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An Automatic Driver Drowsiness Detection System using DWT and RBFNN

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ABSTRACT--- In this work an application to recognize sleep using computer vision techniques was developed. Here an automatic approach was developed for Driver drowsiness detectionfrom low-resolution images. A method is developed to attain high accuracy with fewer training samples. To detect the face and extract the eye region from the face images, Viola-Jones face detection algorithm was used. DWT was used for extracting the features from the eye region of images. Radial basis function neural network (RBFNN) was used as a classifier to detect the sleeping and non-sleeping images from the testing images. The proposed method was evaluated on our created dataset and exhibited 95.4% accuracy.

Keywords: DWT, RBFNN, Viola–Jones

1. INTRODUCTION

In a car safety technology, driver drowsiness detection [1-3] is very essential to prevent road accidents. Nowadays most of the people using automobiles, there is an increase in road accidents also. Driver drowsiness is also a reason for some of the road accidents. Today the major challenge is detecting Driver drowsiness and alerting with an alarm. The general structure of the Driver drowsiness detection system is shown inFig. 1.

The recognition system for Driver drowsiness detectionconsists of the following phases:

- Face Detection
- ROI Extraction
- Feature Extraction
- Classification.

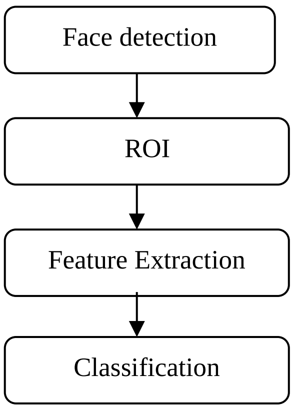

Fig .1: structure of driver drowsiness detection system

To identify the face regions from the input images, various face detection algorithms [4] have been used in the Face Detection step. For humans face detection task is easy but this task is difficult in computer vision. Face detection techniques are classified into feature-based techniques and image-based techniques. Statistical, Neural Networks and Liner subspace methods have been used by the Image-based approaches for face detection.

In the second step, different eye region detection algorithms were used to detect and extract the eye region from the face images. After locating facial regions, in the preprocessing stage normalization takes place to reduce the effects of illumination. The contrast differences among face images can be adjusted by performing histogram equalization.

In the third step, feature extraction was implemented on the input eye region images. There are two main methods for extracting features from images: appearance-based feature extraction and geometric-based extraction methods. The geometric extraction method extracts shape- and location-related metrics that are extracted from the eyes, eyebrows. Conversely, appearance-based feature extraction extracts skin appearance or facial features by implementing techniques such as PCA [5], Discrete Cosine Transform (DCT) [6] and Linear Discriminant Analysis (LDA). These methods can be applied on the entire face or particular regions for extracting the facial features of face. To extract the local features of a face, Gabor wavelets can be used; however, the occurrence of high-dimensional feature vectors is the main problem with this method.

In the fourth step of driver drowsiness detection is classification which uses a classifier to classify the sleeping and non-sleeping images based on the features extracted in the previous two steps. Different classifiers such as the Hidden Markov Model (HMM)[7-8], SVM[9], k-Nearest Neighbor and Neural networks have been used for the recognition and classification

