

# DESIGN AND DEVELOPMENT OF DRIVER'S DROWSINESS DETECTION SYSTEM USING BIOLOGICAL PARAMETERS

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**Abstract:** Recent years increase in use of automobiles has resulted in road accidents alarming the road safety. One of the major reasons for accident is decrease in driver alertness or drivers falling asleep. Hence, an Intelligent Driver's Drowsiness detection and prevention system using biological parameters of the driver without driver's awareness for Road safety has to be designed and developed. In this system, we are determining the drowsiness of the driver by using biological parameter namely facial expressions which is to be monitored and recorded without the awareness of the driver. As drowsiness is detected, a signal is issued to alert the driver. The system deals with detecting face and eyes within the specific segment of the image. Drowsiness is determined by observing the eye blinking action of the driver.

**Key words:** Drowsiness detection system, Fuzzy logic and FIS editor, Image processing, eye pattern, facial expressions, Kalman filter.

## 1. INTRODUCTION

Driver fatigue is a major cause of road accidents and has implications for road safety [1]. Sleep related vehicle accidents (SRVAs) are not only more common than is generally realized but are more liable to result in death and serious injury owing to the relatively high speed of the vehicles on impact [2]. Liu et al. pointed out that the circadian rhythm produces small, but significant, changes in vehicle-based measures [3]. The model based approach [4] system named as Driver Assisting System (DAISY) was reported as a monitoring and warning aid for the driver in longitudinal and lateral control on German motorways. The warnings are generated based on the knowledge of the behavioral state and condition of the driver. In a review of various driver drowsiness detection system [5] by designing a hybrid drowsiness detection system that combines non-intrusive physiological measures with other measures one would accurately determine

the drowsiness level of a driver. Determining the driver's drowsiness using Electro Encephalo Graph (EEG) signal is claimed to be more accurate [6], however acquiring the signal in real time environment is not feasible. Visual features such as eye index (EI), pupil activity (PA), and Head poses were used to extract critical information on nonalertness of a vehicle driver [7-9]. Facial images were captured using various camera and facial features were extracted to determine the driver alertness [10-11].

In the driver drowsiness detection system a non-intrusive driver drowsiness monitoring system has been developed using computer vision techniques. The system which can differentiate normal eye blink and drowsiness can prevent the driver from entering the state of sleepiness while driving [12]. A driver drowsiness detection system in which sensor like eye blink sensor are used for detecting drowsiness of driver. If the driver is found to have sleep, buzzer will start buzzing and then turns the vehicle ignition off [13]. Face detection and eye localization is done by Viola Jones method and Hough Circle Transform (HCT) is used to determine the drowsy state that is open or closed state of eye. If the eyes are found closed for ten successive frames, the implemented system draws the result that the driver is drowsy or falling asleep and issues alarm in order to warn driver [14]. The simple flow chart of the existing system is shown in Fig. 1 below.

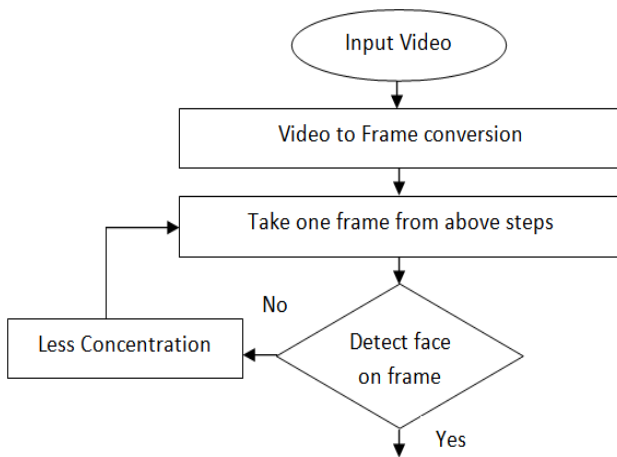


Fig. 1. Flow Chart of the existing system.

## 2. Proposed System

The objective of the proposed work is to design and develop A Driver's Drowsiness Detection System (DDDS) using biological parameters without driver's awareness for Road safety. Measurement of eyelid movement and facial expression were carried out using Mat lab R2013a.

