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DRIVER DROWSINESS DETECTION SYSTEM

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ABSTRACT

In recent years' motive force fatigue is one among the fore more causes of car accidents within the world. A right away manner of measure motive force fatigue is measuring the state of the motive force i.e. somnolence. Therefore, it is vital to notice to notice the somnolence of the motive force to avoid wasting life and property. This project is aimed towards developing a prototype of somnolence detection system. This project is aimed towards developing a model of somnolence detection system. This technique may be real time that captures image continuously and measures the state of attention in line with the required formula and gives warning whenever required.

Though the square means many ways for measuring the somnolence however this approach is totally non-intrusive that does not have an effect on the motive force in any manner, thus giving the precise condition of the motive force. For detection of somnolence the per closure worth of eye is taken into account. Therefore once the closure of eye exceeds a definite quantity then the motive force is known to be asleep. For implementing this technique many OpenCv libraries square measures used as well as Haar-cascade. The whole system is enforced victimization Raspberry-Pi.

Chapter 1

1.1 Introduction

The attention level of motive force degrade as a result of less sleep, long continuous driving or the other medical condition like brain disorders etc. Many surveys on road accidents says that around thirty percent of vehicle accidents are caused by fatigue of the motive force. When driver drives for over traditional amount for human then excessive fatigue is caused and conjointly leads to weariness that drives the motive force to asleep condition or loss of consciousness.

Drowsiness many be advanced development that states that there is a decrease in alerts and aware levels of the motive force. Although there is no direct live to notice the sleepiness however many indirect ways can be often used for this purpose.

In chapter 1, in initial sections differing types of ways for measuring the somnolence of the motive force are mentioned that includes Vehicle primarily based measures, Physiological activity measures, Behavioral measures. Mistreatment of those ways that associates intelligence system are often developed that might alert the motive force just in case drowsy condition and stop accidents. Benefits and non benefits comparable to every and each system is explained. Reckoning on benefits and downsides the foremost appropriate technique is chosen and projected. Then the approach for entire system development is explained using a flow chart that includes capturing the image in real time continuously, then dividing it into frames. Then every frames square measures analyzed to search out face first. If a face is detected then then next task is to find the eyes. After the positive result of locating eye the number of closure of eye is set and compared with the reference values for the drowsy state eye. If drowsy condition is detected then driver is alarmed else repeatedly the loop of finding face and detective work drowsy condition is disbursed.

In latter sections object detection, face detection and eye detection and eye detection is explained in elaborated manner. As a result of which face may be a variety of object thus many studies on object detection is finished. In face detection and eye detection totally different approaches for each square measure projected and explained.

In chapter three, theoretical base for planning the whole system is explained that incorporates Principal Component Analysis (PCA) and Chemist face approach. We all know that the structure of face is advanced and multidimensional. A face desires nice hard ways and techniques for recognizing it. During this my approach will treating a face as a two dimensional structure and accordingly it should be recognized. Principal Component Analysis (PCA) is used for face recognition for this context. This concept involves the projection of face pictures into that specific face area. Then we tend to write in the code the variation or distinction among the required known faces. Chemist face decides and defines the face area. We tend to represent these faces as chemist vectors. These vector consists of all sets of faces. Cases of similarity with totally different options of our face seems like nose, Eyes, lips etc.

The Chemist face approach uses the PCA for recognition of the pictures. The system performs by projecting pre extracted face image onto a collection of face space that represents significant

variations among notable face pictures. Chemist face approach includes Chemist Values and Chemist Vectors, Face Image Illustrations, Mean and Mean focsed Pictures, variance Matrix, Chemist Face Space.

In chapter four, the implementation half is described. The hardware that is used for the entire system is Raspberry Pi. Hence a quick introduction on Raspberry Pi is given followed by theoretical approach in details on somnolence detection system that features Haar Cascade, forming Integral Image, Adaboost and Cascading. All those four higher than ways were used infinding the state of eyes and forming algorithmic program for that. Then correct code were written to implement the planned algorithmic program. Raspberry Pi was set up properly for implementation. several subjects were taken to record the response and dealing of the system. The opening ofeyes were indicated by circular shapes. If drowsy state is detected then circle doesn't seem indicating the closure of eye or drowsy state of a driving force. Results were shown with Several photos with both eye gap and shutting condition.

In chapter Six, drawbacks of the system were explained and also the needed future work to get rid of those drawbacks and to create a sturdy intelligent motive force assistance system was stressed. Finally the conclusive half includes the general performance of the planned and enforced system.

Chapter 2

Somnolence

Somnolence is outlined as a shriveled level of awareness delineated by drowsiness and bother in staying alarm however the person wakes with straightforward excitement by stimuli. It would be caused by absence of rest, medicine, substance misuse, or a cerebral issue. It is principally the results of fatigue that may be each mental and physical. Physical fatigue, or muscle tiredness, is that the temporary physical failure of a muscle to perform ideally. Mental fatigue is a temporary failure to stay up ideal psychological execution. The onset of exhaustion amid any intellectual action is progressive, depends on a human psychological capability, what is more upon totally different components, for instance, lack of sleep and general well-being. exhaustion has in addition been seemed to diminish physical performance. It can show as sleepiness, dormancy, or coordinated thought weakness.

In the past years in step with accessible information driver drowsiness has gotten to be one in all the important reasons for street mishaps prompting ending and extreme physical injuries and loss of economy. A driver United Nations agency falls asleep is in a grip of losing management over the vehicle prompting crash with alternative vehicle or stationary bodies. Keeping in mind to prevent or cut back the quantity of accidents to a good extent the condition of drowsiness of the driver ought to be discovered unceasingly.

Measures for detection of Somnolence

The study states that the explanation for a mishap will be categorized united of the related primary classes: (1) human, (2) transport, and (3) encompassing issue.

Many measures accessible for the measuring of sleepiness that has the following::

1. **Vehicle based mostly measures.**
2. **Physiological measures.**
3. **Behavioral measures**

1. Vehicle based mostly measures.

Vehicle-based measures survey path position, that monitors the vehicle's position because it identifies with path markings, work out driver weakness, and accumulate wheel

movement data to characterize the fatigue from low level to high level. In several research, researchers have used this methodology to sight fatigue, light the continual nature of this non-intrusive and cost-efficient observance technique.

This is done by: **1**. Explosive deviation of car from lane position.

2. Explosive movement of steering wheels.

3. Pressure on acceleration paddles.

For each measures threshold values area unit determined that once crossed indicated that driving force is drowsy.

Advantages: 1. It's non invasive in nature.

2. Provides nearly correct result.

Disadvantages: 1. Vehicle based measures mostly affected by the geometry of road that sometimes unnecessarilyactivates the alarming system.

2. The driving form of the present driving force has to be learned and sculptures for the system to be economical..
3. The condition like small sleeping that principally happens in straight highways can't be detected.

2. Physiological measures.

Physiological measures area unit the target measures of the physical changes that occur in our body as a result of fatigue. These physiological changes will be merely live by their individual instruments as follows:

ECG (electro cardiogram) EMG (electromyogram) EOG (electro occulogram) EEG (electroencephalogram)

Monitoring Heart Rate: Associate degree cardiogram sensing element will be put in within the wheel of a automotive to observe a motive force's pulse that offers a proof of the motive force's level of fatigue indirectly giving the state of sleepiness.

