Received: 09 March 2025, Accepted: 26 April 2025, Published: 8 May 2025
Digital Object Identifier: https://doi.org/10.63503/j.ijaimd.2025.60

Research Article

Virtual Reality (VR) in Work Environment for Stress Reduction

Payal Thakur[1], Navjot Singh Talwandi[1], Shanu Khare[1], Vikash Yadav[2]

[1] Dept of Computer Science Engineering, Chandigarh University, Punjab, India

[2] Department of Technical Education, Government Polytechnic Bighapur Unnao, Uttar Pradesh, India

payalthakur16@gmail.com, navjotsingh49900@gmail.com, shanukhare0@gmail.com, vikas.yadav.cs@gmail.com

*Corresponding author: Vikash Yadav, vikas.yadav.cs@gmail.com

ABSTRACT

This study suggests a virtual reality (VR)-based game-based technique to reducing stress in the workplace. This design uses a virtual reality headset to immerse users in a very relaxing virtual world, guided deep breathing exercises, pulse and electro dermal activity sensors for stress estimation, and feedback to the VR environment. Two detectors were utilized to assess stress circumstances qualitatively and quantitatively: Scosche Rhythm+ for pulse monitoring and Mood metric Ring for EDA signal monitoring. The purpose of this study is to suggest a major game for stress relief in a virtual reality environment, with potential implications in the workplace. Our focus is on reducing stress in the workplace, where the appearance of stress is likely linked to high levels of demanding working conditions and a lack of resources to deal with these demands. Virtual Reality (VR) is a simulation environment that combines computer graphics, digital image processing, system simulation, sensing, and measurement. It's a computer-generated (artificially constructed) environment with realistic-looking sights and objects that make the viewer feel involved and engrossed in its surroundings.

Keywords: *Stress, Sensor, Biomedical Signals, Heart Rate, EDA, Virtual Reality, VR, Serious Games*

1. Introduction

VR is a technique that combines computer graphics, digital image processing, system simulation, sensing, and measuring to create a highly perceptible simulation environment [1]. It's generated by the computer devices with looking real sights and that make the looker feel involved and engrossed in its environment. A VR device is basically used to immerse the user in this Surrounding. Virtual Reality shows us to involves us in video games, online games based on real views as if we will try to make us one of the characters in the video games, also learn new skills that would be impossible to learn otherwise, such as upgrading sports training standards to maximize performance, performing procedures, and the latest development of Metaverse [2]. Virtual reality is not as recent as we think, despite its futuristic appearance. Lots of people believes that the machine which has a built-in seat that played 3D games and movies, released fragrances to create the most immersive experience for the real view, was the first Virtual Reality devices. The invention dates to the midto-late 1950s [3]. Technological and software improvements have resulted in a progressive evolution of both devices and interface design over time. Our goal is to create a system that combines sensors and virtual reality serious gaming to quickly measure and alleviate stress, notions that have been proven in previous research The following points summarize the primary objectives:

1. To create a calm, serene atmosphere in which for deep breathing, visual instruction is provided; stress alleviation The interaction between the user and the system has very less for unwinding purposes [4].
2. When we have connected the application to a heart rate sensor for the signal capture and addition Feedback that is visualized based on changes in values of heart rate
3. Collect EDA and heart rate at the same time signal in order to determine the stress levels of individuals and how these alter as a result of the users' engagement

The purpose of this study is to suggest a serious game for stress relief in a virtual reality setting, with potential applications in the workplace. The important point and the goal is to help lessen stress in work, where the level of stress may linked to big level of potentially hectic working conditions (i.e., job, business strategies) and there are lesser resources to handle these demands. To accomplish, they evaluate the successive part of a virtual reality conciliation aimed at advancing stress-reduction techniques like deep breathing [5]. The problem has received little attention. Thoondee and Oikonomou created a virtual reality application for the Oculus Rift that focused on to alleviate job hectic schedules with exposing employees to serene places during their breaks. To detect and alleviate work stress, a similar technique employed a Gear VR headset and different sensors to capture physiological signals such as (ECG), (PPG), (GSR), and blood pressure. A questionnaire was used to investigate the user's experience. The GSR signal, according to the findings, represented stress better than the other signals obtained [6]. Another technique (Salkevicius, 2019) focused on tracing stress levels using physiological data collected during exposure to virtual reality environments. Blood volume pressure, galvanic skin reaction, and skin temperature were the physiological signals recorded [7].

