How a mobile platform for emotion identification supports designing affective games

Grzegorz J. Nalepa
AGH University of Science and Technology
al. Mickiewicza 30, 30-059 Krakow, Poland
Email: gjn@agh.edu.pl

Barbara Giżycka
AGH University of Science and Technology
al. Mickiewicza 30, 30-059 Krakow, Poland
Email: bgizycka@agh.edu.pl

***Abstract*—Afective computing is a multidisciplinary area of research regarding modeling, identification, and synthesis of emotions using computer-based methods. Affective gaming is dedicated specifically to developing games that use the information regarding player's emotional condition. Such games focus on the emotional dimension of gaming experience, to provide greater player engagement. In this short paper we give an overview of our recent works aimed at developing a mobile software platform for emotion identification using wearable devices. Furthermore, we have been working on the integration of this approach with the design and development of affective games.**

I. Introduction

In this paper we report on recent results presented in the *Future Generation Computing Systems* [1], and relate it to our most recent follow up work on applications to computer games presented at the *IEEE GEM* conference in August 2018 [2].

We believe that information regarding the affective condition of a user can lead to a better understanding of interactions of users with machines. This is one of the applications of Affective Computing (AfC), that was originally introduced in [3]. AfC builds on the assumption that emotions are both physical and cognitive, and can be modeled using low-level physiological data, such as heart rate (HR) or galvanic skin response (GSR). Numerous problems that arise regard specific measurment hardware for these signals, which should be both accessible and unobtrusive, as well as appropriate software – to handle the collected data. Wearable devices, such a wristbands, seem like a promising solution for this matter. In our research we have been working towards developing computational models of emotions, that could be used based on the measurement data from wearable devices. We envisage several uses of such models, including affective gaming.

Emotional layer of gaming experience has brought attention of many research fields [4]–[6]. Data of player's emotional state (derived from her behavior on one or more levels, from physiological to some general behavior metrics) can be used to develop systems comprising of affect models. Affective gaming, stemming directly from a more global account – affective computing (AfC), applies precisely this approach.

In the next two sections we describe our recent works in these two areas, focusing on these two keywork papers.

II. Research on the AfCAI Platform

Our prelimary proposal for combining affective computing with context-aware systems for ambient intelligence applications (so-called *AfCAI* proposal) was presented in the first *AfCAI* workshop (see https://www.affcai.eu). It was based on the use of wearable devices as sources of affective physiological data. This data could be used to exend the notion of context in context-based reasoning [7]. We also developed new software called *Bandreader* for supporting our experimental procedures using a range of wearables [8].

The synthesis of this stage of work can be found in our recent paper [1] in *FGCS*, where we elaborate on detection of affective states, their proper identification and interpretation with use of wearable and mobile devices. We proposes a data acquisition layer based on wearables to gather physiological data, and we integrate it with mobile context-aware framework.

Our solution extends the platform we developed for building mobile context-aware systems [7]. The architecture of this extended platform is presented in Fig. 1. It is an extension of standard Model-View-Controller software architectural pattern that includes context and adaptability as a part of the model. The *adaptable model* layer of the architecture is responsible for discovery and adaptation to user long-term preferences and habits (profiles), but also should provide mechanisms allowing to react on dynamically changing environmental conditions. The *context-based controller* provides mechanisms for context-based mediation between the user and the system that allows the system to resolve vagueness and incompleteness of background data. We extended this basic architecture with two components marked red in Fig. 1: 1) Physiological context provider plugin, responsible for obtaining heart rate, GSR and possibly other data from wearable sensors, and 2) Emotion detection and recognition module, which objective is the discovery of correlations between context and user emotional state. Our solution offers a non-intrusive measurement of affective thanks to the use of wearable devices, such as wristbands. As such, it is suitable for gaming environments.

III. Towards the Design of Affective Games

Our first works in the area of applications of AfC to gaming were described in [9]. We assumed that a change in the affective condition of a player can be detected based of the monitoring of physiological signals following the James-Lange

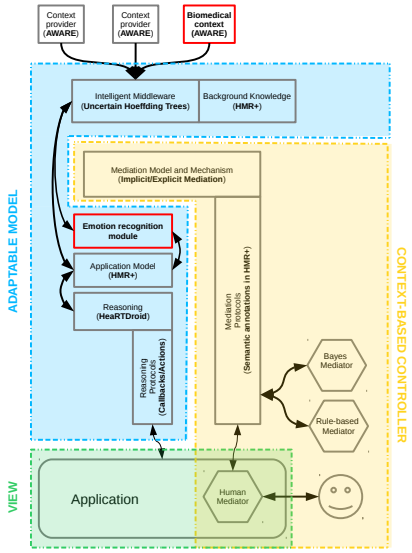

Fig. 1. Our architecture extended with emotion recognition and processing [1]

theory of emotions [10]. We build on the idea of game design patterns [11], which originate in the repetitive nature of game mechanics. We identified a preliminary set of patterns that can be considered affective. Then we demonstrated how these patterns can be used in a design of a scroll-runner game.

Affective games comprise various techniques and tools, which highlight their distinction from the regular kinds of games. We observed that they also require a thoroughly different design approach. To address this challenge, in our most recent work ath *IEEE GEM* [2] we formulated a framework based on game design patterns, more specifically – affective ones. The considered patterns integrate design strategies with measuring player's emotional reactions.

The main contribuition is the proposal of the *Affective Game Design Patterns Framework*. We build on the above mentioned concept of game design patterns introduced by Björk and Holopainen [11]. Patterns form an intricate web of interrelations, and can be abstracted from different levels of interaction with the game. Furthemore, in [12] we built on this idea and discussed the application of our approach to build games with the so-called affective loop.

Our account (Fig. 2) is built on premises: 1) One can infer about their affective state based on physiological data on e.g. HR and GSR. 2) This data may be used to develop both models of affect for in-game agents and player affect, 3) By applying affective game design patterns game developers can use knowledge on the described gaming situation early in the design phase to provide affectively adaptive game world.

To evaluate our approach, four series of experiments have taken place. In [9], where we present our approach and explain our first experimental game designed with affective patterns in mind. The findings and observations from all of conducted studies allowed us to critically evaluate several measurement devices in the light of afffective computing purposes. We also confirmed reliability of our custom mobile application for data acquisition from wearable devices [8].

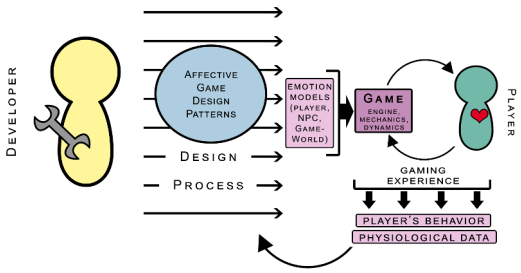

Fig. 2. Affective Game Design Patterns Framework [2]

IV. Conclusion and Future Works

We provided a general overview of our recent works on the intersection of affective computing and video games. Our ultimate goal is to provide a unified affective game design framework. As a foundation, we suggest the use of affective game design patterns, which are a convenient design tool that realizes the affective loop. Currently, we examine the possibilities brought by Unity API delivered for BITalino (http://bitalino.com) we use and experiment with our first affectively adaptive game prototypes. As for our future plans, we will aim at identifying correlations between affective game events, evoked by affective design patterns, and physiological reactions of the player.

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