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With this publication, the CD with all papers from the International Conference on Information Technology and Development of Education, ITRO 2017 is also published.

INTRODUCTION

The Technical Faculty "Mihajlo Pupin", Zrenjanin, of the University of Novi Sad, the Republic of Serbia organizes VIIIth International Scientific Professional Conference "Information Technologies and Development of Education 2017" (ITRO 2017). The Conference will be held on 22nd June 2017 at the Technical Faculty "Mihajlo Pupin" in Zrenjanin, Serbia.

The Conference "Information Technologies and Development of Education 2017" (ITRO 2017) is organized due to the needs to connect science, profession and education through topics and content concept, first of all concerning the teaching process as base of information society. The tendencies of developed countries are in accordance with the efforts of UNESCO to improve this area related to the needs of life and work in the XXIst century. It is necessary to assess the state, detect the problems and perspectives of the development of education by competent professionals and teachers as well as the influence of the development of education on the development of the society as a whole.

The central topic of the meeting is the model of dual education as base for creating good base for the development of industry. Thus, our aim is to gather the representative entities who are able constructively contribute to establishing link between the educational system and industry as follows: Chamber of Commerce of Serbia – Centre for Dual Education, Ministry of Education, Science and Technological Development, Union of Employers of Serbia, ZREPOK – Business Organization of Zrenjanin and Companies that run their business in the region, directors of grammar schools and secondary vocational school, members of the academic communities and other participants who are interested in the topics.

The main topics of the scientific professional conference are:

- Model of dual education
- Teaching based on the concept of entrepreneurship

Other thematic areas of the Conference:

- Theoretical and methodological questions of contemporary Pedagogy
- Digital didactics media
- Contemporary communication in teaching
- Curriculum of contemporary teaching
- Developing teaching
- E-learning
- Management in Education
- Teaching methods of natural and technical subjects
- Information-communication technologies

The Chairman of the Organizing Committee of the ITRO 2017 Prof. Dragana Glušac opened the Conference. The participants were addressed by the vice dean of the Technical Faculty »Mihajlo Pupin«, Prof. Dijana Karuović; provincial secretary for science, higher education and scientific Research prof. Zoran Milošević, and the vice-major of Zrenjanin Mr. Dusko Radisic.

There were total of 143 authors that took part at the Conference from 12 countries, 2 continents: 82 from the Republic of Serbia and 61 from foreign countries such as: Macedonia, Bulgaria, Slovakia, Austria, Cyprus, Albania, Hungary, Spain, Bosnia and Herzegovina, USA, Portugal.

The Proceedings of papers contains 60 papers and it has been published in the English language.

President of the Organizing Committee
Prof. dr Dragana Glusac

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CONTENTS

Review: Using physiological parameters for evaluating User Experience

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Abstract - The study of physiology-based measurement of emotion reactivity for evaluating user experience (UX) has gaining attention in HCI research recently. Physiological methods uses various sensors to measure physiological responses, like: change in skin conductance, changes in heart rate, breathing rate, pupil size, or even brain activity. These physiological methods can be used as alternative to the well-established evaluation methods. This paper summarizes researches done in this area, in recent years. At first, a brief overview of user interfaces, user experience and emotions are given. Then, some physiological parameters (for measuring emotions) that can be used during evaluation are explained. At the end, the methods used by various researchers, for evaluating UX are presented, as well as our next plans in this area of research.

I. INTRODUCTION

User interface (UI) is defined as a set of commands or menus through which a user interacts with an application or a website. It is some kind of connection between users and computer programs [1]. Every application should have easy for use and user friendly interface in order to be used by more people. An application or website with confused and complicate UI is hard to be used and does not have big value [2].

The UI interface is often talked about in conjunction with user experience (UX), which may include the aesthetic appearance of the device, response time and the content that is presented to the user within the context of the user interface [Fig. 1].

