IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676, p-ISSN: 2320-3331, Volume 17, Issue 5 Ser. I (Sep. – Oct. 2022), PP 15-18
www.iosrjournals.org

Model of Fatigue Detection Using Facial Expression Applications in Oil and Gas Companies

Muzammil Abdulrahman
Department of Electrical/Electronic EngineeringPetroleum Training Institute Effurun, Delta Nigeria

Abstract
The use of questionnaires to determine the fatigue level of persons is generally in adequate due to the inherent inaccuracies in self-reports, asking someone how tired they are, is not reliable and therefore self-reports would also clearly be an inefficient system for detecting fatigue. There is need of an automated system to detect how fatigued someone truly is. This research proposes a model plan to perform facial expression experiments with a number of rested and fatigue individuals so as to obtain a very good threshold values for detecting eye fatigue, frequency of eye blinking, frequency of yawning, head nodding and rotation in order to ascertain the actual fatigue of an individual. By identifying fatigue and taking proactive measures before it becomes an issue, you can ensure a safe, healthy, and productive work environment for your entire employees.
Key words: *Fatigue Detection, Face Detection, ROI, Oil and Gas*

Date of Submission: 24-08-2022 Date of Acceptance: 07-09-2022

I. Introduction

Fatigue at work is a usual daily experience, however, in the case of severe fatigue it may affect the person's performance in the occupational as well as the home setting. Furthermore, severe long term fatigue may lead to sick leave and work disability.However, the use of questionnaires to determine the fatigue level of persons is generally in adequate due to the inherent inaccuracies in self-reports [1], asking someone how tired they are, is not reliable and therefore self-reports would also clearly be an inefficient system for detecting fatigue. We need an automated system to detect how fatigued someone truly is [2].

Fatigue is a term used to describe an overall feeling of tiredness/weakness or lack of energy [3-5]. When you're fatigued, you have no motivation and no energy. While Fatigue Detection is a system that uses Facial Expressions to recognize the presence of fatigue [6]. The common workplace issues that can cause fatigue include:

Shift work: the human body is designed to sleep during the night. This pattern is set by a small part of the brain known as the circadian clock. A shift worker confuses their circadian clock by working when their body is programmed to be asleep. The other ones are poor workplace practices, workplace stress, unemployment etc.

Facial expression is among the most important type of human information, since the face contains rich information and therefore by just looking and analyzing them, much useful information can be learnt for communication with people[7]. In face-to-face human communication for example, only 7% of the communicative message is due to linguistic language, while 93% of communication is nonverbal (without the use of word) in nature out of which 38% is due to paralanguage (pitch, volume & Intonations) while 55% of it is transferred by facial expressions [8]. Facial expression recognition has been one of the fast developing areas due to its wide range of applications in the areas of human-computer interaction, security, health, emotion analysis and so on. In the design of human computer interaction, the robots can interact with humans by interpreting human gestures and facial expressions in more natural manner, so that it can respond more appropriately during tasks where the two must work together [9].

II. Review of Related literature

Fatigue detection is one of the many commercial applications of facial expression recognition technology [26, 27]. In order to detect fatigue probability, we must extract the facial expression parameters first. As fatigue level can be properly characterized by eye and mouth movements, a vision sensor is needed to recognize and track the eyes and the mouth. We can use a normal video-camera as a vision sensor on the premise that the environment is bright enough. The Gabor wavelet-based method is used to identify each feature in the tracking initialization. Linear and nonlinear filters have been used for eye detection: oriented Gabor wavelets form an approximation of the eye gray-level images; nonlinear filters are applied to color images.