The proposed system is built in four stages namely, Localization of Face, Localization of the Eyes, Tracking the eyes in the subsequent frames and finally detection of failure in tracking. The proposed system function is broadly classified as detection of eyelid and state of drowsiness. As the driver becomes more fatigued, we expect the eye-blinks to last longer. We count the number of consecutive frames that the eyes are closed in order to decide the condition of the driver. For this, we need a robust way to determine if the eyes are open or closed; so we used a method that looks at the horizontal histogram across the pupil. The complete flow chart of the proposed system is shown in Fig 2

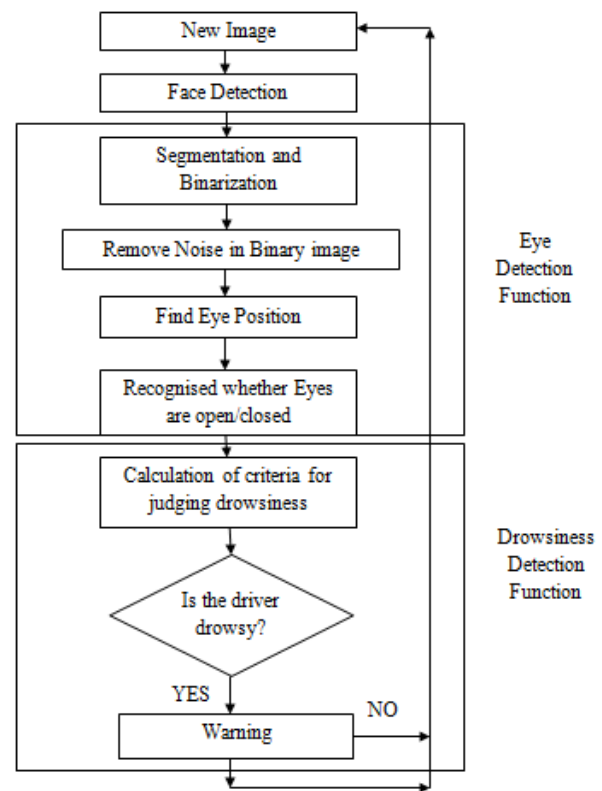


Fig. 2. Flow Chart of the proposed system.

The function of the system can be broadly divided into eye detection function, comprising the first half of the pre-processing routine, and a drowsiness detection function, comprising the second half.

After inputting a facial image, pre-processing is performed to binarize the image and remove noise, which makes it possible for the image to be accepted by the image processor. The maximum width of the face is then detected so that the right and left edges of the face can be identified. After that the vertical position of each eye is detected independently within an area defined by the center line of the face width and lines running through the outermost points of the face. On that basis, the area in which each eye is present is determined. Once the areas of eye presence have been defined, they can be updated by tracking the movement of the eyes. The degree of eye openness is output simultaneously with the establishment or updating of the areas of eye presence. That value is used in judging whether the eyes are open or closed and also in judging whether the eyes have been detected correctly or not. If the system judges that the eyes have not been detected correctly, the routine returns to the detection of the entire face.

### 3. Image preprocessing and Noise removal results.

Three different case studies namely case 1 depicting the eyes are fully opened, case 2 shows the eyes are fully closed and case 3 shows the eyes are partially open have been considered and the results are obtained using Image processing and Fuzzy logic tool box. Figure 3 shows the eyes cropped and figure 4 shows the grey scale converted image to which salt and pepper noise is added as shown in figure 5. Figures 6 to 9 shows the kalman response, filtered, binary and dilated images respectively for case 1. Similarly, responses for other cases are obtained.

#### Case -1- When Eyes are Open:

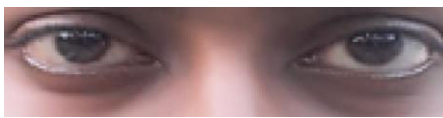


Fig. 3. Eyes Cropped.



Fig. 4. RGB to Grey conversion.



Fig. 5. Noisy Image.

The noisy image output is then processed using Kalman filter [16] to remove the salt and pepper noise from the image as shown in Fig. 5. The Kalman filter response is shown in Fig. 6 and the filtered image is obtained as such, Fig. 7.

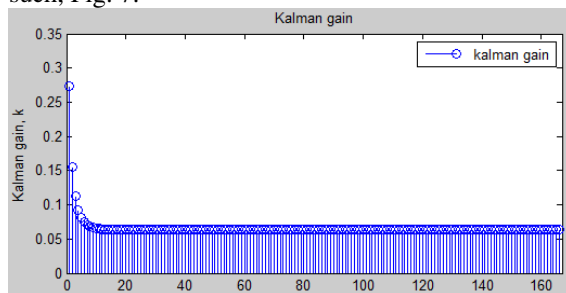


Fig. 6. Kalman Filter response.

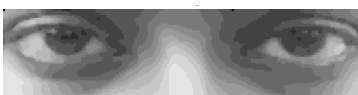


Fig. 7. Filtered Image.

The filtered image is then converted to a binary image as shown in Fig. 8.



