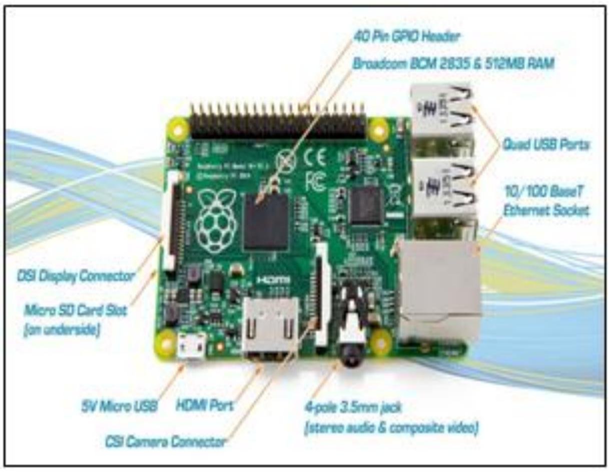
3. Proposed System

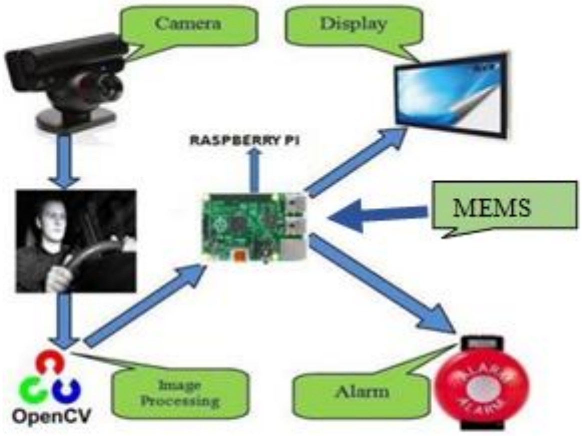
The proposed system is build upon the open mobile platform of raspberry pi, a credit card size compute module, which runs upon the raspbian operating system based on linux kernel an open source software .The hardware consist are pi board, buzzer and accelerometer (MEMS).The components such as accelerometer and buzzer are attached through are attached to the GPIO and are programmed via PYTHON language. The reason behind choosing the opencv as image processing tool is OpenCV was designed for image processing. Every function and data structure has been designed with an Image Processing application in mind. Almost all the functions are available for image processing in real-time which are available in matlab.

3.1 System Implementation & Algorithm



- **Capturing**- Here the camera is used to capture the facial images of the driver.
- **Detection-** Analysis of the captured images is done to detect eyed open state or closed state. The driver current behavioural is deduced by inbuilt haar classifiers.
- **Corrective phase**- This phase is responsible for doing the corrective actions required for that particular detected abnormal behaviour. The corrective actions include in vehicle alarms and displays. An accelerometer gives the head position of the driver depending on the threshold values that are set in the program. The Raspberry pi single board computer which is connected serially to the buzzer and the display to show the corrective measures.

The block diagram of the system is shown below.

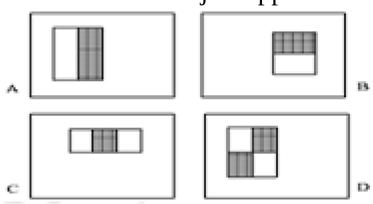


3.2 Procedure and Implementation

The primary focus is given to the speed of drowsiness detection and processing of data. The number of frames in which the eyes are kept closed is monitored. If frames captured by the camera detects a closed eyes then a warning message is generated on the display showing that the drowsiness is detected. The accelerometer (MEMS) show the head position that is programmed in python language which generates the warning sound when head position in bent after a particular threshold limit. The system should be capable of detecting drowsiness in spite of the skin color and complexion of the driver, all these objectives have been well satisfied by choosing the system using appropriate classifiers in OpenCV for eye closure detection.

3.3 Haar like Features

A Haar-like feature considers affixed rectangular regions at a specific part in a detection window; each Haar like feature expressed by two or three jointed black and white rectangles shown in figure. The value of a Haar like feature is the difference between the sums of the pixel values within the black and white rectangular regions. These sums are used to find the difference between regions. Then the differences can be used to classify the sub region of an image. These differences are compared against learned threshold values to determine whether or not the object appears I the region.



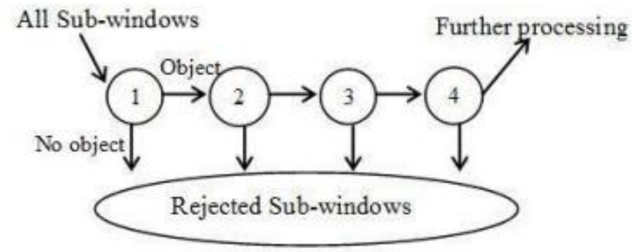
The method which is implemented in this proposed method is template matching process. It is the technique for finding the areas of an image that match to the template patch. **Source image (I)** the image in which we expect to find a match to the template image **Template image (T)** the patch image which will be compared to the template image. To identify the matching area we have to compare the source image to the template image. We use templateMatch and minMaxLoc function in opencv. By **sliding**, we mean moving the patch one pixel at a time (left to right, up to down). At each location, a metric is calculated so it represents how "good" or "bad" the match at that location is. For each location of **T** over **I**, you *store* the metric in the *result matrix* **(R)**. Each location (x, y) in **R** contains the match metric and then we normalize the input by

Method=cv_TM_SQDIFF=R(x,y)

$$\sum_{x',\, y'} \left(T(x',y') - I(x + x',y + y')\right)^2$$

Method=cv_TM_SQDIFF_NORMED=R(x,y)

$$\frac{\sum_{x',\, y'} \left(T(x',y') - I(x + x',y + y')\right)^2}{\sqrt{\sum_{x',y'} T(x',y')^2 \cdot \sum_{x',y'} I(x + x',y + y')^2}}$$



