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Distraction Detection by Eye Tracking using Raspberry-Pi for Driver Safety

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***Abstract*—Passively monitoring driver's eyes can help in detecting state of mind and alertness of driver and thus can reduce risk of accidents. Proposed system includes three main parts 1) Facial feature tracking 2) Eye gaze 3) Eyes off the road and fatigue detection. Video feed from camera installed on car dashboard tracks features of driver in real time (25FPS). Image processing algorithm is developed in OpenCV and implemented on Raspberry Pi board to make a compact embedded system. Different gaze zones are defined, few of which are eyes off the road points. SVM is used to train and classify different combinations of gaze and head pose angles to determine exact point of gaze. Based on algorithm output, if driver's eyes are off the road or eyes are closed due to fatigue then accordingly audio and steering vibration warnings are given to driver.**
***Keywords*—Moore law, Non-ideal effects, Carbon nanotubes, MOSFET, CNFET, Opamp, 32nm technology etc.**

I. INTRODUCTION

The main motive for eye gaze tracking based driver monitoring system is to reduce automobile accidents caused by distracted driving. Driver Monitoring System is a process where a system continuously monitors drivers face in a vehicle and detects one or more parameter at a time like face, eye, eye gaze, eye blinking, etc. Driver monitoring system based Eye gaze tracking and head pose estimation can help in continuously monitoring and alerting driver in case of distraction or eyes off the road (EOR). Implementing system that will give audio alerts depending on situation and wheel vibration alerts used to alert driver and reduce number of accidents caused by distraction is the motivation behind this project in order to improve traffic safety.

Proposed system requires video camera, Image processing, alert system and microprocessor as main blocks for the design.

Selection of microprocessor will be done based on number required memory size, number of analog and digital input/output pins. Hence, for system design microprocessor boards like Raspberry Pi, Banana Pi and Intel Atom can be considered. Depending upon number of peripheral used and memory size required for system design, system will be design Raspberry Pi as main control unit due to following design considerations.

1) Raspberry Pi is open source and its documentations are easily available.

2) Raspberry Pi has USB ports that can be used to connect USB video camera as per the need of project.

3) GB RAM and 1.2 GHz, 64 bit processor facilitates faster execution.

4) Raspberry Pi 3 has 40 digital input/output pins.

5) Raspberry Pi 3 contains Broadcom video core IV processor, which is very helpful in performing image-processing applications as per the need of project.

The automobile industry is growing continuously. Thus, number of vehicles and traffic problems are going to increase in near future. To reduce risk of accidents driver-monitoring systems are very important for traffic safety. In view of this, the objectives of the work are as per the following:

To track driver's face and eyes in real time.

- Eye gaze tracking and eye gaze estimation.
- Eye gaze estimation to determine fatigue detection.

- Eye gaze estimation to determine eyes off the road detection.
- Generating alarms for driver based on the scenario.
- To alert driver continuously.
- To reduce number of accidents caused by driver distraction.
- Make portable and nonintrusive system.
- To alert driver continuously basis.

II. LITERATURE SURVEY

Literature is reviewed in three sections. First section presents literature reviewed related to Driver monitoring systems. In second section, literature related to existing methods of eye gaze tracking is reviewed. The third section is related to proposed system using Raspberry Pi.

Driver monitoring systems:

This section presents literature review regarding different approaches for driver monitoring systems.

Types of driver monitoring system:

Fatigue/distraction detection can be categorized into three categories (1) Approaches based on bioelectric signals (*e.g.*, EEG and ECG), (2) Approaches based on steering motion, lane departure (3) Approaches based on driver face monitoring (eye closure, eyelid distance, blinking, gaze direction, yawning, and head rotation etc.)

Table 2.1 Comparison between the types of driver monitoring systems

Property	**Approaches**		
	Steering Motion	***Bioelectric Signal***	***Driver Face monitoring***
Fatigue Detection	Yes	Yes	Yes
Distraction Detection	Yes	No	Yes
Accuracy	Good	Very Good	Moderate
Complexity	Moderate	Complex	Easy
Detection Speed	Slow	Very Fast	Fast

Eye gaze tracking systems can be broadly classified into intrusive and non-intrusive techniques. Intrusive techniques require special attachments such as goggles, electrodes, contact lenses or head mounted devices. But intrusive methods interfere with the user and are inconvenient thus limited for laboratory testing. The systems which do not have any physical contact with the user and the eye tracker apparatus are referred as non-intrusive systems or remote systems. Non-intrusive techniques are mainly based on image processing and can be passive image based or video feed based.

