Fusing Autonomy and Sociability in Robots

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Abstract

Quoting some robotic examples, I will list some key issues in fusing autonomy and sociability: tools and control architecture, attention, behavior matching, embodiment, similarity, and imitation.

1 Introduction

An ideal *agent* should have a good mixture of autonomy and sociability; Autonomous enough to do things properly even without specific commands. Sociable enough to properly communicate with you and help you do arbitrary tasks. These two modes must be fused together at all levels of complexity, because the level of your request vary quickly and drastically, often intervening the ongoing task. The request level can be as low as primitve motion or as high as an entire project.

The word "autonomous" means self governing, no external control and independent. At an extreme, it can have a countermeaning to "sociable". A robotic example would be the "artificial insect robots" created by Rodney Brooks' group. They had high degrees of autonomy and could survive in realistic envrironments for a long time without human intervetion. But the robots were unable to accept task requests from humans, as opposed to more traditional less autonomous robotic systems claimed to do.

My main claim in this paper is that we should actively investigate how we can fuse autonomy and sociability in the entire spectrum of behavior complexity. Quoting some robotic examples, I will list some key issues: tools and control architecture, attention, behavior matching, embodiment, similarity, and imitation. Due to the limitation of the length of the paper, I will only list the points briefly and leave the discussions to an extended version of this paper to be published elsewhere.

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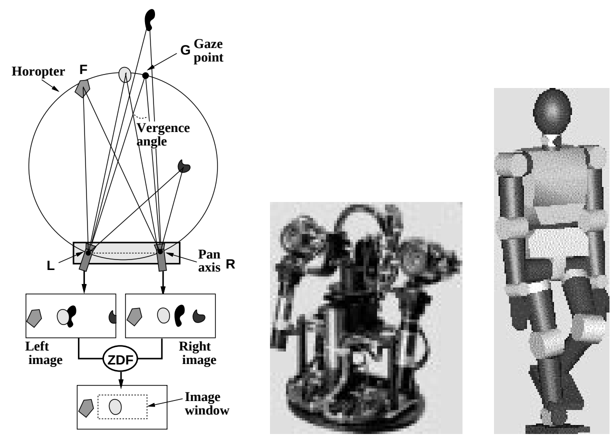

Figure 1: Tools for real world interaction. ZDF for target tracking/segmentation in a complex environment (Left). ESCHeR - The 4DOF active vision head with foveated wide angle lenses(Center). ETL-Humanoid in dynamics simulation (Right). Real humanoid is currently under construction.

2 Tools for Real World Interaction

Without media of interaction your agent will never be autonomous nor sociable. Fig.1 shows some of our tools which mediate both autonomous and social interaction through the real world.

Real time vision is very important for both autonomous/social interaction. Basic visual functions are, find, track, anticipate, and event detection. ZDF (Zero Disparity Filtering)[3] proved practical in realistic situations. This method best matches a vergence controllable camera system. Our latest vision system integrates optical flow based detection/tracking and our Extended ZDF at frame rate.

For mobility, we use several mobile robots all with cameras, a 6DOF manipulator, and a simulated humanoid. A real humanoid is currently under development. Achieving complex mobility is important for achieving high level communication, as discussed later.

3 Attention Relates Real World Events

The Learning by Watching system[1] acquires assembly task knowledge from visual observation of human performance.

The important points with this sysmtem are the following:

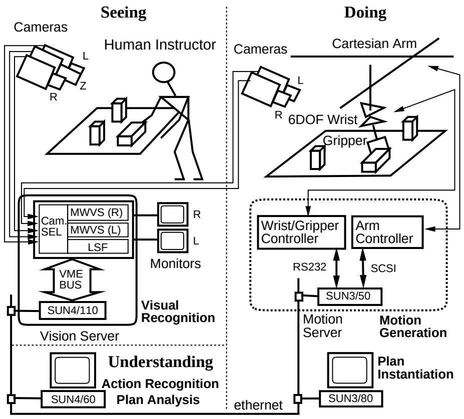

Figure 2: Learning by Watching System. The system, by observation, extracts symbolic procedure from a human performance, then re-instantiates the procedure to a different set-up and copies the task.

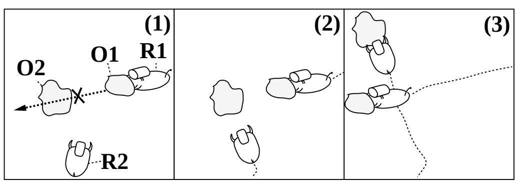

Figure 3: Unblocking Behavior. Robot R1 pushes cargo O1 and on its way there is an obstacle O2. Robot R2, by observing, predicts the collision and push O2 aside to help R1.

- Knowledge is extracted/reused in different situations (initial states and mechanisim).
- Context based controlled attention establishes the above mapping over continuous action streams.

4 Embodiment and Fusion of Autonomy/Sociability

In Cooperation by Observation[2] (Fig.3), cooperating robots try to match their behavior by actively observing each other. Merging of attention occurs here because each robot pay attention to what it is working on. Since coopearation and communication have a common structure, joint attention also supports meaningful communication, which is a widely accepted notion.

Embodiment (being situated in a body) plays an essential role. Once a robot moves to achieve its task, the movement is immediately perceived by another robot without any explicit communication, leading to an effective help by the other robot. In other words, *embodiment binds autonomy and sociability together*.

The architecture in Fig.4 fuses autonomy and sociability at a basic level. The key components are attentional modules and the behavior pattern monitor (arbitors).

5 Towards Imitating Humanoid

A humanoid robot will be a flagship for research on autonomy/sociability fusion.

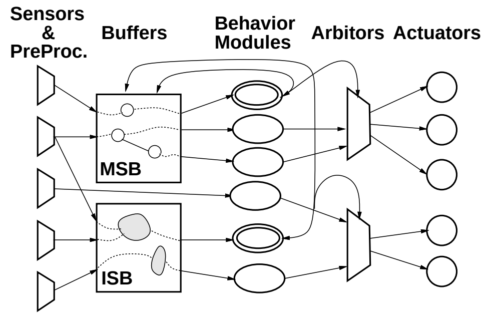

Figure 4: An Extended Behavior Architecture based on attention and dynamic action selection. Arbitors detect the behavior activation patterns (conflict, invalid, etc.) and feed signals to the attention buffers via abstract behavior modules to collect more data, memorize the current state, and change behavior coordination.

Following the Brooks' COG project, we are building our humanoid. It has legs and not fixed to the ground. This is important because it introduces highly complex interaction with the environment.

One of the central issue we are studying here is development of imitation. Imitation is achieving similarity over separate events in the real world. (This of course implies an attention process.) And it can be defined for a broad spectrum of complexity and abstraction, from a single movement to a purposeful level. We regard this as a fundamental process which fuse the physical/social interactoin through the real world. Currently we are following developmental stages proposed by J. Piaget for vision-based imitation[4]. And we believe it will lead to development of sociability, because this way we should be able to construct a system which uses its own behavioral skills to understand others, then use the result to increase your skills.

6 Conclusions

Bottomlines are that embodiment and attention binds autonomy and sociability together, and imitation is the fundamental mode of such interactions. We have basic tools and an architecture and starting to tap on the problem.

References

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