2. Related Work

The literature exploring the integration of Virtual Reality (VR) in work environments for stress reduction underscores its potential to positively impact employee well-being and productivity [8]. Studies by [Author et al., Year] emphasize VR's effectiveness in creating immersive and relaxing environments. They highlight how VR simulations, offering serene landscapes or calming scenarios, can alleviate workplace stress by providing employees with a virtual escape from high-pressure work settings [9]. Moreover, investigations by [Author et al., Year] delve into the use of VR for mindfulness and relaxation techniques.

Their research demonstrates how VR-based mindfulness sessions or guided meditations within the work environment contribute to reducing stress levels and enhancing mental well-being among employees [10]. Additionally, research effort focus on VR applications for stress management training. They discuss how VR simulations of stressful situations coupled with stress-reduction techniques help employees develop coping mechanisms and resilience in handling workplace stressors [11]. Furthermore, studies highlight the potential of VR-enhanced wellness programs in the workplace. They explore VR's role in facilitating stress-reducing activities like yoga, meditation, or nature-based experiences, offering employees accessible means to unwind during work hours [12]. Overall, the literature review underlines VR's potential in mitigating workplace stress by offering immersive and relaxing experiences, mindfulness sessions, stress management training, and wellness programs. However, while promising, more research is needed to understand the long-term effects and optimal utilization of VR technology in cultivating a less stressful and more supportive work environment [13].

3. Methodology

The software development tools and sensors will be choosing to present in this section. Following that, a detail overview in the project's development work parts taken during the time of creation is given [14]. Finally, the real video game as well as the experiment techniques is discussed. Virtual Reality Scosche Rhythm+ This is a basic Low Energy Bluetooth Device sensor that reads heart rate signals and can be connected to a proper efficient computer-based device which needs Bluetooth to present the data and save the data [15]. As previously discovered, this gadget provides an economical and simple option for measuring heart rate, with adequate accuracy in office conditions (not strenuous activity), which was sufficient for the project's aims. For the sake of simplicity, the Scosche Rhythm+ sensor was also chosen to virtual reality application device connection [16]. The device's worth noting the Heart rate signal which are provided every second, allowing for visualization of the signals with the time as well as the computation of standard deviation technique. Other HR variability aspects which may be some additional significant to the level of stress estimate are not captured [17]. The Mood metric Ring is a commercial sensor that analyses electro dermal activity using a patented processing method. As a result of this analysis, the user's stress levels are indicated by an index number. The various types of signals used in this project are the signal of the index number, but some of the signals are the raw signals of electro dermal activity. Despite this fact that the EDA signal's raw data could be obtained, we chose the Mood metric signal to measure the index value because it is use in related studies and works has proven definite success. There are some categories of stress levels [18]. The Mood metric Ring is a sensor that combines a number of benefits, including portability, ease of use, and the capacity to collect objective data from common life scenarios, as well as user comparability and resistance to motional aberrations [19]. The following points highlight the steps used to meet the project's objectives:

1. After analyzing the current literature and consulting with skilled therapists – psychologists, choose and build a serious game for stress reduction. The visualization of deep breathing for a tranquil virtual reality setting was chosen.
2. At the time of Creating the video games or a serious game in the various game engines for use on the operating system of the android devices, specifically the Oculus Go Virtual reality mask.
3. At the time of Creating of an Android library to allow the application to connect with the Bluetooth devices to the Scosche Rhythm+ sensor.
4. We use the Bluetooth and android connected library as a plug in Unity source to take advantage of its features. The information collected was seen on the applications UI and it will automatically saved after every session time, there is the possibility of introducing contextual feedback based on heart rate value.
5. Some Preliminary and final practical methods comprising the above primary session parts: such as relaxation session at the initial, stress busting activities, and relaxation session at the final stage. The usages of various sensors were judged required during the studies.
6. At the time of completion of the final practical session and collects and give extra information for analyzing and visualizing.
7. User Experience Questionnaire implementation
8. Signals are collected and at the time of visualization of the statistics data taken from self-created report questionnaires.

