International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 07 | July 2019 www.irjet.net p-ISSN: 2395-0072

Estimation of Effect of Sleep on Software Development

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Abstract - *For a human being, sleep is highly essential as it is a necessary body function that has the capabilities to refresh the mind as well as repair the body. It is imperative for every human being to sleep the minimum time stipulated, which is around 6-7 hours, failing which the body will be sleep deprived and it would affect the person negatively. A sleep-deprived employee is a safety hazard as the brain would not function properly under sleep deprivation conditions, especially in the software industry as it requires a highly skilled individual. There is a lack of systems that can accurately measure the effects of sleep deprivation on a subject. Therefore, this paper proposes an innovative technique for the evaluation of the effects of sleep deprivation in developers and its effect on their work. This technique utilizes the Adaboost framework in amalgamation with dumpster Shaffer and Decision taking theories to determine the drowsiness of the subject accurately.*

Key Words: **Adaboost, Deicision taking, Dumpster shaffer reasoning. Sleep deprivation effect.**

1. INTRODUCTION

Sleep is one of the most important aspects of human life. The biological necessity has not yet been understood by the researchers, but it is needed nonetheless as it is one of the most integral parts of a human being's routine. The effects of sleep can be noticed in every cell and tissues in the body, as they get revitalized. Sleep is highly essential for the brain as it helps organize and get some much-needed rest. The brain needs sleep to be able to make new memories and retain concentration and response time.

Sleep is highly needed and is as essential as is water and food for the human body. It is one of the most crucial processes that is compulsory in a day. Regular and healthy sleep has the potential to maintain the electrical pathways inside the brain, which enhances memory and recollection, which can make the brain faster and help reduce the risks of degenerative brain diseases, such as Alzheimer's, dementia, etc. sleep helps the neurons communicate with one another efficiently. This is highly useful as the neurons are the most basic and fundamental element of the brain.

Sleep has also been documented to be a very dynamic and complex process that can have a lasting effect on how a person function efficiently. A lot of research has also proved that sleep is also responsible for the cleaning of toxins and other chemicals that build up in the brain throughout the day, therefore, when they sleep and wake up, an average human being feels fresh and lively. This is due to the fact that the brain is now devoid of any chemicals and toxins and is in the cleanest stage possible.

The brain does not shut down when a person sleeps, quite contrary, it actually works the same even while in sleep, as the brain is tasked with regulating the bodily functions it does not cease its operations while sleeping, but actually does most of the metabolism and regulation in the time of sleep. This is when the brain is actively making repairs and balancing the hormone cocktail flowing in the blood, the immune system is also extremely active in sleep and helps the brain develop resistance to most of the toxins.

The sleep is not a single process, but it is formed of three different phases of sleep. The sleep has 3 stages, stage one is a short intermediate stage which is called non-REM (Rapid Eye Movement) sleep. This stage is concerned with the relaxation of the muscles and slowing down the brain waves relative to the waves formed when the person is awake. The second stage is the next stage which is an intermediate stage between the REM and non-REM sleep. It is characterized as a light sleep which lowers the body temperature, breathing, heartbeat and reduces eye movement.

The third and last stage is the most important and can be called true sleep. This is the deep sleep stage also known as the REM sleep stage. This stage is approximately 90 minutes into the sleep cycle and is characterized by rapid eye movements. This stage is characterized by mixed brain signals and increased blood pressure and heart rate. This is the stage of sleep that most of the dreams occur in a healthy individual. It is the most important stage and is highly essential for repair, refreshment, and organization of the brain.

Sleep Deprivation could lead to none of the above stages happening and the brain not getting its desired rest every 24 hours. This can be very detrimental to the normal functioning of the brain. Reduction in sleep can wreak havoc on an individual's body and leads to memory issues, such as forgetfulness and reduction in the capacity of short-term memory and can have lasting effects on the long-term memory.

