Mental Fatigue Detection

Biswaranjan Maharana[1], Nikhil Niwate[2], Harsh Patel[3], Prof. Srijita Bhattacharjee[4]

[1,2,3]Department of Computer Engineering, Pillai HOC College of Engineering and Technology, Rasayni, Mumbai University, Mumbai, India

[4]Assistant Professor, Department of Computer Engineering, Pillai HOC college of Engineering and Technology, Rasayni, Maharashtra, India

---***--

Abstract - *Mental Fatigue is a major problem of our society, as it is the cause of many health problems and huge economic losses. Mental fatigue is the result of brain over-functioning and reaching its potential level depending upon the individuals. It can happen when you exert too much mental effort on a project or task. Analysis shows that mental fatigue leads to an inability to concentrate and a rise in easy mistakes. Unchecked, mental fatigue results in feeling stressed, irritated that you simply cannot sustain and even depressed. Washed-out employees will place themselves or others in danger, thus it is important for safety managers and supervisors to grasp the signs of fatigue. So, a robust system is needed which can detect mental fatigue and reduce the chance of mistakes and accidents. The current system identifies the blink behavior that will help in detecting mental fatigue. Our model detects the mental fatigue based on natural viewing situations where an individual will be asked some set of questions and mental fatigue tracking will be done simultaneously. In our model, we tried to make it very compact and portable. Here we have used two unique feature (i) instead of using any eye tracking technology, we are using a simple webcam to track the data from individual's eye (ii)Our project initially takes answers of a set of questions which are based on psychological behavior which will analyze the mental conditions of the subject. Haar cascade algorithms are employed for the blinking behavior where eye blinks are counted per minute so as to search out the fatigue level.. The advantage of our model is its simplicity, price effectiveness and portability.*

Key Words: Depression, Anxiety, Eye Tracking, Fatigue, Cognitive, K-means

1. INTRODUCTION

Monitoring health system in a smart domain, for example, versatile work environments and keen houses has been progressively perceived as a method for improving wellbeing results just as psychological and social execution, particularly considering the developing interest for health checking framework. Past examinations on wellbeing observation have directed activity in speech and eye movement as a technique for deducing an individual's state, as physical conditions, stress, and mental work. Considering an example, depression, and encephalopathy.

These observation technologies will monitor day by day changes in wellbeing and notice early indications of unwell-ness. One part of a person's every day wellbeing

standings that presently can't seem to be used is mental fatigue during heavy workload and tasks. Mental fatigue is turning into an increasing genuine wellbeing and social issue, and it comes at a gigantic general wellbeing cost. In the working environment, mental exhaustion is known to influence psychological and behavioural execution. Truth be told, mental exhaustion has been proposed as one of the most regular reasons for mishaps and blunders in the work environment. Past examinations on observing stress have essentially centred around eye- tracking measures during any mental task, for example, driving. However, model equipped for examining mental stress from eye-tracking data in natural circumstances would stretch out the extent of utilization to watch fatigue in different regular circumstances.

1.1 Background

Mental fatigue could be a condition activated by delayed mental psychological feature. Fundamentally, it sends your mind into overdrive, harming your productivity and generally speaking psychological performance. the first common symptoms are absence of inspiration, irritability, stress take-up or loss of craving and sleep disorder. Mental fatigue can influence you for both present moment and long haul. Mental fatigue causes physical and emotional symptoms. Depression, anxiety, feeling of not caring are included as emotional signs of mental fatigue. Headache, body pain and chronic fatigue etc. are included as physical signs of mental fatigue.

Our model detects the mental fatigue based on natural viewing situations where an individual will be facing a set of questions and mental fatigue tracking will be done simultaneously which is based on blinking behavior of the human being. In our model we tried to make it very compact and portable. Here we have used two unique feature. Instead of using any eye tracking technology, we are using a simple webcam to track the data from individual's eye.

A set of questions are asked based on current psychological behavior of the subject. Convolutional Neural Network is used for used for model training. The advantage of our model is its simplicity, cost effectiveness and portability.

1.2 Relevance

This model on mental fatigue detection will provide the society a different perspective to the mental health. People will start giving importance to the mental health as well. It will be helpful to the employees in the corporate world to check their mental health on weekly basis. This will provide

a prior suggestion whether to consult a doctor or not. It will be helpful to the doctors while diagnosis of the patient. It will helpful while driving a vehicle, it will predict whether you are fit for the driving or not to avoid accidents.

1.3 Existing system

Existing model uses data extracted from six different features of eyes while doing any cognitive tasks. Support vector Machine(SVM) algorithm is used to find mental fatigue or not taking all six features into consideration. This model considers oculomotor-based features consisted of nine features. The features are saccade amplitude, saccade duration, saccade rate, inter-saccade interval, saccadic mean velocity and fixation duration. The pupil of eye measures were isolated into six alternatives related with pupil diameter, constriction speed, and amplitude of every eye, and 9 other options related with the pupil diameters of each eyes. The most advanced technology was EEG (Electronic Encephalography). It used to capture brain nerve activity including eye tracking.