Implemented driver monitoring systems:

Different papers explore the potential to use wearable devices for steering and driver tracking. There are wrist mounted inertial sensors that can track steering wheel usage and angle. Inparticular, tracking steering wheel usage and turning angle provide fundamental techniques to improve driving detection, enhance vehicle motion tracking by mobile devices, and help identify unsafe driving. The approach relies on motion featuresthat allow distinguishing steering from other confounding handmovements. Once steering wheel usage is detected, it furtheruses wrist rotation measurements to infer steering wheel turningangles. This approach can achieve hand on steering wheel detection with a rate around 99% and provide warning of unsafe driving when a driver's hand is off the steering wheel with a rate above 80%.

Another paper developed an in-vehicle measurement system that monitors the physiological signals i.e. bioelectric signals (i.e., heart rate, heart rate variation, breathing and eye blinking) of drivers. These physiological signals will be utilized to detect the onset of driver fatigue. This study developed a non-contact sensing platform that can remotely detect bioelectrical signals in real time. With delicate sensor electronics design, the bioelectrical signals associated with electrocardiography (ECG), breathing and eye-blinking can be measured. The current sensor can detect the Electrocardiography (ECG) signals with an effective distance of up to 30 cm away from the body. The sensor performance was validated on a high fidelity driving simulator. Digital signal processing algorithms has been developed to decimate the signal noise and automate signal analyses. The characteristics of physiological signals indicative of driver fatigue, i.e., the heart rate (HR), heart rate variability (HRV), breath frequency and eye blinking frequency, can be determined. A robust drowsiness indicator is being developed by coupling the multiple physiological parameters to achieve high reliability in drowsiness detection. EOG (Electro-calligraphy), sEMG (**Static and Dynamic Surface Electromyography**), EEG (electroencephalogram) are other bioelectric methods to estimate driver inattention but are costly to implement.

Techniques that use face monitoring use eye closure, eyelid distance,blinking, gaze direction, yawning, and head rotation as a parameters to estimate driver distraction. There have been some studieswith regard to eyelid movements, such as blink frequency, average eye-closure speed (AECS), percentage of eye closure (PERCLOS) as quantitative measures of the drowsiness level of an individual. Among them, PERCLOS is reported to be the best and most robust measure for fatigue detection.

Broadly there are two approaches to estimate gaze direction. Techniques that only use the head pose and those that use the driver's head pose and gaze. Systems based only on head pose use size, shape, and distance of facial features and the distance between these features, such as the distance between the left and right pupils to estimate driver's head orientation. The head-pose only estimation often requires multiple cameras or complex face models that require accurate and lengthy initialization. Also using only eye gaze estimator is not sufficient and accurate in case of non-frontal faces, sunglasses and poor lighting conditions. Thus using hybrid scheme to combine head pose and eye location information to obtain enhanced gaze estimation is suggested.The detection of driver distraction mostly relies on the classification techniqueSupport Vector Machine (SVM) classifier for gaze estimation. One or more features are used to design SVM. The commonly used features include driving performance based indicators e.g., speed, steering angle, lateral lane position, brake pressure and eye movement based indicators, e.g., gaze distribution, head orientation, fixation duration and saccade frequency. Driver cognition or distraction can hardly be presented by a linear model, and hence, nonlinear modeling techniques are adopted in the cognitive distraction detection. Real time Hidden Markov Models (HMMs) were also used in some approaches. But SVM are more common and accurate with average accuracy of 82%.

Eye gaze tracking and estimation

This section presents review regarding different eye gaze tracking and estimation approaches used for different applications.

Approaches for eye gaze tracking

The concept of eye-gaze tracking and estimation in unconstrained conditionshas become a hot research topic in the last few years' with a variety of algorithms and setup configurations being developed through interdisciplinary research. Much of the initial research involved intrusive systems for gaze tracking, such as electrooculography, scleral coils, or special contact lenses, requiring the user to wear some kind of head-mounted device eye attachment to estimate gaze. Such systems are awkward and intrusive for the user and generally unsuited for use.

