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# Data Synchronization in Games User Research

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**Abstract**

By overlapping information from a variety of techniques, researchers are able to gain a better overall picture of the user experience. In Games User Research (GUR) a variety of methodologies are in use ranging from qualitative approaches (e.g. interviews), quantitative approach (e.g. metrics), as well as, physiological approaches (e.g. electroencephalography (EEG)). With the combination of different techniques, synchrony of data collection becomes essential. In the presented paper, details such as sampling rate, marker placement, and time stamps are discussed.

**Author Keywords**

Games User Research (GUR); Mixed Measures; Physiological Measures; Time Stamps; Data Synchronization; Sampling Rates

**ACM Classification Keywords**

H.5.0. Information interfaces and presentation (e.g., HCI): General; G.3. Probability and Statistics: Experimental Design

**Introduction**

Games User Researchers (GUR) work with different methodologies, often involving large data sets from distinct sources recorded simultaneously. Researchers use multiple measures or mixed measures to capture

the data, which best represents the experience of the participant. Capturing data on one facet of the experience requires the synchronization between measures. Synchronizing different measures is essential for ensuring the collection of high quality data. By better understanding the measures in use, one can better understand the necessity to synchronize data for more accurate data collection. This paper discusses the use of popular research methodologies in the field of Human Computer Interaction (HCI) and the attention to detail necessary to capture clean, usable data.

### **Mixed Measures**

The hypothesis of the study guides the research team to the technique best suited to capture the data. Due to the complex environments that the user experiences when playing a video game (e.g. visual, sound elements, cognitive demands, and sociality), researchers often use a mixed measure approach. For example, in [5] researchers used a physiological techniques including Electroencephalography (EEG), Electrocardiography (ECG), Electromyography (EMG), Skin Conductance (SC), as well as, eye tracking combined with questionnaire data to understand how users experienced flow and immersion, while playing a first person shooter.

Qualitative data collection techniques (e.g. interviews, focus groups) offer the ability to capture rich data surrounding the user experience. Questionnaires are a versatile tool that allow the researchers to gather data from a wider range of participants but not at the same level of detail. In contrast, big data in the form of player interaction can be collected (e.g. collecting records of player deaths in an online game).

Physiological measures provide information about non voluntary physiological responses.

Each methodology has its strengths and a weakness; consequently some GURs find it suitable to combine multiple techniques. Combining techniques may be necessary to capture the complexity of player experience, validate other approaches to collecting user information, or allow researchers to precisely find the moment in data needed for analysis.

### *Understanding the complete picture*

If the researchers are trying to understand a user's emotional response to a game they may combine both questionnaires and ECG. For example in [6], researchers used questionnaires to understand player's through self-report and ECG to investigate physiological responses.

### *Validating Responses*

By ensuring that participants answer similarly on both the questionnaire and the physiological measures, researchers can confirm that conclusions from the physiological data are accurate. For example, by using the Facial EMG, researchers can classify the valence of a response. In [4], SC levels indicating high arousal responses with activation from the Zygomatic Major or smile muscles was used to indicate positive excitement from players during gameplay.

### *Finding the 'Sweet Spot'*

Researchers may also overlap techniques to find the moment of interest in the data set. By focusing in on a moment of the experience, researchers can collect clean, precise data free from noise which can compromise significant data. For example, researchers

studying error-related negativity, an EEG analysis technique, may use EMG to detect in combination with EEG recordings to understand and pinpoint errors during a visual recognition task [2].

### **Technical Details**

With the introduction of multiple approaches considerations must be made to correct clean, accurate, usable data. The experience of the participant is not uniform. For instance, during gameplay a player may find facets of the experience more rewarding, frustrating, or entertaining. When capturing data from different sources, researchers tailor their methodologies for the best possible results. Some considerations may include: sampling rate, marker placement, and synchronization of time stamps.

Sampling rate is the samples taken per second. Choosing the right sampling rate is essential to the study design. Sampling rates which are too low can distort data. For example, low EEG sampling rates can cause alias noise, the trade off is high sampling rates are problematic for digital storage [1,7].

To understand the user experience around a gameplay event it is important that the data all points to the same event. Although different data collection techniques may be used, it is important that they align to the same point in data.

Data set synchronization and marker placement are equally important. Although data markers in the data set may align, it is important that both correspond to the right point in data. Offsets in synchronization and marker placement can lead to non-significance in sensitive collection techniques.

For example, if you are studying an event related potential event, measurements are taken within milliseconds after the onset of a stimulus [3]. In contrast, skin conductance data maybe measured as a change in skin conductance level over minutes [1].

### **Data Collection Systems for GUR**

Integrating data from different sources is ideal for acquiring a richer more complete picture of the gameplay experience. However, the integration of different data formats is not always simple. Researchers may choose to analyze data from different the same facet of data by using individual time stamps for each data collection device. Although, commercial integration software is readily available, these solutions are not often catered to GUR. Currently, stimulus presentation software and turn-key physiological recording lab systems help researchers synchronize physiological measures complete solutions are not yet available for the specific requirements of GUR. Researchers have sought to resolve this problem by creating systems that integrate data both for research purposes, as well as for game design review.

PLATO [8] is an interface designed to visualize the data for the reviewer, which maybe a player, GUR, or game designer. The system can be used with a wide variety of games by importing the data to categories provided by the interface. After the data is imported, the system makes use of known visualization techniques from the HCI literature to display data for quick comprehension, while still linking the data to game records (e.g. screenshots). Although the system solves many problems presented to GURs, it does not integrate physiological data.

Similarly, the Biometric Storyboard [4] system integrates data for the review for GUR. However, in contrast to the PLATO system, it integrates physiological measures (Skin Conductance), video footage, as well as, commentary entered by the researcher to allow for the analysis of a video game under development. In the paper, the authors show that with the use of this tool there is a positive difference in feedback from expert designers using the system.

### **Conclusion**

Synchronizing data allows researchers to see the bigger picture clearly. Allowing for more accurate and clear analysis of data, resulting in more accurate conclusions made from the research.

### **Author Biographies**

*Rina R. Wehbe*

Rina has a B.Sc. Psychology, M.Sc. Computer Science and is currently attending University of Waterloo to complete her Ph.D. Computer Science as part of the HCI Games Group. Her work focuses on understanding user errors in games and productivity applications. She often uses a mixed measure approach combining physiological measures, with other qualitative or quantitative methodologies. Her most recent work examines the extent of which user are aware of their own errors. She is currently supervised by Dr. Lennart E. Nacke (University of Waterloo, Canada), Dr. Stephen Fairclough (Liverpool John Moores University, UK), and Dr. Edward Lank (University of Waterloo, Canada).

*Lennart E. Nacke, Ph.D.*

As the director of the HCI Games Group at the University of Waterloo Canada, Lennart supervises all

ongoing research. Lennart recently transferred from University of Ontario Institute of Technology (UOIT), where he taught courses in game design and HCI. His work is diverse and includes game design evaluation, exergames, games for health, gamification, and physiological measures for GUR.

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