2. PROPOSED SYSTEM

2.1. Proposed System Algorithm in MATLAB

Step 1: Pre Processing

```
I=rgb2gray(I);
img = histeq(I);
```

Step 2: Face detection

```
Facedetect=vision.CascadeObjectDetector;
```

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```
        BB=step(Facedetect,img)
        a=imcrop(img,BB)
Step 3: Eye Region detection
        EyeDetect=
        vision.CascadeObjectDetector('EyePairBig');
        BB=step(EyeDetect,a);
        I=imcrop(a,BB);
Step 4: Feature Extraction
        [a b c d]=dwt2(img,'haar');
        v(:,v_col)=reshape(a,size(a,1)*size(a,2),1);
        input=v;
Step 5: Training
        NET=newrb(input,target,.0001,90);
Step 6: Testing
        D=sim(NET,x);
```

2.2. Proposed System Architecture

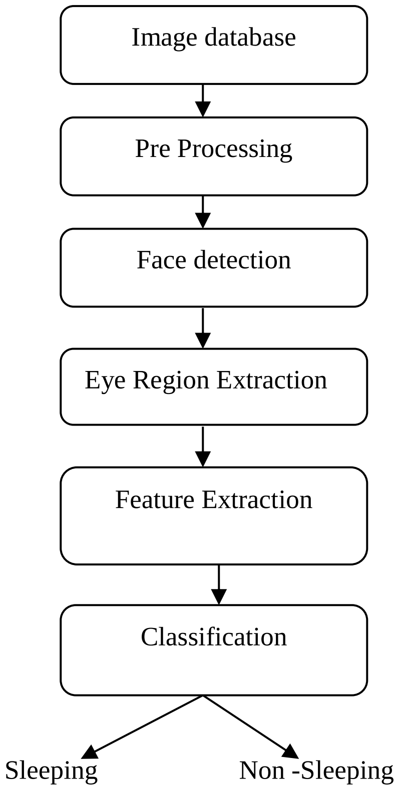

Fig. 2: Proposed system architecture

3. FACE DETECTION AND EYE REGION EXTRACTION

In this work to detect the sleeping entire face region may not be required but only eye region is enough for detecting sleep. At first step by using viola-jones face detection algorithm face was detected from the images. Once the face was detected, the same viola-jones face detection algorithm was used to extract the eye region from the face images.

In 2001 P Viola and M Jones developed the Viola-Jones object detection algorithm [10-11], it is the first algorithm used for face detection. For the face detection the Viola-Jones algorithm having three techniques those are Haar-like features, Ad a boost and Cascade classifier.

In this work, Viola-Jones object detection algorithm with haar cascade classifier was used and implemented using MATLAB. Haar cascade classifier use Haar features detecting the face from images. Fig. 3 shows the Eye region images extracted from the face image.

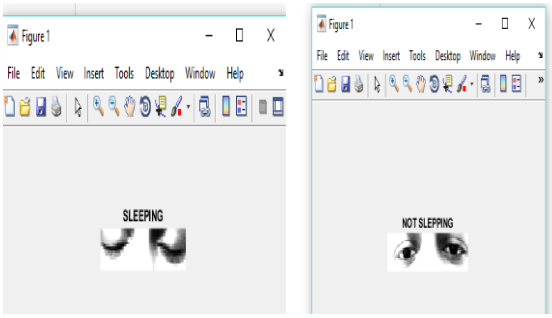

Fig. 3: Eye Region images

4. FEATURE EXTRACTION

Feature extraction is one type of dimensionality reduction where useful parts of an image represented as a feature vector. In this paper features from the eye region images are extracted using a discrete wavelet transform (DWT) [12].

4.1. Discrete Wavelet Transform

DWT is a wavelet transform that divides the data into distinct frequency components. There are different wavelets are available such as haar wavelets, Daubechies wavelets and the dual-tree complex wavelet transforms. In this work, we have used haar wavelets because it provides better recognition rate. Discrete wavelet transform (DWT) computes 4 coefficients namely LA(All Components), LH(Horizontal Component), LV(Vertical Components) and LD(Diagonal Component). We have used LA coefficients to obtain a reduced set of eye features. Fig. 4 shows the DWT decomposition.

LA	LH
LV	LD

Fig. 4: DWT decomposition

5. RBFNN

In this paper for training and testing the images Radial basis function neural network (RBFNN) [6] was used. As activation functions RBFNN uses Radial Basis Functions. The RBF Neural Network architecture was shown in Fig. 5. RBFNN architecture having 3 layers those are input, hidden and the output layer. The N Dimensional feature vector elements are given as input to the RBFNN input layer. The input and hidden layers are fully connected with Q RBF units. The weights between the hidden and the output layers of RBFNN were calculated by using the Moore-Penrose generalized pseudo-inverse method. It is very suitable for real-time applications because of its lowest training time ability. The number of hidden neurons, activation function, the weights between the

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output layer and hidden layer, the centre of activation functions are key to the RBFNN performance.

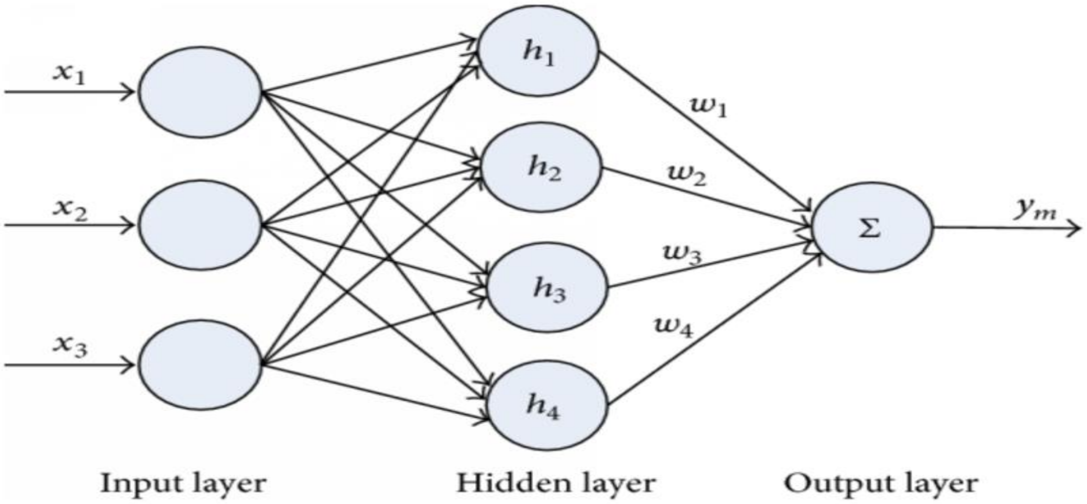

Fig. 5: RBFNN Architecture

Fig. 6: non-sleeping and sleeping image samples from dataset

6. EXPERIMENTAL RESULTS

6.1. Dataset

Currently, there is no available dataset of images of sleeping and non-sleeping. As a part of this experiment to evaluate our proposed method we have created a dataset. To create this dataset we have collected sleeping and non-sleeping samples from 30 persons and each person given 20 samples out of which ten samples are sleeping samples and reaming ten samples are non-sleeping samples. Totally this dataset having 600 samples out of which 300 samples are sleeping samples reaming 300 samples are non-sleeping samples. We have used a smartphone with a 15MP camera to create this dataset. Few samples from the dataset are shown in Fig. 6.

In this paper, our created dataset was used to perform the experiment. The proposed method shows 95.4% accuracy when the 60% of the image samples are used for training and 40% of the image samples are used for testing from the total of 600 image samples. Table 1 shows the Recognition rate and table 2 shows the recognition rate (%) for varying no of training and testing image samples.

6.2. Result

Table 1: Recognition Rate

Train images	*Test images*	*Recognition Rate (%)*
360	240	95.41

Table 2: Recognition rate based on of training and testing samples

Train images	*Test images*	*Recognition Rate(%)*
360	240	95.4167
300	300	94.667
240	360	93.6111
180	420	93.5095
120	480	93.21

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