2D vs 3D Visualization and Social Networks Entertainment Games: A Human Factor Response Case Study

Zlatogor Minchev

Institute of ICT, IT for Security Department, Bulgarian Academy of Sciences,
Sofia, Bulgaria
zlatogor@bas.bg

Abstract. In today's world modern 3D visualization screens are already entering the entertainment world of future smart homes together with the social networks popular games. The paper describes and experimental study of volunteers' focus group spontaneous EEG dynamic changes related to 2D/3D screen modes stimuli during short-time gaming activities. A quantitative difference between 2D and 3D gaming stimuli have been found by implementing relative power spectra approach.

Keywords: social networks entertainment games, human factor response, visualization, EEG.

1 Introduction

Nowadays modern personal 3D visualization screens are getting more and more popular for the regular computer gamers and the new smart homes that will encompass many new smart devices and technological solutions in the near future [7]. These are also producing and many negative effects like: fatigue, stress, addiction, physical discomfort, overweight, etc. [4], [9], [11].

Apart of this the recent appearance of lightweight cheap passive 3D personal glasses is strongly supporting the process of 3D visualization entering in the everyday life. Furthermore, the new emerging technologies in the field like simulated virtual and the upcoming augmented reality are opening a vast field for studying the multiple influence effects of all these technologies to the human factors (i.e. entertaining users) response in different smart environments and scenarios of usage.

An interesting direction for exploration in the field is related to the upcoming Web 3.0/Web 4.0 modern social networks games [6], [16] that are getting large popularity amongst social networks, to mention different Zynga games, hi5 - Pets and even the popular smart device Android applications like Rovio's Angry Birds. It is also important to note and the fact that according to [10], [13] the current trends in social network usage are more than fifty percent oriented towards entertainment activities opening a vast field for research concerning the effects of human-machine interaction related to cyber threats and the effects related to the human factors [2], [3], [5], [14].

The present paper outlines shortly an empirical case study concerning the human factor 2D/3D brain activity response to the recently appeared in the most popular social network Facebook [15] and the famous entertainment game on-line modification – Angry Birds [1].

2 Methodology

A simple visual stimulation study of a volunteers' focus group of 25 people (23 men and 3 women, average age 36 years $\pm$ 3) EEG screening methodology was used.

Fig. 1. General idea of the conceptual framework used in the study for EEG game response monitoring

As it is clear from Fig.1 the conceptual framework encompasses: (i) Monitor (a 2D/3D IPS LG D2343P was used during the experiments together with a set of passive glasses, implementing the build-in 2D/pseudo 3D regime switching), (ii) Simulation PC (a desktop Intel®Core™ i5, 6 GB 1600 Mhz RAM station with NVIDIA 2 GB DDR3 video card connected to the LG monitor via HDMI interface) and (iii) EEG recording (utilizing Nation 7128W-C20 EEG panel wireless device together with a mobile HP8220 laptop station that encompasses the Data PC and 16 bit ADC block, $f_s = 512$ Hz).

During the experiments a 6 lead recording mounted with T20 EEG conducting paste, plastic helmet and Ag/AgCl electrode leads were utilized following the international Jasper 10/20 system [12]: F3, F4, C3, C4, P3, P4; reference electrodes A1, A2 have been positioned on processi mastoidei of the studied volunteers with the ground electrode positioned on their foreheads.

The experimental series cover 3 minutes epochs (records) of the Angry Birds online game in the Facebook environment encompassing 3 game levels in 2D and 3D visual stimulation regime of the screen. All experiments were conducted in silent mode, normal working light office conditions and comfortable chair sitting position. The volunteers were using only a standard Creative®2 button optical mouse with a scrolling wheel as an input interface device and a known Facebook account for single player game access.

Fig. 2. A photo with a volunteer for the experimental implementation of the conceptual framework for EEG game response monitoring

The recorded spontaneous EEG series have been sorted and only artifacts free ones have been further used for further digital filtering. A Butterworth 12 dB/oct band pass zero-phase shift filtering within the following four frequency bands have been performed [12]: theta (4-8 Hz), alpha (8-13 Hz), beta (13-30 Hz), gamma (30-70 Hz). Additional notch filtering with Chebyshev 18 dB/oct digital filter in the frequency band 45-55 Hz have been implemented.

In order to achieve the 12dB/oct and 18 dB/oct filter characteristics a multiple 3 dB/oct filter base was used. Next, after the [17] algorithm a Fourier based Relative Power Spectrum calculation of the selected four frequency bands have been performed averaging the results for all monitored volunteers for both 2D/3D stimuli. It is important to note that the whole EEG signals processing have been performed in Matlab®2011b environment.

3 Results

The resulting averaged power spectra concerning F3, F4, C3, C4, P3, P4 leads are depicted on Fig.3 (for 2D) and on Fig.4 (for pseudo 3D):

Fig. 3. Averaged Power Spectra for F3, F4, C3, C4, P3, P4 leads of theta, alpha, beta and gamma frequency bands during 2D visual stimulation with Angry Birds on-line social network game for 3 minutes epochs

The obtained results from both Fig.3 and Fig.4 are demonstrating an interesting quantitatively measured phenomenon concerning the gamma EEG frequency band with prominent difference of 8-10 % between the 2D and pseudo 3D visual stimulation. The other spectral parts differences are rather small - 1-2 %. These could be considered as an interesting finding that practically produces a higher fractal dimension of the measured signals [8].