The effects just don't stop at deteriorating the memory, lack of sleep can cause intense fluctuations in the blood chemistry and the concentrations of the various hormones in the blood and can lead to mood swings and can also lead to depression in the long run. Sleep Deprivation can also lead to a decreased response by the immune system which can lead

to frequent illnesses that could've been prevented. It also increases the risk of diabetes and blood pressure.

Short term side effects of sleep deprivation include the reduction in sex drive and concentration, which could lead to increased frustration and trouble thinking clearly. These side effects can lead to extreme harm to others. If a sleep-deprived person is handling heavy machinery or driving, this is a very dangerous proposition as his thinking has been impaired which could lead to an accident. Therefore, sleep-deprived people are not allowed to operate heavy machinery and drive as it could lead to disastrous results.

Several studies have indicated that there is a correlation between sleep deprivation and increased risk of heart ailments. Sleeping for less than 5 hours in a day can increase the blood pressure which puts undue pressure on the heart. Sleep deprivation also increases the concentration of the various chemical that catalyzes the inflammation of the heart putting the person at risk for injury. Reduction in the sleep hours can lead to a poor posture and balance due to lethargic tendencies of the person which can further lead to accidents and other injuries that can be avoided.

The AdaBoost algorithm is short for an adaptive boosting algorithm. It was designed by two scientists in the late 1990s. It is from a class of boosting algorithms that are formulated to decrease the time taken for a particular predictive task. The boosting algorithms are strong, fast and quite easy to deploy on existing frameworks. As most of the predictive learning algorithms are quite slow and can turn sluggish when encountering especially tricky and processing large databases.

The AdaBoost algorithm is a specialized algorithm that is designed for implementing algorithms that deal with classification problems. The central idea that the AdaBoost algorithm is based upon is, that a weak classifier will produce unsatisfactory results and take a longer time to process. therefore, the Adaboost algorithm works by amalgamating various weak classifiers and transforming them into a strong classifier. This increases the performance of the algorithm and makes it even more accurate.

This research paper dedicates section 2 for analysis of past work as literature survey, section 3 deeply elaborates the proposed technique and whereas section 4 evaluates the performance of the system and finally section 5 concludes the paper with traces of future enhancement.

2. LITERATURE REVIEW

J. Baumeister [1] states that it has been well documented that there are some serious drawbacks associated with sleep deprivation which include a reduction in job performance and the executive functioning of the employee. Therefore, the authors have implemented a spatial augmented reality instruction to study the impact of task performance amongst the employees that are sleep deprived. The proposed technique has been performed on various individuals and has returned very positive results. The only drawback is that the SAR technology has not been utilized fully to register the impact of partial sleep deprivation.

M. Choubisa explains that there has been a lot of research concerning the Human Brain and especially for the development of Brain-Computer Interface. The authors state that the BCI can be achieved through various different techniques with one predominant technique being used is through the scalp to record the electrical activity. Therefore, the researchers in this paper detect the different stages of the mind such as the sleep deprivation stage and the mind awake stage [2]. The main drawback in this technique is that the authors have utilized an EEG device with only a single channel.

T. Wijayantoperformed a study to determine the effects of sleep deprivation on an individual's driving performance and situation awareness. This study was done on 12 students on a driving simulator and their results adhering to various parameters was recorded [3]. The various conditions faced by the students were morning conditions, night conditions, without sleep deprivation and with sleep deprivation. The results have depicted that driving during the night and being sleep deprived reduces the situation awareness and degrades driving quality. The only problem with this study was the very small test group which could reduce the accuracy.

Y. Zeng describes that sleep deprivation can be really distracting to most people. One of the most predominantly used techniques for the determination of sleep deprivation has been polysomnography and Electroencephalography. But most of the elderly and people suffering from dementia are highly unlikely to wear the device as they tend to be uncomfortable. Therefore, to ameliorate this effect, the authors have presented a technique for the determination of sleep deprivation with the help of a wearable device and Support Vector Machine [4]. The accuracy of the system only exceeds the traditional techniques by 5%.

