Detecting Social Emotions with a NAO robot

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Abstract. This article aims to give an approach of a dynamic and emotional propagation, which allows to calculate the propagation of the emotion of a group of humans and/or intelligent entities. The dynamic model is based on the *Newton laws* in order to calculate the emotional attraction among them. To obtain the emotions we use a *NAO* robot as a tool to move around of a real environment for interacting with the humans. The robot obtains the emotions through image processing. Moreover, the robot can start a dialogue game with humans in order to estimate the personality of a new individual.

1 Introduction

Human beings manage themselves in different environments, either in the working place, at home or in public places. In each of these places the human interacts with other human beings. In this interaction the humans can express and/or perceive the emotion of the other humans that have around them. In this perception is possible that a human could be influenced by the emotion expressed for other human. In such a scenario if you could distinguish two elements that could influence the emotional contagion, the first is the level of affinity that have both individuals and the second is how empathetic is the agent that perceives the emotion. This two situations have been taken into account in our dynamic emotional model. The empathy has a correlation with the personality [1], the empathy is related with *Agreeableness*. The empathy level can be extracted using the *OCEAN* test estimating the personality of the human beings. This test allows to know which is the personality of the human and to use these values to get a personality estimation. Intelligent agents technology have emerged as a way for the development of autonomous entities in order to act on behalf of people anticipating their decision-making processes. Therefore, these artificial intelligent entities may include the capabilities and required elements that will help them to recognize and simulate emotions[2].

2 Dynamic Emotional Model

This section proposes a dynamic emotional model based on the PAD emotional model. This model will represent the emotional contagion of an heterogeneous group of entities capable of expressing and/or communicating emotions. The emotional representation of an emotional state of an agent on the PAD model, the emotion of an agent ag_i in an instant t ($\overrightarrow{E}_t(ag_i)$) is defined as a vector in $\mathbb{R}^3$. The variation of each component allows to modify the emotional state of the agent (Equation 1).

$$\overrightarrow{E}_t(ag_i) = [P_t(ag_i), A_t(ag_i), D_t(ag_i)] \quad (1)$$

The emotional dynamics described is based on the *Newton* universal attraction law. Based on this theory, we define the force that an agent ag_j makes over an agent ag_i at instant t ($\overrightarrow{F}_t(ag_i, ag_j)$) to attract or repulse it in the PAD space, that is, this force will control the emotion contagion between all the agents. (Equation 2).

$$\overrightarrow{F}_t(ag_i, ag_j) = \frac{\varepsilon(ag_i) \cdot Af_t(ag_i, ag_j)}{2^{D_t(ag_i, ag_j)}} \cdot ||\overrightarrow{E}_t(ag_i) - \overrightarrow{E}_t(ag_j)|| \quad (2)$$

$\overrightarrow{F}_t(ag_i, ag_j)$ represents the force vector, which contains all the mathematical properties of vectors as, direction and magnitude. Using these elements help us to know if the emotion of the agent ag_i is attracted by the agent ag_j. $\varepsilon(ag_i)$ represents the emphatic level of entity ag_i, and $Af_t(ag_i, ag_j)$ represents the affinity level between ag_i and ag_j at instant t. $D_t(ag_i, ag_j)$ is the physical distance between ag_i and ag_j at instant t and $\overrightarrow{E}_t(ag_i)$ represents the emotion of the ag_i at instant t and $\overrightarrow{E}_t(ag_j)$ represents the emotion of the ag_j at instant t. According with this, we define the *Emotional Attraction Forces* of agent ag_i at instant t, as as summation of all forces over agent ag_i at instant t. Using this forces and following the *Newton* laws we calculate the velocity ans finally using this velocity we calculate the new emotion. This new emotion is a PAD vector for entity ag_i at instant $t+1$ ($\overrightarrow{E}_{t+1}(ag_j)$) (Equation 3).

$$\overrightarrow{E}_{t+1}(ag_j) = \overrightarrow{E}_t(ag_j) + (\overrightarrow{v}_t(ag_i) \cdot t) \quad (3)$$