In addition the cardiogram sensing element will be introduced within the back of the seat.

Monitoring Brain Waves: Special caps embedded with electrodes measures the brain waves to spot fatigue in motive forces and report ends up in real time. Then every brain waves may be classified consequently to spot drowsiness.

Monitoring muscle fatigue: As muscle fatigue is directly associated with drowsiness. we all

know throughout fatigue the pressure on the wheel reduces and response of the many muscle drastically reduces thence it may be measured by installation of pressure sensors at wheel or by mensuration the muscle response with applied stimuli to find the fatigue.

Monitoring eye movements: Invasive activity of eye movement and eye closure may be done by exploitation electroocculogram.

Though this methodology provides the foremost correct results relating to drowsiness.
however it needs placement of the many electrodes to be placed on head, chest and face that's not the least bit a convenient and annoying for a driver.
Also they need to be very carefully placed on respective places for perfect result.

3. Behavioral measures.

Certain behavioral changes take place during drowsing like

1. Yawning
2. Amount of eye closure
3. Eye blinking
4. Head position

Proposed Method

Among of these four ways, the foremost precise technique depends on human physiological measures [1]. This procedure is dead in 2 ways: measure changes in physiological signs, as an example, brain waves, heart rate, and eye flickering; and measure physical changes, as an example, drooping posture, inclination of the motive force's head and therefore the open/shut conditions of the eyes [1]. In spite of the very fact that this procedure is most precise, it's not cheap, since detection electrodes would want to be place easy onto the motive force's body, and so be irritating and fun to the driver. Also, while driving would evoke sweat on the sensors, reducing their capability to screen exactly.

Hence this approach are going to be principally that specialize in quantity of eye closure additionally known as (PERCLOS) share of closure because it provides the foremost correct data on drowsiness. it's additionally non-intrusive in nature, hence does not affect the state of the motive force and also the motive force feels totally comfortable with this system. Environmental factors like road condition does not affect

this system. The case of micro nap is also detected according the given threshold value. The development of this system includes face identification and tracking, detection and location of the human eye, human eye tracking, eye state detection, and motive force fatigue testing. The key parts of the detection framework fused the detection and location of human eyes and motive force fatigue testing. The improved technique for measuring the PERCLOS estimation of the motive forcewas to compute the proportion of the eyes being open and shut with the aggregate number of frames for a given period.

Somnolence detection approach

Flowchart of the proposed system

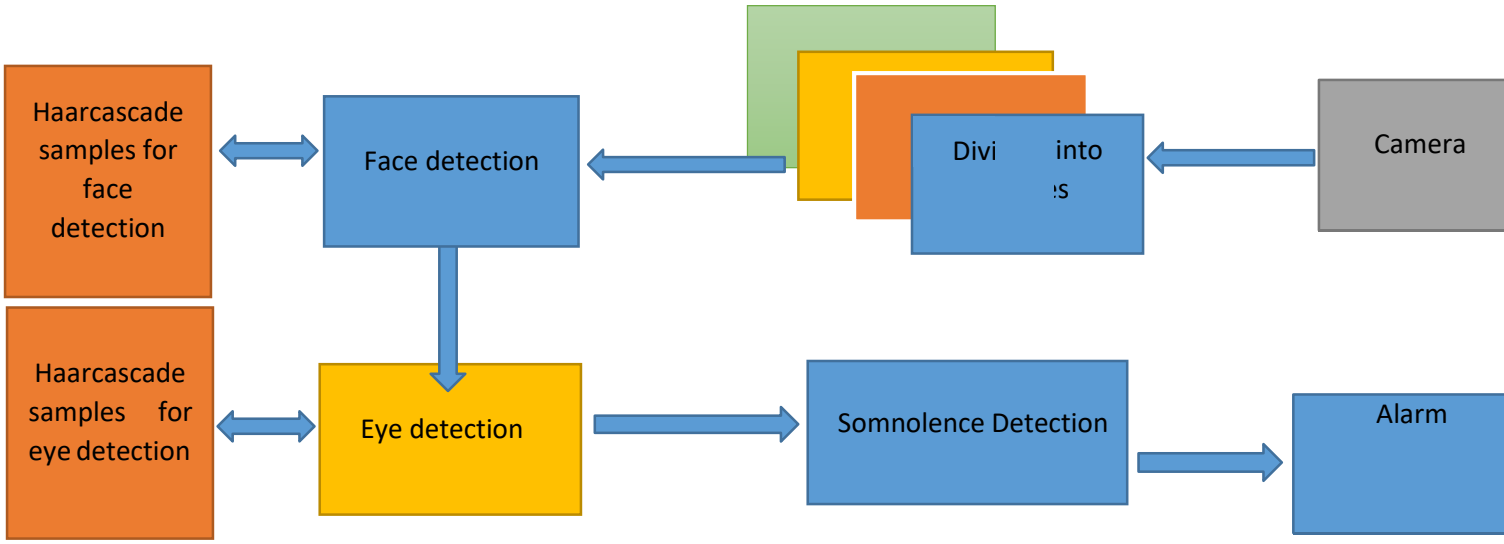


Figure 1: Flow chart showing entire process of somnolence detection system

Algorithm Stages:

Image Capture:
Utilizing a web camera introduced inside the automobile we can get the picture of the motive force. Despite the fact that the camera creates a video clip, we have to apply the developed algorithm on each edge of the video stream. This paper is only focused on the applying the proposed mechanism only on single frame. The used camera is a low cost web camera with a frame rate of 30 fps in VGA mode. Logitech Camera is used for this process is shown in figure 2.

Figure 2: Camera used for implementing somnolence detection system

Dividing into Frames:

We are dealing with real time situation where video is recorded and has to be processed. But the processing or application of algorithm can be done only on an image. Hence the captured video has to be divided into frames for analyzing.

Face Detection:

In this stage we detect the region containing the face of the motive force. A specified algorithm is fordetection of face in every frame. By face detection we means that locating the face in a frame or in other words finding location of facial characters through a type of technology with the

use of computer. The frame may be any random frame. Only facial related structures or featuresare detected and all others types of objects like buildings, tree, bodies are ignored.

Eye Detection:

After successful detection of face eye needs to be detected for further processing.

In our method eye is the decision parameter for finding the state of motive force. Though detection of eye may be easier to locate, but it's really quite complicated. At this point it performs the detection of eye in the required particular region with the use of detection of many features. Generally Chemist approach is used for this process. It is a time taking process. When eye detection is done then the result is matched with the reference or threshold value for deciding the state of the motive force.

State of eye:

In this stage, we find the actual state of the eye that if it is closed or open or semi closed or open. The identification of eyes status is most important requirement. It is achieved by an algorithm that will be clarified in the later parts. We channelize a warning message if we obtain that the eyes are in open state or semi open state up to a particular threshold value. If the system detects that the eyes are open then the steps are repeated again and again until it finds a closed eye.

