Neurocomputing xx (xxxx) xxxx–xxxx

Contents lists available at ScienceDirect

Neurocomputing

journal homepage: www.elsevier.com/locate/neucom

Influencing over people with a social emotional model

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A R T I C L E I N F O

Keywords:
Multi-agent systems
Neural networks
Emotional software agents

A B S T R A C T

This paper presents an approach of a social emotional model, which allows to extract the social emotion of a group of intelligent entities. The emotional model *PAD* allows to represent the emotion of an intelligent entity in 3-D space, allowing the representation of different emotional states. The social emotional model presented in this paper uses individual emotions of each one of the entities, which are represented in the emotional space *PAD*. Using a social emotional model within intelligent entities allows the creation of more real simulations, in which emotional states can influence decision-making. The result of this social emotional mode is represented by a series of examples, which are intended to represent a number of situations in which the emotions of each individual modify the emotion of the group. Moreover, the paper introduces an example which employs the proposed model in order to learn and predict future actions trying to influence in the social emotion of a group of people.

1. Introduction

In the 80s decade, Human–Computer Interaction (HCI) appeared as a new field giving access to the new digital technologies and converting all the people in potential users without any knowledge about computers. During last decades, HCI has involved information interchange between people and computers using some kind of dialogue, like programming languages and information interchange platforms. These platforms have been included from input devices such as keyboards and optical mouses to output devices as the own computer screens.

Lastly, cognitive psychology integration within the HCI field leads to adopt new forms of information processing and to better understand how people communicate with the devices. Nevertheless, in spite of the accessibility solutions presented by HCIs, user interfaces were very limited. As a result, the discipline has adopted other research subjects focused in usability, ergonomics trying to build new interfaces and allowing a more natural interaction between humans and machines.

These research subjects have made to appear new interaction paradigms created by the mobile computing, portable and ubiquitous. They have incorporated devices to communicate directly with the physical world such as movement and gestures capture through the *Kinect* [1] and even user biosignals capture through the *MYO* and *Emotiv* devices [2,3]. The idea is that machines will not only receive orders from users but also they will perceive their emotional states or behaviors using all this information to execute the different actions [4,5].

The information increase generated by the new ways of interaction has made to appear the need of using other computational toolkits to analyze and process information to benefit users. Artificial Intelligence tools such as pattern recognition ones, machine learning, and multi-agent systems (MAS) allow the development of this kind of complex tasks, creating adaptive environments to human needs to improve his welfare and life quality.

Human beings manage themselves in different environments, either in the working place, at home or in public places. At each one of these places we perceive a wide range of stimuli that interfere in our commodity levels modifying our emotional levels. For instance, the high levels of noise or the temperature conditions may produce stress situations. Before each one of these stimuli, humans answer by varying their face gestures, body or bio-electrical ones. These variations in our emotional states could be used as information useful for machines. Nevertheless, it is needed that the machines will have the capability of interpreting or recognizing such variations. This is the reason for implementing emotional models to represent the different emotions.

Emotional models such as *OCC* [6] presented by *Ortony, Clore & Collins* and the *PAD* model [7] are the most used ones to detect or simulate emotional states. Nevertheless, these models do not allow the

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http://dx.doi.org/10.1016/j.neucom.2016.03.107
Received 15 November 2015; Received in revised form 26 February 2016; Accepted 22 March 2016
Available online xxxx
0925-2312/

execution of intelligent decisions based on the emotional state perception. Between these toolkits, we can find MAS, which are able to modify their behavior based on the emotional state perception. This way it is obtained that the agent being part of the MAS contains an emotional model which is able to interpret and/or emulate different emotional states. To detect emotional states, it is needed to include pattern recognition algorithms, automatic learning contributing to the decision making in order to execute an action. For instance, if an agent detects that the user presents an emotional state of sadness, it is able to counter that emotional state by executing actions trying to modify it. This way a clean and transparent human–machine interaction is obtained. However, this situation is only valid for a lonely entity inside the environment. The incorporation of more entities inside the environment (multiple emotions) is not contemplated by current emotional models.

The goal of this work is to give an approach to a social emotional model including multiple emotions between humans and agents. Our model uses as base the *PAD* emotional model to represent the social emotion of a group. Moreover, the paper introduces a case study where the social emotion is used for predicting next actions in order to improve the emotional state of a group of people. Concretely, the case study has been developed simulating a bar, where there is a DJ in charge of playing music and a specific number of persons listening to that music. The main goal of the DJ is to play the music making all the people within the bar mostly as happy as possible. This proposed application engages *Ambient Intelligence* (*AmI*) and *Ubiquitous Computing* (*UC*) involving humans and helping to improve their living conditions. This kind of applications involves the interaction between humans and agents, being these responsible for a continuous monitoring of the different emotional states. This is mainly due to the influence that the music can have on people's moods. This influence has already been studied [8] analyzing how different musical genres can influence people's emotions. Existing works take into account the social and cultural importance of music which influences positively or negatively on people behavior [9–11].

