Modeling Fun Factor in Electronic Entertainment and Video-Games

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***Abstract*—With hundreds of millions worldwide market revenues, it is surprising that mostly self-report methods are still the only metric used for assessing user experience in electronic entertainment (EE). The fun factor of EE consumers is difficult to measure using only such methods, which is why we propose a model based upon correlations of psychophysiological measurements and self-report methods. Focusing on autonomic nervous system which control involuntary physiological responses, we will eliminate subjects' bias and interpretation difficulties. We will use multiple psychophysiological measurements - heart rate, electrodermal activity, respiratory activity and electroencephalogram in combination with self-report methods to create dataset for our research. Using several methods for processing and analyzing time-series data we will be able to determine which of selected measurements affect the fun factor of EE consumers during their experience. In initial set of experiments, we successfully collected heart rate data of the subjects and found several observable patterns in its experience.**

***Keywords*—Fun factor, Psychophysiological measurements, Electronic entertainment, Correlations, Time-series data**

I. Introduction

Electronic entertainment (EE), especially video-games has undergone an extensive growth over the past decade. In USA alone (country with biggest video-game market) the sales went from $7.3 billion in 2006 to $23.5 billion spend on game industry in 2015 - see Fig. 1. Global value of video-game industry is in the neighborhood of $99.6 billion, with estimated $120 billion until 2019 [1].

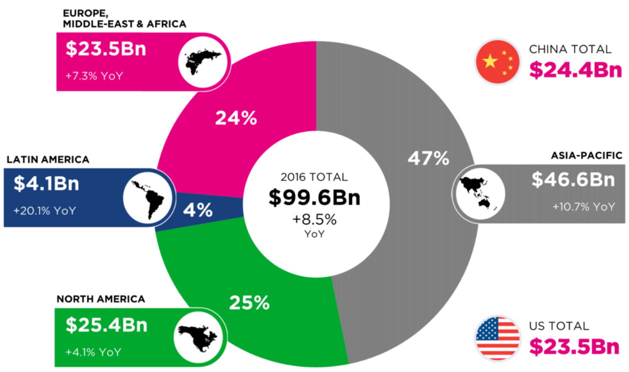

Fig. 1. Year-over-Year (YoY) analysis of video-game industry in 2015 done by Global Games Market.

Companies creating electronic entertainment content are gathering as much data about their customers as possible. Considering that most of the EE content is consumed online, the data are fairly easy to collect. According to Zook [2], leading development companies even collect data that are seemingly not directly connected to gameplay or other content to be used in the future.

Yet, the assessment of user experience in video-games is still done using old-fashioned self-report techniques, such as questionnaires and interviews. We propose an approach for assessing players' experience more effectively while eliminating some disadvantages of self-report techniques such as untruthfulness or emotional bias. Using different psychophysiological measurements, we plan to create a model of fun factor of players. We will investigate correlations between these measurements in combination with players' self-report. After creating the model, we will attempt to find patterns which should help developers predict how players will react to particular events in the future. Also, one of the goals of the work will be to compare several selected methods based on their performance in modeling the fun factor of players.

II. Problem domain

In this paper we will be focusing primarily on video-games as an EE domain. Even though movies are also an interesting field for future research, significant amount of past research about video-games in combination with our interest and experience made video-games the main goal of our research. Also, unlike video-games, the movie industry has significantly smaller European market in comparison to USA, which in combination with our plan to address results of our research to business sphere has made video-games our priority. Nevertheless this research still briefly pursue movies as a domain for psychophysiological measures research.

A. Autonomic Nervous System

Based on previous research, where different psychophysiological measures were proven as good indicators of stress and arousal [3], we have chosen several of them for our work. All the measurements used in our research are parts of a human nervous system, more specifically the autonomic nervous system (ANS), which controls involuntary physiological responses. One of the most important features of measurements controlled by ANS is that they function automatically - therefore can not be affected or controlled willingly, reducing the risks of unsuccessful experiments. Initial experiments have already proven that using absolute values of psychophysiological measures is not practical due to major variability in readings connected to subjects' states prior to the experiment. Instead, the deviation from average values of subject in each experiment session will be used. In Fig. 2, we show three sessions of experiments performed by same subject where average HR of subject is varying significantly even though the experiment setup and time of day remained the same.