S. Abdullah elaborates on the fluctuations experienced by an individual in their alertness throughout the day. It is common knowledge that a human being goes through various stages of attentiveness and cognitive performances throughout the day. Therefore, the authors have collected extensive amounts of data, through the use of the Psychomotor Vigilance Test, which has clinically proven to be valid. The detection was done in real time through the use of a smartphone on the patient. the only drawback in this study is that the authors have not considered the impact of various other activities such as technology usage and other instances; on the test subjects. [5]

J. Siegmund [6]states that program comprehension is one of the most crucial aspects of a programmer's cognitive processes and has been very difficult to assess or quantify. Therefore, the researchers in this technique utilized the fMRI or Functional Magnetic Resonance Imaging, to measure and quantify the cognitive process when comprehending a particular program. The study was performed extensively to determine the effectiveness of the proposed technique. The researchers in this technique have only measured the activity but not utilized this information to make further assessments.

J. Siegmund explains that the programmers nowadays depend on the various cognitive processes that help to shape and filter various software programs for a greater understanding of the software. A multitude of papers have attributed this sense of judgment to various different effects but none of them got close enough to correctly represent the actual cognitive processes. The authors have developed an analysis technique based on fMRI for isolating the characteristics that make a good coder [7]. This technique lacks the means to understand the various other aspects of the comprehension process, which is one of the drawbacks in this technique.

S. Sarkar explores the impact of sleep deprivation on the developer coding software. There is an increased amount of risk involved when a developer is sleep deprived as the decreased cognitive ability can lead to unforced errors and increased probability of human error. The study has experimented on a very large amount of test subjects and the results have indicated the reduction in performance and increased fatigue [8]. The authors have concluded that sleep deprivation and fatiguehave a correlation between them and it highly impacts the performance of the developer.

T. Fritz investigates the incidence of encountering bugs in particular software and its correlation between the fatigue experienced by the developers due to sleep deprivation. Sleep deprivation can impact the developer's performance that would eventually lead to the developer making mistakes and introducing bugs in the software, that would take a lot more time to fix and cost a lot of time and money. Therefore, the authors have proposed a technique that utilizes various sensors to determine the bodily functions of the developer to detect various parameters of stress or fatigue [9]. The only drawback is the cost and the implementation of such a complex technique.

S. Muller [10] introduces a fact that is not that well-known that the developer at an office goes through a range of emotions while working on a project. These emotions can range from happy to frustrated depending upon the task being performed. These fluctuations could lead to a big disaster. Therefore, the authors have implemented a technique that utilizes EEG and electrodermal activity for the evaluation of the emotion. The main drawback of this paper is that the proposed technique has not utilized extensive parameters for an accurate assumption.

K. Becker describes Besuro which is a test-driven methodology that has been used for development. The proposed technique has been utilized for determining the customer perspectives as well as examining, analyzing and improving the code, due to the fact that this technique has been able to correlate exact operational definitions. This framework has been extensively tested and has produced remarkable results [11]. The Besuro framework that has been implemented in this technique lacks the resources for the code coverage metrics, that is the only drawback.

J.P Ostberg explores the realm of Salutogenesis which is a psychological framework that is utilized for analyzing a lower cognitive load and also predict the quality issues which can reduce significant amounts of stress. Salutogenesis is based on the fact that cognitive ability can be affected through various different parameters, such as emotional trauma, time pressure, and most importantly stress. Therefore, the authors have performed various experiments for stress and corresponding cognitive measurements that depict that stress can hamper task performance and productivity. [12]

M. Rosekind explains that there is a correlation between the performance and productivity of an individual and sleep deprivation. This was quantified by the researchers by performing various experiments on a large number of employees [13]. This study was done in the United States through a questionnaire which included four sections, insomnia, at-risk, insufficient sleep and good sleep, which was used to categorize the sleep patterns and the productivity was reported by the employer. The analysis proved that sleep deprivation can negatively affect the productivity of a certain company, which could lead to various inconsistencies and reduced safety.

