ORIGINAL ARTICLE

Visualization Factor Distraction During the Driving Task in a Real Reality Environment Using EEG Analysis

Nursyuhadah Zulfakur[1], Dian Darina Indah Darius[2], Nurhafizah Moziyana Mohd Yusop[1] ,Yuhanim Hani Yahaya[1]

[1] Department of Computer Science, Faculty of Defence Science and Technology Sciences, National Defence University of Malaysia, Kem Perdana Sungai Besi 57000 Kuala Lumpur, Malaysia.
[2] Department of Mechanical Engineering, Faculty of Engineering, National Defence University of Malaysia, Kem Perdana Sungai Besi 57000 Kuala Lumpur, Malaysia.

ABSTRACT

Introduction: A visually cluttered environment is described as one that has visual qualities that have the potential to affect driving efficiency. It is the theory that performance is determined by the interaction of the individual, the task, and the surrounding environment. – Statistics of an accident reported in Malaysia has been increasing rapidly. General observation found that the main cause of car accidents reported in due to the distraction of the driver during. This study aims to examine the visualization factor distraction that causes an accident during the driving task. **Methods:** The driver distraction is measured based on the analysis of attention level of Electroencephalogram (EEG) signal. The EEG signal waves that are produced from the brain will be recorded while the driver is driving on the road with controlled parameters. The data are analyzed in order to retrieve the level of attention level of the driver. **Result :** Findings from this study show that the percentage of attention level reduced with the most significant factors in visualization. **Conclusion:** Based from the results of this study, the activity in the brains reacts differently to the different visualization that the drivers are exposed to during driving.
Malaysian Journal of Medicine and Health Sciences (2022) 18(9):66-70.doi:10.47836/mjmhs18.s9.10

Keywords: Driver; Driver Distraction; EEG; Real Reality; Visualization Factor

Corresponding Author:
Nursyuhadah Binti Zulfakur
Email: nursyuhadahzulfakur.nz@gmail.com
Tel: +60-1133887254

INTRODUCTION

INTRODUCTION
The increasing number of road users every day causes many problems that can contribute to the increasing rate of accidents that occurs in Malaysia. In the last five years, statistic from SOCSO and DOSH has shown an increasing number of fatal accident cases for about 231.9% and 125.8% respectively(1). The primary goal of this research is to discover more about the driver's perception of the effects of a visually cluttered environment on the driver. This case study will be focused on drivers in Malaysia.

A visually cluttered environment is described as one that has visual qualities that have the potential to affect driving efficiency. It is the theory that performance is determined by the interaction of the individual, the task, and the surrounding environment. Visual clutter in roadscapes including roadside advertising, (2) is continuing to increase, and it could have an impact on driving performance. There are three types of visual cluttered which are situational clutter, designated clutter and built clutter. Attention is the behavioural and cognitive process of focusing selectively on a discrete aspect (3) of information whether considered subjective or objective while avoiding other perceivable information. The attention level of the drivers can be measured using the Electroencephalogram (EEG) waves.

According to (4), road advertising signs adds additional demands to the driving task which can be considered as environmental clutter. Road advertising sign which can change frequently is known as a digital billboard, and it increases the crash risk. Eye movement data have been explored to study the influence of advertising billboards.

According to (5) as a catch-all word, attention is also used to explain that selection mechanism are engaged in practically every phase of brain activity, from sensory perception to making a choice and consciousness. An

attentive driver must have sufficient knowledge of the present situation, include that the ability to anticipate how the situation will probably develop as well as the specifics of how, when, from where to sample new information in order to stay relevant. Based on (5) definition of driver distraction and inattention is when the focus is diverted away from driving-related tasks, distraction is believed to be present and the subsequent driver action is harmful to safe driving, or risks being dangerous.

The act of taking out a cigarette from the box, reaching your lighter and controlling your hand to light the cigarette means that your gaze and focus are likely to be away from the road. You need to put your lighter and packet of cigarettes somewhere once you have lit it. Any distractions like these reduce your ability to react quickly to road situations. According to (6) smoking is one of the main risk factors for a traffic incident. This is because driving while performing another task has been shown to potentially cause reductions in driving performance based on a study by (7). According to the examination done by (8) found that the process of smoking in a car increases the crash risk by between 2-3 times.