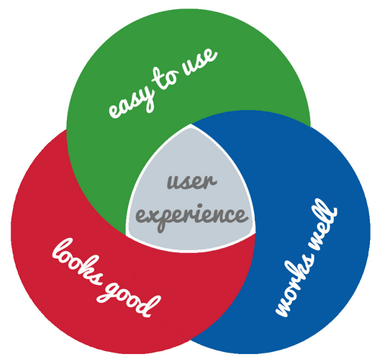

Fig. 1 User Experience

UX refers to the quality of the user's interaction and the perception of the particular product, system or service. It focuses on users understanding - what they need, what they want, what they value, their abilities, and also their limitations [3], [4].

It's important to know that there is a difference between user interface and user experience. An attractive website can have a very good interface, but if it loads slowly or isn't accessible to users on various devices, it's providing a bad user experience. So, creating an effective UI is the starting point for creating a good UX.

One branch of UX research focuses on emotions. This includes momentary experiences during interaction. This arises from the fact that all human behaviors are regulated with nothing else but emotions. But, what are emotions? According to Saberi Roy emotions are probably the most fascinating of all mental processes [5]. Emotions involve two phases of feeling and reaction who are necessarily intertwined. In psychology there is a lot of written about emotions and there are also many theories about it. One of the most influential is James Lange theory, according to which emotion is a perception of states of the body. At first there is a reaction in the body and this reaction creates a feedback, and only then we perceive the emotions according to this theory. Emotions could be positive like love, happiness, empathy, and affection and negative such as anxiety, jealousy, frustration etc. Our own emotions can help us make sense of every situation. For example, appraisal theory states that our emotions are accompanied by inferences about the situation, or environment, we are in [6].

The amount of research dedicated to assessing emotional responses has grown nowadays [7], [8], [9]. According to Picard [10], the goal of these researches is to design products that will better serve people's needs by recognizing and responding to user emotion. It seems just not enough, today, to design an efficient and effective product interaction that satisfied user requirements. It is also very important to design interactive systems that stimulate or please us aesthetically, psychologically, physiologically, socially, intellectually, etc. Using emotions for evaluating UX is relatively new method that can be used as an alternative to the well established evaluation methods such as questionnaires and interviews. However further research is needed in order to establish these method reliable.

This paper focuses on surveying the recent work done by various researchers for evaluation of UX using physiology sensors to capture human emotion reactivity.

II. Physiological Measures

Recently there are two major approaches for measuring emotional reactions. The first one is subjective self-reported ratings (through questionnaires) and the second one is objective physiological measurements. We will focus on the last one: objective physiological measurements.

There are a lot of physiological parameters used during evaluation of UX in HCI. Some of them are: heart rate, respiratory rate, body temperature, blood pressure, electrodermal activity (EDA), electroencephalogram (EEG), electromyography (EMG), electrocardiography (ECG) etc. These physiological parameters can be measured by various sensors, attached to human body.

Body temperature

Most of life dependent metabolic processes are sensitive to changes in temperature and for that is important people to have a constant temperature of approximately 37 ◦C. Two types of thermoreceptors send afferent sensory information to the thermoregulation center, deep inside the brain. The thermoreceptors are peripheral - in the skin, convey information about external temperature conditions and internal central thermoreceptors - detect internal changes in the blood temperature [11].

Heart Rate

Heart is part of the cardiovascular system and consist of organs who regulate the blood flow in the body. The cardiovascular system offers many measuring options to determine the arousal. One of that options is Heart Rate (HR). The heart beats faster after beautiful emotion or when we are surprised or stressed and beats slower when everything is ok or in anticipation [12], [13]. Heart beats for about 60 to 80 times in a minute in an average adult. Older people may have it between 60 and 100. There is also a difference between heart rate of a women and a men (heart rate is higher in women than in men).

Pulse

The pulse can be measured manually by palpation with finger tips on a peripheral artery. From this measurement can be deduced: the pulse frequency, which is the number of impulses per minute; the pulse rhythm, which is the cadence of the pulsation, including spaces between pulses; and the pulse quality, i.e., the strength of the pulse, which varies based on the amount of blood leaving the heart (the stroke volume). The pulse cadence is highly dependent on the heart rhythm and changes with innervation of the heart muscles. In addition to the innervation of the heart, the autonomic nervous system has control over the smooth muscles in the vascular walls [11].

