SYNAPSE

Name: RAJ GANDHI

SAPID: 60004200154

Branch: Computer Engineering

Task 2)

Synopsis on Computer Vision

Preprocessing steps on the image:

1) Noise reduction: The noise in the background can be removed by convolving the original image with a mask that represents a low-pass filter or something operation. Noise can cause unwanted information in digital images such as unrealistic edges, unseen lines, corners, blurred objects and disturbs background scenes.
2) Morphology: In this process, pixels are added or removed from the images for better image processing results. The structure and shape of the objects are analyzed so that they can be identified.
3) Segmentation: It is branch of digital image processing which focuses on partitioning an image into different parts according to their features and properties. This method helps in concentrating to a specific area of the image.
4) Thresholding: In this method, the pixels of an image can be changed which makes the image to be easily analyzed.

Techniques to determine eyes in the entire image:

1) Face Detection: The face needs to detected correctly in order to determine whether the driver is drowsy or not. For detecting the face correctly, the preprocessing steps were carried out.
2) Region of Interest: A region of interest (ROI) is a portion of an image you want to filter or operate on in some way. The toolbox supports a set of ROI objects that you can use to create ROIs of many shapes, such as circles, ellipses, polygons, rectangles, and hand drawn shapes. Since we have segmented the image earlier, it would be easier to find the ROI which in this case are the eyes of the driver. Now this is then feed into the classifier.
3) Image Classification: This refers to a task of extracting information classes from the images. In this case, it would be an example of

supervised classification since an input dataset of sample images are given. With the help of image classification toolbar we can extract the class of images we want to. After the classification, if the image sent by ROI matches with the open eyes image in the input dataset then no alarm would be sounded but if the image sent by ROI matches with the closed eyes or with a person with a drowsy face, then an alarm might be sounded. This would make the driver alert and hence would prevent an accident. In this way, image classification plays an important role in determining whether the driver is drowsy or not.

Techniques to detect drowsiness in eyes:

1) Blink Frequency: A person who is drowsy would blink frequently and would blink for a longer time than a person who is attentive. This would clearly help in detection of drowsiness.
   Algorithm:

$$\text{BFi}=\frac{\text{BFei}-\text{BFsi}}{\text{t0}},$$

$$\text{i}=1,2\cdots\text{n}, \text{ if BTi}\neq 0$$

   This algorithm helps in calculating the blink frequency.
   BF_{si}=blink time at the start of I time window from start.
   BF_{ei}=blink time at the end of I time window from start.
   t_0=time window size.

2) Viola Jones algorithm and percentage of eye closure (PERCLOS): Viola Jones algorithm along with PERCLOS is used to determine the drowsiness of the driver in order to prevent accidents.
   Algorithm:

$$\text{h(x)}=\text{sgn}(\textstyle\sum_{j=1}^{M} \alpha j h j(x))$$

   Each weak classifier is a threshold function based on the feature f_j

$$h_j(\mathbf{x}) = \begin{cases} -s_j & \text{if } f_j < \theta_j \\ s_j & \text{otherwise} \end{cases}$$

Threshold value: θ_j
Polarity: $s_j \in \pm1$
Coefficient: α
All the values of these constants are determined during the training.

PERCLOS calculates the mean size of the eyelids and helps in determining whether the driver is drowsy or not.

$$\text{LELM}=\frac{1}{100}\sum_{i=1}^{100}\text{LELi}$$

$$\text{RELM}=\frac{1}{100}\sum_{i=1}^{100}\text{RELi}$$

LELM=Mean size of left eyelids
RELM=Mean size of right eyelids

$$np=\begin{cases} np+1, & \text{if } \frac{\text{LEL}_i}{\text{LELM}}<0.2 \text{ and } \frac{\text{REL}_i}{\text{RELM}}<0.2 \\ np, & \text{other} \end{cases}.$$

Confidence level=P80

$$\text{P80}=\frac{np}{t_0\times f_0}$$

t0=time window
f0=frequency of eye movements data collected.

Hence this method proves to be quite useful in determining whether a driver is drowsy or not.

3) Gaze direction and fixation time: This method determines the time in which the driver gazes at a particular direction and also the time duration where the driver continuously looks at a specific location with stationary state of eyes(fixation).
A drowsy person would have a greater fixation time than a normal and attentive person.
This eventually helps in determining the drowsiness of a driver.

<u>Algorithm</u>:

$$\mathrm{GD} = \begin{cases} 1, & \text{if}\,\mathrm{NFR}X_{\min} \leq \mathrm{GD}X \leq \mathrm{NFRI}_{\max} \\ & \text{and}\,\mathrm{NFR}Y_{\min} \leq \mathrm{GD}X \leq \mathrm{NFR}Y_{\max} \\ & \text{and}\,\mathrm{NFR}Z_{\min} \leq \mathrm{GD}X \leq \mathrm{NFR}Z_{\max} \\ 0, & \text{other}, \end{cases}$$

$$\mathrm{FT1} = t_0 \times f_0 \times \textstyle\sum_{j=1}^{n_1} m_j, \quad \text{if GD} = 1,$$

$$\mathrm{FT0} = t_0 \times f_0 \times \textstyle\sum_{j=1}^{n_2} m_j, \quad \text{if GD} = 0,$$

GD: Gaze direction
NFR: Normal Fixation Region
FT: Fixation time
These factors help in the calculations.

<u>Conclusion</u>: To sum up, I would choose the second method i.e. Viola Jones algorithm and PERCLOS because it seems to be safest. This method yields the eye detection rate reaching up to 99% and blinking detection rate up to 97.8%, thus being superior compare to other approaches. It gives an analysis based on calculating a number of frames of the data stream where the driver eyes are closed. The result of the processing is sent to the alarm board, which activates an alarm signal when the drowsiness index exceeds a pre-specified parameter. This method has been very useful in accident prevention.