International Journal of Engineering & Technology, 7 (3.27) (2018) 516-519

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Driver's Drowsiness Behaviour Detection by Using PSO/DPSO Algorithm for Urban Road System

J. Sudhakar[1*], S. Srinivasan[2]

[1]*Research Scholar, Department of E.C.E, St. Peter's Institute of Higher Education and Research, Chennai, India.*
[2]*Professor & Head, Department of Biomedical, Saveetha School of Engineering, Saveetha University, Chennai, India.*
E-mail:srinivasan.me.03@gmail.com
**Corresponding author E-mail:Sudhak1241@gmail.com*

Abstract

In recent years driver fatigue is one of the major causes for vehicle accidents in the world. A direct way of measuring driver fatigue is measuring the state of the driver drowsiness. So it is very important to detect the drowsiness of the driver to save life and property. In our system, this aims to develop a prototype of drowsiness detection system. This system is a real time system which captures image continuously and measures the state of the eye according to the specified algorithm and gives warning if required. Though there are several methods for measuring the drowsiness but this approach is completely non-intrusive which does not affect the driver in any way, hence giving the exact condition of the driver. For detection of drowsiness the each closure value of eye is considered. So when the closure of eye exceeds a certain amount then the driver is identified to be sleepy. The entire system is implemented using PSO, DPSO and FODPSO algorithm and detection of drowsiness behaviour of driver different eye state level.

***Keywords**: Driver drowsy detection, fatigue behaviour, eye state detection, face tracking, eigen vectors, particle swarm optimization (PSO), DPSO and FODPSO.*

1. Introduction

The attention level of driver degrades because of less leep, long continuous driving or any other medical condition like brain disorders etc. Several surveys on road accidents say that around 30 percent of accidents are caused by fatigue of the driver [1].When the driver drives for more than normal period for human then excessive fatigue is caused and also results in tiredness which drives the driver to sleepy condition or loss of consciousness [2]. Drowsiness is a complex phenomenon which states that there is a decrease in alerts and conscious levels of the driver. Though there is no direct measure to detect the drowsiness but several indirect methods can be used for this purpose. In initial sections different types of methods for measuring the drowsiness of the driver are mentioned which includes Vehicle based measures, Physiological measures, Behavioral measures [3].Using those methods an intelligence system can be developed which would alert the driver incase drowsy condition and prevent accidents [4][5]. Advantages and disadvantages corresponding to each and every systems are explained. Depending on advantages and disadvantages, the most suitable method is chosen and proposed. Then the approach for entire system development is explained using a flow chart which includes capturing the image in real time continuously, and then divided it into frames. Then each frame is analyzed to find face first. If a face is detected then next task is to locate the eyes [6]. After the positive result of detecting eye, the amount of closure of eye is determined and compared with the reference values for the drowsy state eye. If drowsy condition is found out then the driver is alarmed else repeatedly the loop of finding face and detecting drowsy condition is carried out [7]. In latter sections object detection, face detection and eye detection is explained in detailed manner. Because, face is a type of object hence a few studies on object detection is done. In face detection and eye detection different approaches for both are proposed and explained [8]. Theoretical base for designing the entire system is explained which includes Principal Component Analysis (PSO Algorithm) and Eigen face approach. We know that the structure of face is complex and multidimensional. A face needs great calculating methods and techniques to recognize it [9].In my approach, it will treat a face as a two dimensional structure and accordingly it should be recognized. Principal Component Analysis (PSO ALGORITHM) is used for face recognition in this context. This idea involves the projection of face images into that particular face space. Then we encode the variation or difference among the desired known faces.
Eigen face decides and defines the face space. We represent these faces as Eigen vectors [10]. This vector consists of all sets of faces. A case of similarity with different features of our face appears like nose, Eyes, lips etc. The Eigen face approach uses the PSO ALGORITHM for recognition of the images. The system performs by projecting pre extracted face image into a set of face space that represents significant variations among known face images [11]. Eigen face approach includes Eigen Values and Eigen Vectors, Face Image Representation, Mean and Mean Centered Images, Covariance Matrix, Eigen Face Space [12].

2. Proposed Methodology

Drowsiness is defined as a decreased level of awareness portrayed by sleepiness and trouble in staying alarm but the person awakes with simple excitement by stimuli. It might be caused by an absence of rest, medicine, substance misuse, or a cerebral issue. It is mostly the result of fatigue which can be both mental and physical. Physical fatigue, or muscle weariness, is the temporary physical failure of a muscle toper form ideally. Mental fatigue is a temporary failure to keep up ideal psychological execution. The onset of mental exhaustion amid any intellectual action is progressive, and relies on an individual's psychological capacity, further more upon different elements. for example, lack of sleep and general well-being. Mental exhaustion has additionally been appeared to diminish physical performance. It can show as sleepiness, dormancy, or coordinated consideration weakness.