(9) the differences in driving performance deterioration linked to typing a message against reading a text message were studied. The study found that typing a text message was associated with higher perpendicular variability than just reading a message. Typing a text message, which needs the driver to touch the keypad for visual input, may cause the driver to lose focus more than reading a message. (10) both typing and read texts were found to be correlated with driving on Facebook app decrements compared to mere driving, particularly the message writing. Typing and reading the messages will decrease the attention level to the roadway and slow the response to important traffic events. This activity also can make vehicle loses control and at the same time reduce the safety of the drivers, passengers and other road users (11).

Based on a study (3) the changes in functional brain activity are correlated with eating behaviour, and effective food/beverage manipulation to avoid spillage necessitates the use of additional cognitive resources. Another possible element is visual, as looking away from the road for longer periods of time has been linked to an increased risk of accidents. Studies by (12) found that compared to control, eating activity decreases the average travel speed and causes the standard speed deviation to increase. Several studies have compared the effects of running a navigation system using voice-activated input and a manual destination input. According to a research by (7) shows that manual activity has a greater influence on driving efficiency than voice-activated control. This research also found that driving performance is less detrimental to following voice-guided direction from the navigation system than following directions that are only visually displayed. The influence of listening to music depends on what type of music on driving performance. Simulated and experimental studies reveal that loud, fast-paced, or stressful music has a negative impact on driving performance. According to the (7) Drivers who are listening to overly loud music respond slower and commit more traffic offences than other drivers. Emotional music whether happy or upset the pace of driving gradually decreases. The authors argue that the existence of passengers may cause the driver to have a degree of cognitive distraction that leads to a more focused central gaze, which may pose a danger as a peripheral event may be missed.

In a simulated driving study by (14) the drivers' capacity to detect harmful occurrences was affected by the presence of passengers. According to (15) several studies have shown that advertising signs, such as eye glances, draw drivers' attention. In a study by (7) observed that road advertising also can decrease in speed, a larger variance in the lateral position, a rise in reaction time and more mistakes. Effect of handling equipment are also involved in this study. According to a study by the European Road Safety Observatory (7), drivers who engage in these activities drive slower, have more lateral position deviations, and look away from the road for longer and more frequently. Simulator experiments also indicate slower response times and a higher number of conflicts.

In (16), the EEG technique is used to examine neurophysiological assessments based on individuals' brain waves. According to (17) EEG is the electrical activity recorded from the brain's surface/scalp and is usually represented in terms of rhythms and transients. EEG signals are classified into frequency ranges based on their rhythmic activity. Alpha, beta, theta, and delta waves are the most typical EEG rhythms. Based on a study (18) driving performance is affected by mind wandering due to the driver's attentional state changes can be observable as a result of the underlying brain physiology. The NeuroSky Mindwave Mobile Headset was used to measure the level of attention in this research.

Based on a study by (19) investigates the impact of sign advertising on accidents, while two interventions were considered taking away (or covering) and subsequent reconstruction of existing billboards. The results show based on this study when the billboard is removing the percentage of injury crashes decreased by 30 to 40% while when the billboards are restoring the injury crashes increase by 40 to 50%.

According to a study (20) within the context of a three-task paradigm meant to stimulate particular elements of driving, a pool of 161 photos of real commercial billboards were used as stimuli to determine the most distracting billboard features for drivers. In (21) as they drove on a number of roadways that differed in visual

clutter and the existence or absence of advertising billboards, drivers' eye glance behaviour was analyzed. The results in this study showed that how drivers glance at scenes impacts the amount of visual clutter found in highway environments.

Based on the experimental study that is done, the challenge was to make sure the attention level of the driver while driving is at a high level. This happens because there are many disturbances such as traffic jams, billboards and traffic lights.

MATERIALS AND METHODS

Participants
Five drivers were selected to perform a pilot test to validate the visual distraction factors from the roadscapes environment wore headset and drive through the roads that has the five points. From the literature, five points that are involved in this additional experiment are roadside advertisement has more than roadside signages, colourful and bright digital billboard, positions of roadside advertisements, size of the roadside advertisements and colour of roadside advertisements.