4. Game Design

The serious video game's creation and the development intend to serve as an introductory for deep breathing activity as well as a serene

Three D atmosphere which induces user's relaxation session. There is only one important scenario in it [20]. The following free asset packages were required before the scene could be built: For environmental design, use the Fantasy Forest Environment asset bundle. Because empirical research reveals that walking in nature surrounding and relaxation session activities help people recuperate from various types of stress. Oculus integration asset package, which included all of the tools needed for the final Oculus Go implementation. In the application, audio files are used as soundtracks. Figure depicts the central scene. There are five objects in the scene: The scene's terrain is the wooded environment. OVR Camera Rig: the scene's main camera, there is a long camera characters and things seen from the Oculus developing tools [21].

There is a sphere on the primary camera on the centre that counts and measures the user's recommended breathing rate. At the time when the volume of the sphere is increased, the colour of the device changes to white, and then the user is advised to inhale at the same rate as the sphere expands. The sphere's colour changes to red as its volume decreases, and then the user is advised to exhale at the same rate [22]. The heart rate collected from Scosche Rhythm+ is shown via a text component. An audio file that will be used as a soundtrack in figure 1.

Figure 1. Overview of the game

.

5. Results

In this section, the initial experiment results will be discussed. Two students, both female and unfamiliar with VR technologies, were advised to help and volunteer to take part in this phase of the study [23]. The subjects thought the experiments were a simple and enjoyable experience. During the studies, they were required to wear both sensors. The heart rate signal, the Mood metric signal value according to the index and the relation between both the signals are depicted in the diagrams derived as results [24]. The shading logic of the Mood metric index value follows the categorization, there are 5 zones ranging from green is for 'calm' contains index value from 0 to 20 to red for 'running high' contains index value from 80 to 100[25]. The volunteer and the helpers were urged to stick to the technique; however, the recording period was extended to learn more about the relationship between both of the signals and their specific role as stress indicating device. The provided findings are based on an experiment in which the Stroop test was utilized as a stress-stimulating activity. The test started at 17:55 and ended five minutes later in fig-2.

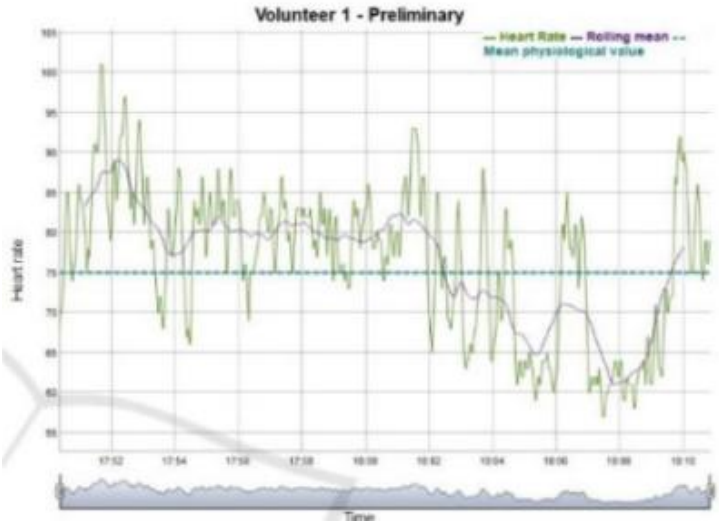

Fig. 2. Initial Preliminary Experiment Results

The final practical results at the final stage are discussed in this results part. Two females and two male students who are familiar with virtual reality technologies and gaming surrounding participated in this experiment.

Volunteer 1 is the subject of the results that will be given. The influence of the Oculus Go application was studied in this experiment. As a result, the output will be a representation of both of the signals without and also with the use of the Oculus Go mask. The first volunteer's results show a positive response to the Oculus Go application in terms of its impact on stress levels. When using the VR mask, there appears to be a minor trend for decrease. This result is basically dependant on the observation of the Mood metric signal value according to the index, which shows no significant variations on both occasions. The results of the questionnaire are displayed. These findings confirm the idea that the Oculus Go application has a good impact on stress levels from the volunteer's perspective in fig-3. The rest of the findings are a little hazier. The fact that the first two volunteers which are both the females were unfamiliar with FPP shooting Games appeared to have a beneficial impact on the protocol's ability to produce tension. The remaining two volunteers (males) were, on the other hand, more accustomed to reacting to this virtual surrounding, and also the stress stimuli were not as effective. After that, whether heart rate or EDA exhibit more pronounced that related to stress variations is dependent on the helper and volunteer. The heart rate standard deviation signal had a stronger relationship with the Mood metric signal value based on index, which is implying that it could be a superior stress based indicator than heart rate.