Fig. 8. Binary Image.

Finally the image is dilated, as shown in Fig. 9.



Fig. 9. Dilated Image.

The purpose of performing the dilation function is to enhance the foreground features.

#### Case -2- When Eyes are Close:



Fig. 10. Eyes Cropped.



Fig. 11. RGB to Grey conversion.

To the obtained grey scale image, **Salt and pepper noise** is added.

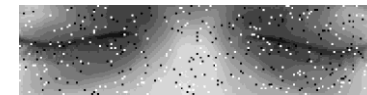


Fig. 12. Noisy Image.

The noisy image output is then processed using Kalman filter to remove the salt and pepper noise from the image as shown in Fig. 12. The Kalman filter response is shown in Fig. 13 and the filtered image is obtained as such, Fig. 14.

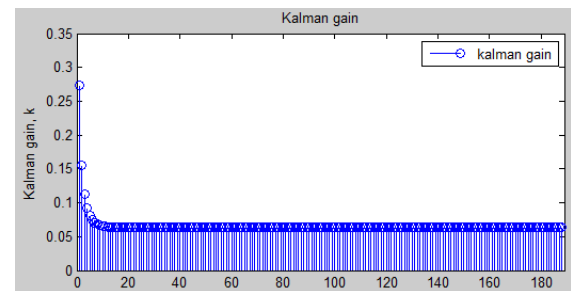


Fig. 13. Kalman Filter response.



Fig. 14. Filtered Image.

The filtered image is then converted to a binary image as shown in Fig. 15.



Fig. 15. Binary Image.

Finally the image is dilated, as shown in fig. 16.



Fig. 16. Dilated Image.

The purpose of performing the dilation function is to enhance the foreground feature.

**Case -3- When Eyes are Partially Open:**



Fig. 17. Eyes Cropped.

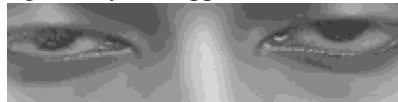


Fig. 18. RGB to Grey conversion.

To the obtained grey scale image, **Salt and pepper noise** is added.

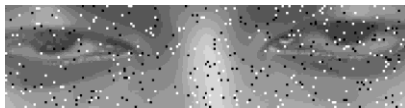


Fig. 19. Noisy Image.

The noisy image output is then processed using Kalman filter to remove the salt and pepper noise from the image as shown in Fig. 19. The Kalman filter response is shown in Fig. 20 and the filtered image is obtained as such, Fig. 21.

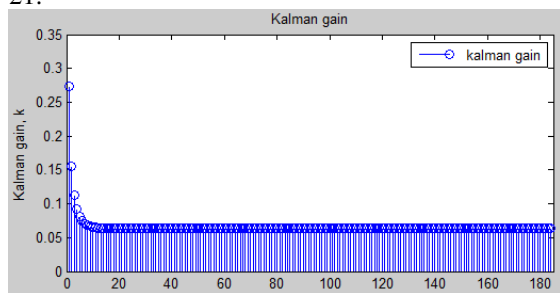


Fig. 20. Kalman Filter response.



Fig. 21. Filtered Image.

The filtered image is then converted to a binary image as shown in Fig. 22.



Fig. 22. Binary Image.

Finally the image is dilated, as shown in fig. 23.



Fig. 23. Dilated Image.

The purpose of performing the dilation function is to enhance the foreground feature.

**4. METHOD OF DROWSINESS LEVEL ESTIMATION**

This section explains the implementation of Fuzzy logic in determining the level of drowsiness. To establish the grade of membership, we enter the standard Deviation and mean of the eye as the input variables. Based on standard deviation and mean of the eye, nine rule base of the fuzzy logic is defined as follows:

Rule 1: IF standard deviation is low AND mean is also low

THEN the eyes will be open

Rule 2: If standard deviation is low AND mean is medium

THEN the eyes will be open

Rule 3: IF standard deviation is low AND mean is high

THEN the eyes will be drowsy

Rule 4: IF standard deviation is medium AND mean is low

THEN the eyes will be drowsy

Rule 5: IF standard deviation is medium AND mean is medium

THEN the eyes will be drowsy

Rule 6: IF standard deviation is medium AND mean of the eye is high

THEN eyes will be closed

Rule 7: IF standard deviation is high AND mean of the eye is low

THEN the eyes will be drowsy

Rule 8: IF standard deviation is high AND mean of the eye is medium

THEN the eyes will be closed

Rule 9: IF standard deviation is high AND mean of the eye is high

THEN closed

Fuzzy output for fully opened eyes: Take rule 1 into account, IF standard deviation is low AND mean is also low THEN the eyes will be open.