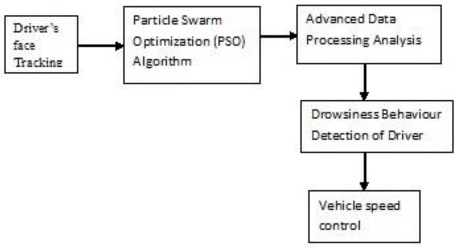


Fig. 2.1: Proposed block diagram

Image Capture Analysis

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.

(I)Eye State 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 driver. 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 several features. Generally Eigen 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 driver.

(ii)Object Detection

Object detection is commonly defined as method for discovering and identifying the existence of objects of a certain class. Also it can be considered as a method in image processing to find out an object from images. There are several ways to classify and find objects in a frame. Out of that one way can be based on color identification. But it is not an efficient method to detect the object as several different size object of same color may be present.

(Iii) Face Detection

We know that face is also a type of object. So we can consider detection of face as a particular case of object detection. In this type of object type of class detection, we try to know where the objects in the interest image are located and what is their size which may belongs to a particular class. The work of algorithm that is made for face detection is mostly concentrated on finding the front side of the face. but the algorithm that are developed recently focus on more general cases for our case it may be face in the tilted position or any other portion of the faces and also it finds the possibility of multiple faces. This means the rotation axis with respect to the present observer from the reference of face in a particular. Even if there is vertical rotation plane then also it is able to solve the purpose.

Particle Swarm Optimization (PSO)

A particle swarm optimization (PSO) is a population-based stochastic optimization algorithm modeled after the simulation of the social behavior of bird flocks. PSO is similar to EAs in the sense that both approaches are population-based and each individual has a fitness function. Furthermore, the adjustments of the individuals in PSO are relatively similar to the arithmetic crossover operator used in EAs .However, PSO is influenced by the simulation of social behavior rather than the survival of the fittest. Another major difference is that, in PSO, each individual benefits from its history whereas no such mechanism exists in EAs.PSO is easy to implement and has been successfully applied to solve a wide range of optimization problems such as continuous nonlinear and discrete optimization problems.

PSO algorithm

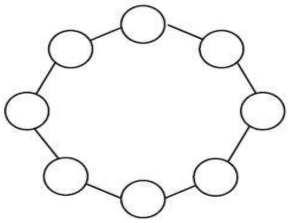
Principle component analysis (PSO ALGORITHM) was invented in 1901 by Karl Pearson. If the resulted data is repeated again and again or has redundancy the PSO Algorithm helps in reducing this redundancy. It has basically removes the variables to reduce redundancy. So after the reduction of variables we will get less variables named as Principle Components. Principle components will generally represent all the variables present in the obtained variable. The main objective of this algorithm is to decrease the no of dimension as well as retain more and more possible variation in the given data set. But we know that reductions in dimension results in information loss as information are directly linked with dimension. Hence we can overcome the problem of data loss by choosing the best principal components as main principle components determines the low dimension. Though use of PSO algorithm has many advantages but mostly it is used for Eigen face approach. In Eigen face approach the reduction of size of the data base is achieved for recognizing the test images. The obtained images are stored in the data base in vector form which is also called feature vectors.

Eigen Values and Vectors

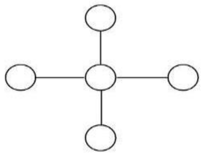
In linear algebra, a linear equation in matrix form is represented by Ax= D. The eigenvectors of a linear operator are non-zero vectors which, when operated by the operator. The result of this is a scalar multiple of them. For the Eigen vector X the obtained scalar called Eigen value (λ). A vector which is paralleled by linear transformation is called an Eigen vector. It is one of the properties of matrix. When we calculate a matrix on it, 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.

PSO Neighbourhood Topologies

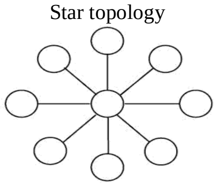
Different neighborhood topologies have been investigated. Two common neighborhood topologies are the star (or wheel) and ring (or circle) topologies. For the star topology one particle is selected as a hub, which is connected to all other particles in the swarm. However, all the other particles are only connected to the hub. For the ring topology, particles are arranged in a ring. Each particle has some number of particles to its right and left as its neighborhood Recently, Kennedy and Mendes [2002] proposed a new PSO model using a Von Neumann topology. For the Von Neumann topology, particles are connected using a grid network (2-dimensional lattice) where each particle is connected to its four neighbor particles.