The road used for this pilot study is starting from Silk Residence to Pantai Cheras Hospital in Kuala Lumpur. The type of car that has been used in this pilot study are Perodua Bezza and all drivers are given instructions before the experiment begins. This experimental study involved five drivers which are two males and three females. The age involved in this experimental study is between 20 to 30 years old while their experience in driving is between two to five years. All drivers that are involved in this study are non-drinking and non-smoking drivers to ensure their health is in the optimum range. Before the experiment is done, the drivers are advised to get enough sleep the night before to ensure they avoid the stress and are in a good condition. This experiment will be held in the morning at 10 am on the weekend. This is to ensure the roads are clear from traffic jams that may distract the attention level of drivers. All drivers also use the same speed 70km/h to make sure the data are accurate and to increase the safety of drivers.

Experiment Design and Procedure
(Fig. 1) shows the drivers wearing the headset while driving along the road. The headset will count the attention level of the driver while driving and data of attention level when reaching the points will be recorded. The data will calculate by using average data from five seconds before reaching the points and ten seconds after reaching the points of the billboard. The data will be divided by 16 to make sure the average data are accurate.

Experiment Equipment
This experimental study has been conducted using factor visual in questionnaire and EEG will be used in

Fig. 1. Driver wearing the headset while driving

this factor by using the Neurosky Mindwave Mobile. Visual factors that are involved in these additional experiments are roadside advertisement has more than roadside signages, colourful and bright digital billboard, positions of roadside advertisements, size of the roadside advertisements and colour of roadside advertisements.

The measurement category of attention level is shown in Table I based on the research (22). There are five categories in this table. The first is great attention, which is defined as a level of attention between 80-100. Following that is good attention, which indicates a level of attention between 60-79. One of the measurement categories that measure the attention level at 40-59 is the neutral category. Less attention and Poor attention are also included in measuring categories, with attention levels of 20-39 and 1-19.

Table I. Measurement category of attention level

Attention Levels	Category
80-100	Great Attention
60-79	Good Attention
40-59	Neutral
20-39	Less Attention
1-19	Poor Attention

The NeuroSky Mindwave Mobile Headset is shown in (Fig. 2). The EEG wave is measured by using this headset, and the data is recorded using EEG Analyzer software.

(Fig. 3) illustrates the outcome of the EEG Analyzer's capture of the driver's attention level. EEG Analyzer will capture the alpha, beta, gamma and theta but in this study focus on attention level.

RESULT

Table II show the result of attention level drivers on visualization factor. For factor one and factor two, which are roadside advertisements have more than roadside safety signs along with the colourful and bright digital billboard, three drivers achieve neutral

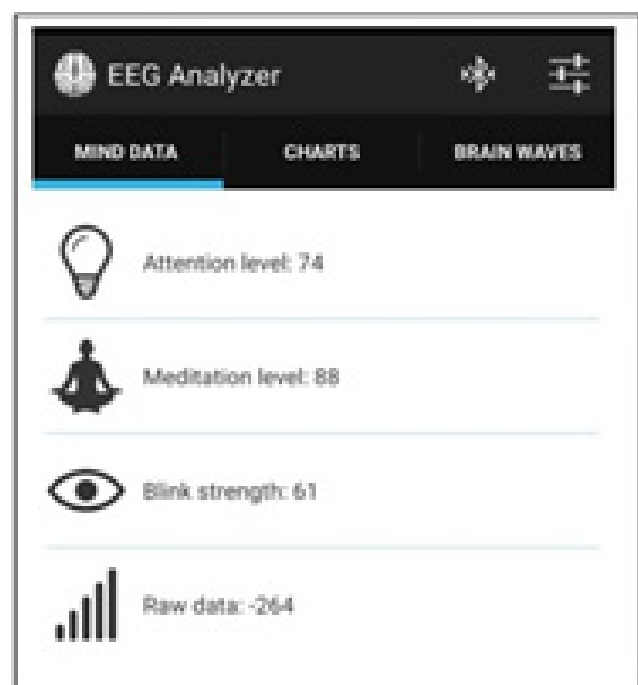**Fig. 2. Mobile Headset**

Fig. 3. Data collected by EEG Analyzer

category between 40-59 which are 60% of the total percentage. The rest two driver achieved good attention category between 60-79. Neutral category achieved by all drivers on the third factor which is positions of roadside advertisements that made up of 100% of the total percentage that involved all drivers. For the fourth factor, which is the size of the roadside advertisements, three drivers achieve neutral category between 40-59 which are 60% of the total the percentage. One driver achieved good attention which is between 60-79. The other driver achieved less attention which is between 20-39. For the fifth factor, which is the colour of roadside advertisements, three drivers achieved neutral category and the rest two drivers achieved good attention level.