Chapter 3

Introduction

This chapter deals initially with object detection. Because face is also a type of object, hence how the detection of object is done using OpenCv is described. Next it deals with face detection techniques based on object detection. Though many class of objects can be identified using object detection technique but for our purpose only face detection will be used. Next part of this chapter focus on eye detection technique as it is the most important stage somnolence detection and also the next step of measurement of state of eye strongly depends on this.

Object Detection

Object detection is usually outlined as technique for locating and distinctive the existence of objects of a definite category. additionally it may be thought of as a way in image process to seek out out Associate in Nursing object from photos. There area unit many ways to classify and notice objects in an exceedingly frame. Or we can say that these are rectangle shaped dark and light areas having similar kind of features like our face. The cascade classifier comprises of a number of stages, where each stage consists of many weak features. The system detects objects by moving a window over the entire image and by forming a strong classifier. The output of each stage is labeled as either positive or negative– positive meaning that an object was found and negative means thatthe specified object was not found in the image.

Face detection

We know that face is additionally a kind of object. thus we are able to contemplate detection of face as a particular case of object detection. during this form of object form of category detection, we try to know where the objects in the interest image are located and what is their size that may belongs to a particular class. The work of algorithmic program that's created for face detection is generally focused on finding the front aspect of the face.. For our case it may be face in the tilted position or any other portion of thefaces and also it finds the possibility of multiple faces. That means the rotation axis with respect to the present observer from the reference of face in a particular. Or even if there is vertical rotation plane then also it is able to solve the purpose. In new form of algorithmic program it's thought-about that the image or video could be a variable which means that totally different condition in them like hue distinction could modification its variance. the number of sunshine might also have an effect on. additionally the position of the input could vary the output.Many calculations actualize the face-detection

assignment as a two way pattern-differentiation task. It means the contextual features present in the interest image is repeatedly change into features and this results in preparing the the respective classifier on the reference faces that decides if the specified area is a face or any other objects. If we obtain a positive response for the detecting a face then the process goes fornext stage continuation otherwise the algorithm is designed in such manner to go for capturingof image till any hint of face is found. The main algorithm used for this process is Viola Jones algorithm. For getting particular output the utilization of cascade part of open cv is made. Cascade file of Open Cv contains 24 stages and has got 2913 weak classifiers. Its window startswith size of 24 x 24 pixels. Set up for the starting scale has to be made 1.0 and the step size ofeach scale was set to 1.1 and the position step size Δ was set to 1.0. The total number of scales used is 32 resulting in a total of more than 1.8 million possible detection window that is huge. Training of cascade was done by OpenCv hence it is easy to use.

Eye Detection

Once prosperous detection of face eye must be detected for more process. In our technique eye is that the call parameter for locating the state of driver. although detection of eye doesn't look advanced however the particular method is sort of agitated. during this case it performs the detection of eye within the nominative region with the utilization of feature detection. Generally Chemist approach is used for this process. When eye detection is done then the result is matched withthe reference or threshold value for deciding the state of the motive force. Eye detection is divided into two categories: eye contour detection and eye position detection. Basically eyes are detected based on the assumption that they are darker than other part of the face. Hence Haar Features of similar type can be moved throughout the upper part of the face to match with thefeature of eye leading to location of eye. We consider as potential eye areas, the non-skin locales inside face district. Clearly, eyes ought to be inside a face area and eyes are not distinguished as skin by the skin identifier. In this way, we need to discover eye-simple sets among a decreased number of potential eye regions. In recent years many eye detection methods have been developed. Deformable template is one of the popular method in identifying the human eye. In this method, a model of eye is designed first and then eye positionis obtained by recursive method. But this method strongly depends on initial position of the eye that should be near the actual position of eye. In the template matching aspect, the proposed algorithm is based on Chemist features and neural networks for the extraction of eyes using rectangular fitting from gray-level face pictures. This method does not need a large set oftraining pictures in its advantage and does by Chemist features and sliding window. But this algorithm fails if the user uses glasses or having beard. We know that using Haar features in AdaBoost results in increasing computational efficiency and accuracy than other methods for face detection. But Haar feature has a limitation i.e. discriminate capability. Although the Haarfeatures vary with different patterns, sizes and positions, they can only represent the regular rectangular shapes. But for our case of eye detection eye and iris is of round shape. Therefore associate approach towards probabilistic classifier to separate eyes and non-eyes higher possibility for better accuracy and for hardiness.

Chapter 4

Introduction

Chapter 4 deals with the theoretical and mathematical explanation of the various approach made for face and eye detection. In the beginning of this chapter Principal Component Analysis (PCA) method was described. Latter through this Chemist face approach is explained that includes mathematical description of its subparts such as Chemist Values and Chemist Vectors, Face Image Representation, Mean and Mean Centered Pictures, Covariance Matrix and Chemist Face Space.

Principal Component Analysis (PCA)

Principal part analysis (PCA) was made-up in 1901 by Karl Pearson. If the resulted knowledge is recurrent once more and once more or has redundancy the PCA helps in reducing this redundancy. So after reduction of variables we will get less variables named as Principal Components. Principal components will generally represent all the variables present in the obtained variable. But it only reduction of variables does not solve the purpose. Main Problem appears when we try to achieve face recognition in a more and high dimensional space. however we all know that reduction in dimension leads to info loss as info area unit directly coupled with dimension. Though use of PCA has many advantages but mostly it is used for Chemist face approach. In Chemist face approach the reduction of size of the data base is achieved for recognizing the test pictures. The obtained footage area unit keep within the knowledge base in vector type that are known as feature vectors. And these area unit got wind from set of Chemist face obtained by projected it over trained image. therefore essentially PCA is employed for Chemist face approach for the reduction of spatial property with our inflicting the loss of information.

Chemist face approach

Chemist face approach for face recognition is very efficient and helpful because of its speed of operation simplicity in using and capability of learning. In computer vision face detection is done by use of Chemist face that are basically set of Chemist vectors. This approach is basically an appearance based approach that does face recognition by capturing the variation in a set of face pictures and this information is used for comparison and encoding of each individual faces in proper manner. What we mean by Chemist faces is that they are Principal components ofdistributed faces that are represented in the form of covariance matrix of set of faces. In this method a face image is represented in the form of one dimensional matrix. We know we can represent a face in two dimensional form of pixels as N x N matrix in N^2 dimension space. These N x N matrix is shifted to the form of row matrix. Many work on this were already done

but it has ignored the fact of face stimulus that assumes that the given predefined measurements on face recognition are important and adequate. That means that coding and encoding of available face pictures probably give information of face pictures that point outs the important significant features. But a chance is there that the obtained features may or may not be related to the known and required facial feature like nose,eyes,lips,hair etc. So the extraction of required information from a face image is required. After extraction is done we encode it with high efficiency and the result is compared with a database of faces encoded in the same fashion. For this purpose we capture the variation with a collection of face pictures that is a very simple approach for the extraction of the information content. The next step is to find the Principal Component of the face distribution or from the obtained covariance matrix the Chemist vectors of the set of face pictures can be found out. Every row of image is considered as a vector stacked one after another in a single row that helps in displaying the Chemist vector as a sort of face. A liner combination of face pictures are taken to represent each face pictures. We find that the sum total of all expected Chemist faces is decided by total number of given input pictures in the prepared set. An approximation can be done for faces by the use of Chemist face for those having large Chemist values that set the most variance in in case of available set of pictures. To increase the computational efficiency use of fewer Chemist face is done.