Generally, the gamma frequencies are related to motor tasks and awareness rising from physiological view point [12] but the present finding being with an empirical character could be used for quantitatively differentiating between the generalized visual stimuli. A further emotions recognition work was initially planned but due to the fact that there exists an individual peculiarities that require single user calibration before every experiment an assumption for real-time on-line detection more accurate results is under development in the framework of [2].

Fig. 4. Averaged Power Spectra for F3, F4, C3, C4, P3, P4 leads of theta, alpha, beta and gamma frequency bands during pseudo 3D visual stimulation with Angry Birds on-line social network game for 3 minutes epochs

4 Discussion

The briefly presented conceptual framework for studying the differences between 2D vs 3D visual stimulation in social network entertainment games concerning the human factors' EEG response is adding data to the vast discussion about the technological influence to the human factor in the new information 21st century. This very large problem is still unconsciously underestimated but sooner will become a significant player with the practical development of smart homes and cities ideas. Currently, the problem is not well studied and requires a more serious observation in the near future accentuating on the multiple human factor responses like: behavior, psychology and physiology correlates together with the fast progressing technological developments.

Acknowledgement. This study is partially supported by: A Feasibility Study on Cyber Threats Identification and their Relationship with Users' Behavioural Dynamics in Future Smart Homes, Research Grant 'Funding of Fundamental & Applied Scientific Research in Priority Fields', Bulgarian Science Fund, Ministry of Education Youth and Science, 2012-2014, DFNI-T01/4, www.smarthomesbg.com. The author is also expressing gratitude for the methodological support to: A Study on IT Threats and Users Behaviour Dynamics in Online Social Networks DMU03/22, Bulgarian Science Fund, Young Scientists Grant, 2011-2013, www.snfactor.com.

References

1. Angry Birds Web Page (May 2013), <http://www.rovio.com/en/our-work/games/view/1/angry-birds>
2. A Study on IT Threats and Users Behaviour Dynamics in Online Social Networks DMU03/22 Project Web Page (2012), <http://www.snfactor.com>
3. A Feasibility Study on Cyber Threats Identification and their Relationship with Users' Behavioural Dynamics in Future Smart Homes, Research Grant 'Funding of Fundamental & Applied Scientific Research in Priority Fields, DFNI-T01/4 Project Web Page, <http://www.smarthomesbg.com>
4. Bavelier, D., Green, C.S., Han, D.H., Renshaw, P.F., Merzenich, M.M., Gentile, D.A.: Brains on Video Games. *Nature Reviews, Neuroscience* 12, 763–768 (2011)
5. Boyanov, L., Minchev, Z., Boyanov, K.: Some Cyber Threats in Digital Society. *International Journal' Automatics & Informatics* (January 2013) (in Bulgarian), <http://www.syssec-project.eu/media/page-media/3/boyanov-autoinfo-2013.1.pdf>
6. Codorniou, J.: Top Rated Social Games of 2012 (December 5, 2012), <https://developers.facebook.com/blog/post/2012/12/05/top-rated-social-games-of-2012/>
7. De Silva, L.C., Mirokawa, C., Petra M.I.: State of the art of smart homes. *Eng. Appl. Artif. Intel.* (2012), <http://dx.doi.org/10.1016/j.engappai.2012.05.002>
8. Georgiev, S., Minchev, Z., Philipova, D., Christova, C.: EEG Fractal Dimension Measurement before and after Human Auditory Stimulation. *International Journal Bioautomation* 12, 70–81 (2009), <http://www.clbme.bas.bg/bioautomation/2009/vol12.1/files/122.3.pdf>
9. Hazelle, R.: Effects of Technology on Younger Generations – Children (October 10, 2012), <http://sciencetray.com/earth-sciences/effects-of-technology-on-younger-generations-children/>
10. Minchev, Z.: Cyber Threats in Social Networks and User's Response Dynamics, SMU 03/22 I Stage Report (December 2012) (in Bulgarian), <http://www.it4sec.org/system/files/IT4SecReports1059.pdf>
11. Minchev, Z.: Smart device q-based survey results (Context definition), DFNI-T01/4 III Project Meeting Report (April 29, 2013), <http://www.smarthomesbg.com/files/dfnit014meetingtalksapril292013.zip>
12. Niedermeyer, E., da Silva, F.L.: *Electroencephalography*, 5th edn. Lippincott Williams & Wilkins (2005)

13. State of the Media: The Social Media Report, Nielsen (2012),
[http://www.nielsen.com/us/en/reports/2012/
state-of-the-media-the-social-media-report-2012.html](http://www.nielsen.com/us/en/reports/2012/state-of-the-media-the-social-media-report-2012.html)
14. SySSec Project Web Page (2010), <http://www.syssec-project.eu>
15. Top 15 Most Popular Social Networking Sites (May 2013),
<http://www.ebizmba.com/articles/social-networking-websites>
16. The Top 25 Facebook games (February 2013),
[http://www.insidesocialgames.com/2013/02/01/
the-top-25-facebook-games-of-february-2013/](http://www.insidesocialgames.com/2013/02/01/the-top-25-facebook-games-of-february-2013/)
17. Mina, M.: Real Time Emotion Detection Useing EEG, The American University in Cairo (2009),
<http://www.cse.aucegypt.edu/~rafea/CSCE590/Spring09/Mina/Mina.pdf>