More recent research has employed passive video-based gaze trackers placed at a specific distance from the user, and gaze estimation is effected by capturing and processing images of the full face or eye region in natural light or using active illumination at near infrared (NIR) wavelengths. The NIR illumination is not perceived by the subject, and such systems are nonintrusive. Apart from improved user convenience, another advantage of these passive systems is their low setup cost, as they just use one or two cameras and a few LEDs.

Eye-gaze tracking methods can be broadly categorized into two general approaches:

Appearance-model-based:

The appearance-model-based methods use the general shape of the eyes and position of the pupils relative to the eye corners to find the point of gaze. A pre-trained model of the shape and of the eye region are fitted to a sequence of image frames. It provides a fit to eye regions depending on whether the model is trained with sufficient data that match the acquisition conditions and physical characteristics of the input eye region.

Advantages of the appearance-model-based methods:

The main advantage of these approaches is their low hardware requirements. This method is suitable for implementation on platforms without a high-resolution camera or additional light sources. Algorithm for processing is also simple.

Disadvantages of the appearance-model-based methods:

The main disadvantage of this class of methods is low accuracy. Considering head position, it is typically 2˚ or 3˚ for fixed head position. As a result, it can be stated that small changes in eye gaze (1–2˚ difference) may not be detected by the appearance-based methods. Other problems arise with changes in head pose, variation in global illumination due to different directional light sources, facial expressions, and skin color. Compensating for all of these issues requires large training data sets and makes appearance-based methods computationally expensive.

Feature-based methods:

These methods take into account various characteristics ofthe human eye to identify a set of distinctive features like contours, eye corners, and corneareflections of NIR illuminators (LEDs). Feature based models can be further divided into regressionbasedand model-based methods. Regression based method is also called pupil center corneal reflection (PCCR). A vector between corneal reflections and pupil center is tracked and mapped geometrically with a polynomialregression function to gaze coordinates on virtual screen / monitor screen.The eye-model-based techniques use the geometrical modelof the human eye along with NIR light sources.

Advantages of feature-based methods:

The advantages of feature-based methods include higher accuracy in comparison to the appearance-based methods. This method is computationally inexpensive.

Disadvantages of feature-based methods:

The main disadvantage is the hardware requirements for implementing these techniques as they need severallightsources or multiple cameras. The other problem is that if theNIR glints in the cornea disappear due to head movements oradditional glints appear in the eye from other NIR sources (e.g.halogen lights, sunlight, and reflections from eyeglasses), themethod will fail.

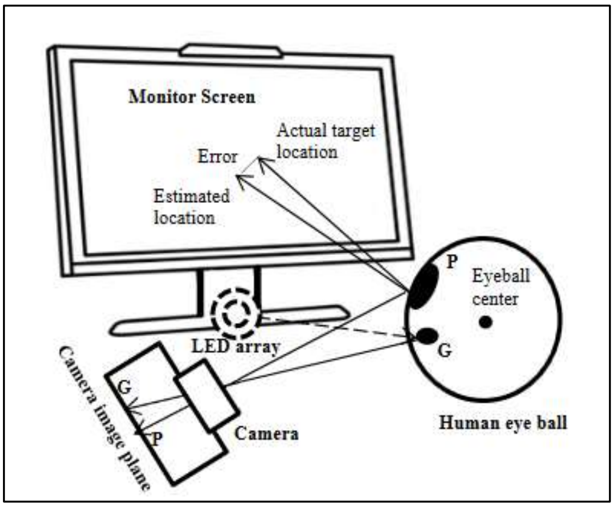

Fig 2.1 schematic for a feature-based eye-gaze-tracking method

III. SYSTEM ARCHITECTURE

In this chapter system block diagram, its working and design flow is explained in brief.

Driver monitoring system

Proposed driver monitoring system based Eye gaze tracking and head pose estimation can help in continuously monitoring and alerting driver in case of eyes off the road (EOR) or distraction and drowsiness. Implementing system that will give audio alerts and wheel vibration alerts depending on situation. To reduce number of accidents caused by distraction is the motivation behind this project in order to improve traffic safety.

