A Neuro-Genetic System Design for

Monitoring Driver's Fatigue

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Summary
International statistics shows that a large number of road accidents are caused by driver fatigue. Therefore, a system that can detect oncoming driver fatigue and issue timely warning could help to prevent many accidents, and consequently save money and reduce personal suffering. In this proposed system security camera can be used that points directly towards the driver's face and monitors the driver's eyes & mouth in order to detect fatigue. If the fatigue is detected a warning signal is issued to alert the driver. The skin color based algorithm is used to detect the face of the driver. Once the face area is found, the eyes and mouth can be found by thresholding & segmentation process. The propose system uses neural network along with genetic algorithm for detecting the Driver's Fatigue, named as Neuron-Genetic system.

Key words:
Digital Image Processing,Neural network,Genetic Algorithm

1. Introduction

The ever increasing numbers of traffic accidents all over the world are due to diminished driver's vigilance level. Drivers with a diminished vigilance level suffer from a marked decline in their perception; recognition and vehicle control abilities and therefore pose a serious danger to their own lives and the lives of the other people. For this reason, developing systems that actively monitors the driver's level of vigilance and alerting the driver of any insecure driving condition is essential for accident prevention.

Many efforts have been reported in the literature for developing an active safety system for reducing the number of automobiles accidents due to reduced vigilance. Drowsiness in drivers can be generally divided into the following categories: sensing of physiological characteristics, sensing of driver operation, sensing of vehicle response, monitoring the response of driver. Among these methods, the techniques based on human physiological phenomena are the most accurate. This technique is implemented in two ways: measuring changes in physiological signals, such as brain waves, heart rate, and eye blinking; and measuring physical changes such as sagging posture, leaning of the driver's head and the open/closed states of the eyes. The first technique, while most accurate, is not realistic, since sensing electrodes would have to be attached directly on to the driver's body, and hence be annoying and distracting to the driver. In addition, long time driving would result in perspiration on the sensors, diminishing their ability to monitor accurately. The second technique is well-suited for real world driving conditions since it can be non-intrusive by using video cameras to detect changes. Driver operation and vehicle behavior can be implemented by monitoring the steering wheel movement, accelerator or brake patterns, vehicle speed, lateral acceleration, and lateral displacement. These too are non-intrusive ways of detecting drowsiness, but are limited to vehicle type and driver condition. The final technique for detecting drowsiness is by monitoring the response of the driver. This involves periodically requesting the driver to send a response to the system to indicate alertness. The problem with this technique is that it will eventually become tiresome and annoying to the driver.

The propose system based on eyes closer count & yawning count of the driver. By monitoring the eyes and mouth, it is believed that the symptoms of driver fatigue can be detected early enough to avoid a car accident. The eye blink frequency increases beyond the normal rate in the fatigued state. In addition, micro sleeps that are the short periods of sleep lasting 3 to 4 seconds are the good indicator of the fatigued state, but it is difficult to predict the driver fatigue accurately or reliably based only on a single driver behavior. Additionally, the changes in a driver's performance are more complicated and not reliable so in this system second parameter is also considered which is a yawning count. In order to detect fatigue probability the facial expression parameters must be extracted first. As fatigue level can be

properly characterized by eyes and mouth movements, a vision sensor is needed to recognize and track the eyes and the mouth, a normal video-camera as a vision sensor can be use on the premise with the environment is bright enough. Here, eye closing count, and yawn count in successive frames can be detected using a web camera. In real time implementation if 30 fps considered then it is observed that successive frames have same information ,so instead of considering all frames of video files, select   frames such that which gives more information but less computational requirements. In this proposed system instead of analyzing complete frame of video file, eyes and mouth portion are separated after detecting face area , the facial features in these regions are considered in detail and corresponding eyes closing count & yawning count can be obtained using correlation method for this type of Digital Image Processing   filtering and segmentation process has to be carried out. In this system a feed forward backprapogation neural network is used along with Genetic algorithm for giving more intelligence to the system since the input parameters are highly unreliable and non linear in nature ,it provides the optimized structure of the NN which can give result close to that of Fixed structured NN.