2. METHODOLOGY

2.1 Working

We have developed a model which can predict the mental fatigue status of an individual. This model uses questionnaire and eye blinking model which gives the combined result for this test. We have used Harr cascade algorithm for the eye blinking model and for the questionnaire k-mean algorithm is used to find groups which have not been explicitly labelled in the data.

We are asking participants to give test without giving them hint that there blinking behavior is captured. When they finish the test they are informed about it. This is important for this test so that they do not give the fake blinking behavior.

2.2 Design of Questionnaires

The Fatigue State Questionnaire (FSQ) was developed by the researchers by using a set of 24 questions generated by them. The questions were developed and arranged in such way that it can develop the definition of fatigue. For instance, "weariness and weak spot" have been determined with questions like "how slow and sluggish are you right now? ". To see how energetic participant is while giving the test, questions like "how energetic do you feel right now?" were included in the questionnaire.

The unique query listing was narrowed using each qualitative and quantitative strategies. In a pilot reading, 20 subjects have been asked to reply all 24 questions and to provide an explanation for their solutions in an open-ended layout. This process of gathering the data of specific participants was important for the purpose of model

training. The questions on the FSQ have been offered in a multiple-choice format with 5 alternatives: Very High, High, Medium, Low and Very Low. Responses to questions have been scored as 5 for Very High, 4 for High, 3 for Medium, 2 for Low and 1 for Very Low. Along with the responses to the questionnaire, Eye blinking count was also recorded. The Eye Blink count was calculated as an average per min. General rankings had been calculated via including the responses from the questions and the Blinking behavior of an individual. Viable scores ranged from 1 to 120 figures.

2.3 Participants

A seminar for college kids was carried out in our college (Pillai HOC College of Engineering and Technology) for recruiting them as participants. We also recruited our society members as participants. We recruited participants to gather the data for the training purpose of our model. Individuals have been eligible to participate only if they have been at least 18 years old. A further 10 individual's data were not taken into consideration for analysis as they took more than 15 mins to finish the study.

2.4 Factors Responsible

There are many factors which can be the cause for the mental fatigue for a person. One of the important factor is amount of sleep. To measure the sleepiness factor, we have included few questions like "How drowsy or sleepy do you feel right now?". This can help us to know whether the participant is giving the test in sleepy state or not. If he/she is doing so then it can lead to false result of this test. It is a fact that the state of being sleepy and fatigue would be reasonably undoubtedly connected. Studies suggests that the perfect quantity of sleep an individual require can differ broadly. Similarly, both under sound asleep and oversleeping can cause fatigue. Consequently, the degree of sufficient amount of sleep turned into no longer the amount of sleep individuals had the night earlier than, but whether or not or no longer they obtained inside ninety minutes in their perfect degree of sleep. Earlier of record series, it became known to code contributors who obtained that not more than 90 mins above their ideal sleep time, or not fewer than 90 minutes under their best sleeping time, as having a good amount of sleep. Members who had more than 90 minutes more or less their best amount of sleep time were coded as having changes in their amount sleep. Contributors have been coded as having sleep debt when the amount of sleep stated get changed to less than ideal amount of sleep. Each sleep adjustments and sleep debt had been expected to be undoubtedly related with FSQ rankings.

2.5 Procedure

Participants completed the study from our computer turn by turn. They answered the questionnaire (FSQ) prepared to measure mental fatigue. The similar answer questions were inserted between the FSQ. During the test participants Eye blinking behavior was also captured using webcam. They were not instructed about capturing their

blinking behavior before the test. But after finishing the test they were informed about it. The Eye blinking test was not informed to them prior the test to ensure that they do not give fake reactions. The participants were asked to finish the test within 15 minutes. After finishing the test result was displayed within few seconds on the basis of the questionnaire and the blinking behavior. Data is collected from various users belonging to various age groups and their blink count.
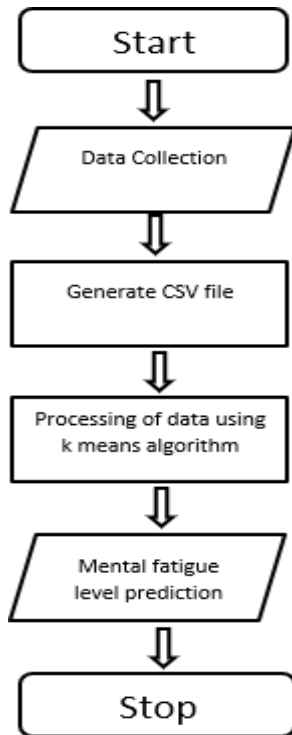

Fig. 1: Flowchart

A web application is created using flask framework which host an internal server for debugging to represent the result. Databases are created to store all the real time data to process users fatigue level and the data are taken by using questionnaires and eye detection. All the data is converted into an CSV file to merge all the collected data of the users. Finally, k means algorithm is applied to the fetched data to decide the user's data belongs to which cluster. Five clusters are generated which states every user's fatigue level and the current user's fatigue is decided based upon to which cluster its data belongs.

