Sensors at Play: A Biometric Framework for Game Developers and Game Users

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ABSTRACT

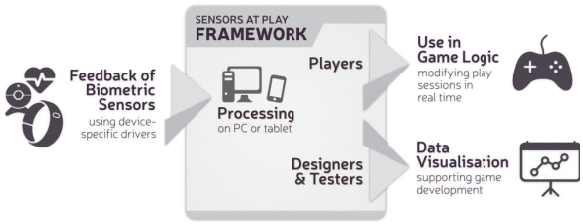
Human body sensors are on the rise, but their integration in games and game development is lagging. With many commercial sensors on the market, it should be easy to gauge player's reactions using biometrics (psychophysiology). Players will soon expect their sensors to interact with the game, similar to gym equipment. We present a simple but powerful framework to connect games to a many devices without hassle: Our framework returns two key biometric measures independent of the input device(s). This works in the lab or at a testing facility, but also at the user's home, due to the distributed nature of our software. In all, our middleware and interpretation framework can improve game research and game development, and add biofeedback to any game.

1. BACKGROUND

Biometrics (psycho-physiology) has a long and productive track record in the design of human-computer interaction. Yet we see that these methods are not systematically applied in the design, testing, interaction design or evaluation of computer games. There are a multitude of reasons for this, but cost and complexity of the equipment is among those.

New devices have started to appear on the consumer market that can track bodily state with good accuracy: It started with accelerometers (Fitbit, Fuelband, Pebble, etc) but it is rapidly expanding to heart rate and other measures (Angel, Polar H7, Intel RealSense, camera based detectors, etc).

These commodity sensor devices can be used for adding real-time biofeedback to a game, allowing the game to adjust its difficulty in response to the bodily state of the gamer. From a game programmer's point of view, commodity sensors are complicated: There is a large and increasing number of sensors to interface with. The data also has to be preprocessed, normalized and interpreted (for example, "increasing arousal") to be useful to a game.



For the game as an end product, the framework we are currently developing can be seen as middleware that bridges the gap between games and the multitude of sensors. The logic in our framework will dynamically adjust to sensors being added or removed (also covering common temporary signal lapses) and it will return an interpretation of the signals from all attached biometric signals in two easily understandable dimensions: Activeness (the amount of physical activity the player is exhibiting) and Arousal (the magnitude of the emotion the player experiencing). Optionally, the framework can relay the raw signals to your game. However, our two dimensions cover a large amount of the human bodily reactions and responding to these two will give the game realistic biofeedback while limiting the complexity for the designer.

At the same time, our solution serves game designers, game researchers and Q&A testers by providing a solid framework for integrating biometrics into your test setup. The measurement and evaluation components used in the end product setup can be distributed over multiple computers and devices in an experimental setup. This allows a researcher to measure heart rate and movement with commodity devices via a tablet, combining that data with webcam streams and extracted data from a PC, and interfacing this all to a game running on a console. Remote monitoring tools allow you to connect and monitor data streams, so many users can be tested in parallel.

2. BENEFITS

- The framework does the interface work for you.
- Interpretation provided in two easy measures. Addi-

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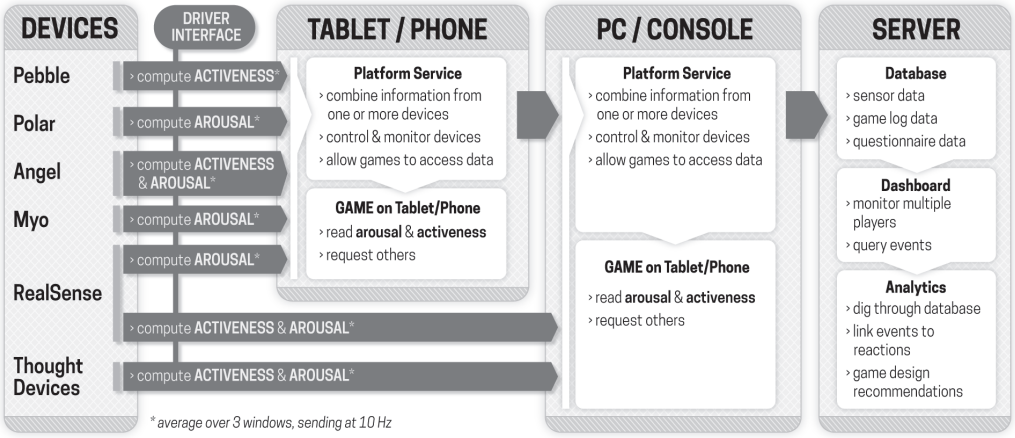

tional raw signals available on request.

- Two measures you can count on:
  - Activeness: the amount of physical movements the player makes. This measure can be deduced from an accelerometer, a heart rate sensor, muscle sensors, etc.
  - Arousal: the amount of emotion felt by the player. We cannot reliably measure valence, the type of emotion, but the strength of the emotion is a more informative measure for games.
- Stability and accuracy: Averaging and interpolation will automatically be used to deal with multiple sensors proving supporting information, and with temporary loss of signal. An accuracy measure indicates these operations.
- Highly modular design: The framework consists of number of independent modules that are queried at run-time to create a plug-and-play architecture. Each module can be developed independently, which makes programming easier and testing a breeze.
- Industry-strength components: Communication between modules and over the network is done via ZeroMQ. Signal processing is done in Numpy/Pandas and Java JMathStudio. Graphing is done with Bokeh, Kivy, and OpenGL. We use C++ for low-level drivers, Java and Python/Kivy for the phone/tablet applications, and Python for high-level monitoring and graphing.

2.1 Benefits for Development

- Networked setup, which can spread over devices, PCs and consoles.
- Video and audio recordings are integrated in the data stream.
- We are creating a simple visual dashboard which can dynamically display the raw biometrics, game log messages, the two key measures, and the video feeds from multiple players
- The same application can be used to replay stored data, with seamless movements between stored and live data.

2.2 Benefits for User deployment

- For the user the only required action is to allow the game to use the biometric input.
- Smartphone and PC based operation. The 'Sensors at Play platform' application is needs to be installed only once for each computing device.

3. CONCLUSION

Human body sensors are on the rise, but their integration in games and game development is still lagging. From simple accelerometers (FitBit) to more feature-rich devices (Angel), it has never been easier to measure the player's reactions using biometrics (psycho-physiology). Conversely, players are increasingly bringing their own biometric devices and expecting their favorite games to respond to these sensors (like gym equipment).

We will present a simple but powerful framework to connect your game to a large array of devices without having to worry about the implementation details or interpretative algorithms. Our framework returns two key measure independent of the input device(s), while additional measures can be queried if necessary. This simplifies the work for programmers (need to interface to only one library) and for designers (need to react to two generic biometric measures).

We demonstrate how the framework is used in a game. We hope to present the first results of a study that we are currently conducting. In this study, we aim to validate this framework and to evaluate how effective the two measures are for influencing the game during run-time.

The framework can not only be used after the game has been released: We developed it so that designers, researchers, and testers can easily add biometric measures during development, using the same library and API used for final deployment. Our framework will include visualization over time and aggregation of measures based on game events. Because all components are networked, the framework can collect and combine sensor information from a multitude of devices. For example: commodity heart rate sensors connected to a tablet, webcam recording and activity classification from a PC based webcam, and event logging information from a game running on a console.

In all, our middleware library and interpretation framework can help speed up game development and add biofeedback to any game. Crucially, the same framework can be used for game testing and research and to provide the player with biofeedback after the game has been released.