Heart rate and pulse rate are often misunderstood as one and the same thing. However, there are some differences between them. The source of a pulse is the heart. The contraction of the heart results in a heart beat. This beat forces blood to pass through the arteries resulting in the formation of pulse. Actually, heart rate, or pulse rate, is the number of times your heart beats per minute and they should be the same, in healthy individual.

Respiratory system

The breathing rate is the second "clock" of the body, in addition to the heart rate. When air is breathed in via the pulmonary artery to the lungs, oxygen flows into the alveoli, from where it is taken up via the capillary bed into the bloodstream. Oxygen, in combination with glucose, is needed primarily for cellmetabolism and maintenance of cell life. In addition, carbon dioxide, which is the waste product of the body's metabolism, is transported via the pulmonary veins and capillary beds to the alveoli and is exhaled from the body. The main function of breathing is to regulate the partial pressures of O2 and CO2 and the pH of the arterial blood [11].

Calm and positive emotions, cause a lower breathing rate, a more regular breathing pattern, and a longer exhalation time than inhalation time, otherwise stress and fight situations cause a higher breathing rate, a more irregular breathing pattern, and a longer inhalation time than exhalation time.

Blood pressure

The pressure exerted by the blood against the walls of the blood vessels, especially the arteries. Blood pressure is characteristically recorded and described as a value pair, the first being the (higher) systolic number and the second being the (lower) diastolic number. It varies with the strength of the heartbeat, the elasticity of the arterial walls, the volume and viscosity of the blood, and a person's health, age, and physical condition. Normal blood pressure is commonly defined as 120/80 mmHg. A repeatedly elevated blood pressure that exceed 140 mmHg over 90 mmHg is defined as high blood pressure (hypertension). A blood pressure reading lower than 90 mmHg for systolic or 60 mm Hg for diastolic is generally considered low blood pressure (hypotension). Blood pressure can change from moment to moment with changes in posture, exercise, stress, or relaxation. Stress and physical activity increase blood pressure, while physical and mental quiescence reduce blood pressure [19].

Electrocardiography (ECG)

An ECG allows the detection of electrocardiac activity, particularly R peaks, and based on these signals, the heart rate can be determined. Heart rhythm changes depending on various internal or external triggers, particularly emotional stimuli. In situations of anxiety, stress, or physical exertion, a SA node firing rate increased as well as transmission velocity of the signal from the SA node to the AV node. As a result the contractile strength and stroke volume increased, that lead to an increased heart rate.

Electrodermal activity (EDA)

When people have physical arousal, sweat is produced in the eccrine glands. The sweat glands changes the electrical conductivity of the skin. Typically for measurement a sweat glands in the palms of the hand or the soles of the feet are used. Measures of EDA are also known as skin conductance levels (SCL) or galvanic skin response (GSR) [12], [13], [14].

Electromyography (EMG)

Electromyography (EMG) is a diagnostic procedure to assess the health of muscles and the nerve cells that control them (motor neurons). Motor neurons transmit electrical signals that cause muscles to contract. EMG measures the electrical activity of muscle during rest, slight contraction and forceful contraction. An EMG translates these signals into graphs, sounds or numerical values that are interpreted by specialist. The test is used to help detect neuromuscular abnormalities [13].

Electroencephalogram (EEG)

An electroencephalogram (EEG) is an electrophysiological monitoring method that measures and records the electrical activity in your brain. Usually it used a small, flat metal discs (electrodes) attached to the scalp. Your brain cells communicate via electrical impulses and are active all the time, even when you're asleep. This activity shows up as wavy lines on an EEG recording. EEG data can be collected by electrode cap placed on user's head (noninvasive method), or by using the electrodes placed on the surface of the brain (invasive method). EEG is most often used to diagnose epilepsy, sleep disorders, coma, encephalopathies, and brain death. EEG sometimes is also used for diagnosis tumors, stroke and other focal brain disorders [20].

III. USING PHYSIOLOGICAL MEASURES FOR UX EVALUATION

Various measurement techniques have been used for measuring physiological parameters, in context of evaluating UX.