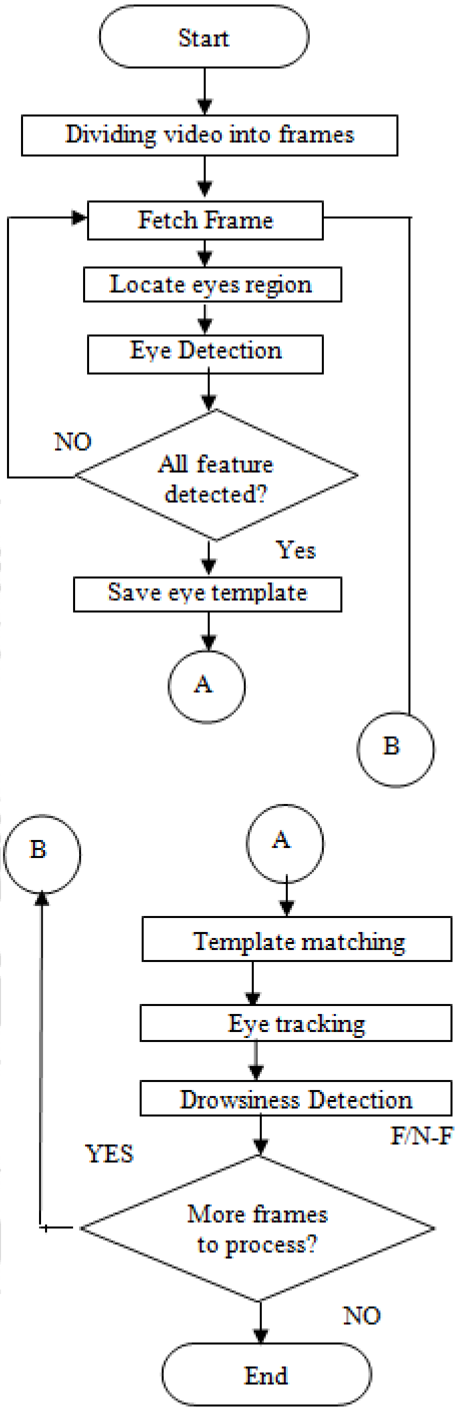
3.4 Cascade Classifier

The cascade classifier consists of number of stages, where each stage is a collection of weak learners. The weak learners are simple classifiers known as decision stumps. Boosting is used to train the classifiers. It provides the ability to train a highly accurate classifier by taking a weighted average of the decisions made by the weak learners.

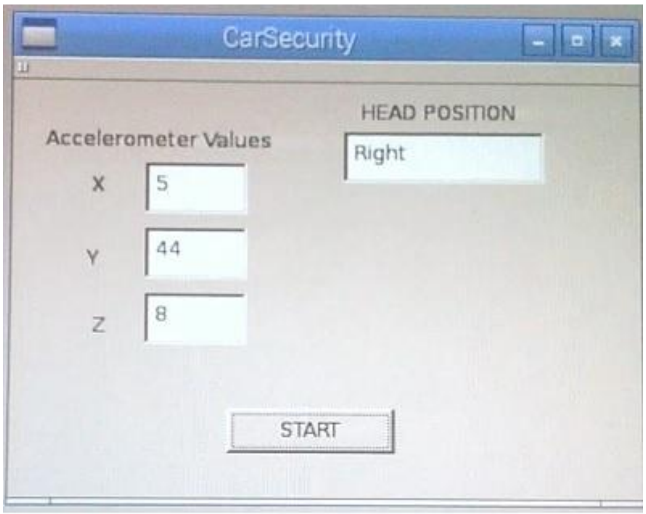
Each stage of the classifier shows the region defined by the current location of the sliding window as either positive or negative. Positive indicates an object was found and negative indicates no object. If the label is negative, the classification of this region is complete, and the detector shifts the window to the next location. If the label is positive, the classifier passes the region to the next stage. The detector reports an object found at the current window location when the final stage classifies the region as positive. It is used to eliminate less likely regions quickly so that no more processing is needed. Hence, the speed of overall algorithm is increased.

4. Flow of the proposed method

Here the head position is programmed in python which the accurate angles of the head, which is written as a separate routine. Firstly the camera is initialized, memory is allocated to the various attributes of the program and cascade classifier is initialized and loaded. The video frames form camera are compared to the template patch by template matching function by sliding technique. Later the input values are normalized. Here the trained file contains the vector values of large number of positive samples. These normalized are calculated on Region of interest (ROI) i.e. eyes. We can localize the location with higher matching probability by using minMaxLoc function in opencv and later check match template value reaching the threshold. Depending upon the threshold value eyes open or closed are detected.



F=Fatigue
N-F=Non-Fatigue



5. Results

The proposed system can detect the drowsiness of the driver when the eyes are closed or open in real-time. When the eyes are closed a buzzer is turned on to alert the driver and a visual notification is shown in the display. Depending upon trained classifier which consist of the vector values can able to detect almost all types of eyes of any gender.

6. Conclusion

The proposed system is used to detect the driver drowsiness in real-time. Here the camera is used to capture the video in real-time and the frames processed in OpenCV library. It alerts the driver through buzzer when driver is drowsy and gives the visual notification on the display. It also gives the head position information such as left, right, up, down depending upon the certain threshold angles which are defined. The developed system is low cost as it uses open source software and cheap Raspberry Pi board.

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