The uses of robots in security, entertainment, health care and household increase the need in researches in the area of digital processing and pattern recognition [28, 29]. In the design of human computer interaction [30], the robots can interact with humans by interpreting human gestures and facial expressions in more natural manner [31], so that it can respond more suitably during tasks where the two must work together. In education for instance, a robot teaches a lesson and ask some questions to the audience afterwards. Knowing human emotion and fatigue level, the quality and success of these lessons will be achieved as the robot will be aware whether to progress with the lesson when the humans are ready or to go for a break when they are tired. Robot can detect deceit during interrogation of criminals in security areas, using micro expressions [32]. Also the safety of the driver and that of the passengers [33] can be ensured by detection of the drowsiness or fatigue of a driver from his gestures and facial expressions, so that a warning system can automatically triggers to prevent accidents. In health-care [34], the improvement in patient can be monitored from their facial expressions.
The significant facial features are extracted by using relative positions and sizes of the components of face. The important directions of the edges or region of images containing important components are detected, and then the feature vectors are built from these edges and directions. Filters such as canny filter are used to detect eyes or mouth region of face image, the other methods are based on the grayscales difference of important components and less significance components, by using feature blocks i.e. set of Haar like feature block in Adaboost method [35] to change the grayscales distribution into the feature.

Ekman [36] established prominent facial expression representation and coding system, called facial action coding system. The aim was to describe all facial muscle movements using 46 actions units (AUs), each AU correspond to the physical behavior of a specific facial muscle, giving an appearance-based description of faces. Hence, a facial expression relates to the combination of a set of AUs, which humans utilize to communicate their emotions [37]. From a physiological point of view, a particular facial feature deformation give rise to facial expression, as a result of muscle contraction and relaxation in a face.

III. Relevance of the research to the oil and gas industries

(i) Employees of industries that requires 247 operations of which oil and gas facilities are among are impacted by fatigue as a result of shift work and therefore performance and safety are also affected [10]. This fatigue can damage their health, affect work performance, and increase the frequency of costly errors and accident as a result of poor decision and lack of concentration. According American College of Occupational and Environmental Medicine, lost productivity due to fatigue costs employers a total of $136.4 billion every year in US and lower efficiency asa rework hours' increase, output and performance decrease[11].The Exxon Valdez accident in 1989 was due to fatigue, caused by reduced sleep and extended work hours [12]. In the gas plant of southern Sweden, a study shows that errors in meter readings over a period of 20 years in a gas works had a pronounced peak on the night shift due to fatigue [13]. Findings from other researchers show dominance of accident during night shift as a result of fatigue [14, 15].By identifying fatigue and taking proactive measures before it becomes an issue, you can ensure a safe, healthy, and productive work environment for your entire team. The research can equally be used to access the actual fatigue level of the attendant personnel so as to come up with best work schedule in line with the best practice.

(ii) Nowadays, about 80% of refined petroleum products in Nigeria are transported by road [16] and many road accidents including tankers that transport petroleum products occur due to driver fatigue. Road transport is the area where the link between safety and night work sleepiness is most pronounced. Studies have shown that single vehicle truck/ oil tanker accidents have, by far, the greatest probability of occurring at night due to fatigue [17-19]. Single vehicle automobile highway accidents are also greatest at night[20-22]. Furthermore, the USNational Transportation Safety Board (NTSB) found that 30–40% of all US truck accidents are fatigue related.

In Nigeria, according to Federal Road Safety Corp (FRSC)Corps Marshal, BoboyeOyeyemi, Nigeria loses billionsto trailer/tanker crashes and many lives were lost and several others wounded because of fatigue on the part of the truck drivers who are always on long journeys, driving for several hours without stopping and resting [23-25].

Driver fatigue detection based on facial expression is one of the most hopeful applications that can minimize the frequency of these accidents. A web camera as a vision sensor is installed on the dashboard of the tanker to acquire video-images of the driver. Three typical characteristics of driver fatigue are involved, pupil shape, eye blinking frequency, and yawn frequency.

(iii) It can equally be incorporated with the CCTV within the oil and gas facility to keep drowsy personnel awake and active by sounding an alarm whenever drowsiness is detected as a result of fatigue.

IV. Organization of the Research Model

The proposed model in this research uses a camera as a fatigue detection system. The camera captures images of the person, and then sends the images for image processing which is then pass to the micro expression algorithms for face detection, eye and mouth detections.