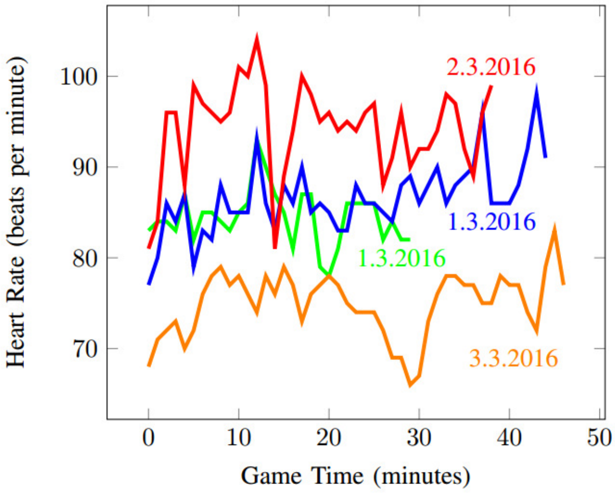

Fig. 2. 4 games of Dota 2 played by tested subject in 3 sessions.

B. Psychophysiological Measurements

Implementing psychophysiological measurements (PPM) has to be done very carefully and with great care due to the many variables that can alter the result. Temperature, humidity, attachment of electrodes, individual differences, differences concerning gender (womens' readings even differ depending on the menstrual cycle), age, time of the day, consumed stimulants such as coffee or energy drinks, medicaments, drugs, etc. can cause different reactions in sensors and in people [4]. Following is the list of psychophysiological measurements we plan to use in our research:

1) **Heart Rate + Heart Rate Variability (HR)** is a measure of cardiovascular activity which reflects emotional state [5].
2) **Respiratory Activity (RA)** is measured as the rate of volume at which an individual exchanges air in their lungs [6].
3) **Electrodermal Activity (EDA)** measures the activity of the eccrine sweat glands and is said to correlate linearly to arousal [7].
4) **Electroencephalography (ECG)** provides data about the brain's electrical activity with millisecond accuracy, for example it's processing of visual emotional stimuli [8].

III. Methods

In order to measure fun factor in video-games we should be able to model relations between changes in psychophysiological measures and subjects' emotional states. Our experiments will produce simple time-series data (see Fig. 3) which should prove straight-forward in order to model such relations. Furthermore, possibility of previous states affecting subjects' present emotional state procure the need to take these into account. This means using methods that are able to consider such specifics, such as:

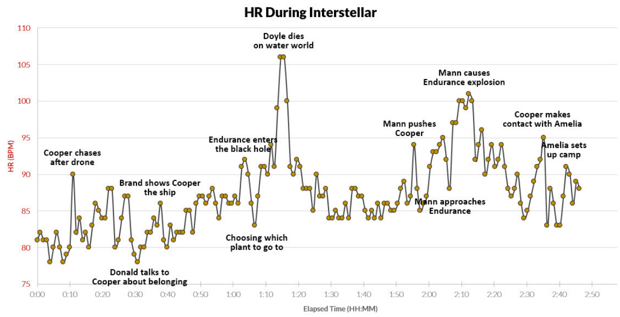

Fig. 3. HR of a subject watching the Interstellar movie.

1) **LSTM Neural Network** should be able to exploit possible dependencies of consecutive psychophysiological values in our data.
2) **Hidden Markov Model** may provide some hidden (unobservable) patterns in time-series data which we will gather during the experiments.
3) **Random Forest** should allow us to extract rule-represented knowledge from successfully trained model.

IV. Previous Results & Future Work

We have already published results of some initial experiments that have been done in our research [9]. During these experiments, one subject participated in 18 games of Dota 2 [10], consisting of approx. 20 hours of gameplay. These experiments exposed several interesting patterns, concerning both game-specific events as well as overall useful facts about the measurements. We repeatedly detected increased HR in specific game situations (deciding fights, first contact with opponent) or decreased HR in times subject waited for his character to respawn after death.

However, as stated in Sec. I, for successful training of fun factor model, simply measuring psychophysiological states of subject is not sufficient for prediction purposes. We plan to combine these measurements with specifically designed interviews as well as video recording of subjects' gameplay in order to determine fun factor of the subject. With this information, experiments should pose as a training set for our model, with goal to predict fun factor of players in the future.

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