Table II. Result of attention level drivers on visualization factor

Factor	Driver 1	Driver 2	Driver 3	Driver 4	Driver 5
Factor 1	54	57	60	60	59
Factor 2	52	47	60	60	49
Factor 3	54	52	57	58	52
Factor 4	35	45	56	75	55
Factor 5	47	52	64	61	49

DISCUSSION

(Fig. 4) show the line graph result of attention level drivers on visualization factor. From the line graph result of attention level of the drivers on visualization factor can conclude that the male drivers have a stable attention level. Male drivers in this study are driver 2 and driver 5 which have a similar result of attention level compare to driver 1, driver 3 and driver 4 which showed an unstable result of attention level. The result also shows that in factor 4, which is the size of the roadside advertisements have an impact on the drivers that produce an unstable result. The result of factors 1 and 3 are slightly the same where the attention level of all drivers are almost all are in the neutral category.
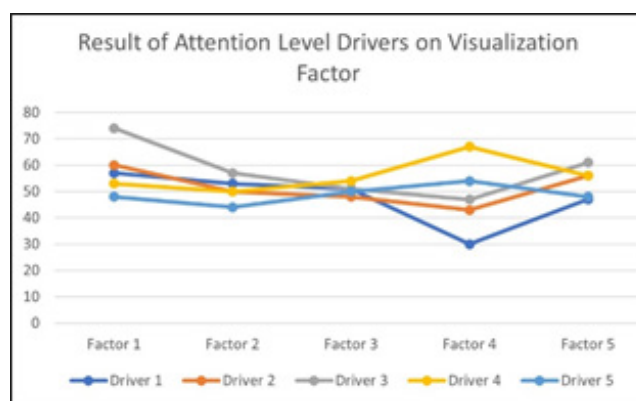

Fig. 4. Line graph result of attention level drivers on visualization factor

CONCLUSION

Malaysia's accidents statistic has been increasing rapidly that are causing worry among the government nowadays. This study aims to examine the visualization factor distraction that causes an accident during the driving task. In this study, the emphasis was given to the drivers in Malaysia. Findings from this study shows that the percentage of attention level reduced with the factors which are the most significant in visualization factor. In the future, this research will highlight the relationships between EEG and virtual reality that can prove the combination of two technologies. As a result, this study will be able to examine the factors that distract the attention level of drivers while driving. Findings from this study show that the percentage of attention level

reduced with the most significant factors in visualization.