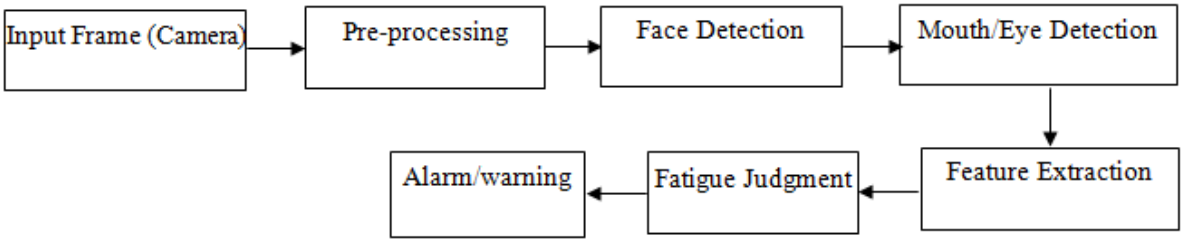

Figure 1: Block diagram of the Proposed Model

The fatigue detection algorithms will be carried out inthe following steps:

(i) The input is a still image or an image from a video frame.

(ii) **Image preprocessing** to reduce the image sizes, make the images have uniform sizes and change them to grey.

(iii) The second step is **face detection**: Detection of the face in an image or video frame which defines if any face exists in a given image and estimates the location and size of that face. A face is located using Haar-like feature detectors(AdaBoost).

(iv) **Eyedetection**the upper half of the detected face is the Region of Interest (ROI)within which eye is detected using Principle Component Analysis (PCA) or AdaBoost algorithm. The eye will be detected by tracking the darkest pixels in the predicted region.
Mouth detectionone third of the detected face will be the mouth ROIwhile the mouth is detected by mouth contour techniques using Viola Jones algorithm.

(v) **Feature extraction** involves extraction of salient feature elements of the detected eye/mouth that contribute most to the fatigue analysis using Gabor Wavelet Transform and PCA.

(vi) **Blink detection** by estimating the changes in black pixels within the eye regions. An open eye will have a larger visible pupil than a blinking eye. The pupil is often darker than the color of the rest of the eye. Thus, an open eye should have more black pixels. In the detected eye region, the eye image is converted to a binary image using image thresholding. Then, the ratio of black pixels in the binary image of the eye is calculated. The ratio of black pixels is used as the criterion for eye blinks.

(vii)**Fatigue judgment**: To determine the state of person fatigue, three criteria are used:

- ✓ The frequency of yawning
- ✓ PERCLOS (Percent Eye Closed). A drowsy person may exhibit frequent head nods and eye blinks. An eye is treated as closed if the height of the visible pupil is smaller than 30% of its maximum opening.

This proposed method which is based on image processing will be fast and precise to detect drivers' drowsiness. Fatigue and drowsiness lead to some apparent signs on driver's face.

V. Conclusions

The research model has presented a plan to perform analysis with a number of rested and fatigue individuals so as to obtain a very good threshold values for detecting eye fatigue, frequency of eye blinking, frequency of yawning, in order to ascertain the actual fatigue. By identifying fatigue and taking proactive measures before it becomes an issue, you can ensure a safe, healthy, and productive work environment for your entire team.

VI. Recommendation

It is recommended that this proposed Model of Fatigue Detection Using Facial Expression Applications in Oil and Gas Companies be implemented with a view to improving the work performance/efficiency and decrease the frequency of costly errors and accident as a result of poor decision and lack of concentration by a fatigued employee.

References

[1]. A.J**.** Beurskens, U. Bultmann, I. Kant, et al **"Fatigue among working people: validity of a Questionnaire Measure''**Journal of Occupational Environment Med. vol.57(5) pp. 353–357, 2000.