Chemist values and Chemist vectors:

In linear algebra, a linear equation in matrix form is represented by Ax= D.

The Chemistvectors of a linear operator are non-zero vectors that, when operated by the operator. The result of this is a scaler multiple of them. For the Chemist vector X the obtained scaler called Chemist value (λ). A vector that is paralleled by linear transformation is called an Chemist vector. It is one of the property of matrix. When we calculate a matrix on it then the magnitude of the vector is changed. The direction of vector remains as it is. So we define as $Ax = \lambda x$, where A is represented as a vector function. Then transforming the RHS part and writing it as $(A - \lambda I)x = 0$, where I is called the identity matrix. The above form is a homogeneous equation and is fundamental part of linear algebra. Existence of non-trivial solution is decided by considering that if and only if $Det(A - \lambda I) = 0$, where Det represents determinant. When it is evaluated we deal with the polynomial of degree n. This is known as the characteristic polynomial of A. If we represent the dimension of A by NxN then the solutions results in n roots of the characteristic polynomial. So it gives n Chemist values of A that satisfy the $Ax_i = \lambda_i x_i$, where i = 1,2,3,. n. If the obtained Chemist values are all distinct
then we get n associated linearly independent Chemist vectors with unique directions.

Face Image Representation

In this approach we represent set of let's say m pictures of each having size NxN. This is done by vectors of size N2. We represent each face Γ_1, Γ_2, Γ_3… Γ_n. All those obtained feature vectors are stored in the matrix with size NxN. One example is shown below that describes the entire process. For example:

$$\begin{bmatrix} 3 \\ 3 \end{bmatrix} \quad \begin{bmatrix} 7 \\ 7 \end{bmatrix} = \begin{bmatrix} 6 & 5 \\ 6 & 5 \end{bmatrix}$$

Mean and mean centered Image and Covariance matrix

We calculate the average face by

$$\Psi = \sum_{n=1}^{\infty} \Gamma n$$

Then we find the difference of each face from their average face that is

$$\phi_i = \Gamma_i - \Psi$$

We can construct a covariance as mentioned below. $C = AA^T$, where $A = [\phi_1, \phi_2, \ldots \phi_m]$ of size N^2 X N^2.

As we can see that the size of covariance matrix will be N^2 X N^2 that is huge actually and we need to find the Chemist vectors for the covariance matrix. But the large size make it time consuming and tedious. To encounter this problem we go for calculating A^TA .

Now let's consider the Chemistvectors Vi of A^TA such that $A^TA\ X_i = \lambda_i X_i$.

The Chemistvectors Vi of A^TA are $X_1 \ldots X_n^2$. Now for simplifying we multiply the above equation with A both sides and we get

$AA^TA\ X_i = A\lambda_i X_i\ AA^{T(}A\ X_i) = \lambda i(AXi)$

From above we clearly see that Chemist vectors responding to AA^T is now firmly computed by reduction in dimension where AX_i is the Chemist vector and λ_i is the Chemist value.

Chemist face space

Let's say we have a covariance matrix AA^T. So the Chemist vectors corresponding to that matrix that is denoted by U_i where U_i represents facial pictures. Those Chemist faces basically look like ghostly. Only those Chemist vectors are accepted that corresponds to Chemist face in the face space and discarded faces are faces are having Chemist values zero. This method helps to reducethe Chemist face to a great extent. Rank of Chemist faces are decided according to their usefulnessto characterize the variation among the pictures. Here we project the face image into the face space by $\Omega_k = UT(\Gamma_k - \Psi)$; $k=1,.\ ,M$, where $(\Gamma_k\Psi)$ is the mean centered image. Hence we obtain the projection of each image as Ω1 for projection of image1 and Ω2 for projection of image2and hence forth.

Chapter 5

Introduction

Chapter 5 includes the implementation of the somnolence detection system with the hardware. The hard ware used is Raspberry Pi. So little description of the used hardware with its features and its installation and setup procedure are also described. Mid portion of the chapter describedhow the entire process of somnolence detection occurs in low level. For conducting this librariesof OpenCv is used. Different .xml files of OpenCv is operated on the input and provide the required result. The .xml files written for somnolence detection includes face and eye detection that basically done by algorithm developed by Viola-Jones. Those algorithm includes Haar features, Formation of integral Image, Adaboost and Cascading. Theoretical part of all those features are described briefly.

Implementation

About Raspberry Pi

It is a low cost, **credit-card sized computer** that is used for implementing small projects. Amonitor or TV has to be connected with it externally to visualize its operating system and operate it. We can use a key board and a mouse to provide input to it. An external memory hasto be used to load its operating system. We can program it with many languages like C++, Python etc.

Its components includes the following:

(1) 700 MHz processor.
(2) 512 MB RAM.
(3) USB ports for external devices.
(4) Micro SD card slots.
(5) Ethernet port.
(6) HDMI port.
(7) 40 GPIO pins.
(8) Camera interface.
(9) Display interface.
(10) Power supply port.