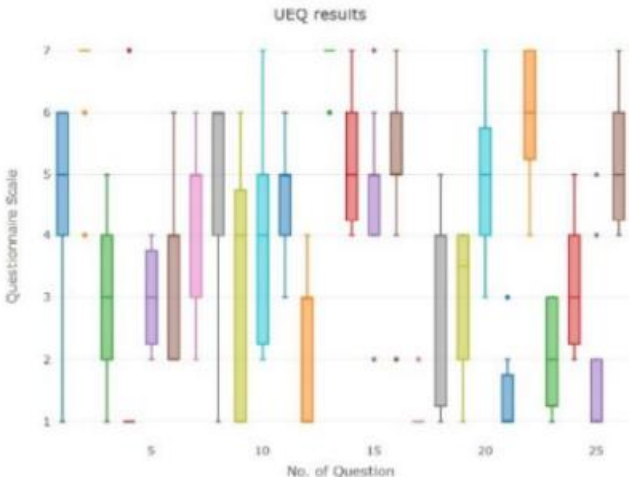

Fig. 3. Final Stage Experiment Results

6. Conclusion

The main goal of this research paper was to present the creation and the development of a virtual reality application. Two experiment procedures were created and carried out to this goal, with preliminary results given. The results show the project's potential, but also the need for various new practical methods based on virtual reality, more complicated signal processing, and refinements to the Virtual Reality environment, notwithstanding the smaller number of volunteers that will take part in the studies.

The smaller number of volunteers who took part in the stress buster activities and the need to improve and standardize the stress buster and the stimulation stage in the practical stages protocol to better simulate working surrounding conditions and responses by various categories of relation of stress of people are both limitations of this effort. Future development should focus on improving the VR system and integrating it with commercial sensors in a harmonious manner. Access to immediate HR and HRV features would help quantify stress levels more accurately. Overall, to develop a more robust system capable of effectively addressing the problem of job stress, it is important to detect the appropriate stress indicators. One future extension of this study could be the creation of a VR serious game suite for the treatment of the various chronic stress or anxiety problems.

Acknowledgements

We would like to express our sincere gratitude to all those who have supported and guided us throughout the completion of this research project. Firstly, we extend our heartfelt thanks to our advisor, Navjot Singh Talwandi, Shanu Khare and Payal Thakur for their invaluable guidance, encouragement, and continuous support. Their expertise and insights have been instrumental in the successful completion of this work. We are also grateful to our institution, for providing the necessary resources and a conducive environment for research. Special thanks to the Department of Department of Computer Science & Engineering for their assistance and support. We would like to acknowledge our colleagues and friends for their encouragement and constructive feedback during this research. Their input has been invaluable in refining our work. Finally, we extend our deepest appreciation to our families for their unwavering support and understanding throughout this journey. Their encouragement and patience have been our driving force.

Funding source

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

References

[1] Pourmand, A., Davis, S., Lee, D., Barber, S., Sikka, N. (2017). Emerging utility of virtual reality as a multidisciplinary tool in clinical medicine. Games for Health Journal, 6(5), 263-270

2] Lau, H. M., Smit, J. H., Fleming, T. M., Riper, H. (2017). Serious games for mental health: are they accessible, feasible, and effective? A systematic review and metaanalysis. Frontiers in psychiatry, 7, 209

[3] Valmaggia, Lucia Latif, Leila Kempton, Matthew Rus-Calafell, Mar. (2016). Virtual reality in the psychological treatment for mental health problems: An systematic review of recent evidence. Psychiatry Research. 236. 10.1016/j.psychres.2016.01.015.

[4] Ferreira, Nuno. "Serious Games." Distributed Computer Graphics. Universidade do Minho. Portugal (2002). [5] Karasek, R.A. (1979). Job demands, decision latitudes, and mental strain: Implications for job redesign. Administrative Science Quarterly, 24 (2), 285-308.

[6] McCallie, M. S., Blum, C. M., Hood, C. J. (2006). Progressive muscle relaxation. Journal of human behavior in the social environment, 13(3), 51-66.

[7] Richardson, K. M., Rothstein, H. R. (2008). Effects of occupational stress management intervention programs: a meta-analysis. Journal of occupational health psychology, 13(1), 69.

[8] Thoondee, Krsna Oikonomou, Andreas. (2017). Using virtual reality to reduce stress at work. 492-499. 10.1109/SAI.2017.8252142.