3. RESULT

The observation made on the participants data are analyzed and results are listed in Table. The participants are of various age group ranging from 18 to 70. The majority of the participants taken part within the examination were between 20 and 38-year-old. Mostly college students, faculty and office workers participated in the examination. All participants were given self-governed questionnaire which contained questions about current behavior, tiredness, fatigue & burnout. These questionnaires were used to

measure fatigue, it consists of 24 questions for which each person has to mark an answer on a 5-point scale to what extent the particular questionnaires indicate the current status of the participant. The questions refer to characteristics of fatigue experienced by that person. Based on the score of the participants clusters are formed using k-means algorithm. The participant with a higher score of fatigue level has mental stress. This system can make the process of analysis of mental state or status of the patients more simplified and effective.

The total scored obtained after the completion of the examination will determine the current mental fatigue status of that person. If the total point scored by the person is higher than the average value (0-20) than the person is suffering from mental fatigue. Each question in the examination are assigned specific number of points (zero if the patient does not have or does not show the indicated signs of mental fatigue) given answer, after evaluating an individual on the bases of the examination his/her mental status is displayed.

Score	Mental Status	Doctor's diagnosis required?
0-20	Normal	No
21-40	Very Low	Yes
41-60	Low	Yes
61-80	Moderate	Yes
81-100	High	Yes
101-120	Very high	Yes

Fig. 2: Value Table

The first column indicates scores assigned to each mental status. If Total Points scored by the person ranges from 0 to 20 then the person is considered as Normal and output will be displayed as Mental Status is equal to Normal and no further diagnosis is required; otherwise, the person have to visit the doctor for diagnosis
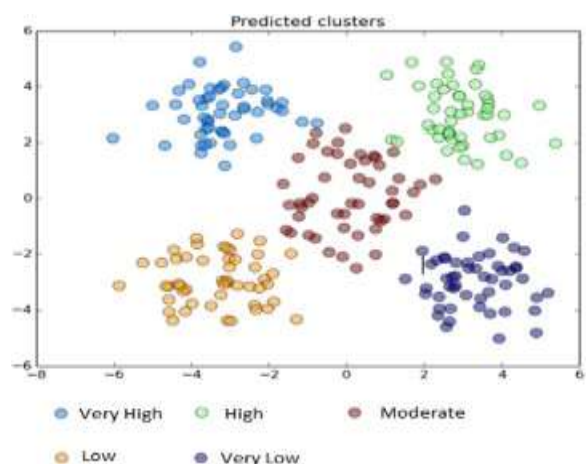

Fig. 3: Clusters of data

4. CONCLUSION

We developed a model assisting us to detect mental fatigue based on the person's feedback int the mental status examination. This examination system for detecting mental status of an individual aims to assist new doctors in analyzing the mental status of an individual. As the demand for various health monitoring system is increasing, this model also offers multiple age- related changes in blinking and facial behavior of that person. Testing is carried out by performing surveys for collecting blinking data from people of different age groups, younger and older volunteers while the examination was carried out, most of the participant are school/college students, professors and employees. After performing the analyses, we verified that our model can detect mental fatigue status depending on the result of the mental stress examination. As increasing number of mental health issues in colleges/universities this model would offer a great referral system which will benefit both students and employees in taking more active role in handling their mental health concerns. This project can extend to further level by including more eye features to increase the accuracy of the result.

REFERENCES

[1] Liwei Zhang, Qianxiang Zhou,Qingsong Yin, Zhongqi Liu , "Proceed- ings of the AHFE 2018 International Conference on Human Factors and Systems Interaction" published "Assessment of Pilots Mental Fatigue Status with the Eye Movement Features " , volume 781.

[2] Renata, V., Li, F., Lee, C.-H., & Chen. , International Conference on Cyber worlds (CW) 2018. , "Investigation on the Correlation between Eye Movement and Reaction Time under Mental Fatigue Influence ".

[3] Palaniappan, R., Mouli, S., Balli, T., & McLoughlin, 2nd International Conference on BioSignal Analysis, Processing and Systems (ICBAPS) 2018, "On the Mental Fatigue Analysis of SSVEP Entrainment".

[4] Yiqi Ai, Qianxiang Zhou, Yun Tian Zhongqi Liu, International Confer- ence on Human Error, Reliability, Resilience, and Performance, 2017 , "Characteristics Analysis for the Effect of Mental Fatigue in Monitoring Task" volume 589.

[5] Yamada, Y., & Kobayashi, M, Artificial Intelligence in Medicine 2017, published, "Detecting Mental Fatigue from Eye-Tracking Data Gathered While Watching Video", volume 91 .

[6] Pfleging, B., Fekety, D. K., Schmidt, A., &Kun, A. L , "Conference on Human Factors in Computing Systems – CHI 2016" published "A Model Relating Pupil Diameter to Mental Workload and Lighting Conditions".

[7] Spencer Greenberg* , Pluta Aislinn and DeConti Kirsten , "Develop- ment and Validation of the Fatigue State Questionnaire: Preliminary Findings", June 9, 2016 .

[8] Anna J H M Beurskens, Ute B u¨ltmann, IJmert Kant, JanHMMVercoulen, Gijs Bleijenberg, Gerard M H Swaen , "Fatigue among working people: validity of a questionnaire measure", September 23, 2015 .