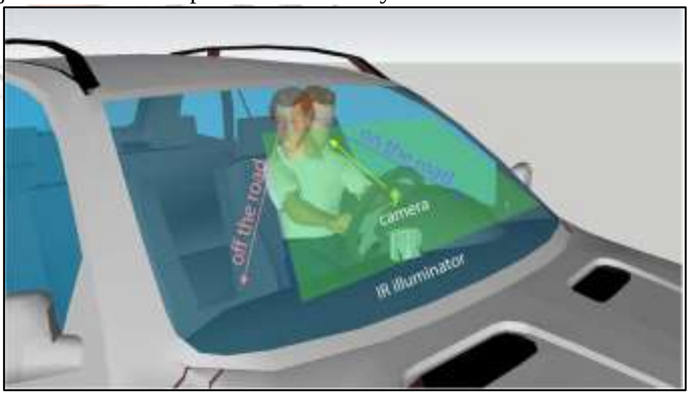

Fig.3.1: Concept of eyes off the road (EOR)

Block diagram of the system

Figure3.2 shows, the block diagram of the system. It consists of Raspberry PI unit, Power supply, USB web camera, Alarm Generator and Vibration Generator. All blocks are explained in detail as follows. Main working of the project lies in its algorithm i.e. software part.

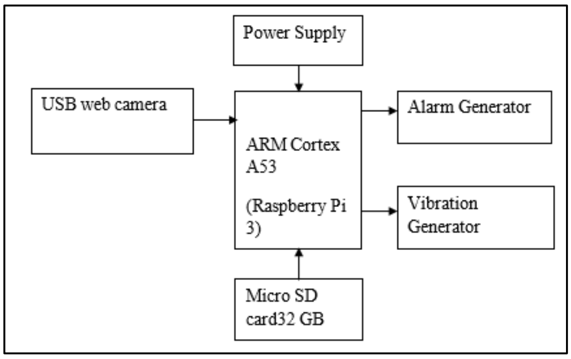

Fig.3.2: System block diagram

Control Unit

Control unit consists of Raspberry Pi 3 single board computer which is very compact in size equal to size of credit card. It is used in the system as central module of complete embedded image capturing and processing system. The main signal processing chip unit used in Raspberry Pi3 is Broadcom BCM2837 Arm Cortex A53 Quad Core Processor powered Single Board Computer running at 1.2GHz.CPU is a 64 bit ARM- RISC processor. It has on-chip graphics processing unit GPU (VideoCore IV) which makes it most suitable for image-processing applications. It is powered with 1 GB RAM to run powerful applications. It has 40 pin extended GPIO with4 USB ports. Other than this it is also provided with HDMI port, Ethernet port and micro SD card slot. A 3.5 mm 4 pole stereo output jack provided for audio output.

Software part i.e. operating system plays an important role in working of control unit and handles major working part of algorithms and control functions. Raspbian-stretch operating system image is installed on Raspberry Pi which is a version of Linux. Raspbian-stretch is operating system, which is based on Debian which is optimized specially for the hardware of Raspberry Pi and is free. Operating system is the set of basic utilities and programs that makes Raspberry Pi run properly as a standalone computer. Micro SD card plays important role in software part as operating system and OpenCV will be residing on it. Fig 3.3 labels various peripherals of raspberry Pi 3 board.