2. System Overview

The complete block diagram representation of the proposed system is as shown in figure 1.while flowchart of the major functions of The Drowsy Driver Detection System is shown in Figure.2 After inputting a facial image, the skin color based algorithm is applied to detect the face in the image.. Using the sides of the face, eyes portion and mouth portion of the image is separated from which the open or closed state of the eyes are detected along with yawning count. This two parameters which are the output of the DIP Module are given as the input to the Hybrid Intelligent System which is a combination of Neural network and Genetic Algorithm, which can give corresponding fatigue probability, Depending on the fatigued probability ,system draws the conclusion that the driver is falling in fatigued state and issues a warning signal.
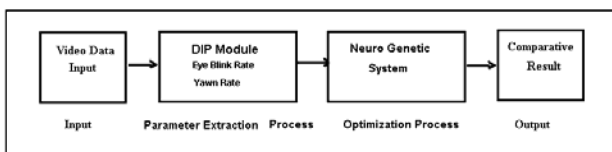

Figure 1. Neuro-Genetic System Block Diagram

        In this system AVI file is used which is converted to frames and random frames are selected from it for further processing. The next step will be of eye and lip detection. Eyes are located by performing some morphological operations on the face. This is done by converting the image to a binary image, based on threshold. In the binary image there are two significant intensity changes that can be seen. The first intensity change is the eyebrow, and the next change is the upper edge of the eye. The state of the eyes (whether it is open or closed) is determined by distance between the two intensity changes. When the eyes are closed, the distance i.e. the no. of white pixels between the two intensity changes is larger as compared to when the eyes are open. The number of white pixels between the two intensity changes is recorded. For Lip detection R/G ratio process is used.The parameter extraction is performed by DIP Module which is then provided to Genetic process based Optimized Neural Network, which gives comparative result of fatigues.
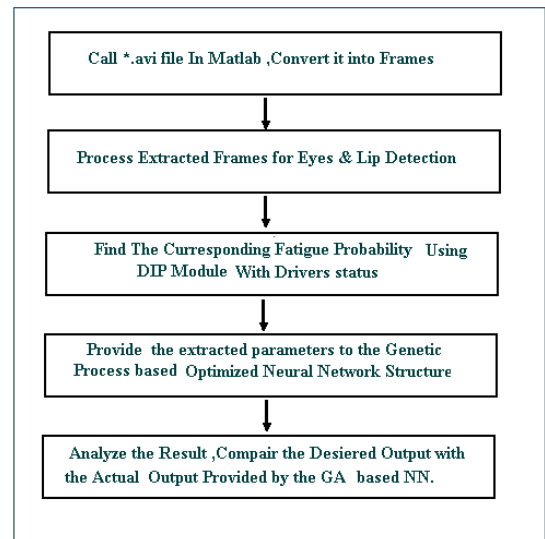

Fig 2 : Flow chart for Neuro-genetic System.

2.1. Face Detection

   Human face localization and detection is often the first step in applications such as video surveillance, human computer interface, face recognition and /or facial expressions analysis, and image database management. A lot of research has been done in the area of human face detection .

   In prior studies, different human skin colors from different races have been found to fall in a compact region in color spaces. Therefore skin can be detected by making use of this compactness. The face detection is performed in three steps . The first step is to classify each pixel in the given image as a skin pixel or a non-skin pixel. The second step is to identify different skin regions in the skin-detected image by using connectivity analysis. The last step is to decide whether each of the skin regions identified is a face or not. After the probable location of the face is found the left and the right edges of the face is determined

Fig-3 Face Detection

2.2 Eyes & mouth detection

The next step in locating the eyes & mouth, that can be obtained by using the edges of the face obtained after skin detection algorithm , finding the intensity changes on the face as given by Parmar (2002) . This is done using the gray scale image and not the RGB image. By using proper threshold values it is possible to find out & crop the image portion of the eyes and mouth.Image data is available in RGB planes,where every pixel in image has R, G and B value associated with it.That image is converted into binary image.then image will be cut into a quarter.In this Geometric approximations will help in filtering and clearing unwanted regions surrounding eye.After this first instance of Black Pixel will be counted from top of image as well as bottom of image and if there is white portion in between the upper eyebrow and lower eyelid hairs; all such pixels will be counted which will indicate the width of skin region between upper eyebrow and lower eyelid.Separation from start of eyebrow to end will be measured.Maximum separation between them will indicate the state of blinking. If person is awake there will be presence of black region due to pupil, upper eyelid and white region will be less and white pixels will be less.