Von neumann topology



Star topology



Ring topology

Fig. 2.2: A diagrammatic representation of neighborhood topologies

The choice of neighborhood topology has a profound effect on the propagation of the best solution found by the swarm. Using the gets model, the propagation is very fast. However, using the ring and Von Neumann topologies will slow down the convergence rate because the best solution found has to propagate through several neighborhoods before affecting all particles in the swarm. This will slow propagation and it will enable the particles to explore more areas in the search space and thus decreases the chance of premature convergence. This problem is magnified in PSO where modifying a PSO parameter may results in a proportionally large effect. On the other hand, decreasing the value of w will decrease the speed of the particle resulting in more exploitation and less exploration. This finding the best value for w is not an easy task and it may differ from one problem to another. Therefore, it can be concluded that the PSO performance is problem dependent.

Discrete Particle Swarm Optimization (DPSO)

The classical PSO algorithm described in previous section is not applicable if the search space is discrete, that is if the position of each particle is bound to a discrete set of values. A modification of the classical algorithm is proposed in the current paper suitable for optimization within such a search space. The velocity vector is calculated by using the same formula as in the classical PSO, but it is saturated after by using the hyperbolic tangent function to obtain a new quantity, that is referred to as the saturated velocity

Fractional Order Darwinian Particle Swarm Optimization (FODPSO)

In FO-DPSO may also be seen as a collection of FO-PSO"s as in which each swarm individually performs with some natural selection rules. A swarm behavior can be divided into two activities: a) exploitation; and b) exploration. The first one is related with the convergence of the algorithm, thus allowing a good short-term performance. However, if the exploitation level is too high, then the algorithm may be stuck on local solutions. The second one is related with the diversification of the algorithm which allows exploring new solutions, thus improving the long-term performance. However, if the exploration level is too high, then the algorithm may take too much time to find the global solution. The trade-off between exploitation and exploration in the classical PSO has been commonly handled by adjusting the inertia weight. A large inertia weight improves exploration activity while exploitation is improved by using a small inertia weight. Since the FO-DPSO presents a fractional calculus. Strategy to control the convergence of particles, the coefficient α needs to be defined in order to provide a high level of exploration while ensuring the global solution of the mission. If a new global solution is found, a new particle is swarmed. If the swarm fails to find a fitter state in a defined number of steps, the particle is deleted.

3. Kit and Result Implementation

Result Analysis

Successful detection of the face is followed by the detection of stress. If closure of eye for successive frames were detected then it is classified as drowsy condition else it is regarded as normal blink and the loop of capturing image and analyzing the state of driver is carried out again and again. During the implementation of the drowsy state, the eye is not surrounded by circle or it is not detected by corresponding message. [14]

Fig. 3.1: (a).Various segmentation level captured image using PSO, DPSO and FODPSO algorithms

Fig. 3.1: (b) Driver's image segmentation by using PSO, DPSO and FODPSO algorithms

If the driver is not drowsy then eye is identified by a circle and it prints 1 for each successful detection of an open eye. If the diver get drowsy level, the different captured images are implemented different algorithms like PSO, DPSO and FODPSO .The abnormal image(driver sleepy) should be identified and the alert to driver by using alarm ensured and the speed the vehicle can be reduced automatically. The concern information should sent to the authorized person. Whoever the driver drowsy can be easily identified by using PSO algorithm method.[13]