The rest of the paper is structured as follows: Section 2 introduces related work; Section 3 presents the social emotional model; Section 4 describes the case study introducing some illustrative situations and analyzing the obtained results; finally, Section 5 includes some conclusions.

2. Previous approaches

This section presents an introduction to the emotional models *OCC* and *PAD*. The goal is to give a general view of both emotional models.

2.1. Ortony, Clore & Collins: OCC

The *OCC* model designed by Ortony, Clore & Collins is a model frequently used in applications where an emotional state can be detected or simulated. This has allowed to create applications to emulate emotions in virtual humans [12] and to create agents reacting to stress situations [13].

The *OCC* model specifies 22 emotional categories, which are divided into five processes: (1) the classification of the events, the action or the found object, (2) the quantification of the affected emotions intensity, (3) the interaction between the just generated emotion with the existing ones, (4) the cartography of the emotional state of one emotional expression and (5) the one expressed by the emotional state [14]. These processes define the whole system, where the emotional states represent the way of perceiving our environment (objects, persons, and places) and, at the same time, influencing our behavior positively or negatively [15]. However, the *OCC* model utilization presents one complication due mainly to this high dimensionality.

2.2. PAD model

The *PAD* [16] is a simplified model of the *OCC* model, since the *OCC* model represents the emotion using eleven dimensions whilst the *PAD* only uses three. This reduction of dimensionality allows to do mathematical operations faster and to represent the emotion as a vector in the $\mathbb{R}^3$ space. In this representation, the values that compose the emotion are usually normalized in the range $[-1, 1]$, and correspond to the three components conforming the emotional model (*Pleasure, Arousal*, and *Dominance*). Each one of these components allow to influence over the emotional state of an individual in a positive or negative way. This influence evaluates the emotional predisposition of such individual, modifying in this way his emotional state. The Pleasure–Displeasure Scale measures how pleasant an emotion may be. For instance both anger and fear are unpleasant emotions, and score high on the displeasure scale. However joy is a pleasant emotion. This dimension is usually limited to 16 specific values [17, pp. 39–53]. The Arousal–Nonarousal Scale measures the intensity of the emotion. For instance while both anger and rage are unpleasant emotions, rage has a higher intensity or a higher arousal state. However boredom, which is also an unpleasant state, has a low arousal value. This scale is usually restricted to 9 specific values [17, pp. 39–53]. The Dominance–Submissiveness Scale represents the controlling and dominant nature of the emotion. For instance while both fear and anger are unpleasant emotions, anger is a dominant emotion, while fear is a submissive emotion.

As have been presented above, the existing emotional models are thought to detect and/or simulate human emotions for a lonely entity. That is, it is not taken into account the possibility of having multiple emotions inside a heterogeneous group of entities, where each one of such entities have the capability of detecting and/or emulating one emotion. The need of detecting the emotion of a heterogeneous group of entities can be reflected in different applications that could be obtained. With the appearance of different smart devices, ubiquitous computation and ambient intelligent, emotional states turn into valuable information, allowing to develop applications that help to improve the human being life quality. Therefore, it is needed to create a new model that allows to detect the emotion of a group.

3. Social emotional model based on the PAD model

This section proposes a model of social emotion based on the *PAD* emotional model. This model will represent the social emotion of a heterogeneous group of entities capable of expressing and/or communicate emotions. To define a model of social emotion, it is necessary first to define the representation of an emotional state of an agent on the *PAD* model. The emotion of an agent ag_i is defined as a vector in a space $\mathbb{R}^3$, represented by three components that make up the *PAD* emotional model: *P=Pleasure, A=Arousal* and *D=Dominance*. Each one of these elements allow to represent the emotion of each agent ag_i. The variation of each component allows to modify the emotional state of the agent:

$$\overrightarrow{E}(ag_i) = (P_i, A_i, D_i) \tag{1}$$

A first approach to a social emotion representation of a group of n agents $Ag = \{ag_1, ag_2, \ldots, ag_n\}$ is obtained by averaging their P, A, D values (Eq. (2)). This average will enable us to determine where the central emotion (CE) of this group of agents and be visualized in the *PAD* space:

$$\overline{P} = \frac{\sum_{i=1}^{n} P_i}{n}, \quad \overline{A} = \frac{\sum_{i=1}^{n} A_i}{n}, \quad \overline{D} = \frac{\sum_{i=1}^{n} D_i}{n} \tag{2}$$

The final result is a vector in the space $\mathbb{R}^3$ which is the core emotion or $\overrightarrow{CE}(Ag)$ of a group of agents: