Emotions Detection on an Ambient Intelligent System Using Wearable Devices

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Abstract. In this paper we present an Ambient Intelligent System, the iGenda, and the integration of a wearable device. The aim is to detect emotional states through the wearable device and ultimately represent and manage the social emotion of a group of entities. The advantage of this action is that its usability is in line with retirement homes and similar places, where the community is extended and an harmonious environment is imperative. The iGenda serves has the visual interface and the information centre, receiving the information from the wearable device and managing the community emotion by sending information to the care-receivers, caregivers, or changing home parameters (like music or lighting) to achieve an specific emotion (such as calm or excitement). Thus the goal is to provide an affective system that directly interacts with humans by discreetly improving their lifestyle.

Keywords: Aging, Emotion, Simulation, Wearables

1 Introduction

Ambient Assisted Living (AAL) is an booming area where a large number of projects are being developed with the aim of providing assistance to elderly and disabled people [1,2,3]. What we can observe is that most of them have as a goal to be simple and provide the least interaction with the users as possible. But a common issue that they possess is that they rely solely on automatisms and static user profiles. While they are effective to a certain degree (simple tasks and basic likes) they do not encompass punctual changes that are part of the complex human states (like boredom), which forces changes to the profile [4].

These changes are usually associated to certain emotional states [4,5,6] that affect the human procedures, and asking every time the user for its consent to every action/decision defeats the purpose of being discrete and ubiquitous [6].

A solution would be the adoption of an adaptive system that is able to perceive these emotional changes and adjust to them. Furthermore, with sufficient information, emotional profiles could be created in order to mimic the user common response and pre-emptively use this information to respond to decisions.

They way that humans perceive the world influences their emotional state and that has a repercussion on the physical level. While most can hide facial expressions and body movements (like hiding a state of surprise) there are low-level signals that the human body sends inadvertently like skin/muscle tensioning, pupil dilatation and micro-movements. These most of these signals have a corresponding bio-electrical impulse, thus they can be captured by sensors.

We propose the usage of a wearable device in form of a wristband, named *Emotional Smart Wristband* (ESW) that feed information to the iGenda in order to schedule new tasks according the emotional status.

The paper is structure as follows: section 2 presents the ESW architecture, the emotional model and the virtual actor concept; section 3 presents the conclusion and future developments.

2 Emotional Smart Wristband

The ESW monitors the Galvanic Skin Response and the Photoplethysmogram, processes that information locally and sends that information to other systems like the iGenda [7,8,9]. The platform that supports the ESW ontology is able to receive the information of multiple ESW's and process them individually or in group. The group emotion detection is very useful to determine the general emotion status of an environment that is composed of multiple people, like an nursing home. In the AAL concept the individual is the most important factor in the system, but that is applicable only when there is only one individual in a smart home; when we consider multiple individuals we find that the best way to maintain an harmonious ambient is when most of the people tend to an overall emotion (considering varying degrees).

For instance, it is well known that there is typically one or a few more leaders in elderly communities [10]. One issue with these leaders (specially in older adults) is that they establish the likability of certain activities and the rest of the group follows (even if they are internally in disagreement). This tends to result in a very biased set of activities that the leader enjoy and the rest tolerate. By using the ESW the users can respond unbiased of what their feelings are towards an activity. Tracking the community responses results in the overall likeness and in the social aspect identify if the leader is a good one or not.

2.1 Architecture

The ESW platform is composed of agents that calculate the group emotion (or Social Emotion) of the participants, through the Social Emotion Agent (SEtA) and resorting to machine learning techniques and makes it available for consumption [11,12]. The voltage outputted from the sensors is captured locally (in the wristband) and pre-processed there, thus the information fed to the agents is already a high-level one. Additionally, the multi-agent system has dedicated agents that grab that information and verify against the adopted models to extract the current emotion, joining it to the rest of the agents community that represent other users. The overarching result is the availability of the immediate emotion of each user and the global emotion of all users and the emotional trends and evolution. The trend of the group emotion is important as it is easier to find the culprits of the emotional changes.

For instance, consider a bar, it contains a group of friends and has music playing. Now consider that some of these friends have different musical tastes. If a music is playing that is enjoyable to 90% of the group we are able to notice a emotional progression towards "satisfied", while if it is the opposite (90% dislikes) we can observe movement in the opposite direction. One of the possible aim of this analysis is obtaining a playlist that is enjoyable to most of the group with a specific alignment of songs that cater to each individual like. This specificity is used to avoid reaching a tension point where one or more person has reached a saturation point and refuses any further change or abandons the environment.

