# AZ66

## Clues For a Game Design Validation Tool

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***Abstract* — Many researches were conducted in the affective computing field, since the precursor work of Picard in the 90's. Affective computing devices are slowly gaining acceptance in the mass market through some particular digital entertainment products. We present in this paper a prototype, resulting from the association of a physiological sensing device (EKG, GSR and temperature) with an original virtual reality game. Beyond the interactive experiment, we explain how this kind of devices i/ may be used in a game validation process and ii/ can provide to the game designers new possibilities in terms of adaptative mechanisms.**

**Keywords-component; video game, interactive experience, affective interaction, physiological sensors.**

## I. INTRODUCTION

Since the early 90's, many researches were conducted in the affective computing field, starting with the precursor work of Picard [1]. The physiological aspects of the emotion were studied, in order to determine which variables are interesting to be monitored. New hardware were built then improved: devices became smaller, more accurate and even wireless [2]. The sensing parts of these devices were also enhanced little by little. They became more discrete, lighter, until today's situation where they are fully integrated in the clothing [3,4]. Researches on signal processing also contributed to this global enhancement. New filters were applied, resulting in a better material to study. Analysis techniques and recognition mechanism are now able (under certain conditions) to recognize a basic set of emotions from a human user and all this led to numerous fields of application, from health care [5] to entertainment computing.

In this paper, we present an original virtual reality game that is built upon our homemade physiological sensing device. This article is structured as follow: the monitoring device is presented and the design of the game (or interactive experience) is described, including implementation aspects. We finally conclude on this experience and consider some potential future works.

## II. AFFECTIVE COMPUTING AND VIDEO GAMES

Using physiological sensors as interaction devices for video games is not a novel work. One of the most famous (and older?) one is the "Relax to win" game [6]. It was developed for medical purposes? It tries to compute the user's stress from signals captured from a GSR sensor in order to feed the gameplay. The aim of the game is to win a dragon race: the more the player relaxes, the faster the dragon runs. Many other examples can also be found in very different contexts, like pervasive gaming or tangible interfaces [7].

Using the physiological information to disturb the game, adapt its contents and even manipulate the player is quite interesting, in a game validation process. For example, this previous work could evolve in a validation tool, in order to test and verify that a particular gameplay interests and/or affects the player at a level it is supposed (expected) to do. It would be very useful for a game development team to be able to test some particular aspect of the gameplay, from the early stages.

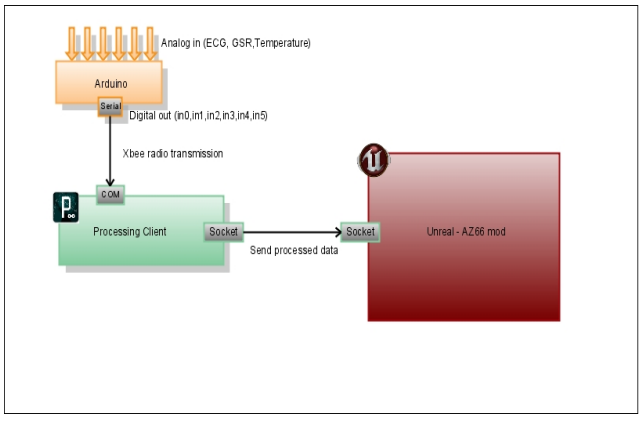


**Fig.1 : Hardware and software architecture**

## III. HARDWARE AND SOFTWARE ARCHITECTURE

The physiological monitoring apparatus was built by us [8]. Inspired from different schematics available on the web, we designed a hardware which is able to monitor the heart signal, from which is extracted the heart rate (HR). The galvanic skin

response (GSR) and the temperature (TEMP) are also monitored with dedicated sensors.

It is declined into two versions, both wireless: one is embeddable and the other not. In this experiment, we use the second one. Both are built around an Arduino card [9], which provides a microcontroller and thus, the intelligence of the apparatus.

Wireless communication is based on the ZigBee protocol. On the PC side, we use a homemade ZigBee-USB dongle which embeds a XBee module from Digi [10]. On the other side, the player's raw signals are fetched by the Arduino on which another XBee module is placed. Hence, computing things depending on the human's physiological state is made possible on the PC.

Whereas the wireless communication is not necessary in the standalone version, it still allows the system to be isolated from the main power line and thus, to be electrically safe for the user (the sensors are battery powered). The temperature sensor is placed on one user's wrist, maintained with a wristband. The two electrodes of the EKG are also located on each wrist, while the ground one is placed on the ankle. Finally, the two electrodes of the GSR sensor are placed on two user's fingers, on the same hand.

All the data are transmitted wirelessly and integrated into the game engine (Unreal Engine 3 [11]), through a socket communication (Fig. 1). This game engine is dedicated to create mods of the original FPS game "Unreal Tournament". Since AZ66 is a FPS like game taking place in a real time 3D virtual world, the engine fits perfectly our needs. Interactions remain typical (through the keyboard and the mouse) and only the monitoring hardware differs compared to a classical playing environment.

## IV. INTERACTIVE EXPERIENCE OR VIDEO GAME?

"In a close future, the player embodies a citizen, registered as AZ66. He lives in a quiet society, without any pain or violence. Responsible for the daily cleaning of his bosses' offices, he is a discrete and well disciplined employee, who never makes any trouble. One day, he is called for a medical check-up. Without any explanation, he's told to wear physiological sensors and asked to pass three tests…"

The story brings the player to the building in which the three tests will occur. Along these three tests, the player will be exposed to stressful challenges:

- Defuse the bomb.

