Synchronous Visualization of Video and Psychophysiological User Data

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Abstract
Evaluating video game players in games user research uses both quantitative and qualitative methods. When a Games User Researcher employs video recordings and psychophysiological measures to collect player data during a game, they need to correlate events from both sources of data (physiological and video data). The correlation of psychophysiological events with videos is regularly done manually, which consumes time. We propose a prototype for an application that combines such data sources of player sessions, allowing a researcher to visualize regions of interest of the video in relation to the specified psychophysiological activity parameters set.

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Games User Research, Psychophysiology.

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H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous. See: http://www.acm.org/about/class/1998/ Mandatory section to be included in your final version.

Introduction
In the field of Games User Research (GUR), many research methods and practices come from its parent "discipline", Human-Computer Interaction (HCI). Of the

possible tools at the disposal of games user researchers, psychophysiological data is one of the most recent or novel possibilities in the field [2,5]. It does not only open new doors for future research, but also complements the already existing qualitative and quantitative research methods applied in the field.

A general practice in GUR is to use this psychophysiological data, a quantitative measure, and use it in combination with video footage observing players, a qualitative measure, to study their interactions. Since the psychophysiological data that is gathered is nothing more than raw electric signal readings, it needs to manually be correlated to the collected video footage to extrapolate any meaning from the obtained physiological results. This manual labeling aims at answering core HCI questions, such as interaction problems, usability problems, or positive highlights of player experience. However, this process can be cumbersome, especially if a study includes a larger number of participants. The more participants, the more manual video labeling will be required.

This project is an attempt to prototype what could be a working tool to aid in the process of correlating psychophysiological signals to video footage, allowing the researchers to visualize meaningful relationships in the same view but quicker.

Related Work

Psychophysiological data can be used to assess states of video game players [1,2,4]. Moreover, from some of these measures, it is possible to establish emotional valence based on two psychophysiological measures: galvanic skin response and facial electromyography.

Galvanic Skin Response (GSR) gauges the level of emotional/psychological excitement or arousal of the participant, which is measured by two electrodes on the hands of the player. These electrodes measure the electrical current differentials existing because of the increase of sweat gland activity, possibly a consequence of excitement. However, this measure is independent in relation to the positive or negative emotional nature of the stimuli. A negative affective stimulus can originate the same level of GSR activity as a stimulus of positive affective nature. Because of this, GSR is usually used in conjunction with a second measure, like facial electromyography.

Facial Electromyography (fEMG) measures the level of movement of two distinct facial muscles, by reading the differential of electrical current that flows in these muscles when they are either contracted or relaxed. The muscles that are commonly observed are the zygomaticus major muscle on the cheek, used for smiling, and the corrugator muscle on the brow, used for frowning.

The work of Biometric Storyboards [3] is important in this field. It combines players' physiological data with the design of specific game levels, all under the same dashboard. Given a particular game level, a researcher or a level designer in the particular case of the industry can set the desirable valence thresholds (GSR and fEMG) for specific parts of the design. These desired thresholds are checked against the collected values of physiological data, at post play session. At this time, both valence curves will be displayed at the same time as in-game footage of the play session. This proves to be a valuable source for improving the designs of levels into more arousing experiences, because it is possible to visualize how particular parts of game levels are perceived by the players in terms of excitement or frustration, being compared against the designer's or

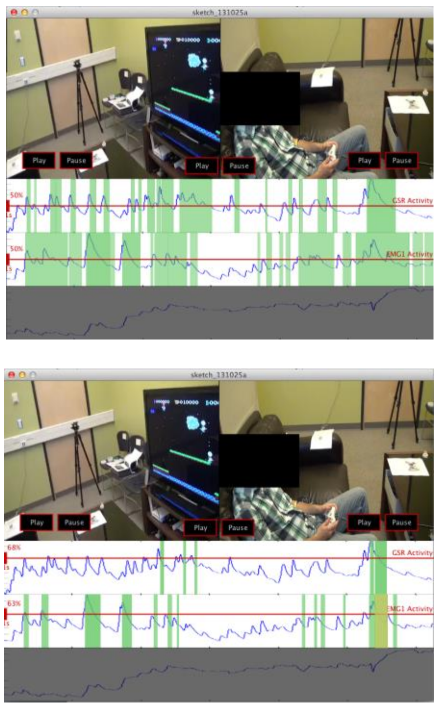

Figure 1 – Main Application Screen (top) with default filtering parameters; Filtered video selected and on playback (bottom). The participant's face was deliberately occluded to maintain anonymity.

researcher's expectations.