If person is sleeping there will be more white region and hence state of driver for blinked eye can be determined easily. For Yawning Count first process is to identify the lip pixels and measure the lip pixel count.The lip pixel can be identified by using R/G ratio which has different values for skin and for lips,in this system for lips count measurement only lower 50 % portion of frame is consideredThe lip count will have different value in different frames of video for 50% of image because when person is yawning, it may cause disappearance of upper lip portion. Thus Lip count will get affected and by using proper threshold value of lip count the state of driver can be easily differentiated i.e. yawn , less yawn or no yawn state of driver.
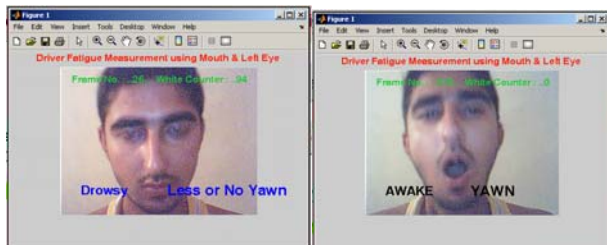

Fig 4 :- Driver with AWAK,DROWSY,YAWN ,NOYAWN Condition.

The parameter extraction is performed using DIP Module and results are as shown in fig.
The total 300 frames in the group of 100 are considered and corresponding   Eye close count ,Yawn count & fatigue probability is calculated by using GUI designed for DIP module as shown in fig
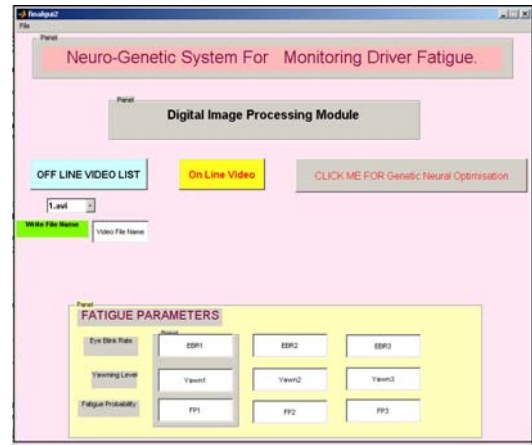

Fig –5 GUI designed for DIP Module

i) Neural network and Genetic process system

A neural network can solve a nonlinear complicated problem very simply and results in a reasonably accurate approximation of an unknown system. In this system a feed-forward neural network with a back-propagation learning algorithm can be use. This is illustrated in Fig. where input data is provided from DIP module.Although neural networks are used for solving a variety of problems, they still have some limitations .One of the most common is associated with neural network training. The back-propagation learning algorithm cannot guarantee an optimal solution.   In real-world applications, the back-propagation algorithm might converge to a set of sub-optimal weights from which it cannot escape. As a result, the neural network is often
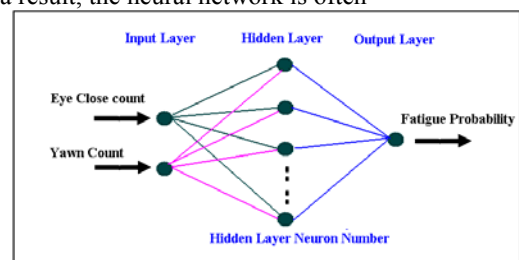
unable to find a desirable solution to a problem at hand. Genetic algorithms are an effective optimisation technique that can guide both weight optimisation and topology selection.
The data of the eye close count and yawn count are then fed to the neural network. The training process of the neural network begins with the selection of any ten random

neuron numbers in the specified limit. This is done to find the best possible number of neurons to be present in the hidden layer with the help of the genetic algorithm. The neural network with the help of the target values and the selected number will produce a plot showing the deviation from the ideal values. The error in the target output values and the present outputs are then given to the genetic algorithm.