The proposed dynamic model allows us to model and represent the emotional contagion phenomena among different intelligent agents. Nevertheless, these entities typically are not alone in the environment but are part of a group of agents. Our proposal is to model not only how an agent is influenced by other agents but also how the group of agents as a whole can be emotionally affected by its components. To do this, we employ the social emotional model defined in [3]. Due to space limitations, please refer to that work for a detailed explanation of the model. Using this model, it is possible to determine the emotional distance among different groups of agents or between the same group in different instants of time. This will allow us to measure the emotional distance between the current social emotional group and a possible emotional target. Next subsection shows an application where a mobile robot implements the two models allowing the robot to estimate and represent the emotional contagion of a heterogeneous group of people and observe how the robot can influence over the social emotion of that group of people.

3 Demo

The application example has been developed in a real environment, where there is a *NAO* robot [3] in charge of interacting with humans in a room. The main goal of the proposed example is the automatic recognition of the emotional states of a group of individuals in order to enhance the wellbeing of these individuals. To do this, the robot is moving around the room and tries to interact with any detected person. The robot calculates the emotional states of the group of identified individuals and, according to the proposed model, it estimates possible emotional contagions among individuals. In order to make this process it uses different tools to communicate with its environment and to obtain the information that surrounds it:

– Speech recognition, the robot speaks with people to try to change their emotional states. Moreover, if the robot does not know the person, it estimates his personality using a dialogue game that follows the OCEAN test.
– Robot movement, the robot is continually moving around the room trying to interact and animate any individual presented in the room.
– Image processing, used to detect the emotional state of people around the room. To detect the emotional states, the robot employs the API presented in the *project oxford*[4]. This project can support the detection and evaluation of around 64 faces extracting the emotion of each one of them. We use these results in order to calculate the emotional dynamic according to the previously presented dynamic emotional model.

Figure 1 shows a simulated environment of the proposed application where we can see the NAO robot interacting with a group of three individuals.

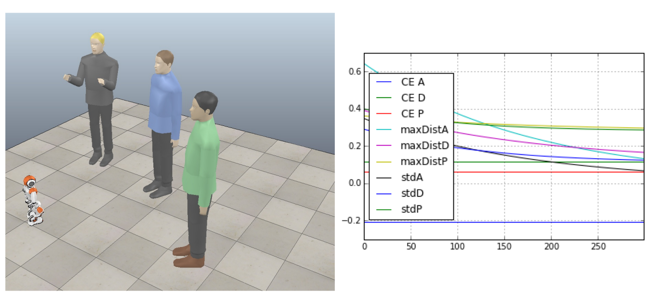

Fig. 1: Simulation of the proposed application

With this information, the robot tries to animate and stimulate people which is in the room. This stimulation actions are performed when the robot detects

[3] https://www.aldebaran.com/en
[4] https://www.projectoxford.ai/

emotional changes that lead to social emotion to move away from a target emotion (happiness, usually). This continuous sensorization of the robot environment, allows to estimate the emotional dynamics of the group and thus the robot is able to react performing different actions like telling a joke, asking what happens to them or make a funny action. One of the possible applications of this system is in nursing homes, where they have to perform tasks playful. The robot would be responsible for carrying out these tasks while analyzing emotions and modifying its actions according to the emotion of the group.[4].

4 Conclusions and future work

A new model for the calculation of dynamic emotions has been presented in this paper, giving a first approach for the emotional contagion and simulation of dynamic social emotions into a group of intelligent entities. The proposed model uses the personality of each entity and the affinity level between entities in order to calculate and represent the emotional dynamic of a group. The dynamic emotional model of a group of agents not only allows a global view of the emotional dynamic of the group, also can improve the decision making based on the attraction level between entities. The paper introduces also a demo about how to calculate, represent and use the dynamic emotional model into a real environment. The proposed application consists of a NAO mobile robot which uses the proposed emotional model to enhance its decision-making process.

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