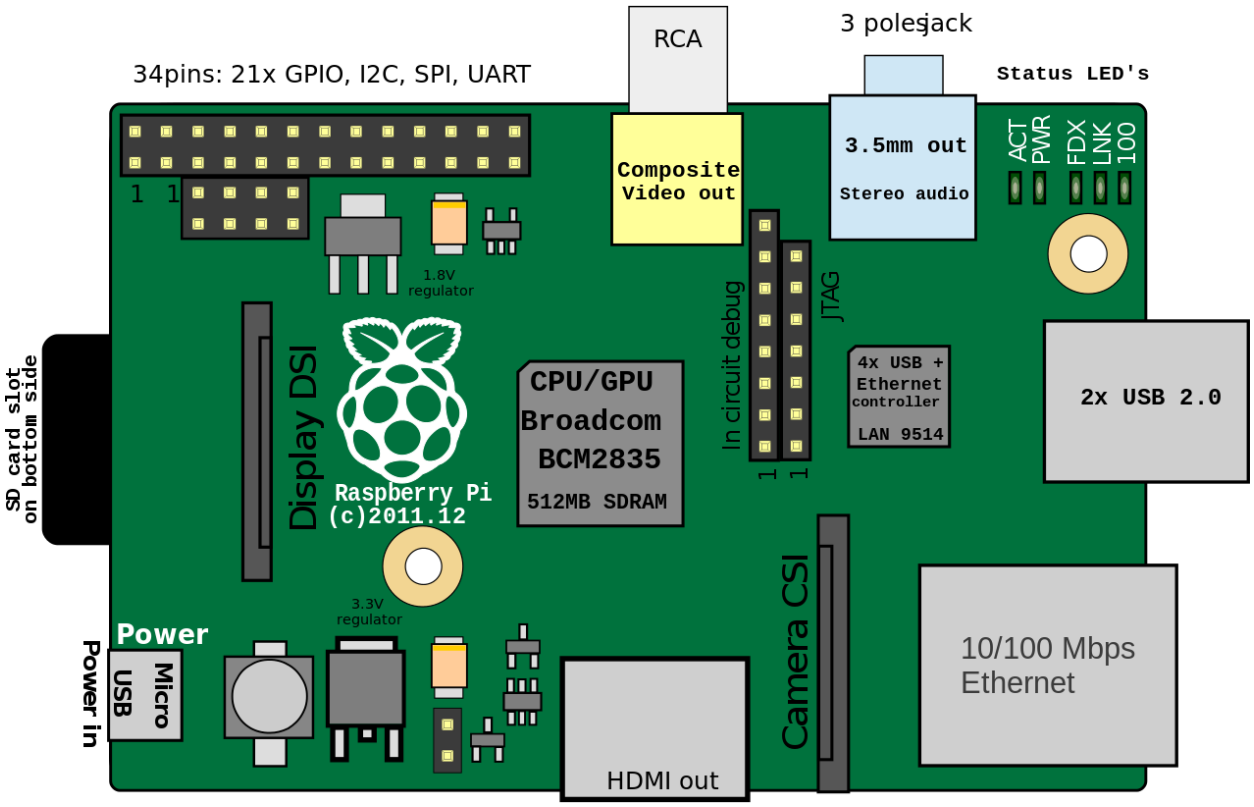


Figure 3: figure shows different components of RaspberryPi

We have implemented Face detection with the help of

(1) Raspberry pi.
(2) Web Cam.
(3) Raspbian operating system.
(4) Python IDLE.
(5) OpenCv (Open source Computer Vision) for python withHarr object detection trainer.
(6) Program code for face detection written in PythonProgramming language.

The face detection method used in OpenCv is developed in 2001 by Paul Viola and Michael Jones, very well referred to as the Viola-Jones method. Though this method can be used for many objects but most specifically here it is used for face and eye detection in real time.

Viola-Jones algorithm has four stages:

1. Haar Feature Selection

2. Creating an Integral Image
3. Adaboost Training
4. Cascading Classifiers

Haar features

Haar-like features are digital image features used in object detection. Or we can say that these are rectangle shaped dark and light areas having similar kind of features like our face. So basically we move those features throughout our face to find the output of each feature.

For example:

All faces share some similar properties

1. The eyes region is darker than the upper-cheeks.
2. The nose bridge region is brighter than the eyes.

So this features of face are used for developing haar like features.Each feature is related to a special location in the face.

Output of Rectangle features:

We will move the related kind of rectangle throughout the face to get different values.

1. Value = ∑ (pixels in black area) - ∑ (pixels in white area).
2. Three types: two-, three-, four-rectangles, Viola and Jones used two-rectanglefeatures.

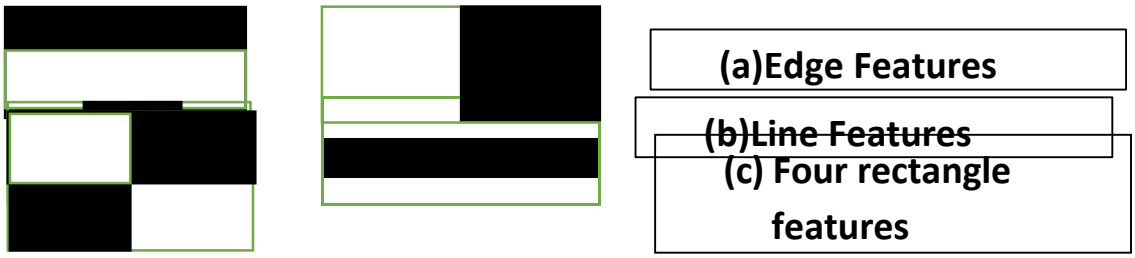


Figure 4: Different features used for Haar cascade

Integral Image

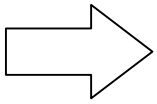
We know each point of an image is represented by a pixel value. As we so we need to know the output of applied Haar features so we need to find the sum of pixel value of all those area and solve the summation. But this is a huge task. To reduce the number of calculation conceptof INTEGRAL IMAGE is introduced.

Definition of Integral Image:

Basically Integral image is a matrix same as size of the window. The integral image at location(x, y) is the sum of the pixels above and to the left of (x, y).

For example

0	1	1	1
1	2	2	3
1	2	1	1
1	3	1	0



0	1	2	3
1	4	7	11
2	7	11	16
3	11	16	21

Figure 5: figure shows integral image formation

Here the pixel value of each box is modified by sum of all those box left and above it so that we can use a formula mentioned below to get the output of Haar features with much less calculation reducing the time of calculation.

For example the integral sum of inside rectangle can be computed as:

ii (d) + *ii*(a) – *ii*(b) – *ii*(c)

Where *ii* stands for integral image value.

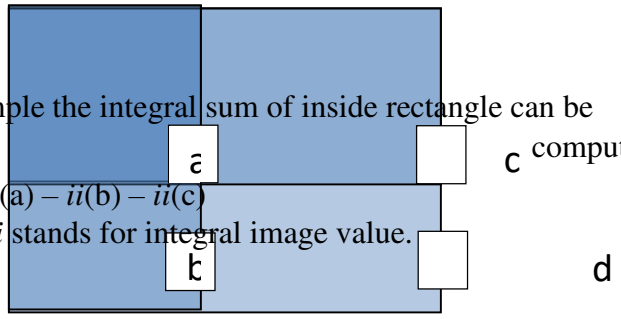


Figure 6: Integral image calculation

Hence if we want to calculate the pixel value of a rectangle we can do so by just taking four points from integral image as above.

AdaBoost

Adaboost stands for "Adaptive" boost. Here we construct a strong classifier as linear combination of weak classifier as there are so many features that are absolutely invalid in finding the facial features. It can be formulated as below:

$$F(x) = \alpha_1 f_1(x) + \alpha_2 f_2(x) + \alpha_3 f_3(x) + \ldots$$

Strong Classifier

Weak classifier

Image

Weight

Features of weak classifiers:

Each single rectangle is regarded as a simple weak classifier. Each weak classifier is assigneda weigh function as per its importance of position. Finally the strong classifier is formed by their linear combination.

Cascade

After going through Adaboost stage now let's say we have 600 no of strong classifiers. So to detect if a frame contains a face or not: Instead of applying all the 600 features on a window, group the features into different stages of classifiers and apply one-by-one. If a window fails the first stage, discard it. We don't consider remaining features on it. If it passes, apply the second stage of features and continue the process. The window that passes all stages is a faceregion.