S. C. Mullerintroduces a novel methodology for the reduction of errors and defects occurring due to sleep deprivation of the developer which leads to a poor understanding of the code, and it has a negative impact on the user experience. Major corporations and companies which develop software regularly conduct code reviews to weed out these irregularities in code. This process takes a lot of time and also increases the cost of development and reduces the efficiency of the whole process. Therefore, the authors have utilized biometric parameters to analyze the code quality in real time. The main disadvantage of this technique is that the authors have not utilized an extensive list of code metrics to ascertain the quality which has decrease the accuracy by a large margin. [14]

B. Floyd [15] states that there is a correlation between a developer's understanding of a certain section of code and

their skills. The authors believe that understanding this correlation would enable a greater understanding of the mind of a programmer and how they perceive code. To test their methodology, the researchers gathered 29 programmers and non-programmers and recorded their brain resonance images while they reviewed a piece of code and prose. The researchers analyzed the images to find some similarity between reading prose and code. The similarity has been measured with a small set of parameters that need to be increased in future research.

3. PROPOSED METHODOLOGY

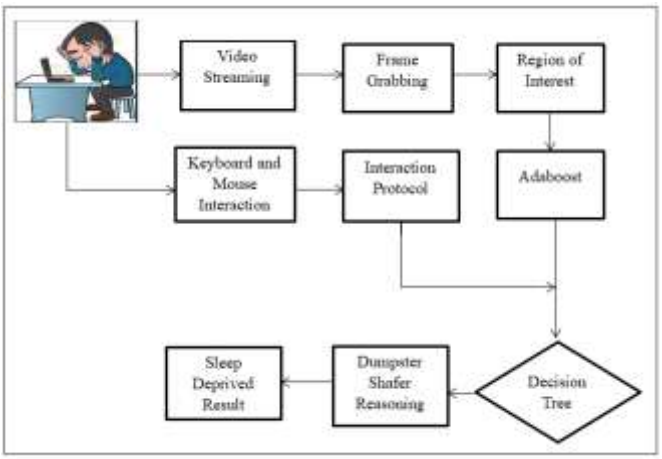


Figure 1: System Overview

The proposed methodology for quantifying the effects of sleep deprivation has been elaborated in Figure 1 given above and explained further below.

Step 1:*Frame Extraction* – The frame extraction is the first step of the proposed system, in which the subject is recorded when he/she sits on their desk for working. The frames are grabbed through a live video feed and fed to the system through the Java Media File Libraries. The video feed is segmented into frames which are spliced at regular intervals and fed to the system for pre-processing.

Step 2:*Frame Pre-processing* – This is the second step where the segmented frames are received by the system and need to be pre-processed in order to proceed with the detection. The frames need to be resized according to the graphics2d object as a different operating system would have different frame sizes.

Step 3:*Region of Interest* – The pre-processed frames are received in this step as a graphics2d object, which is subsequently utilized to detect color using the YCbCr model. This skin detection is the region of interest for the proposed model, as it is the most essential area that is utilized to assess the level of drowsiness in a person. Therefore, the skin detection through the YCbCr color model is highly useful to identify the individual in the input frames.

The algorithm for this has been stipulated in the Algorithm 1 given below.

ALGORITHM 1: ROI Estimation

// Input: Frame image N_I

// Output: ROI Image

1: Start.