However, this work does not cover the video footage of the player's interaction with the game. It only uses in-game footage. Combining the two sources of physiological data, such as GSR and fEMG, is sufficient for a games user researcher to infer whether a player perceived a stimulus or event as pleasant or unpleasant, but nothing more can be extracted other than the affective nature of the stimuli. Player interaction footage can contain hidden nuggets of information that might otherwise escape from the collected physiological data, thus being another important source of relevant player experience information. Typically, a Games User Researcher will have to go back and forth in the video footage of the play session, labeling or identifying key moments, having to manually associate them with the collected physiological data, in search for meaningful results.

Prototype

As mentioned earlier, this prototype aims at providing a semi-automatic alternative for correlating play session videos with psychophysiological data of participants. Because these sources of data are temporally aligned, or should be pre-processed in such way that they respect the same temporal timeframe, it is possible to correlate physiological events to the video footage. Traditionally, this process is done manually and can take considerable time. Thus, the contribution of this prototype is then to alleviate or reduce the amount of time researchers will spend manually correlating in-game events, or in-session events to psychophysiological data, visualizing all data sources on the same application view.

The main window of the prototype (see **Figure 1**) exhibits two different areas. The first one is the video footage area, in which two videos are displayed: one for the gameplay action, and another for the player interaction. The second area, on the bottom half of the screen, displays three different psychophysiological signals, namely GSR and two channels of fEMG.

On the main screen, it is possible to play or pause the video footages displayed. These can be played at the same time, or individually. It is also possible to filter the video footage according to psychophysiological data parameters.

To enable the filtering of the video, the researcher must right-click on the graphs of the physiological measures he wants to consider (e.g., GSR Activity graph and fEMG1 Activity graph for negative affect emotional valence). Upon enabling the desired physiological data sources, the user can set two parameters:

The first parameter that can be selected and set is the physiological activity level: After processing the raw physiological data, percentile activity levels are obtained as the final result. By moving the slider bar that is present on top of a graph, the user is selecting the minimum activity level of the particular signal that he wants to look at. This updates the displayed regions of interest overlaid on the graph, as shown in **Figure 1**. The second filtering parameter that can be adjusted by the researcher is the minimum region of interest duration: By moving the slider that is attached to a slider bar, the researcher can filter the displayed regions of interest. This slider defines the minimum duration of the regions of interest whenever the activity level they relate to meets the threshold defined by the slider bar. This way, unwanted segments of short duration can be removed for a more clear analysis of the player activity.

Finally, after adjusting the filtering parameters, a desired region of interest can be clicked on, thus playing the corresponding segment of the video footages at once. This region becomes highlighted so that the user can understand which video segment is being played.

Limitations and Future Work

Some limitations are still present in this prototype. The lack of finer video controls, such as rewind or fast-forward, is not present, and which could be a valuable addition to the tool.

Additionally, there is no indication on what the current video playback time is. Future versions of this application could include this feature, by having a ball shape overlaid on the signal's graph, which would move as the video footage plays along. This way, not only would the researcher know what the current playback time is, but also how the physiological activity is changing in relation to time while the video keeps him informed of what really happened.

Finally, when considering the representation of the physiological data, no graphs are being plotted. What is being represented is the generated output graph after the raw signals have been processed into activity percentages. Since the graphs are represented by stretched images, the regions of interest displayed on top of these can have a slight offset in relation to the actual activity graph. Future iterations should replace this imagery with actual graph plotting, making the representations more accurate.

Minor limitations, out of the scope of this prototype, include latency (and freezing) of the original video data. Because of this, there is also a slight off-sync between the audio of the two videos, which can become unnerving while watching both at once. The lack of audio mute buttons should then also be considered a limitation of this prototype.

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