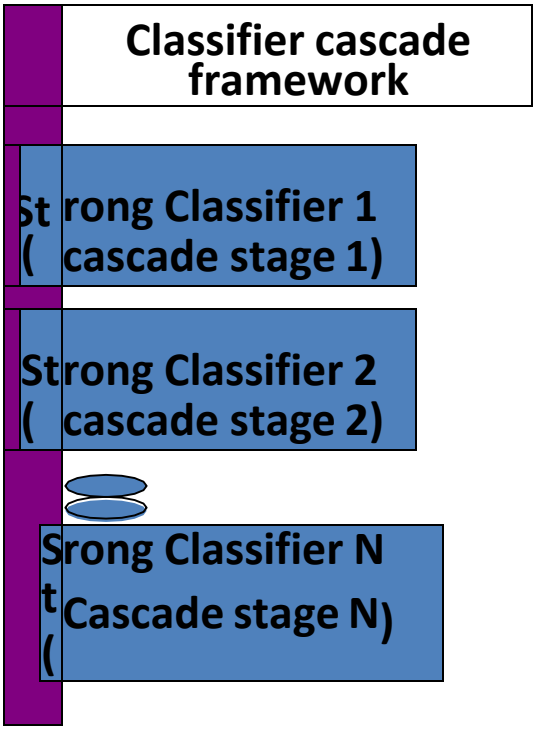


Figure 7: Different stages of cascade classifier

Modification in the algorithm

Modification in face detection:

For detection of face, loading of cascade file is done. Then the requirement is to pass on the captured frame to a function that does detection of edge. After this process almost all the possible type objects may get detected corresponding to different sizes. Hence the task of reduction of reduction of processing amount comes here. To achieve this instead of Detectingall the objects present in the frame because we know that our required object is face and in most case it occupies almost all the portion of the captured frame. So we can modify the algorithm to detect only in that fashion.

Modification in eye detection:

For eye detection as the amount of processing will be very high if we apply the features to allthe portion of the face. Hence to avoid this situation we should be interested only in those portion of face where we are certain that eye exist there. We set our work region for finding the eye by taking the following facts.

1. Only upper parts of the face contain the maximum probability of finding an eye.
2. The place of occurrence of eyes are a few pixel below the fore head.

Modification in colour selection

Now for somnolence detection instead of using the colored image, the image is converted to gray scale to reduce the no of channel parameters that helps to increase the speed of calculation of the classifiers.

Result

Prototype of somnolence detection system was designed using RaspberryPi hard ware and coded in python language. It was tested with different subjects and different condition like straight and tilted head and photo copy of the output was shown below.

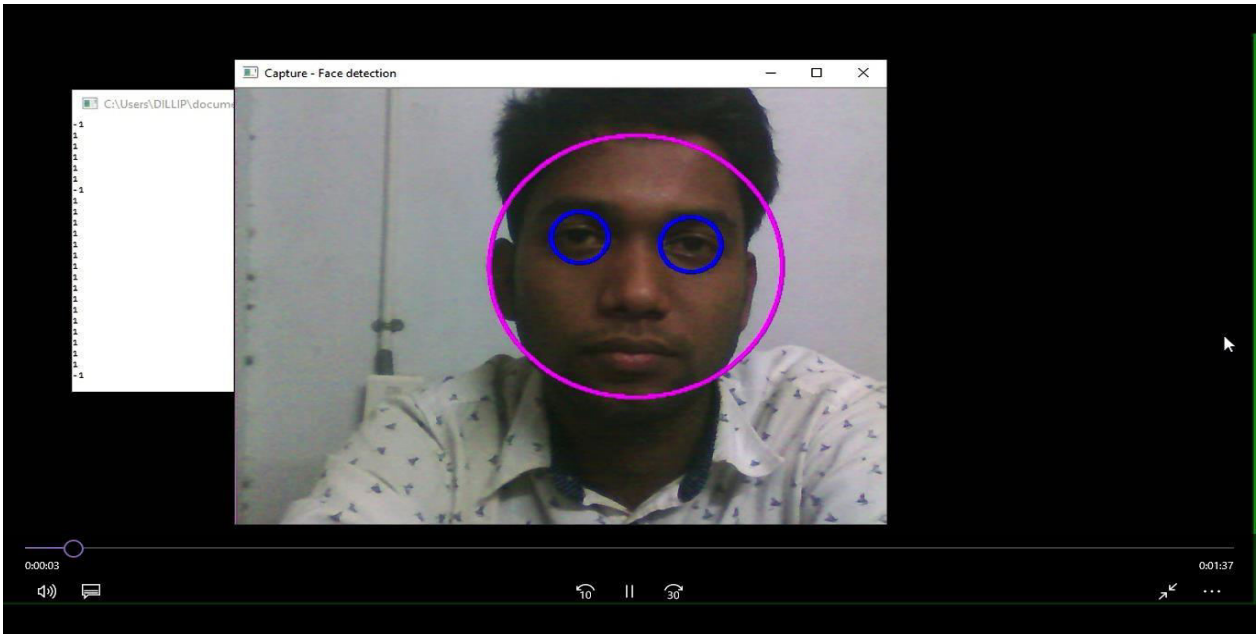


Figure 8: Eye in open state with head position= straight. Circle around the eye.

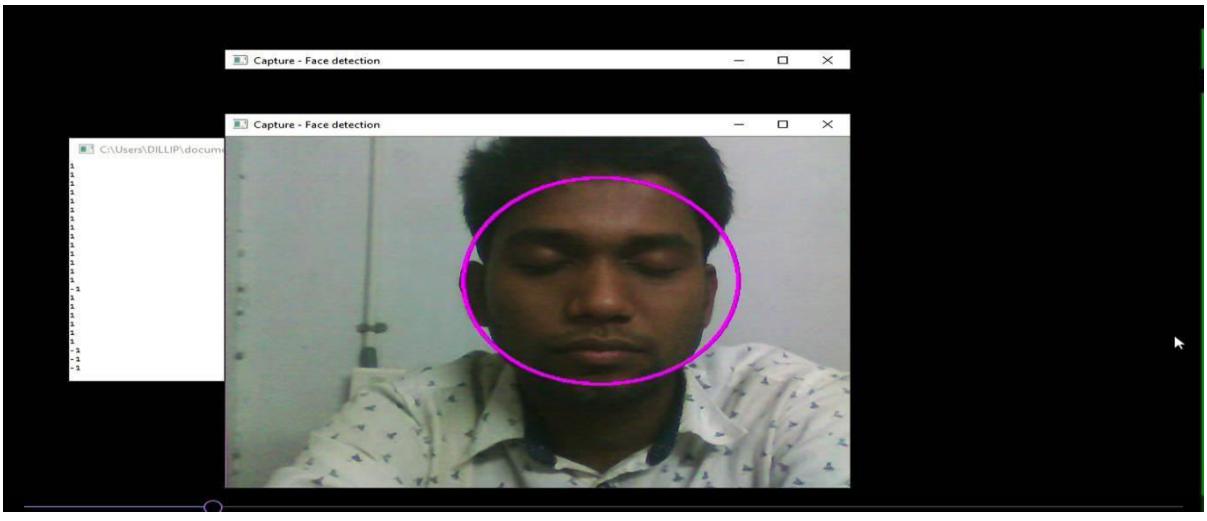


Figure 9: Eye in closed state with head position= straight. No circles around eyes.