2: ROI= Ø

3: **For** i = 0 to size of Width of N_I

4: **For** j=0 to size of Height of N_I

5: $P_{SIGN} = N_{I(ij)}$ RGB

6: R= P_{SIGN} >> 16 & H_D

7: G= P_{SIGN} >> 8 & H_D

8: B= P_{SIGN} >> 0 & H_D

9:

10: Cb = (-0.169 * R - 0.332 * G + 0.500 * B + 128)

11: Cr = (0.500 * R - 0.419 * G - 0.081 * B + 128)

12:**IF** (Cr > 137 && Cr < 177)

13: **IF** (Cb < 127 && Cb > 77)

14: t = Cb + 0.6 * Cr;

15: **IF** (t > 190 && t < 215)

16: **THEN** Set ROI Image Pixel as White

17:**ELSE**

18:**THEN** SET ROI Image Pixel as Black

19: **END IF**

20: **END IF**

21: **End for**

22: **End for**

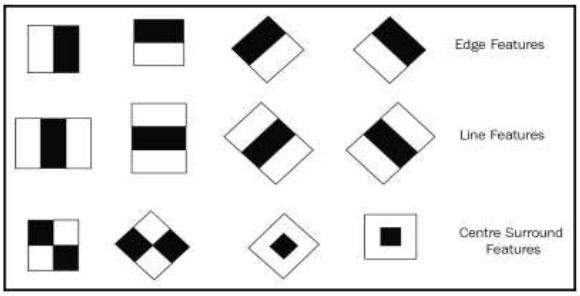
23: **return** ROI

Step 4:*Adaboost* – this is the step where the actual drowsiness of the individual is ascertained from the frames and their region of interest obtained in the steps above. The Adaboost Framework has been utilized to detect and identify

key facial features, such as eyes, nose, and ears to aid in the accurate detection of the drowsiness.

The RGB color model has been utilized for the extraction of the features with the help of the Adaboost Classifier. The various stages of this process have been discussed below.

4.1*Haar Features* – The rectangular features in a human face such as the nose, eye, mouth, and forehead are called Haar Features. The proposed model utilizes the Haar features in the Adaboost algorithm that are just blocks or models that indicate the various facial regions such as forehead, eyes, mouth, etc. The different features that are



obtained have been picturized in figure 2 below.

Figure 2: Haar Features

4.2*Integral Image Creation* – An imaginary Integral face object is created using the Haar features obtained above.

4.3*Training*– For training purposes, the normalized integral image object is utilized to detect and identify the boundaries of the face.

4.4*Cascading* – the next step after the training for face boundaries is complete, is to cascade the trained objects to increase the accuracy of the system.

Step 5:*Decision Tree and Dempster-Shafer Reasoning* – The subsequent stage after the successful identification of the face is to detect the drowsiness factor based on the sizes of the mouth and the eyes. The decision tree is utilized in the form of IF-Then Rules which are subsequently verified with the keyboard input bounded by the specific programming language used by the programmer.

The Developer is allowed to code on an interactive user interface and the keywords typed are recorded. These keywords are then split and tokenized to identify the keywords from the stored list. These keywords are then compared to the accurate keywords saved in a workbook to determine the Levenshtein Distance. The Levenshtein Distance of 0 indicates exact matching without any error, while some amount of error results in a Levenshtein Distance of greater than zero.

Levenshtein Distance is an indicator that can detect the errors committed by the developer. The number of errors or inaccurately spelled keywords is then counted against the keywords typed correctly, which is given to the Decision tree for the evaluation. The Decision Tree analyses the number of errors with the help of the Dempster-Shafer Reasoning theory to output the level of drowsiness and its effects on the work done by the developer.

This verification is validated using the Dempster-Shafer reasoning theory. This theory is based on the evidence of certainty and uncertainty in a particular scenario with the help of plausibility hypothesis, belief, and mass.

4. RESULT AND DISCUSSIONS

The Proposed Methodology for the effects of Sleep Deprivation has been implemented on a Machine running the Windows Operating system. The Methodology is coded in Java Programming Language on the NetBeans Interactive Development Environment. The implementation Machine is powered by a PentiumCore i5 processor, which is assisted by 6 GB of Primary Memory. The technique also utilizes the Java Media Library for capturing the Frames from the camera.

