Car Side Mirrors Angle Prediction Based on Pupil Position

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Abstract— The car side mirrors angle prediction can be done based on the driver's pupil position using machine learning. Using a camera that is placed in front of the driver, the distance between the camera and pupils, and the angle between the camera and pupils are detected by computer vision. This paper is briefed about our experimental setup and the idea of automating the car side mirrors adjustment with the car side mirrors optimum angle prediction based on the pupil position**.**

Index Terms—Computer Vision, Machine Learning, OpenCV, Python

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INTRODUCTION

Improper adjustment of the car side mirrors is one of the reasons for accidents. Drivers cannot see the correct back view if they adjust the car side mirrors at the wrong angle. Adjusting the side mirrors manually at an optimum angle is a complicated task. The driver should check the correct view and set the mirrors manually each and every time before starting the car. These days automation is the solution to many problems. Likewise, if we can find the correct angle of the car side mirrors for different types of people then we can easily automate the car side mirrors based on the optimum angle.

The angle of side mirrors can be predicted based on the driver's pupil position. The driver may be tall, short, and places the seat front or back, the pupil angle and distance from the camera can be taken as the features and we can predict the side mirrors angle from the car surface.

By predicting the angle of the side mirrors, automation becomes easier and henceforth we can reduce the accidents which are caused due to improper adjustment of the car side mirrors.

I. RELATED WORK

There are a few innovations that made the adjustment of car side mirrors easier. Using the buttons to electronically move the side mirrors to adjust them in the desired position is one of the existing methods. The buttons in this method are placed beside the steering or else on the door beside the driver's seat. With these buttons, we can move the side mirrors to the left or right and we can adjust them to the angle we are comfortable with.

Another method is saving the angle of car side mirrors which we adjust and whenever we start the car, the same angle will automatically get set.

In some cars, a joy-stick typed object is placed beside the steering. The glass of the car side mirrors moves according to the moment of the joystick. Without manual adjustment, this device helps the drivers to some extent.

Virtual exterior mirrors are the new version of side mirrors available in the market. In this model, cameras are placed
instead of side mirrors. The cameras will show the side and back view on a small screen that is placed on the car's front doors. The driver needs to swipe the screen and adjust the view accordingly.

The previous studies were made on the automatic mirror adjustment system in which the side mirrors and the room mirror of a car get adjusted to an optimal position for the driver based on the driver's pupil location [1]. This system measures the 3D coordinates of a pair of pupils using a stereo vision system. This system, regardless of driver replacement or driver's posture, can adjust the car side mirror and room mirror automatically.

One more study is based on detecting driver's mirror checking actions [7]. In this research, using non-invasive sensors, driver's mirror checking actions are monitored. Checking the side mirrors frequently is also an important task while driving to avoid accidents. This study compares the driver's mirror-checking behaviors which are observed during different maneuver actions like driving straight, turning, and switching lanes. These observations result in providing contextual information to improve new driving monitoring systems.

In addition to the above studies, an automatically adjustable rear mirror based on computer vision [14], in which this system can orient the car's interior rear-view mirror and provides the driver with a correct rear view. In this system, a camera is placed over a motorized rear-view mirror which is used to scan the interior car space and identifies the driver's face and eyes regardless of the number and position of car occupants. Based on the detection, the system computes the correct orientation of the rear-view mirror and adjusts accordingly.

Sleepy eye recognition for drowsiness detection [15] is one of the related works to this paper. This study is a solution for the accidents caused due to driver inattention. The face and eyes are detected at first and then the eye's state is detected to predict whether the driver is alert or sleepy.

The above works are the ones that are related to this research paper and the concept of reducing car accidents is the main common thing in all the above-mentioned researches. Our paper mainly focuses on detecting the correct angle of the car side mirrors. In this way, finding the correct angle from the surface to the car side mirrors makes automation easier. Predicting the optimum angle from the surface to the car side mirrors related to the driver (irrespective of driver's height, and seat position) can be done with the pupil distance and angle detection.

II. Proposed Method

The proposed method consists of four steps. A 2D camera is placed in front of the driver (above the car front glass). Firstly, the camera detects the pupil, and then the distance and angle between both pupils and the camera are detected (which are considered the features). Using these features, an experimental setup is made. Through the experiment, we get a data set that is needed to be trained. Henceforth, we can predict the car side mirrors' angle by this method.