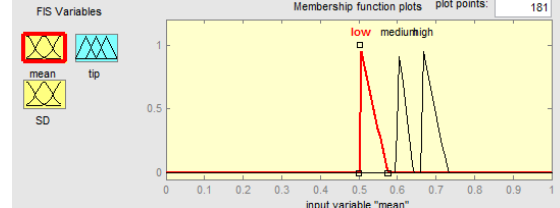


Fig. 24. Showing Low mean of the Eye Triangle.

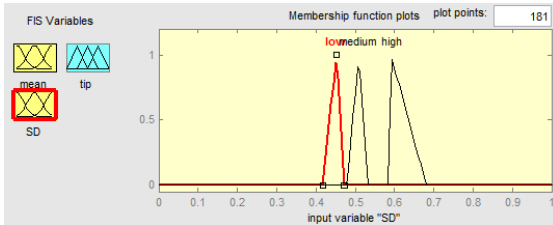


Fig. 25. Showing Low standard deviation Triangle. Low mean Triangular [0.501; 0.502; 0.5754]

Low standard Triangular [0.417; 0.452; 0.4722]

The physical state of the driver is as shown in Fig.26 below-

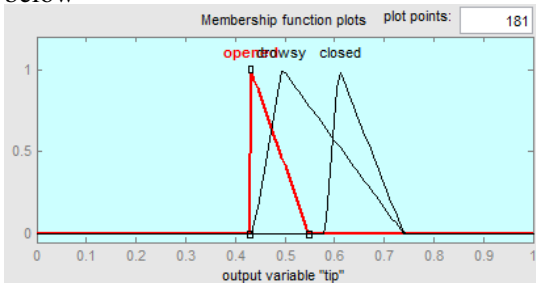


Fig.26. Showing physical state of the driver with eye fully opened.

The physical state of the driver as the output: Open Triangular [0.43; 0.431; 0.5488]

Fuzzy output for fully closed eyes: Take rule 8 into account, IF standard deviation is high AND mean of the eye is medium THEN the eyes will be closed

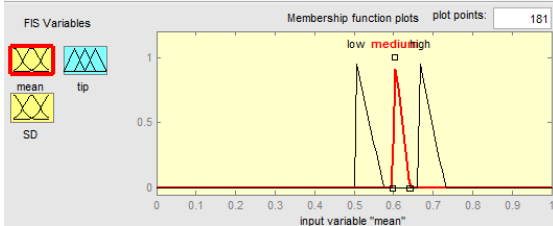


Fig. 27. Showing medium mean of the Eye Triangle.

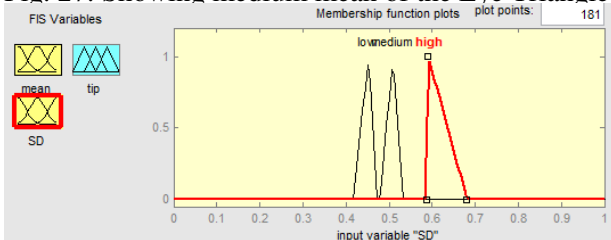


Fig. 28. Showing Low standard deviation Triangle. Medium mean Triangular [0.599; 0.602; 0.6415]

High SD Triangular [0.586; 0.591; 0.681]

The physical state of the driver is as shown in Fig. 29 below-

The physical state of the driver as the output: Close Triangular [0.446 0.5172 0.663]

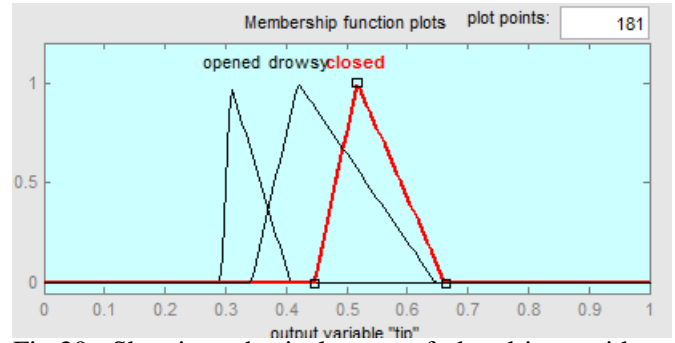


Fig.29. Showing physical state of the driver with closed eye.

Fuzzy output for partially opened eyes- Take rule 4 into account, IF standard deviation is medium AND mean is low THEN the eyes will be drowsy.