The effect of sleep on software developers is measured by conducting some experiments whose values are tabulated below in table 1. Where 10 experiments are conducted for each experiment different software developers are allowed to sleep in four different categories of sleep. Such as good sleep (7-8 hours), At Risk (5-6 hours), insignificant sleep (3-5 hours) and Insomnia (less than 3 Hours). The obtained results for the loss in productivity which is measured as the ratio of a number of wrongly written keywords over the total number of keywords by the developer for the given programming language. The Graph in Fig. 4 clearly indicates that there is a higher productivity loss in Insomnia cases and lesser Productivity loss in good sleep cases.

Table 1: Effects of Sleep Deprivation

Experiment Number	No. of sleeping Hours	Number of Keywords	Wrong Keywords	Sleep Type	Productivity Loss in Percentage
1	2	112	9	Insomnia	8.035714286
2	3	98	8	Insomnia	8.163265306
3	4	76	5	ISS	6.578947368
4	5	85	5	ISS	5.882352941
5	6	136	6	At-Risk	4.411764706
6	5	157	7	At-Risk	4.458598726
7	5	109	5	At-Risk	4.587155963
8	8	79	2	Good Sleep	2.53164557
9	7	137	4	Good Sleep	2.919708029
10	7	121	3	Good Sleep	2.479338843

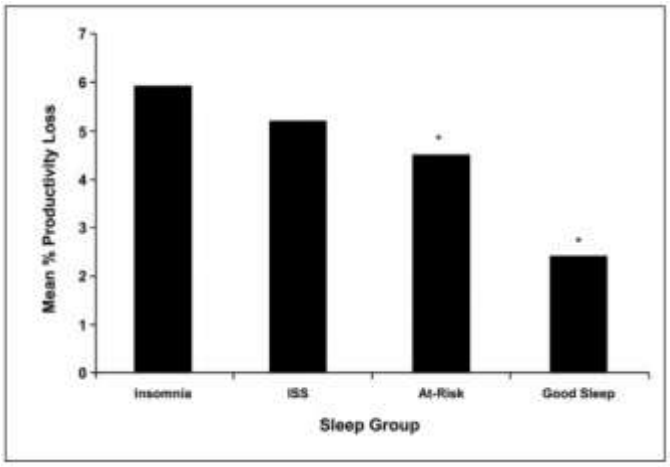


Figure 3: Sleep Deprivation loss by Tuck

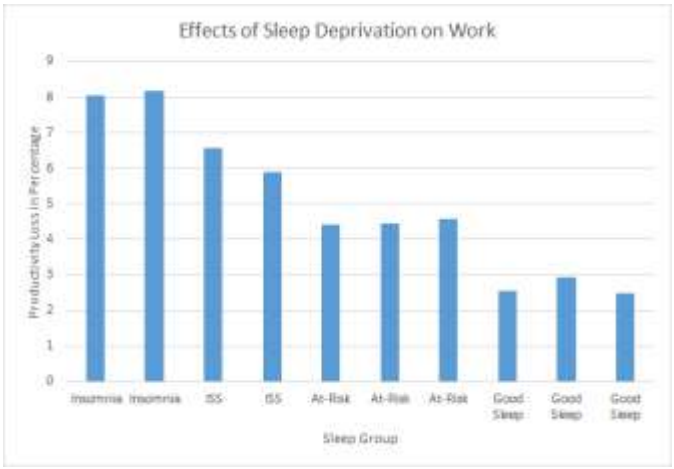


Figure 4: Effects of Sleep Deprivation on Work

The obtained graph in Fig. 4 is correlated with the result of [16]which mentioned in the graph of figure 3. Where tuck.com mainly deals with the advantages and disadvantages of human sleep and this site is one of the leading experts in sleep health management system. This comparison boosts the system so that the proposed model yields a qualitative result through the implemented technique.

