Symbol Recognition and Artificial Emotion for Making an Autonomous Robot Attend the AAAI Conference

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Introduction

LABORIUS is a young research laboratory interested in designing autonomous systems that can assist human in real life tasks. To do so, robots require some sort of "social intelligence", giving them the ability to interact with various types of agents (humans, animals, robots and other physical agents). Our team of robots is made of six Pioneer 2 robots, three indoor and three outdoor models, with each robot equipped with 16 sonars, a compass, a gripper, a camera with a frame grabber and a Fast Track Vision System, a RF Ethernet-modem connection and a Pentium 233 MHz PC-104 onboard computer. The programming environment used is Ayllu (Werger 2000), a tool for development of behavior-based control systems for intelligent mobile robots.

Figure 1: Hercules, the Pioneer 2 robot that will attempt to attend AAAI'2000.

According to Dautenhahn (Dautenhahn 1999), three important characteristics of social robotics are that 1) agents can recognize and interact with each other and engage in social interactions as a prerequisite to developing social relationships, 2) agents can explicitly communicate with each other, and 3) agents have 'histories' and they perceive and interpret the world in terms of their own experiences. The first two characteristics have been accomplished mostly by using explicit radio communication of the position of the robots, obtained by a positioning system (GPS or radio triangulation), and by using other electronic media communication method (like infrared) (Cao, Fukunaga, & Kahng 1997). Vision is also put to contribution, for instance by using color recognition (e.g., RoboCup and (Michaud & Vu 1999)). Using vision for agent recognition and communication does not limit interaction to specific environments, and it is an ability that humans and animals have. One mechanism that we are currently developing it to make a robot capable of recognizing symbols used to identify other agents or to give indications to the robot.

Another project that we are working on is concerned with the concept of artificial emotion (Michaud *et al.* 2000), which is increasingly used in designing autonomous robotic agents. Artificial emotion has up to now been principally used in making robots respond emotionally to situations experienced in the world or to interactions with humans (Velásquez 1998; Breazeal 1998). However, they can also play an important role in solving what is called the **universal problems of adaptation** (Plutchik 1980): hierarchy, territoriality, identity and temporality. Artificial emotion can help a robot manage its own limitations in interacting with the world, interact socially with others and establish a shared meaning for interpersonal communication.

We plan to use our symbol recognition mechanism and the concept of artificial emotion to take part to the *Robot Challenge* and make a Pioneer 2 AT robot attend the AAAI Conference. The goal is to use signs to guide the robot to the registration desk, to let the robot move around in the crowd, recognize dignitaries and recharge itself whenever necessary, go to a conference room and give a short presentation, in HTML using a Web interface, about the whole experience.

Symbol Recognition

Social interaction in a heterogeneous group of robots and humans can be done in various ways: gesture, signs, speech, sounds, touch, etc. Making a robot recognize printed signs is an interesting idea because it can be a very general method for robots to communicate information to and identify each other.

Our symbol recognition technique is done in four steps: 1) image segmentation using colors, 2) robot positioning, 3) features extraction of color segments and 4) symbol identification using an artificial neural network. Image segmentation is achieved using 32 colors and commodity hardware (Bruce, Balch, & Veloso 2000). Each recognizable symbol are assumed to be contained in one segment, i.e., all the pixels of the same color representing the symbol must be connected (8 neighbors) together to avoid recombination of boundary boxes. The robot positioning phase consists of orienting the robot using the Sony Pan-Tilt-Zoom camera, and to extract black on white printed symbols in the robot's environment. Special symbols like arrows and letters are used to guide the robot to specific locations. Features extraction are rotation and scaling independent, using a centroid based method. Finally, character identification is implemented with a standard back-propagation network. The network is trained with designated symbols of different rotations, scales and noise ratios.

Software Architecture with Artificial Emotion

The fundamental objective of the robot's software architecture is to combine various properties associated with 'intelligence', like reactivity, emergence, situatedness, planning, deliberation and motivation, while still preserving their underlying principles (Michaud & Vu 1999). To summarize the approach, the architecture is based on behavior-producing modules (or behaviors) that are dynamically selected using modules that monitor specific conditions (which can be sensed or derived from internal mechanisms). The goals of the robot (e.g., going to the registration desk, schmooze, recharge, etc.) are managed using internal activation variables called motives (Michaud & Vu 1999). A behavior-producing module that is selected may or may not be used to control the robot, according to the sensory conditions it monitors and the arbitration mechanism used to coordinate the robot's behaviors. By observing how behavior-producing modules are used over time, the architecture can infer important information about the overall behavior of the robot in the environment. We believe this to be essential for the implementation of artificial emotions. The emotional capability is incorporated in the control architecture like a global background state, allowing emotions to influence and to be influenced by all of the architecture's modules.

The artificial emotions used for the task are related to temporality, i.e., they allow to take into consideration the limited duration of an individual's life. Sadness, distress and joy contributes in solving this adaptation problem. In our implementation, distress is used to detect external conflicts (like being trapped somewhere, stalling, not being able to grasp something, etc.) or internal conflicts (like the simultaneous activation of too many goals at once). Sadness and joy are used to prioritize the goals of the robots according to what is experienced in the world. These three emotions will be used to express the robot's state. The evolution of these states over time will be memorized for the robot's presentation. We also plan to use a simple interface to communicate these states, other information and requests with the outside world.

Current Status

As of the end of March, our symbol recognition approach has been validated off-line, and we still have to implement it on the robot. The architectural methodology with artificial emotion is functional, as for the charging station, and new behavior-producing modules and mechanisms (like for the Internet HTML presentation) specific to our participation to the AAAI *Robot Challenge* are under development. We do not plan to address the map navigation and elevator use skills of the challenge.

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