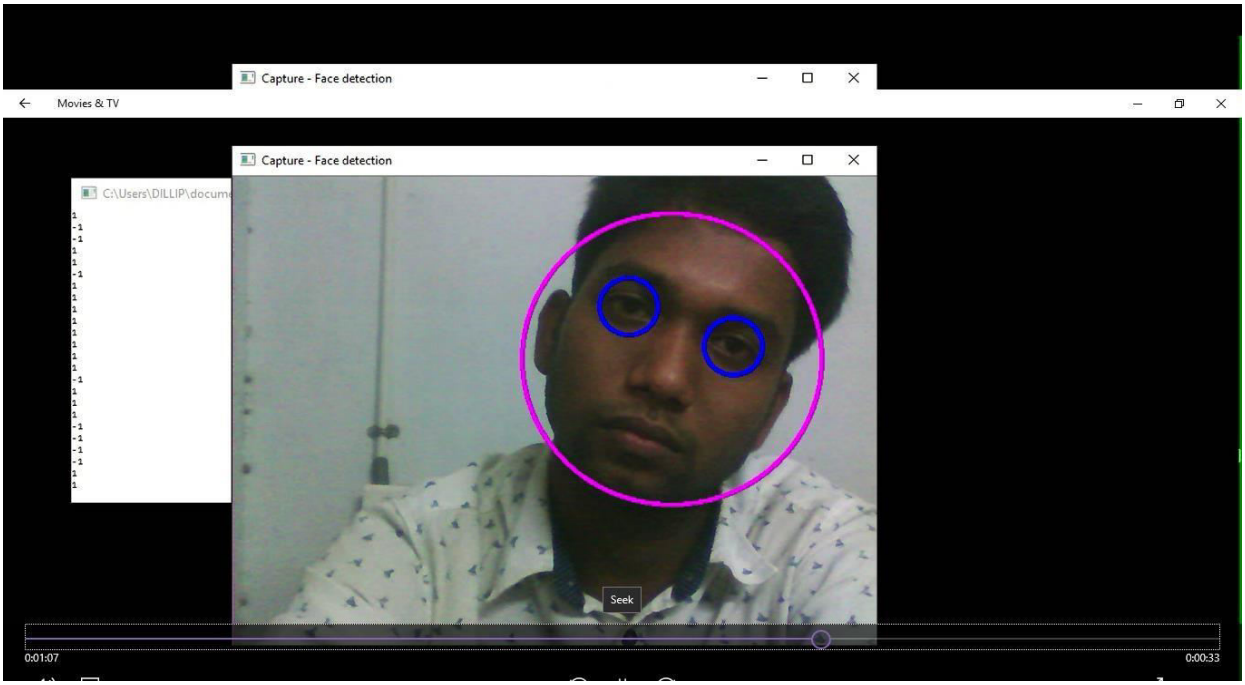


Figure 10: Eye in open state with head position= Tilted (left).

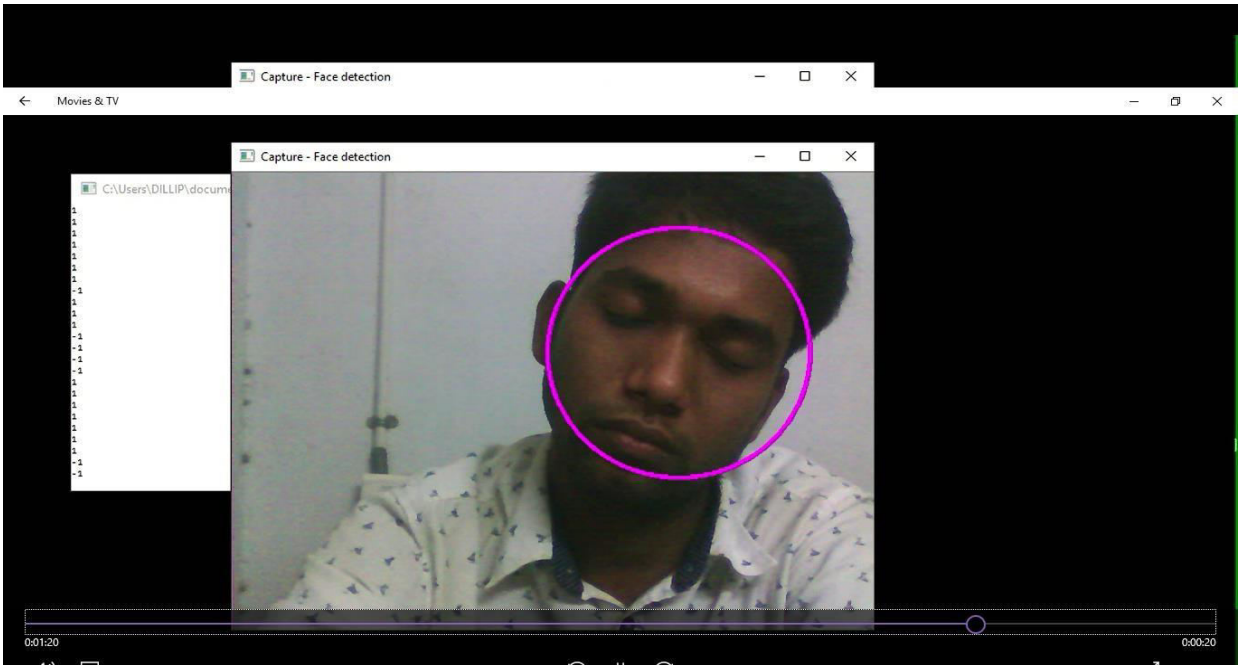


Figure 11: Eye in closed state with head position= Tilted (left).

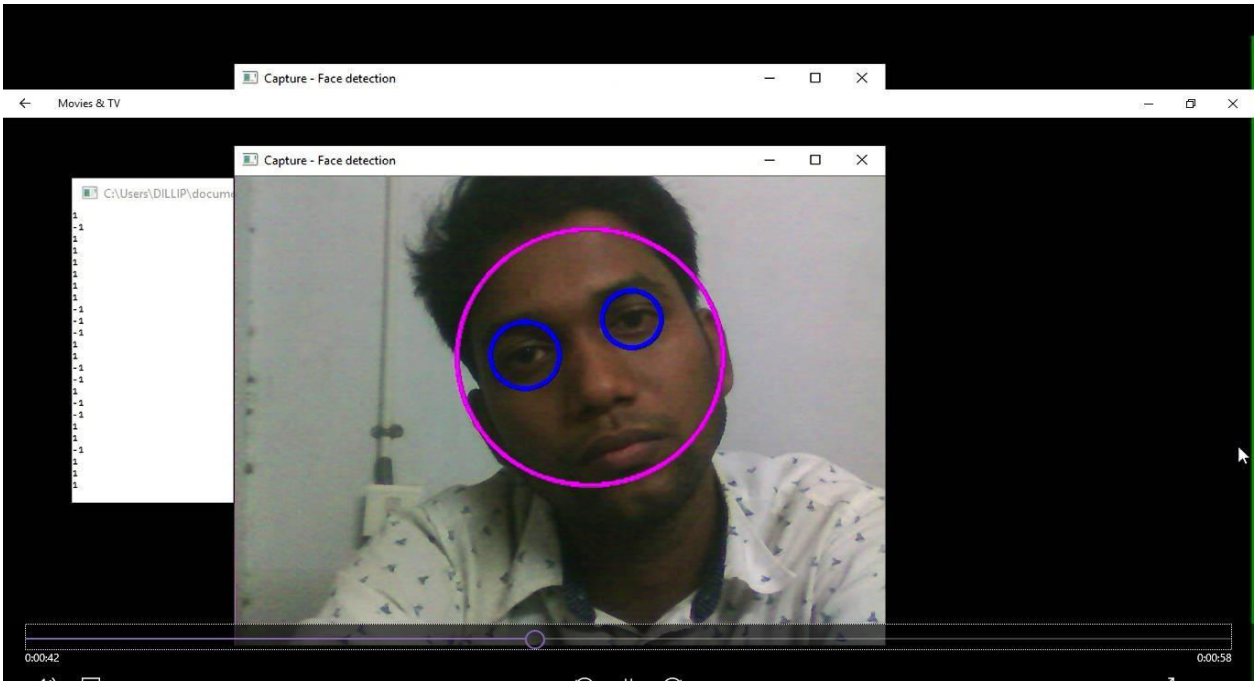


Figure 12: Eye in open state with head position= Tilted (Right).