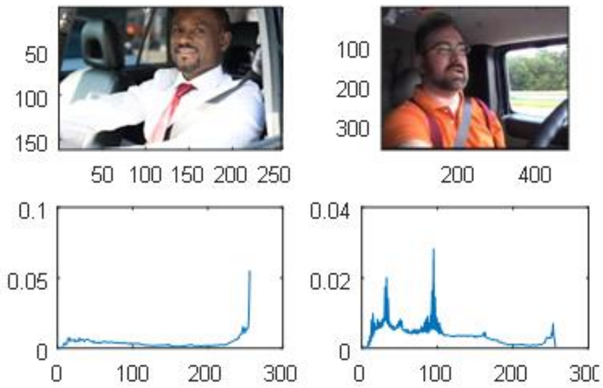


Fig. 3.1(b): Comparison of normal and abnormal histogram images

Kit Implementation Model

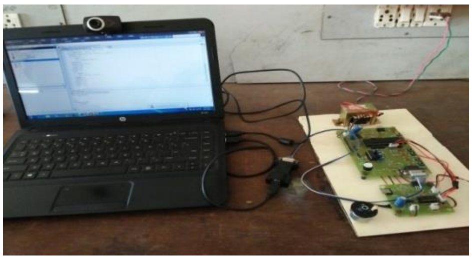


Fig. 3.2: Kit diagram

4. Conclusion

Implementation of drowsiness detection with PIC microcontroller was done which includes the following steps, Captured images were divided into frames and the frames are analyzed separately. The PSO, DPSO and FODPSO algorithms are implemented to analysis the captured images and detect drowsy condition of the driver. After segmentation of each images one by one, finally compared histogram level and the abnormal (drowsy) state level while compared with normal state level is carried out. If closure of eye for successive frames were detected then it is classified as drowsy condition else it is regarded as normal blink and the loop of capturing image and analyzing the state of driver 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 driver is not drowsy then eye is identified by a circle and it prints 1 for every successful detection of an open eye.

References

[1] Yin J, Hu J & Mu Z, "Developing and evaluating a mobile driver fatigue detection network based on electroencephalograph signals", *Health. Technol. Lett*., Vol.4, No.1, (2017), pp.34–38.

[2] Qiao Y, Zeng K, Xu L & Yin X, "A Smartphone-Based Driver Fatigue Detection Using Fusion of Multiple Real-Time Facial Features", *13th IEEE Annu. Consum. Commun. Netw. Conf*., (2016), pp. 230–235.

[3] Pholprasit T, Choochaiwattana W & Saiprasert C, "A comparison of driving behaviour prediction algorithm using multi-sensory data on a Smartphone", *IEEE/ACIS 16th Int. Conf. Softw. Eng. Artif. Intell. Netw. Parallel/Distributed Comput. SNPD*, (2015).

[4] Naz S, Ahmed A, ul ain Mubarak Q & Noshin I, "Intelligent driver safety system using fatigue detection", *19th Int. Conf. Adv. Commun. Technol*., (2017), pp.89–93.

[5] Manoharan R & Chandrakala S, "Android Open CV based effective driver fatigue and distraction monitoring system", *Proc. Int. Conf. Comput. Commun. Technol. ICCCT*, (2015), pp.262–266.

[6] Mandal B, Li L, Wang GS & Lin J, "Towards Detection of Bus Driver Fatigue Based on Robust Visual Analysis of Eye State", *IEEE Trans. Intell. Transp. Syst.*, Vol.18, No.3, (2017), pp.545–557.

[7] Li G, Lee BL & Chung WY, "Smart watch-Based Wearable EEG System for Driver Drowsiness Detection", *IEEE Sens. J.*, Vol.15, No.12, (2015), pp.7169–7180.

[8] Castignani G, Derrmann T, Frank R & Enge T l, "Smartphone-Based Adaptive Driving Maneuver Detection: A Large-Scale Evaluation Study", *IEEE Trans. Intell. Transp. Syst.*, Vol.18, No.9, (2017), pp.2330–2339.

[9] Sharma MK & Bundele MM, "Design & Analysis of Performance of K-Means Algorithm for Cognitive Fatigue Detection in Vehicular Drivers using Skin Conductance Signal", *2nd Int. Conf. Comput. Sustain. Dev.*, (2015), pp.707–712.

[10] Boon-Leng L, Dae-Seok L & Boon-Giin L, "Mobile-based wearable-type of driver fatigue detection by GSR and EMG", *IEEE Reg. 10 Annu. Int. Conf. Proceedings/TENCON*, (2016), pp.1–4.

[11] Ko LW, Lai WK, Liang WG, Chuang CH, Lu SW, Lu YC, Hsiung TY, Wu HH & Lin CT, "Single channel wireless EEG device for real-time fatigue level detection", *Proc. Int. Jt. Conf. Neural Networks*, (2015).

[12] Won M, Mishra A & Son SH, "HybridBaro: Mining Driving Routes Using Barometer Sensor of Smartphone", *IEEE Sens. J.*, Vol.17, No.19, (2017), pp.6397–6408.

[13] Abikhanova G, Ahmetbekova A, Bayat E, Donbaeva A & Burkitbay G, "International motifs and plots in the Kazakh epics in China (on the materials of the Kazakh epics in China)", *Opción, Año*, Vol.33, No.85, (2018), pp.20-43.

[14] Akhpanov A, Sabitov S & Shaykhadenov R, "Criminal pre-trial proceedings in the Republic of Kazakhstan: Trend of the institutional transformations", *Opción*, Vol.34, No.85,(2018), pp.107-125.