An Interactive Multimedia Environment through Artificial Emotion

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Summary
This paper presents a system based on a general architecture [1] to build emotional agents for real-time, interactive multimodal environments. The architecture has been successfully employed in several scenarios and, in particular, in an art installation at “Arti Visive 2”, a museal exhibition held in Palazzo Ducale, Genova. We describe the emotional agent that we developed for the mobile robot in the art installation, which interacts with humans by different channels: visual, music, and “style” of movement.

Keywords: Multimodal human-robot interaction, Art and multimedia, Emotional agent, artificial emotion

1. Introduction

The main goal of our work is to explore paradigms of interaction between humans and a robot in the framework of museal exhibitions, theatre, music and art installations. In our case study presented in this paper, we have a small mobile robot on wheels as an agent capable of communicating by means of several channels, including sound and music, visual languages and its kind of movement (smooth/nervous, tailwagging, fast/slow, etc.). The agent-robot embeds a computational model of artificial emotions, which is constructed by taking advantages of the self-organization of a model of improved Kohonen's Self-Organizing Map. The robot freely tours in a museal exhibition area, as one of the visitors, a sort of medium between humans and machines living together in the exhibition area. Sensors allow him not only to avoid collisions with people surrounding him, but also to observe the artworks, the visitors, to interact with them (see figure 1). This is an example of interactive multimodal environment. Interactive multimodal environments are active spaces capable to observe users and to establish high-level communications with them by means of human gestures, movement, speech and singing. At the same time, such spaces allow users to get feedback in terms of visual media, sound and music. The software component of a multimodal environment can be partially realized as a population of communicating agents.

2. The case study: Art installation at the "Arti Visive 2" museal exhibition

We successfully employed the agent architecture in several applications. In this paper we report our experience from the interactive art installation at "Arti Visive 2", a museal exhibition held in Palazzo Ducale, Genova in October 1998.

2.1 Description of art installation

The small robot on wheels is a Pioneer 1 robotic platform by ActivMedia Inc, that we further equipped with a camera, infrared localization sensors, local audio system, and two wireless communication channels for both audio and video signals. The robot freely tours in the exhibition as one of the many people who frequent it, a sort of medium between humans and machines living together in the exhibition area. Sensors allow him not only to avoid collisions with people surrounding him, but also to observe the artworks and the visitors to interact with them. Figure 1 (right) shows the robot at work. The robot has been "dressed" with a scenography for the art installation. On the top of the dressed robot, a small camera has been installed.
Visitors can communicate with the robot in several ways. For example, they can approach it, act in front of its "eyes", follow it, ignore it, obstacle its path. The robot interprets some stimuli as positive, other as negative causing the evolution of its emotional state. As we say below, the emotional state is exhibited by means of robot's movement, music, sound, and visual media.
The robot integrates inputs from different channels. The Saphira [2] low-level software of the robot gathers information from robot's sensors every 100ms. From Saphira data, the agent computes absolute and relative positions of a human with respect to the robot, the distance and the area occupied by the human near the robot. In this art installation we also use a camera to acquire a video image stream in front of the robot, to warp it on the basis of the current emotional state. The dynamic video images warping is then projected on a video screen visible from the public.
The system can control the robot by means of both high-level behaviors (e.g., avoid obstacles, follow or escape a human), and simple movements. Movements and

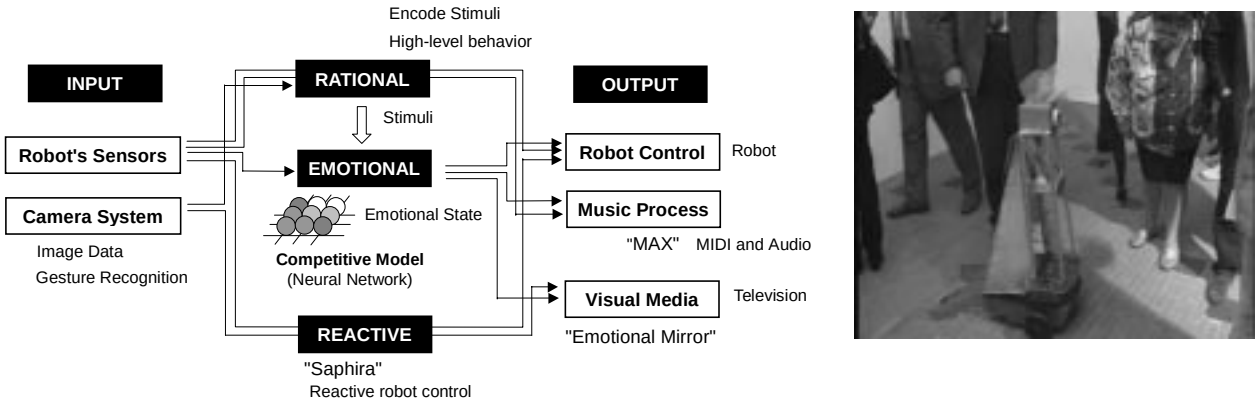

Figure 1. Overall of one-way data flow at the developed system "emotional agent" (left) and Interaction with visitors at museal exhibition "Arti Visive 2" (right)

behaviors can be modulated by parameters: in this way the robot can use also movement to exhibit its emotional state.

Music is also one of the most important ways of communication. In this system, we adopted emotional parameters to "modulate" in real-time a music score skeleton, implemented as an Opcode Max patch. The patch receives an array of emotional values, which influence in real time the music generation algorithm.

In addition, output components include the visual component based on the idea of "emotional mirror". The robot sees what it is in front of it (people's faces, artworks) warped according to its emotional state. For example, a face could appear "mirrored", distorted in a vortex or re-processed with bright colors, respectively corresponding to positive and negative emotional states. During the performance, the system shows such images on a TV screen in real-time.

2.2 The Model of Artificial Emotions

In this case study, the model of artificial emotion embedded with robotic agent consists of four basic emotions: the personality of the agent. These four states are represented by a circle divided into four areas differently colored. For simplicity, we named each state with a typical human's basic emotional condition: Happy, Angry, Melancholy, and Tranquil. The details are described in [3]

2.3 Implementation

The system for the robotic agent works under Win32s operating systems. We also adopted the Saphira software [2] developed at Stanford Research Institute, which provides a behavior-level interface to control Pioneer 1 robot movements. The robot communicates by three different radio links (digital I/O control data, video and audio signals) with the supervisor computer on which the model of artificial emotions is realized. The robot also possesses an on board audio diffusion system, connected by radio, which integrates the audio diffusion system placed in the environment. Three computers connected by an Ethernet network control various different aspects: the first contains the emotional model and control movement, the second deals with "emotional mirrors", the third generates sounds and music. The robot agent and the other applications are written in C++ (MS Visual C++).

3. Conclusion and future work

An important aspect in the developed emotional agent concerns the effectiveness of multimodal communication between the robot and humans: all the improvements mentioned above should be carefully considered from this viewpoint of integration of different modalities [4]. In particular, the role of sound and music is a strong concern in our work.

In conclusion, the emotional agent we have presented in this paper allowed us to achieve some important results. We hope that the ideas we sketched above could lead us to other important results toward a natural and effective human-machine interaction. The further consideration is to apply the emotional agent we developed for psycho-motoric rehabilitation.

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