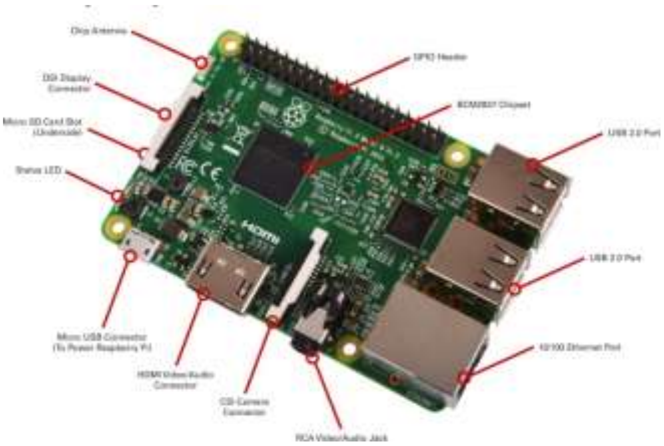

Fig.3.3: Raspberry Pi 3 peripherals

USB web camera

Camera model used in the project is Logitech c270 HD webcam. This is a low cost high definition webcam. USB webcam is used based on CCD mechanism. Camera has HD video recording facility with capture rate of 1280 x 720 pixels. As it has high-speed USB support, it is interfaced with Raspberry Pi 3 using USB port. Camera can be placed on car dashboard above the steering wheel approximately 35-40 cm away pointing straight to the driver. Placing camera in this way makes capturing driver's face very easy. Operation of the camera is mainly to provide clearer image of the driver's face without distracting driver.

Micro SD card

The operating system on Raspberry Pi board ids installed using a class 4 32GB Samsung Micro SD Card with help of Micro SD Adapter. OpenCVis then installed on Raspbian-stretch using Micro SD card. All algorithms are implemented in OpenCV installed on Linux. Different dependencies are also installed on Micro SD card, which will support image acquisition and processing. Micro SD card acts as a memory for raspberry and all the software and data resideson it.This card is loaded with NOOBS (New Out of Box Software) which is further extended to Raspberian Stretch.

Battery/ Power supply

System requires power supply to operate andcontrol all the components. Four wheeler vehicles normally have battery power supply of 12V. All the components takes power from that same source as and when required. Every component has its own requirements of power and based on that, it will take current and voltage from the battery supply. System requires power supply of 5.1 V for Raspberry Pi. For testing purpose, Raspberry Pi is connected sometimes tocomputer. Raspberry pi controller powers other components.

Alarm generator

Proposed driver monitoring system based Eye gaze tracking and head pose estimation can help in continuously monitoring and alerting driver in case of eyes off the road (EOR) or distraction and drowsiness. Implementing system, which will give audio alerts depending on the situation. Audio alarms can be generated using audio output of Raspberry Pi by either using speaker or headphone. Audio alarms used are prerecorded voice messages. Irritating and alarming music can also be used.

Vibration generator

Similar to alarms steering vibration alerts will be generated based on situations. Vibrations apply quick stimulation to driver compared to audio alerts. Especially when the driver is sleepy.

Operation of the system

Figure 3.2 illustrates the block diagram of system. There are not much physical components involved in the design. The software module handles much part. The operation of the system can be divided broadly into steps.

1. Image acquisition.
2. Eye detection and tracking.
3. Gaze estimation
4. Eyes off/on the road detection.
5. Fatigue detection.
6. Alerting the driver.

Logic design flow for the system

Logic flow of system is shown in Figure3.3. Logic design flow of the system is as follows.

i. As long as we get more frames from the camera feed, the frames are being continuously captured and analyzed.

ii. After the frame is captured first step is to detect face and eyes from the frame.
iii. If face is detected but no eyes are detected then the task is to find out if driver is drowsy. If the driver is drowsy i.e. if eyes closed warn driver else go to next frame.
iv. If eyesare detected in the frame then eye gaze direction is computed.
v. By combining steps iv and v algorithm finds if eyes are off the road. If eyes are off the road alert is generated for driver. Else algorithm proceeds to next frame.
vi. If there are no more frames algorithm is stopped.

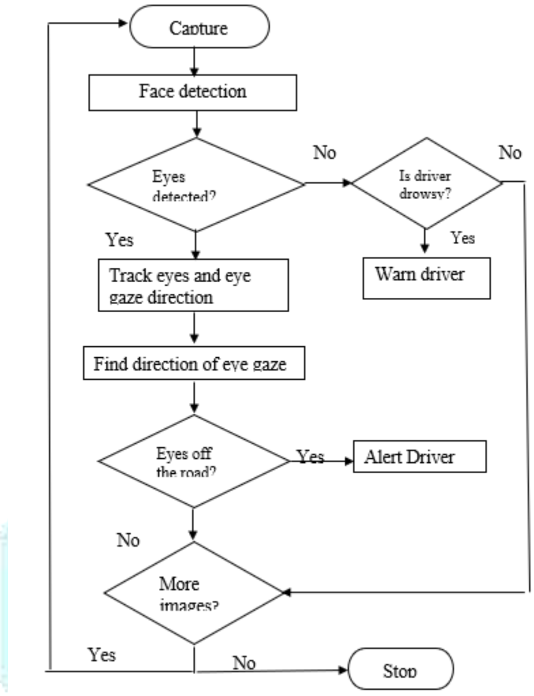

Fig.3.4: Logic design flow for the system

System requirements: Hardware

The system hardware requirements are divided into three parts. The requirements for proposed system are as follows