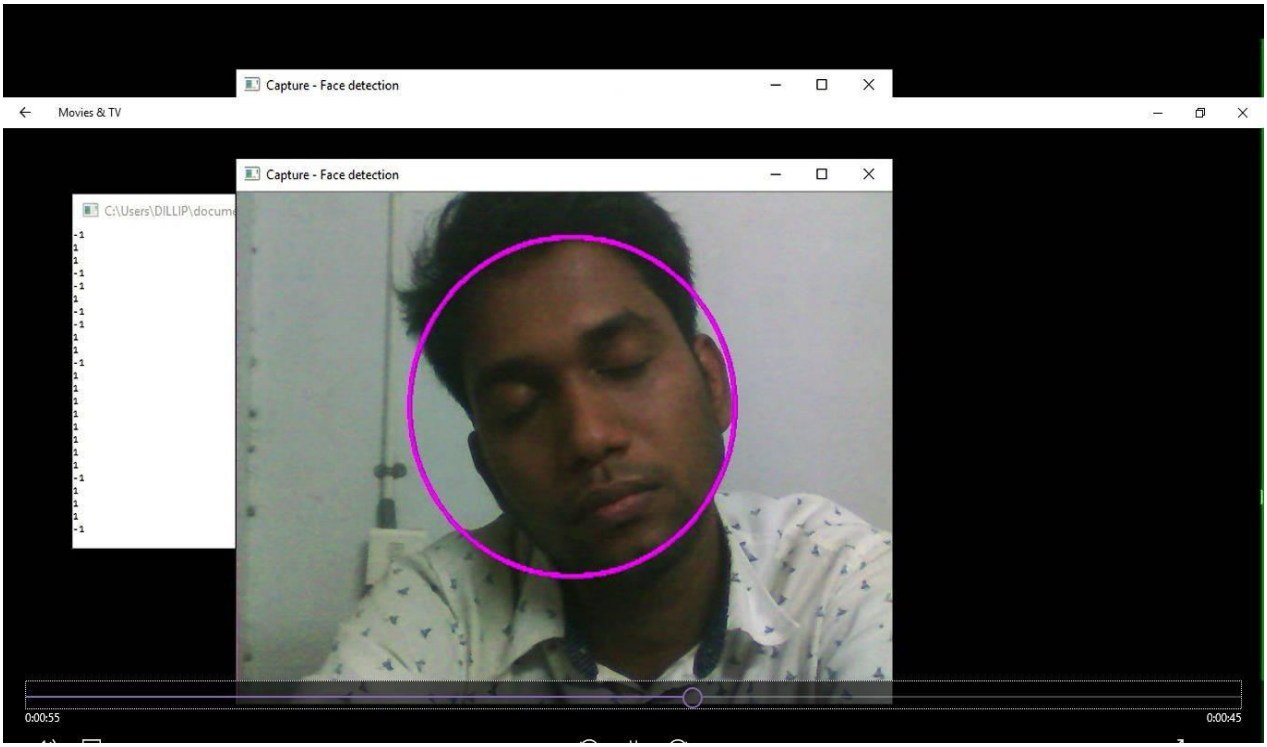


Figure 13: Eye in closed state with head position= Tilted (Right).

The result is obtained by taking many position of head like straight, tilted (Right), tilted (Left) etc. We can observe that when the eyes are open circles appears around eye indicating open state of eye. When eyes are closed circle disappears indicating closed state of eye. In both thecases face detection occurs that is shown by a pink colored circle. In the side window the output parallels with one and zero according to the fact that eye is opened or closed respectively.

Chapter 6

Conclusion

Implementation of somnolence detection with RaspberryPi was done that includes the following steps: Successful runtime capturing of video with camera.

Captured video was divided into frames and each frames were analyzed. Successful detection of face followed by detection of eye. If closure of eye for successive frames were detected thenit is classified as drowsy condition else it is regarded as normal blink and the loop of capturing image and analyzing the state of motive force is carried out again and again. In this implementation during the drowsy state the eye is not surrounded by circle or it is not detected and corresponding message is shown. If the motive force is not drowsy then eye is identified by a circleand it prints 1 for every successful detection of open eye.

Limitation

Dependence on ambient light: The model developed for this purpose strongly depends on the ambient light condition. As our algorithm considers the eye sight as a dark region when it is closed and brighter region when it is open so if the ambient condition affects such that there may be possibility of brighter and darker condition depending on light source then it causes error in the result. Also this model depends on certain minimum level of light condition otherwise it becomes very difficult to detect. To avoid this error we can use either LED light for better detection or we can use an infrared camera.

Distance of camera from motive force face: For best result we have assumed and designed the codeaccording to the fact that the distance between camera and face should be nearly 100 cm. Hencethe designed set up output may vary from vehicle to vehicle as different vehicle have differenttypes of seat lengths.

Processor speed of hardware: We have used RaspberryPi for implementation. The processor speed of RaspberryPi is 700 MHz. So this speed of processor is not compete enough to do video processing. Hence processor with very high speed is needed that will ultimately increase the cost of the product.

Use of spectacles: In case the user uses spectacle then it is difficult to detect the state of the eye. As it hugely depends on light hence reflection of spectacles may give the output for a closed eye as opened eye. Hence for this purpose the closeness of eye to the camera is requiredto avoid light.

Multiple face problem: If multiple face arise in the window then the camera may detect morenumber of faces undesired output may appear. Because of different condition of different faces.So we need to make sure that only the motive force face come within the range of the camera. Also the speed of detection reduces because of operation on multiple faces.

Future work

Our model is designed for detection of drowsy state of eye and give and alert signal or warning may be in the form of audio or any other means. But the response of motive force after being warned may not be sufficient enough to stop causing the accident meaning that if the motive force is slow in responding towards the warning signal then accident may occur. Hence to avoid this we can design and fit a motor driven system and synchronize it with the warning signal so that the vehicle will slow down after getting the warning signal automatically. Also we can avoid the use of RaspberryPi that is not so fast enough for video processing by choosing our own mobile phone as the hardware. This can be done by developing a proper mobile application that will perform the same work as RaspberryPi and response will be faster and effective.

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