REFERENCES

1. Hamid ARA, Noor Azmi MRA, Aminudin E, Jaya RP, Zakaria R, Zawawi AMM, et al. Causes of fatal construction accidents in Malaysia. IOP Conf Ser Earth Environ Sci. 2019;220(1).
2. Edquist J, Johnston I. Visual clutter in road environments-what it does, and what to do about it. 2008 Australas Road Saf Res Polic Educ Conf [Internet]. 2008;400(November):733–8. Available from: http://casr.adelaide.edu.au/rsr/RSR2008/EdquistJ.pdf
3. Alosco, M. L., Spitznagel, M. B., Fischer, K. H., Miller, L. A., Pillai, V., Hughes, J., & Gunstad, J. Both texting and eating are associated with impaired simulated driving performance. Traffic injury prevention, 2012;13(5), 468–475. https://doi.org/10.1080/15389588.2012.676697
4. Oviedo-Trespalacios, O., Truelove, V., Watson, B., & Hinton, J.A. The impact of road advertising signs on driver behaviour and implications for road safety: A critical systematic review. Transportation Research Part A: Policy and Practice.2019. https://doi.org/10.1016/j.tra.2019.01.012
5. Kircher, K., & Ahlstrom, C. (2017). Minimum Required Attention: A Human-Centered Approach to Driver Inattention. Human Factors, 59(3), 471–484. https://doi.org/10.1177/0018720816672756
6. Kogani, M., Almasi, S. A., Ansari-Mogaddam, A., Dalvand, S., Okati-Aliabad, H., Tabatabaee, S. M., & Almasi, S. Z. Relationship between using cell phone and the risk of accident with motor vehicles: An analytical cross-sectional study. Chinese J Traumatol - English Ed. 2020; 23(6), 319–323. https://doi.org/10.1016/j.cjtee.2020.08.002
7. Schneidereit T., Petzoldt T., Keinath A., & Krems J.F. Using SHRP 2 naturalistic driving data to assess drivers' speed choice while being engaged in different secondary tasks. J Safety Res. 2017;62. DOI:10.1016/j.jsr.2017.04.004
8. Klauer, S.G., Dingus, T.A., Neale, V.L., Sudweeks, J., & Ramsey, D.J. The Impact of Driver Inattention On Near Crash/Crash Risk: An Analysis Using the 100-Car Naturalistic Driving Study Data. Analysis. 2006;(April). DOI:10.1037/e729262011-001
9. Reed N, Robbins R. The effect of text messaging on driver behaviour. Transp Res Lab. 2008;(September).
10. Basacik D, Reed N, Robbins R. Smartphone use while driving: a simulator study. Ihs. 2011;67.
11. Caird, J. K., Johnston, K. A., Willness, C. R., Asbridge, M., & Steel, P. A meta-analysis of the effects of texting on driving. Accid Anal Prev. 2014;71,311–318.https://doi.org/10.1016/j.aap.2014.06.005
12. Farah H, Zatmeh S, Toledo T, Wagner P. Impact of distracting activities and drivers' cognitive failures on driving performance. Adv Transp Stud. 2016;
13. Euopean Road Safety Observatory. Driver Distraction 2015. 2015;65.
14. White, C. B., & Caird, J. K. The blind date: The effects of change blindness, passenger conversation and gender on looked-but-failed-to-see (LBFTS) errors. Accid Anal Prev. 2010;42(6), 1822–1830. https://doi.org/10.1016/j.aap.2010.05.003
15. Yannis, G., Papadimitriou, E., Papantoniou, P., & Voulgari, C. A statistical analysis of the impact of advertising signs on road safety. Int J Inj Contr Saf Promot. 2013;20(2):111–120. https://doi.org/10.1080/17457300.2012.686042
16. Astaras A, Moustakas N, Athanasiou A, Gogoussis A. Towards brain-computer interface control of a 6-degree-of-freedom robotic arm using dry EEG electrodes. Adv Human-Computer Interact. 2013;2013. DOI:10.1155/2013/641074
17. Islam, M. K., Rastegarnia, A., & Yang, Z. Methods for artifact detection and removal from scalp EEG: A review. Neurophysiol Clin Neurophysiol. 2016;46(4–5). https://doi.org/10.1016/j.neucli.2016.07.002
18. Baldwin C.L., Roberts D.M., Barragan D., Lee J.D., Lerner N.,& Higgins J.S. Detecting and quantifying mind wandering during simulated driving. Front Hum Neurosci. 2017;11. https://doi.org/10.3389/fnhum.2017.00406
19. Gitelman V., Doveh E., & Zaidel D. An examination of billboard impacts on crashes on a suburban highway: Comparing three periods—Billboards present, removed, and restored. Traffic Inj Prev. 2019;20(sup2). https://doi.org/10.1080/15389588.2019.1645330
20. Marciano H., & Setter P. The effect of billboard design specifications on driving: A pilot study. Accid Anal Prev. 2017;104. DOI:10.1016/j.aap.2017.04.024
21. Perez, W. & Bertola, M. The Effect of Visual Clutter on Driver Eye Glance Behavior; Driving Assesment Conference 6. 2011. https://doi.org/10.17077/drivingassessment.1395
22. Yahaya YH, Moziyana N, Yusof M, Fahmi M, Amran M, Wook M. Electroencephalogram-based Controlled Robot as an Attention Level Indicator. 2018;7:430–2.