[2]. Y**.**Aratake, K. Tanaka, K. Wada, et al **''Development of Japanese Version of the Check-list Individual Strength Questionnaire in a Working Population''**Journal of Occupational Health vol.49 pp. 453–460, 2007.

[3]. J.W.Stephen, S. Cindy, S. Matthew, **''Fatigue and Measurement of Fatigue''**JBI Database of Systematic Reviews and Implementation Reports,vol. 17(3) pp.261-266, 2019.

[4]. L.J. Tiesinga, T.W. Dassen, R.J. Halfens, **"Fatigue: A Summary of the Definitions, Dimensions, and Indicators"** Journal of Nursing Diagnosisvol. 751–62,1996.

[5]. M.C. Dalakas, V. Mock, M.J. Hawkins **"Fatigue: Definitions, Mechanisms, And Paradigms for Study"** Journal of Seminars in Oncology vol. 25(1) pp. 48–53, 1998.

[6]. C.M. Tyng, H.U. Amin, M.N. Saad and A. S. Malik "**The Influences of Emotion on Learning and Memory"**Review ArticleFront. Psychology., 2017.

[7]. Ephratt M. **"Linguistic, Paralinguistic and Extralinguistic Speech and Silence"**Journal of Pragmatics, vol. 43(9), pp. 2286-2307, 2011.

[8]. R. Buck, & C. A. VanLear, **"Verbal and Nonverbal Communication: Distinguishing Symbolic, Spontaneous, And Pseudo-Spontaneous Communication"**Journal of Communication, vol. 52 pp. 522–541, 2002.

[9]. M. Abdulrahman, T. R. Gwadabe, F. J. Abdu and A. Eleyan, "Gabor Wavelet Transform Based Facial Expression Recognition Using PCA and LBP," 22nd Signal Processing and Communications Applications Conference (SIU) pp. 2265-2268, 2014.

[10]. S.Folkard, T. Akerstedt,**"Trends in the Risk of Accidents and Injuries and Their Implications for Models of Fatigue and Performance"** Aviat Space Environ Med. vol. 75(3) pp. 161–167, 2004.

[11]. R. Judith, C. Elsbeth, L. Amy and J. Berger, **"Fatigue in the U.S. Workforce: Prevalence and Implications for Lost Productive Work Time"**Journal of Occupational and Environmental Medicine / American College of Occupational and Environmental Medicine vol. 49 pp. 1-10, 2007.

[12]. National Transportation Safety Board, "**Grounding of the US Tankship Exxon Valdez on Bligh Reef, Prince William Sound Near Valdez, Alaska, March 24, 1989**" Washington, D.C: National Transportation Safety Board, Maritime Accident Report, 1990.

[13]. B. Bjerner, A. Holm, A. Swensson, "**Diurnal Variation in Mental Performance; A Study of Three-Shift Workers"** Br J Ind Med. vol. 12(2) pp.103–110, 1955.

[14]. D.R. Gold, S. Rogacz, et al,**"Rotating Shift Work, Sleep, And Accidents Related to Sleepiness In Hospital Nurses.** Am J Public Health. vol. 82(7) pp. 1011–1014, 1992.

[15]. P. Smith, **"Study of Weekly and Rapidly Rotating Shift Workers"** Ergonomics vol.21(10) pp. 874-880, 1978.

[16]. O. Thompson, M. Francis and J.J. Williams,**"Road Haulage Constraints in the Transportation of Petroleum Products in Northern Nigeria"**IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) vol. 8(3) pp. 1-8, 2014.

[17]. W. Harris,**"Fatigue, Circadian Rhythm and Truck Accidents. In: Mackie RR, Editor Vigilance**" New York, Plenum Press, pp. 133–146, 1977.

[18]. P. Hamelin, **"Lorry Driver's Time Habits in Work and Their Involvement in Traffic Accidents.** Ergonomics vol.30(9) pp. 1323–1333, 1987.