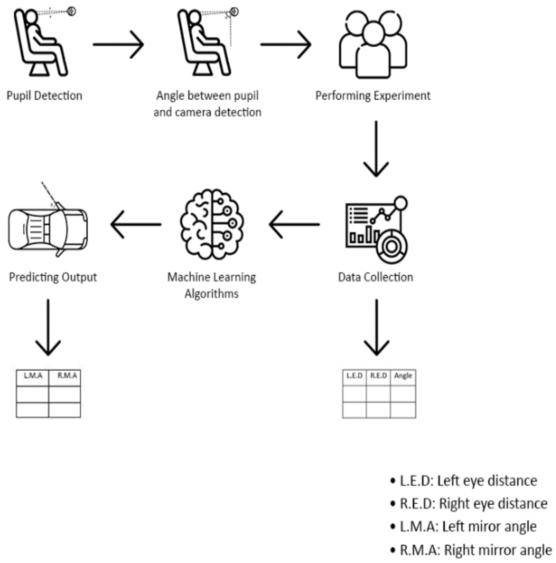

Fig. 1. Architecture diagram of the proposed model

A. Pupil Detection

Pupil detection is the basic and necessary step to be done in this research. Pupils are considered here as the main thing to calculate the car side mirrors angle. This is because the driver may be short, tall, and may adjust his seat to the front or back, the pupil position varies. Corresponding to the driver's placement, the side mirror's angle also varies. Hence, if we take the driver's pupil position as the base, then we can easily predict the car side mirror angle from the car surface.

Pupil detection can be done in various methods. One of the methods is detecting the pupils using harr cascade. The harr cascade classifier is a potential way to detect objects in the surrounding. In this method, a lot of positive and negative images are collected to train the classifier. In the same way, we can detect the pupil using the harr cascade classifier.

Pupil detection can also be achieved using the OpenCV. The function "find contours" in OpenCV, returns a set of boundaries of all the shapes that are found in an input image. The task here is to find the pupil and discard the rest. Therefore, our target pupils get detected using this method.

The below image (fig 2) is the output of our pupil detection. We used both harr cascades classification and the OpenCV contours method to detect the pupil.

Fig. 2. Pupil detection image (green color circles indicate the detected pupil).

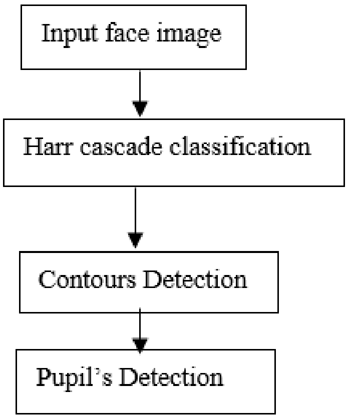

Fig. 3. Pupil detection process flow chart

B. Distance and angle detection from the pupil to the camera

The main features for the car side mirror angle prediction are considered to be the distance and the angle from the camera to the pupils. As mentioned before, the pupil distance and angle vary related to the driver's height and the seat they adjust, and logically the car side mirrors angle changes based on the driver's height and the seat placement. With this indirect relationship between the driver's pupil and the car side mirrors angle, we can predict the optimum angle of the car side mirrors from the surface of the car based on the pupil position.

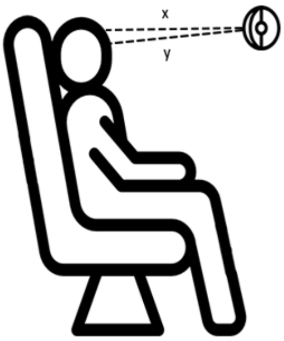

Fig. 4. Illustration of a person sitting in a car seat in front of a camera (x and y are the distances from the driver's left and right pupil to the camera respectively).

The above image (fig 4) is an illustration that specifies that x and y are the distances from the driver's right and left pupils to the camera (which is placed in front of the driver) respectively.

The below image (fig 5) is an illustration that specifies α is the angle between the driver's right and left pupils to the camera.

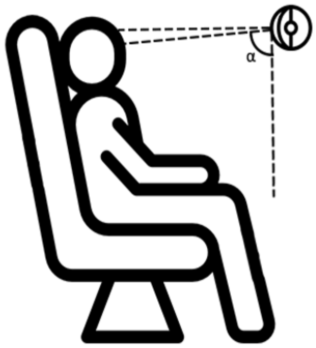

Fig. 5. Illustration of a person sitting in a car seat in front of a camera (α is the angle between the driver's pupils and the camera).