The errors obtained above are provided to the genetic algorithm. The fitness function for the genetic algorithm here is this error in the target output values and the present outputs. The crossover of the binary form of the neuron numbers is done and new generation is obtained. From this set of ten neuron numbers, four of them with the lesser error are selected and are further processed for mutation. After mutation out of these four neurons one is selected having the least error. Thus on the basis of the optimization done by the genetic algorithm, best possible number of neurons is selected for the neural network. The neural network is now trained with the selected neuron number and the previously provided inputs and the target output.

Once the network is trained the inputs are provided to it and the neural network then carries out the calculation for the drowsiness on the basis of the training provided to it. The output about the state of the driver is then displayed with corresponding fatigued probability as shown in fig.

The comparative result between fixed structured NN and Genetic process based optimized structured NN is as shown in fig. after performing number of iteration the best result is obtained which is approximately close to the desired target .
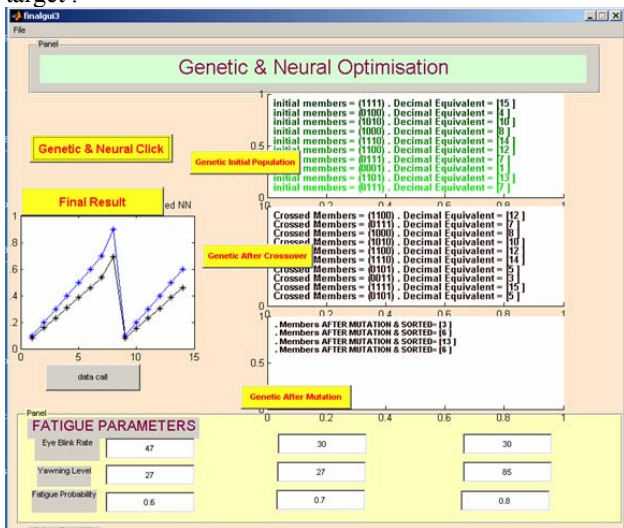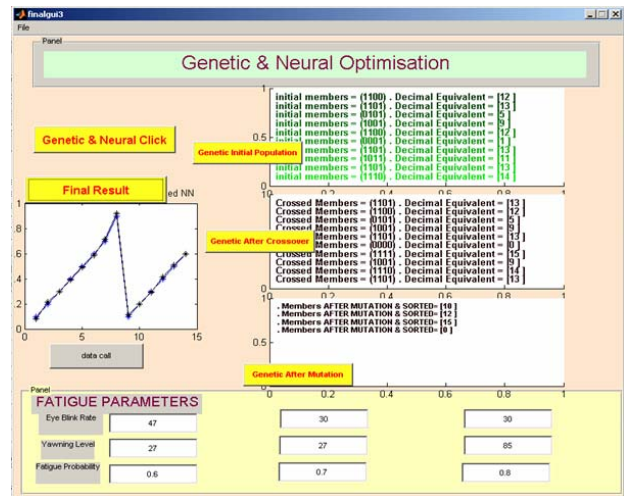

Fig 7-: Initial Comparative Result.

Fig 6-: Comparative Result follows the desired target values.

Conclusion and Future Scope

Thus proposed Neuro-Genetic system for monitoring driver fatigue can be implemented which detects the fatigued state of the driver through continuously monitoring the eyes & mouth of the driver and system performance can be improved by using Neuro-Genetic system which can work efficiently with uncertain data input associated with Driver's Fatigue.

Complete working system can build using virtual instrumentation software like LABVIEW & Add on Cards. Custom chip can be build using VHDL for embedded system. The future lies in making the algorithm working faster. Another improvement is developing an autonomous decision making module which controls or steers the vehicle depending upon the output of the hybrid system. The system is implemented in non-real time. Real time implementation of the system could be the major improvement in the current system

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