5. CONCLUSION AND FUTURESCOPE

There have been various technologies that have been developed for the purpose of quantifying the drowsiness that arises due to lack of sleep. The techniques have also employed image processing to ascertain the level of drowsiness but most of them fall short of addressing the underlying issue of Sleep Deprivation. The model presented in this paper has been centered towards the measurement of the effects of sleep deprivation on a Developer based on the drowsiness of the subject, which is assisted by the AdaBoost Algorithm and the combination of Decision tree and Dempster-ShaferTheory.

The results have been highly consistent and were correlated heavily with the data obtained in [16], which is a reputed website that has conducted real-life experiments and surveys on the effects of sleep deprivation. This concludes that the proposed methodology is adequate for this purpose and has achieved promising and accurate results in the first instance.

For the future scope, this system can be developed as a Web-service which can be utilized by various organizations to easily understand and quantify the impact of sleep deprivation on their employees, that will help to achieve better health and productivity in the organization.

6. REFERENCES

[1] J. Baumeister et al, "Augmented Reality as a Countermeasure for Sleep Deprivation", IEEETransactions on Visualization and Computer Graphics, 2016.

[2] M. Choubisa et al, "Analysing EEG Signals for Detection of Mind awakestage and sleep deprivation stage", International Conference on Green Computing and Internet of Things (ICGCloT), 2015.

[3]T. Wijayanto et al, "Effects of Morning-Night Differences and Sleep Deprivation on SituationAwareness and Driving Performance", Proceedings of the IEEE IEEM, 2016.

[4] Y. Zeng et al, "Estimation of Sleep Status Based onWearable Free Device for Elderly Care", IEEE 5th Global Conference on Consumer Electronics, 2016.

[5] S. Abdullah et al, "Cognitive Rhythms: Unobtrusive and Continuous Sensingof Alertness Using a Mobile Phone", ACM International Joint Conference on Pervasive and Ubiquitous Computing, UbiComp, 2016.

[6] J. Siegmund et al, "Understanding Understanding Source Code withFunctional Magnetic Resonance Imaging", Proceedings of the 36th International Conference on Software Engineering, 2014.

[7] J. Siegmund et al, "Measuring Neural Efficiency of Program Comprehension", Proceedings of the 2017 11th Joint Meeting on Foundations of Software Engineering, 2017.

[8] S. Sarkar et al, "Characterizing and predicting mental fatigue during programming tasks," in Proceedings of the 2nd International Workshop on Emotion Awareness in Software Engineering. IEEE Press, 2017.

[9] T. Fritz et al, "Using psycho-physiological measures to assess task difficulty in software development," in Proceedings of the 36th International Conference on Software Engineering. ACM, 2014.

[10] S. C. Muller et al, "Stuck and frustrated or inflow and happy: Sensing developers' emotions and progress," in Proceedings of the 37th International Conference on Software Engineering- Volume 1. IEEE Press, 2015.

[11] K. Becker, B. de Souza Costa Pedroso, M. S. Pimenta, and R. P. Jacobi, "Besouro: A framework for exploring compliance rules in automatic TDD behavior assessment," Information and Software Technology, vol. 57, pp. 494–508, 2015.

[12] J.-P. Ostberg et al, "Towards the assessment of stress and emotional responses of a salutogenesis-enhanced software tool using psychophysiological measurements," Proceedings of the 2nd International Workshop on Emotion Awareness in Software Engineering. IEEE Press, 2017.

[13] M. R. Rosekind et al, "The cost of poor sleep: workplace productivity loss and associated costs.", Journal of Occupational and Environmental Medicine, vol. 52, no. 1, pp. 91–98, 2010.

[14] S. C. Muller et al, "Using (bio) metrics to predict code quality online", in Proceedings of the 38th International Conference on Software Engineering. ACM, 2016.

[15] B. Floyd et al, "Decoding the representation of code in the brain: An fMRI study of code review and expertise", Proceedings of the 39th International Conference on Software Engineering. IEEE Press, 2017

[16] https://www.tuck.com/productivity-and-sleep/