The next step in our proposed method is making an experimental setup to take the readings and prepare a dataset for machine learning prediction.

C. Experimental Setup

We took a car and placed a 2D camera in front of the driver's seat. The 2D camera is placed to detect the driver's pupil, the distance from the driver's pupil to the camera, and the angle between the driver's pupil to the camera.

We made people of different types of heights sit in the car and asked them to adjust the seat according to their comfort. From the camera placed in front of the person, we detected the distance and angle of the driver's pupils to the camera and then we adjusted the car side mirrors manually by asking the person whether they can see the view properly. After adjusting both car side mirrors at the correct angle, we noted down the angle from the surface to the side mirrors for both left and right mirrors.

Fig. 6. Our experimental setup (a person sitting in a car in front of a camera).

As shown in the below image (fig 7) the angle between the surface and the car side mirrors readings which are different for different types of people are noted down using our experimental setup.

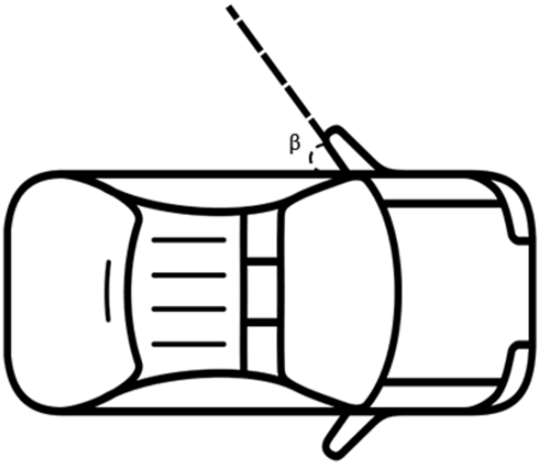

Fig. 7. Illustration of a car (β is the angle between one of the car side mirrors to the surface of the car).

D. Dataset

Distance from left pupil to the camera (in cm)	Distance from right pupil to the camera (in cm)	The angle from the pair of pupils to the camera (in degrees)	Car side mirrors optimum angle	
			Left mirror	Right mirror
25	25	58.8	69.6	63.2
24	24	49.5	64.5	58.7
23	23	39.8	58.9	53.4
22	22	30.0	55.5	50.3
20	20	19.3	50.8	44.6
18	18	17.3	50.0	39.5
16	16	15.5	46.7	34.3
14	14	13.2	44.3	28.9
26	26	59.8	73.2	68.3
26.5	26.5	60.5	75.7	70.8
27	27	68.5	80.9	75.8
27.5	27.5	71.0	83.4	78.3

Fig. 8. Readings noted from our experiment (Santro car Indian version).

Dataset is the main part of the prediction. We can collect data from many resources. The above dataset (fig 8) is made from our experiment. We detected the distance from the driver's pupils to the camera and the angle from the driver's pupils to the camera. Based on the detected values, we experimentally noted down the car side mirror's optimum angle related to the driver.

As we placed the camera exactly in between the person, the distance from the right and left pupil to the camera is approximately equal. As we all know, due to the difference in distance between the person and the car side mirrors, the angle of the right and left mirrors is different.

E. Model training and prediction

After obtaining the dataset, using machine learning regression, we can train the model and predict the output. Using machine learning, we can predict the car's left and right side mirrors angle for different inputs.

III. EXPERIMENTAL RESULTS

We have noted down the experimental values of the features and the optimum values of the left and right car side mirrors angle based on the features considered. Machine learning algorithms can be used on the obtained dataset and train the model, resulting in the prediction of the car side mirrors angle for different feature values (i.e for different drivers with different heights).

IV. LIMITATIONS

The proposed model is just the ideology behind automating car side mirrors adjustment with a connection between all the features which impact the car side mirrors angle. This model can be less feasible under low light conditions.

V. CONCLUSION & FUTURE WORK

Through this proposed method, we can predict the car side mirrors optimum angle, which makes the automation of car side mirrors easier. The existing systems are not successful at automating the car side mirrors. The main reason behind this proposed method is to reduce accidents that are caused by the improper adjustment and minimal usage of the car side mirrors. This proposed method can be scaled to a huge amount of data for building a successful machine learning model to predict optimum angles of car side mirrors. This model can be extended to synchronously work with hardware components for the usage of real-time applications.

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