i. Control unit: -Raspberry Pi 3 model
ii. Web camera: -Logitech c270 HD webcam
iii. Micro SD card: - Samsung 32GB class 4 card loaded with NOOBS (New Out of Box Software).
iv. Speaker or headphone.

System requirements: Software

i. Operating system: - Raspbian-stretch operating system
ii. OpenCV version 2.7 and 3.5.4 for writing image processing algorithm.
iii. Python for writing control operation of Raspberry Pi.

Design issues of the system

Design issues, that are occurred during logic design of the system as follows

i. Image processing techniques can fail sometimes depending upon situations and environment. E.g. In poor light conditions or too fast movements might interfere in correct capture of the frame.
ii. Real driving environments are dynamic and change frequently in terms of speed, light, driver postures etc. which makes correct estimation difficult.

Training the system (machine learning) is very important step and needs to be carried out correctly to ensure correct operation.

IV. DESIGN METHODOLOGY

In this section, design methodologies, which are used for system implementation, are presented. Various algorithms and methodologies implemented are discussed. As mentioned in chapter 3 system operations can be divided in 7 steps.

1. Image acquisition.
2. Eye detection and tracking.
3. Head pose estimation.
4. Gaze estimation
5. Eyes off/on the road detection.
6. Fatigue detection.
7. Alerting the driver.

Image acquisition

USB webcam is used and it is interfaced to Raspberry Pi 3 using USB port. Camera can be placed on car dashboard above the steering wheel approximately 35-40 cm away pointing straight to the driver.Video feed is available continuously provided to raspberry Pi and Image acquisition is carried out from the feed frame by frame. Camera resolution needs to be set. Resolution is set to 640*480.initWebcamis a class used to initialize webcam. Face height and width indicates size of face detection frame.

constintfaceWidth = 70;
constintfaceHeight = faceWidth;
constint DESIRED_CAMERA_WIDTH = 640;
constint DESIRED_CAMERA_HEIGHT = 480;

After the webcam has been initializedcurrent camera image can be grabbed asacv::Mat object (OpenCV's image container). Each camera frame can be grabbedby using the C++ streaming operator from your cv::VideoCaptureobject into a cv::Mat object.

Face and Eye detection

Facial feature tracking algorithm is implemented in OpenCV using Raspberry Pi. Viola Jones algorithm is used which is a four step algorithm

1. Haar feature selection (eyes)
2. Create an integral image
3. Adaboost training on integral image
4. Cascading the classifier

Haar cascade classifiers

In 2001 Viola and Jones invented the Haar-based cascade classifier for object Detection. It is an object, detector that is both fast, reliable and allows real-time face detection and face recognition. This object detector was extended in OpenCV v2.7 to also use LBP (Linear binary pattern) features. LBP-based detectors are several times faster than Haar-based detectors. The basic idea of the Haar-based face detector is that if you look at most frontal faces, the region with the eyes should be darker than the forehead and cheeks, and the region with the mouth should be darker than cheeks, and so on. It typically performs about 20 stages of comparisons like this to decide if it is a face or not.

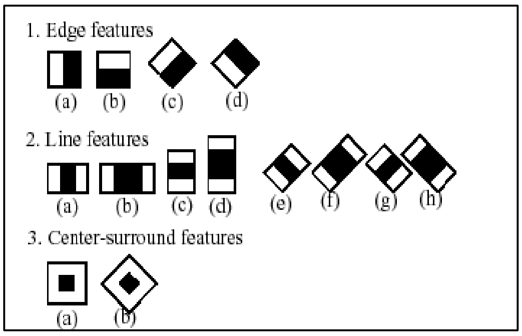

Fig.4.1: Haar like features

The word "cascade" in the classifier name means that the resultant classifier consists of several simpler classifiers (*stages)* that are applied subsequently to a region of interest until at some stage the candidate is rejected or all the stages are passed. The word "boosted" means that the classifiers at every stage of the cascade are complex themselves and they are built out of basic classifiers using one of four different boosting techniques (weighted voting). The basic idea of the LBP-based face detector is similar to the Haar-based one, but it uses histograms of pixel intensity comparisons, such as edges, corners, and flat regions.