The task of the iGenda is to consume this information a use its scheduling feature to change the events of each participant, based on his/her profile, to achieve a specific emotion, thus guiding the group to a common emotional state. The emotional states are measured and placed in the PAD [13,14] model, outputting a representation of the emotional state, easing the task of the iGenda on choosing new events. We have adopted the PAD model due to the simplicity and the datasets available. Furthermore, we are able to project the information captured into a 3D space, which facilitates the way the information is perceived.

2.2 The PAD model

The model seen in Figure 1 is a granular visual representation of the PAD model where the *Valence* replaces the *Pleasure* as in the psychological area is more representative and has a larger range of values [15]. The model has 12 subquadrants that are 30 degrees from each other. The emotion is represented by the vector $\vec{E}(Ag) = [Arousal, Valence]$ and the representation of emotions uses polar coordinates, constituted by the angle and the magnitude of the vector.

We use a fuzzy logic process that transforms quantitative values to qualitative values that are able to be placed in the model showed in Figure 1. Thereon, a neural network is trained using the DEAPdataset [3] as to achieve a real-world result from real humans. The correlation between the data captured and the dataset is established in the neural network meaning that each processed electrical input can be translated into an emotion.

2.3 Virtual Actors

A new development is the inclusion of virtual actors in the system that emulate the real participants. This feature aims to enhance of the decision-making process of the system, detecting in advance the possible emotional states and preparing changes to the participants surrounding environment to accommodate these

[3] http://www.eecs.qmul.ac.uk/mmv/datasets/deap/

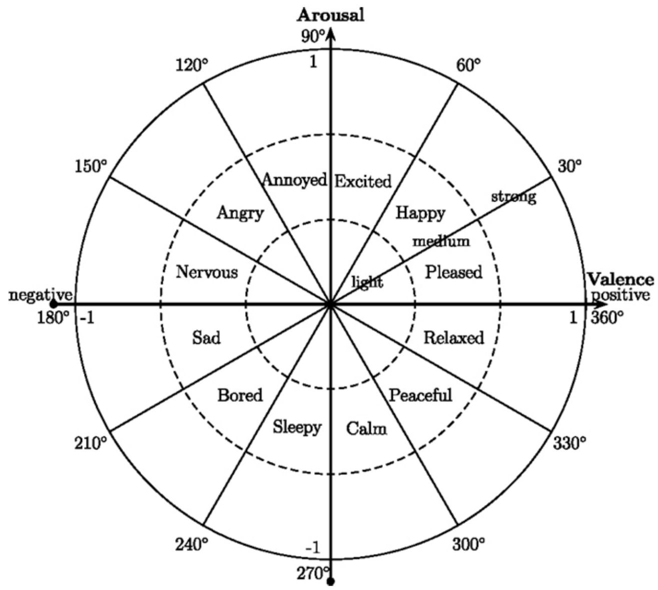

Fig. 1. Emotions circle [16].

changes and proactively shift them to other states if the expected state is not desirable [17,18].

In this case specifically, when related to the elderly there is little margin for experimentation, as they have a large number of conditionings and are very fragile. The emotional profile helps to preview the possible reactions to changes on their daily routines and their daily emotion when performing specific activities. The group emotion is very useful in environments like nursing homes and residential elderly communities. In this type of environment is very common to perform group activities and generate teams of elderly people. One common issue is the user verbal response and the real feeling, e.g., a person may tell that they are enjoying an activity but that be only a "kind" response due to peer pressure or to social engagement with the caregivers [19,20]. If the caregiver is able to receive unbiased information about how one feels about an activity it is easier to schedule similar or different activities or group that person with other people [21].

Another benefit from using virtual actors is the possibility of introducing Immersive Virtual Environments (IVE). In this specific case, the IVE's would be used to project the environments that the users reside and simulate all of the possible components, meaning that every sensor/actuator is mapped as an agent and has agency, thus it is able to directly interact with the human agents. This forwards our research by having an safe environment were there is the ability of testing multiple outcomes of real interactions in fractions of seconds and project the optimal actions to achieve a certain outcome.

3 Conclusions

The main goal of this project is to create cohesive environments in which the users are happy and feel accomplished. This is an arduous task as people is composed of individuals that most of the time are very different to the rest. Furthermore, there are several different applications to the ESW ecosystem apart from the healthcare area, like: crowd control, visual interfaces management, stress and fatigue monitoring, virtual environments societies, among others.

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