M. H. Yang, "IoT-based smart alert system for drowsy driver detection," *Wirel. Commun. Mob. Comput.*, vol. 2021, 2021, doi: 10.1155/2021/6627217.

[4] K. Nguyen, H. Proença, and F. Alonso-Fernandez, "Deep Learning for Iris Recognition: A Survey," *ACM Comput. Surv.*, vol. 56, no. 9, 2024, doi: 10.1145/3651306.

[5] J. R. Malgheet, N. B. Manshor, and L. S. Affendey, "Iris Recognition Development Techniques: A Comprehensive Review," *Complexity*, vol. 2021, 2021, doi: 10.1155/2021/6641247.

[6] D. K. Putra, R. Cahya Wihandika, and A. Ridok, "Ekstraksi Ciri Corner Triangle Similarity dan

Eye Aspect Ratio untuk Deteksi Tatapan Mata Delapan Arah," vol. 6, no. 4, pp. 1848–1857, 2022, [Online]. Available: http://j-ptiik.ub.ac.id

[7] R. T. Puteri and F. Utaminingrum, "Deteksi Kantuk Menggunakan Kombinasi Haar Cascade dan Convolutional Neural Network," *J. Pengemb. Teknol. Inf. dan Ilmu Komput.*, vol. 4, no. 3, pp. 816–821, 2020, [Online]. Available: http://j-ptiik.ub.ac.id

[8] S. Sugeng and T. N. Nizar, "Deteksi Aktivitas Mata, Mulut Dan Kemiringan Kepala Sebagai Fitur Untuk Deteksi Kantuk Pada Pengendara Mobil," *Komputika J. Sist. Komput.*, vol. 12, no. 1, pp. 83–91, 2023, doi: 10.34010/komputika.v12i1.9688.

[9] I. A. Ahmed *et al.*, "Eye Tracking-Based Diagnosis and Early Detection of Autism Spectrum Disorder Using Machine Learning and Deep Learning Techniques," *Electron.*, vol. 11, no. 4, 2022, doi: 10.3390/electronics11040530.

[10] I. P. A. E. D. Udayana, N. P. E. Kherismawati, and I. G. I. Sudipa, "Detection of Student Drowsiness Using Ensemble Regression Trees in Online Learning During a COVID-19 Pandemic," *Telematika*, vol. 19, no. 2, p. 229, 2022, doi: 10.31315/telematika.v19i2.7044.

[11] M. A. Puspasari, "Analisis Pengaruh Chronotype dan Body Mass Index (BMI) terhadap Tingkat Kantuk Pengemudi," *J. Rekayasa Sist. Ind.*, vol. 12, no. 1, pp. 105–112, 2023, doi: 10.26593/jrsi.v12i1.6546.105-112.

[12] M. A. Mulya, Zaenul Arif, and Syefudin, "Tinjauan Pustaka Sistematis : Penerapan Metode Gabor Wavelet Pada Computer Vision," *J. Comput. Sci. Technol.*, vol. 1, no. 2, pp. 83–88, 2023, doi: 10.59435/jocstec.v1i2.78.

[13] R. P. H. Sejati and R. Mardhiyyah, "Deteksi Wajah Berbasis Facial Landmark Menggunakan OpenCV Dan Dlib," *J. Teknol. Inf.*, vol. 5, no. 2, pp. 144–148, 2021, doi: 10.36294/jurti.v5i2.2220.

[14] M. M. Lawal, "Car Plate Number Detection System Using OpenCV," vol. 11, no. 3, pp. 359–364, 2023.

[15] T. C. A.-S. Zulkhaidi and E. Maria, "Pengenalan Pola Bentuk Wajah dengan OpenCV," *Jurti*, vol. 3, no. 2, pp. 181–186, 2019.