Coding requirements

OpenCV comes with some pre-trained Haar and LBP detectors for direct use. Table 2.1 lists different xml classifiers used in coding. Haar-based detectors are stored in the folder data\haarcascades and LBP-baseddetectors are stored in the folder data\lbpcascadesof the OpenCV root folder i.e. C:\opencv\data\lbpcascades\.

Table 4.1 xml file name

Type of cascade classifier	*Xml file name*
Face detector (fast Haar)	haarcascade_frontalface_alt_tree.xml
Face detector (fast LBP)	lbpcascade_frontalface.xml
Left Eye detector	haarcascade_mcs_lefteye.xml
Right Eye detector	haarcascade_mcs_righteye.xml
Eyeglasses eye detector	haarcascade_eye_tree_eyeglasses.xml

To perform object or face detection, first pre-trained XML file need to be loaded using OpenCV's Cascade-Classifier-class.

Eye detection

Eye detection is very useful for face preprocessing, because for frontal faces youcan always assume a person's eyes should be horizontal and on opposite locations of the face and should have a fairly standardposition and size within a face.Onlyeyedetection on a whole face will be much slower and less reliable. Different eye detectors are better suited to different regions of the face, for example, the haarcascade_eye.xml detector works best if it only searches in a very tight region around the actual eye, whereas the haarcascade_mcs_lefteye.xml and haarcascade_lefteye_2splits.xml detectors work best when there is a large region around the eye.

Eye tracking

Driver eye gaze is constantly changing during driving depending on surrounding conditions. Thus detecting eyes is not sufficient. Eyes need to be tracked in real time.Hence detecting eyes is not sufficient. Eyes need to be tracked in real time. Continuously Adaptive Mean Shift (CAMSHIFT) algorithm is used for real time eye tracking. Pupils of the eyes are tracked.

Active Appearance Models (AAM)

Active appearance model is an object model containing statisticalinformation of its shape and texture. It is a powerful way of capturing shape and texture variation from objects.Givenanimagewe can use an Active Appearance search algorithm to find the 2D pose of the human head. Upper-right side figure 4.2 shows a previously trained Active Appearance model used in the search algorithm. After a pose has been found, POSIT can be applied to extend the result to a 3D pose. If the procedure is applied to a video stream then 3D tracking by detection will be obtained.

Fig 4.2 Active appearance model (AAM) search

As mentioned previously, AAMs require a shape model, and this role is played by Active Shape Models (ASMs).The shape model is generated through the combination of shape variations.

Triangulation

The concept of triangulation is very simple. To create triangles including our annotated points andthen map from one triangle to another. OpenCV comes with a handy function called *cvCreateSubdivDelaunay2D*, which creates an empty Delaunay triangulation. This a good triangulation that will avoid skinny triangles.

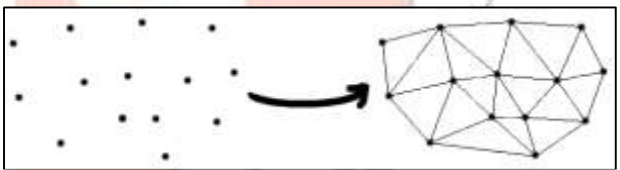

Fig 4.3 triangulation using Delaunay algorithm

Pose from Orthography and Scaling with ITerations (POSIT).

After a pose has been found using AAM, POSIT can be applied to extend the result to a 3D pose.