- Shoot the targets.

- Exit the maze.

These three steps are quite usual in a FPS game. But the fact that the biosignals are implied in the behavior of the game will influence the player's behavior, in real time.

His/her physiological states, monitored through the specific hardware, are taken into account from different manners. In our prototype, the game design is done in order to react and amplify the psycho-physiological states of the player.

First, a high HR triggers a visual perturbation (blur) and make the player unable to see the virtual scene and thus, to complete the task. Depending on his/her relative heart rate (compared to the one recorded before the beginning of the first challenge), the blur applied on the screen is more or less important, avoiding (or not) a good sight of the virtual scene.

In the same way, the more the level of stress is high, the more the disturbing sound effects are audible. Factory sounds (very metallic and piercing) and noises are increasing with the player's HR. The player can also ear a heart beat (whose rhythm is correlated with his/her own), that increases his/her presence in the game and emphasizes the existence of the sensors.

Second, the player's reaction to the audio stimuli is evaluated. If a significant increase in the GSR signal is detected just after a particular stimulus (loud sound), a visual feedback is applied, once again, in order to slow down his/her progression. The visual feedback consists in whitening everything (the same effect than gazing at the sun). After this dazzle, the screen goes back very slowly to its initial state as the real GSR signal does (Fig.3).

Third, the temperature is monitored and a detected increase of this signal makes the character have some chaotic behavior: shaking, slowing down, having spasmodic movements.

One of the originality of this prototype resides in the fact that the player thinks that he/she has the control on the game, whereas not (always). Indeed, depending on the test, the player can change or not the end of the game by his/her actions. The game makes him/her believe that he/she can succeed, for example, to defuse the bomb (encouraging the player, giving him/her a lot of information about the method or procedure to apply) whereas he/she can not.

It is very interesting to observe how the players react when contradictory information are given. This purposely provoked misunderstanding is suitable for stress or emotion manipulation and thus improves the immersion and the experience of the player.

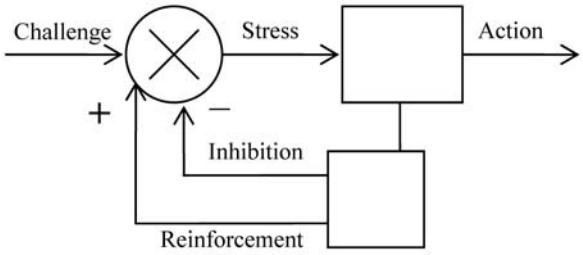


**Fig.2 : Positive or negative feedback model**

## V. DISCUSSION

As we explained it above, this combination between some physiological sensors and a video game allows the game designer to propose richer interactions.

**Fig.3 : The 3 possible feedbacks, depending on the HR level ((a)Low, (b)Average, (c)High) from the same point of view.**

A generic scheme can be used to model these phenomena (Fig.2). The sensors act as a biofeedback loop. The level of stress inputs the system and, according to the game designer's choices, the system outputs a positive or a negative feedback to the player. This feedback is supposed to encourage (positive loop) or inhibit (negative loop) the input signal.

For instance, the game designer may want to increase the level of stress of the player, by raising the number of aggressive sound or enemies (positive loop). At the opposite, a growing level of stress may be unwanted, so the system will decide to cool down the atmosphere or lower the level of difficulty (negative loop).

Of course, this mechanism can be (game) level dependant or not. The game designer may want to make the reaction of the system evolve, depending on the situation of the player in the game narration: the different steps of a narration may have more or less affinity with an adaptative system.

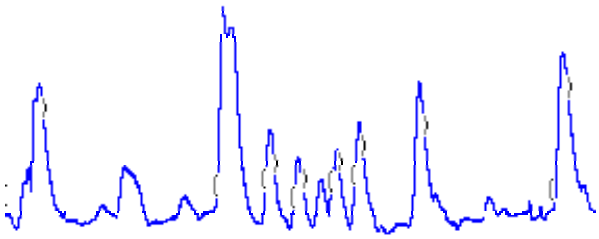

**Fig.4 : A typical GSR signal, with a lot of startle responses.**

Other possibilities exist by introducing a reference and a comparator. A lot of researches in the video game field deals with the concept of flow. One of the major difficulties for a game designer is to tune his/her application so that the player remains in the flow, i.e. challenges must be adapted to the player and his/her skills: neither too difficult (withdrawal) nor too easy (boring).

Thanks to the physiological sensors, the system can extract objective data about the player's physical state and, to some extend, about his/her psychological state. The player's presence can be evaluated taking into account these signals. The flow may be the reference and then the game engine always tries to reach this reference by adding or cancelling difficulties or events, and checking the effects with the signals sensed.

This interactive scenario management system provides a real opportunity for the player to know different sequences of events or difficulties each time he plays the game. Remaining calm or being stressed result in different modulation of the events, and thus provide different experiences.

From the developer point of view, this mechanism is a better solution than scripted events or complex artificial intelligence mechanism. The adaptative rules are based on the real feelings of the player and not to his/her behaviour in the virtual world.

## VI. CONCLUSION

We have presented AZ66, an interactive application which reacts in real time to the physiological states of the player.

Beyond the rich interaction provided by the dynamic adaptation of the virtual environment in this prototype, we expect to design a game validation tool. It will allow the game development team, on the one hand, to compare the effective effects of a chosen gameplay (or a narrative aspect) with the expected ones and, on the other hand, to propose brand new kind of embodied interactions, based on a regulated (or not) biofeedback loop.

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