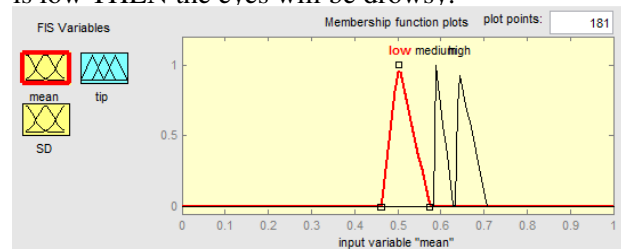


Fig. 30. Showing Low mean of the Eye Triangle.

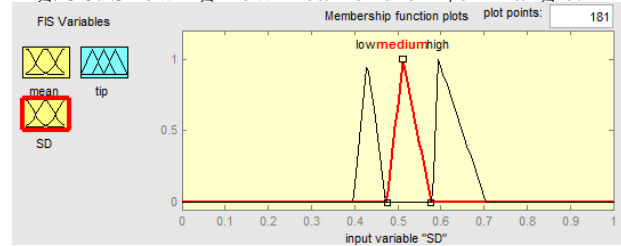


Fig. 31. Showing Medium standard deviation Triangle. Low mean Triangular [0.4616; 0.502; 0.575] Medium SD Triangular [0.48; 0.508; 0.533]

The physical state of the driver is as shown in Fig. 32 below.

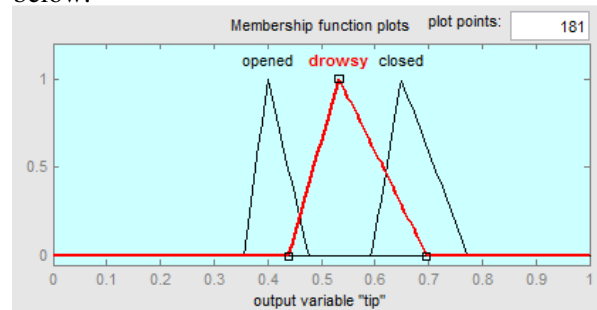


Fig. 32. Showing physical state of the driver with partially opened eye.

The physical state of the driver as the output: Drowsy Triangular [0.446; 0.5172; 0.663].

Surface view of various status of eyelid namely fully open, Partially open and closed are shown in figures 33 to 35v respectively

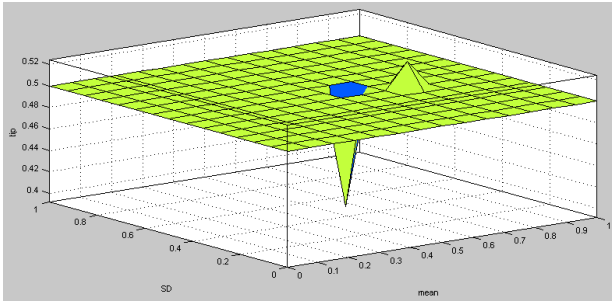


Fig. 33. Surface view of Opened state of the eye.

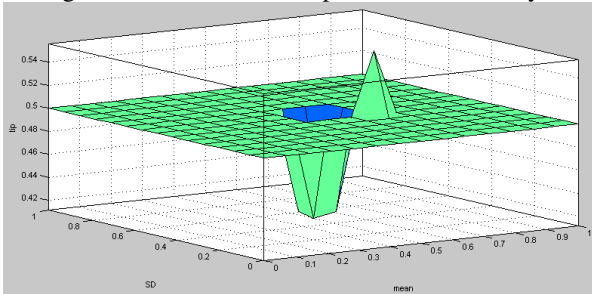


Fig. 34. Surface view of Partially Opened state of the eye.

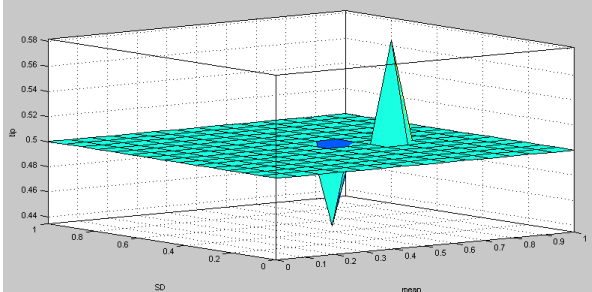


Fig. 35. Surface view of Closed state of the eye.

The statistical parameters calculated from the image namely mean and standard deviation determines the drowsiness state of the driver.

## 5. Conclusion

A vehicle driver drowsiness detection system using fuzzy logic and image processing technique has been done. As, one important issue is the lack of lighting during sunset that may cause errors when the images are read. Also, during night time the system need to properly detect the driver's eyes. This is overcome by use of Kalman filter's which makes the system to read any type of noisy images making the intelligent driver detection system adaptable.

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