[19]. P.H. Langlois, M.H. Smolensky, et al,**"Temporal Patterns of Reported Single-Vehicle Car and Truck Accidents in Texas, U.S.A. During 1980–1983"** Chronobiol Int. vol. 2(2) pp 131–140, 1985.

[20]. J.A. Horne, L.A. Reyner, "**Sleep Related Vehicle Accidents**. BMJ. vol. 310(6979) pp 565–567, 1995.

[21]. A,I.Pack, A.M. Pack, E. Rodgman, et al, **"Characteristics Of Crashes Attributed to the Driver Having Fallen Asleep"** Accid Anal Prev. vol. 27(6) pp. 769–775, 1995.

[22]. T. Akerstedt, G. Kecklund,L.G. Horte,**"Night Driving, Season, And The Risk of Highway Accidents"** Sleep. Vol. 24(4) pp. 401-406, 2001.

[23]. https://www.premiumtimesng.com/news/more-news/311396-nigeria-loses-n39-billion-to-trailer-tanker-crashes-frsc.html

[24]. https://tribuneonlineng.com/3200-persons-killed-by-tankers-trailers-in-four-years-%E2%80%95-frsc/ https://www.vanguardngr.com/2020/03/why-truck-related-accidents-recur-frsc-boss/

[25]. X. Fan, B. Yin, Y. Sun, "**Yawning Detection for Monitoring Driver Fatigue"**International Conference on Machine Learning and Cyberneticsvol. 2 pp. 664-668, 2007.

[26]. R. Wang, L. Guo, B. Tong, L. Jin L, "**Monitoring Mouth Movement for Driver Fatigue or Distraction with One Camera"**Proceedings of the 7th International IEEE Conference on Intelligent Transportation Systems, pp. 314 -319, 2004.

[27]. Z. Niu and X. Qiu, **"Facial Expression Recognition Based on Weighted Principal Component Analysis and Support Vector Machines"**, IEEE 3rd International Conference on Advanced Computer Theory and Engineering, pp. 174-178, 2010.

[28]. K.T. Song and Y.W. Chen, **"A Design for Integrated Face and Facial Expression Recognition"**, 37th Annual conference on IEEE Industrial Electronics Society, pp. 4306-4311, 2011.

[29]. A. Vinciarelli, M. Pantic, and H. Bourlard, **"Social Signal Processing Survey of an Emerging Domain",**Image and Vision Computing, pp.1743–1759, 2009.

[30]. D. Lin, **"Facial Expression Classification Using PCA and Hierarchical Radial Basis Function Network",**Journal of Information Science and Engineering vol.22 (5) pp.1033-1046, 2006.

[31]. A. Ryan, J. Cohn, S. Lucey, et al,**"Automated Facial Expression Recognition System",**Proceedings of the International Carnahan Conference on Security Technology, pp.172–177, 2009.

[32]. E. Vural, M. Cetin, A. Ercil, et al, **"Automated Drowsiness Detection for Improved Driver Safety Comprehensive Databases for Facial Expression Analysis",**Proceedings of the 4th International Conference on Automotive Technologies, pp.1-15, 2008.

[33]. P. Lucey, J. Cohn, S. Lucey, I. Matthews, et al, **"Automatically Detecting Pain Using Facial Actions",**Proceedings of the International Conference on Affective Computing and Intelligent Interaction, pp.1–8, 2009.

[34]. M. Jones and P. Viola, **"Face Recognition Using Boosted Local Features",**IEEE International Conference on Computer Vision, pp.1-8, 2003.

[35]. P. Ekman, and W. Friesen, **"Facial Action Coding System: A Technique for The Measurement of Facial Movements",**Consulting Psychologists Press, California, 1978.

[36]. S. Dubuisson, F. Davoine and M. Masson, **"A Solution for Facial Expression Representation and Recognition",** Signal Processing: Image Communication, pp. 657-667, 2002.

Muzammil Abdulrahman. "Model of Fatigue Detection Using Facial Expression Applications in Oil and Gas Companies." *IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)*, 17(5), 2022, pp. 15-18.