[9] Ahmaniemi, Teemu Lindholm, Harri Muller, Kiti Taipalus, Tapio. ¨ (2017). Virtual Reality Experience as a Stress Recovery Solution in Workplace. 10.1109/LSC.2017.8268179.

[10] Salkevicius, Justas Damasevicius, Robertas Maskeliunas, Rytis Laukiene, Ilona. (2019). Anxiety Level Recognition for Virtual Reality Therapy System Using Physiological Signals. Electronics. 8. 10.3390/electronics8091039.

[11] Navalta JW, Montes J, Bodell NG, Salatto RW, Manning JW, DeBeliso M (2020) Concurrent heart rate validity of wearable technology devices during trail running. PLoS ONE 15(8): e0238569. https://doi.org/10.1371/journal.pone. 0238569

[12] Castaldo R, Montesinos L, Melillo P, James C, Pecchia L. Ultra-short term HRV features as surrogates of short term HRV: a case study on mental stress detection in real life. BMC Med Inform Decis Mak. 2019 Jan 17;19(1):12. doi: 10.1186/s12911-019-0742-y. PMID: 30654799; PMCID: PMC6335694.

[13] Pakarinen, T., Pietila, J., Nieminen, H. (2019, July). Prediction of ¨ Self-Perceived Stress and Arousal Based on Electrodermal Activity. In 2019 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC) (pp. 2191- 2195). IEEE.

[14] Scarpina, F., Tagini, S. (2017). The stroop color and word test. Frontiers in psychology, 8, 557.

[15] Palanisamy, Karthikeyan M, Murugappan Yaacob, Sazali. (2011). A review on stress inducement stimuli for assessing human stress using physiological signals. Proceedings - 2011 IEEE 7th International Colloquium on Signal Processing and Its Applications, CSPA 2011. 10.1109/CSPA.2011.5759914.

[16] de Bloom, J., Sianoja, M., Korpela, K., Tuomisto, M., Lilja, A., Geurts, S., Kinnunen, U. (2017). Effects of park walks and relaxation exercises during lunch breaks on recovery from job stress: Two

randomized controlled trials. Journal of Environmental Psychology, 51, 14-30. https://doi.org/10.1016/j.jenvp.2017.03.00 6

[17] Allen, G.J., Pescatello, L., Coughlan, L., Stephan, C., Barzvi, A., Kwassman, J., et al., A multi-disciplinary, employee- centered health promotion program: Research, service, and evaluation. Presented at the Connecticut Psychological Association, Westbrook, CT, November, 2002.

[18] Pollak Eisen, K., Allen, G.J., Bollash, M, Pescatello, L.S. (2008). Stress management in the workplace: A comparison of a computer-based and an in-person stress-management intervention. Computers in Human Behavior, 24 (2), 486-496. ttps://doi.org/10.1016/j.chb.2007.02.00

[19] Li-fen, C. (2007). Research on Employee's Paid Vacation in China. East China Economic Management.

[20] Kuhnel, J., Sonnentag, S. (2011). How long do you benefit from ¨ vacation? A closer look at the fade-out of vacation effects. Journal of Organizational Behavior, 32, 125-143. https://doi.org/10.1002/JOB.699.

[21] Kawakubo, A., Oguchi, T. (2019). Recovery experiences during vacations promote life satisfaction through creative behavior. Tourism Management Perspectives. https://doi.org/10.1016/J.TMP.2019.02.017.

[22] Nordstrom, R., Rucker, G., Hall, R. (1988). Performance Mangement in City Government: A Case Study. Public Personnel Management, 17, 159 - 165. https://doi.org/10.1177/009102608801700206.

[23] Bloom, J., Geurts, S., Kompier, M. (2012). Effects of short vacations, vacation activities and experiences on employee health and well-being.. Stress and health : journal of the International Society for the Investigation of Stress, 28 4, 305-18 . https://doi.org/10.1002/smi.1434.

[24] Bloom, J., Geurts, S., Sonnentag, S., Taris, T., Weerth, C., Kompier, M. (2011). How does a vacation from work affect employee health and well-being?. Psychology Health, 26, 1606 - 1622. https://doi.org/10.1080/08870446.2010.546860.

[25] Boshi, S., Lavie, M., Weiss, A. (2015). Quasi-Free Goods and Social Norms: The Effects of Quantity Restrictions and Scrutiny. ERN: Experimental Economics (Topic). https://doi.org/10.2139/ssrn.2574131.