Physiological responses caused by emotions should be measured in real-time using various sensors. Sometimes a single sensor is not enough to capture emotional reaction, so a sensor fusion techniques should be used. Bender et al. [14] used this approach in order to predict subjective Self Assessment Maniki (SAM) ratings. Physiological data were collected using EEG, GSR, ECG, and facial tracking. The authors found that it is possible to predict subjective SAM ratings using physiological data measured by various sensors.

Effects of colors on emotions have been studied in [15]. The authors focus on the general effects of hue, saturation, and lightness on the emotions of players, while playing video games. The theory here is that the chromatic stimuli intensity, brightness, and saturation of a video game environment produce an emotional effect on players. Authors have observed a correlation between the RGB (Red, Green, Blue) additives color spaces, HSV (hue, saturation, value), HSL (hue, saturation, lightness), and HSI (hue, saturation, intensity) components of video game images, and the emotional statements expressed in terms of arousal and valence, recovered in a subjective semantic questionnaire. The results show a significant correlation between luminance, saturation, lightness, and the emotions of joy, sadness, fear, and serenity experienced by participants viewing 24 video game images, and also show strong correlations between the colorimetric diversity, saliency volume, and stimuli conspicuity and the emotions expressed by the players.

Drachen et al. [12] reported a case study on HR and EDA correlations with subjective gameplay experience, testing the feasibility of these measures in commercial game development contexts. Three commercial first person shooter games have been used in this study. The authors expect that this type of game would be ideal for measuring of arousal. Results from this study indicate a significant correlation between measured parameters and self-reported gameplay experience.

Bruun et al. [13] presents a systematic empirical study comparing real-time assertion of emotions and emotions asserted in retrospect through cued-recall. They measured emotions in terms of objective galvanic skin responses (GSR) and subjective Self-Assessment Manikin (SAM) ratings, and found a significant correlations between emotions experienced in real-time and those experienced during cued-recall. The contribution of this paper is the validation of alternative methods for assessing UX.

Forne Malin [16] in her master thesis investigate how physiological measures, such as heart rate, skin conductance and EEG (i.e. electrical brain activity), may be useful in UX and usability testing. The measurement of pupil size, or pupillometry is discussed in more detail. An eye tracking system in combination of infrared light sources and infrared video cameras has been used for measuring the pupil size. When in use, (invisible) near infrared light is pointed to the eye of the user, creating a strong reflection in the retina. These reflections are recorded by the infrared camera, and their relative positions are then used to calculate the point of regard. As eye movements are recorded with an eye tracker, pupil size data is collected in the process. The conclusion is that physiological responses should always be interpreted in relation to the context in which data was collected, as well as to the users' own account of their experience.

Alexander et al. [17] proposed a new tool-based evaluation approach for evaluating UX during HCI. They combined user's physiological signals (e.g. heart rate, blood volume pressure, skin conductance), observation data (e.g. users' face recording, screen recording) and self-reported data (e.g. responses in questionnaires, interviews) in an innovative tool (PhysiOBS) that allows continuous and multiple emotional states analysis. Results from a preliminary evaluation study of the tool were rather encouraging revealing that the proposed approach can provide valuable insights to user experience practitioners.

Börjesson and Jonsson [18] examined how the user experience of mobile games can be evaluated with the use of session recording tools. He also investigates how the user experience can be analyzed from the session recordings, i.e. how the user's emotions can be read from the recorded screen, voice and face. The aim of the thesis was to produce a workflow for user testing with session recording tools for mobile devices.

IV. Conclusion and Future work

Emotions are important in determining users' behavior and the quality of UX. In this article, we offer a glimpse at recent studies in which researchers used various physiological measurements to evaluate emotions. The results from these studies show that physiological measurements may help identify significant episodes of human-computer interaction, which are important for designing interactive systems. However, physiological data should always be interpreted in relation to the context in which it was collected, as well as the subject's own account of the experience.

We would also like to contribute to this field, thus in near future we plan to explore in more details heart rate and respiratory rate as a parameters for evaluation of user experience.

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