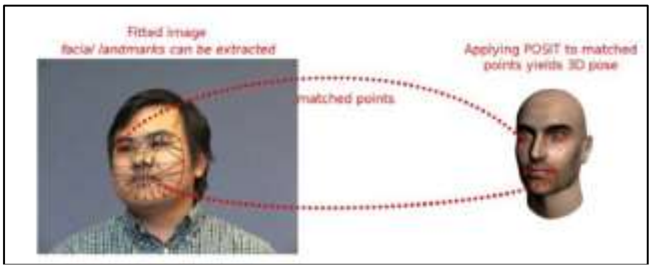

Fig 4.4 POSIT fitting of AAM model

Eyes off the road (EOR) detection

Similar to concept used in [3] [6] [9], Different zones are defined in the car as shown in fig.3. Zones are defined in point of view of a driver with left hand drive system. 11 different gaze zones representing the dashboard, the centre console, the rear-view mirror, two side mirrors and six zones on the windshield. These defined zones cover most of the possible gaze directions involved in real-world driving.

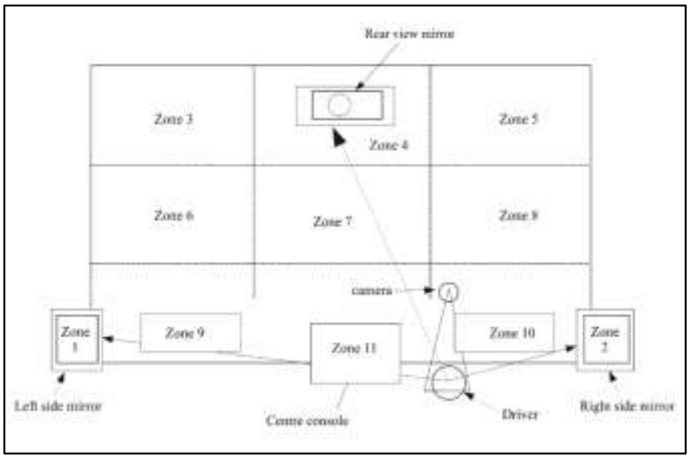

Fig.4.5: Different gaze estimation zones for left hand drive car

TABLE 4.2 shows different on the road and off the road points. Driver's gaze direction lies in which area depends on the combination of eye gaze estimation and head pose estimation calculations. Classifier is designed for different combinations of eye and head pose directions. Then it is decided whether driver gaze lies in off the road and accordingly alerts are generated.

Table 4.2 Gaze zone partitioning

Zones	*Gaze zone type*
2,4,5,7,8	On the road
1,3,6,9,10,11	Off the road

Fatigue detection

A scientific definition for fatigue has not been defined. But there are several relations.Fatigue is of three types: sensory fatigue, muscle fatigue and cognitive fatigue. Sensory fatigue and muscular fatigue are measurable but not cognitive fatigue. There is a relation between the fatigue/drowsiness and body temperature, electrical skin resistance, eye movement, breathing rate, heart rate and brain activity. Eye movement is used to detect drowsiness i.e. fatigue. If closed eyes are detected longer than 3 seconds then driver is supposed to be in drowsy state and wake up alert is generated.

Alerting driver

Once the fatigue is detected, the driver should get notified and alerted. Vibration sensor is used to give vibration alert and also audio output is used to alert the driver.

V. Summary

In this document, the information about the eye gaze tracking and eyes off the road detection and its evolution is discussed. Different techniques used, and related design issues and feasible solutions are discussed along with objectives of the system.

Also, system architecture along with block diagram is explained. This was discussed by explaining different blocks, its function in brief and aalgorithm for that.

Also, operation of the system is explained using basic flow diagram and issues occurred till now in the design has been highlighted.

In chapter 2, literature Also Design methodology is presented in Open loop and Close loop synchronization part. Different design steps, which are used during these parts is also presented. In both parts design challenges that are faced during system implementation are also given. In the end, software tools, which are used for system implementation and experimental setup, are also given.

The document overall explains the details of different algorithms, design methodologies and its result and applications in general.

VI. CONCLUSION

I. Proposed system deals with driver safety considering his / her facial expressions using Raspberry Pi.
II. Different methods and algorithms can be built based upon the location and facial contents in low profile vehicles.
III. Face detection, eye gaze detection can improve driver safety.
IV. Raspberry Pi can adapt itself based upon the inputs / images captured and the accuracy can be increased by improving the contents by machine learning.

VII. Direction of Future work

Future work consists of actual measurements and comparing the results and detection of the eyelid and gaze based on the different algorithms mentioned in above document.
It may also consist of teaching the Raspberry PI module for recognizing the faces efficiently.

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