Humans as Robots

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The Problem: Human intelligence relies on a wealth of commonsense acquired from a lifetime of experience. In order to achieve the long term goals of artificial human intelligence, researchers must find ways to endow machines with this type of commonsense.

Humanoid robots can serve as a direct approach to the acquisition of this type of competence, since a sufficiently sophisticated humanoid robot would be able to experience much of the world in the same way as humans. Currently, however, humanoid robots have very limited experience with the world due to obstacles ranging from mechanical design to social constraints on the use of autonomous robots.

Figure 1: This is a picture of a person wearing the system while inspecting a toy. The backpack holds batteries and a laptop that communicates wirelessly with a computer cluster. A glasses-mounted firewire camera captures video from the person's perspective. Kinematic measurements of the dominant arm are performed by 3 Intersense devices with one worn on the wrist, another on the upper arm and the third on the torso.

Motivation: Wearable computing systems have the potential to measure a great deal of the sensory input and physical output of a person as she experiences everyday activities. Much can be learned through passive observation of these measurements. However, if we can also find ways for the wearable system to control the behavior of the person wearing the system, many learning tasks can be made easier.

Previous Work: Within the wearable computing community many researchers have worked to interpret streams of data from wearable sensors [2]. Prior work has also explored wearable computers that help a human achieve a goal, by giving the human access to instructions [3]. The research literature related to the analysis of 3rd person perspective pre-recorded video of people is vast [4].

Approach: We are designing a wearable creature that exploits a cooperative human for its own learning purposes. Essentially, the human wearing the system becomes the host for a parasitic creature that wishes to learn about the world by watching and sometimes controlling the more experienced host as she goes through common human activities in the day. By using the same sensory input as the host and co-opting the output behaviors of the host, the wearable creature serves as a top layer of control in a subsumption architecture [1]. In essence, by controlling the

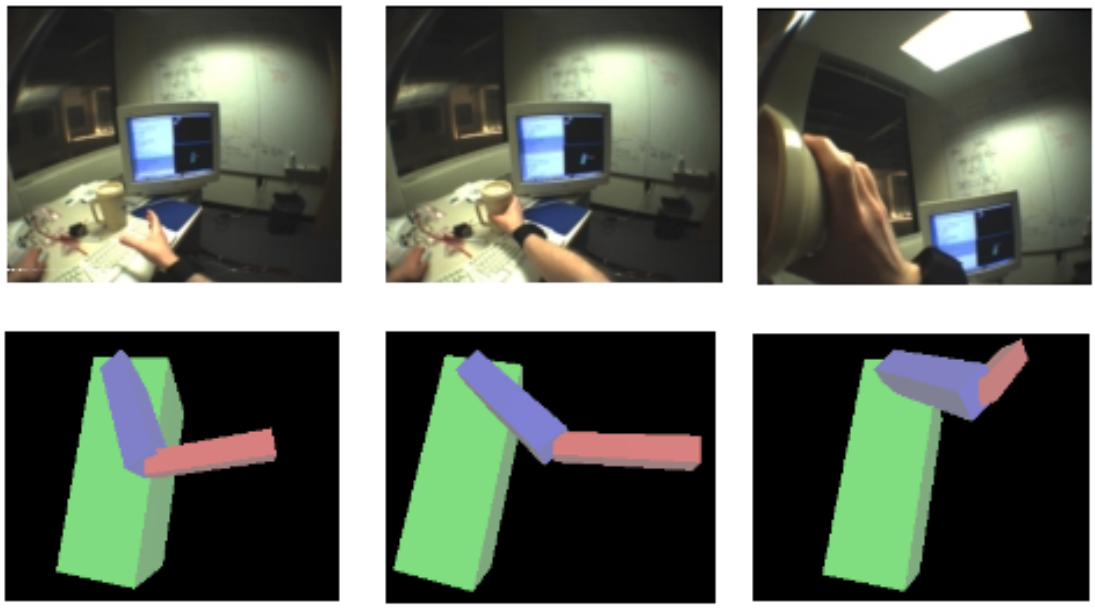

Figure 2: This figure shows three snapshots of data from a sequence of activity monitored by the system. The host reaches for a cup and drinks from it. The top row consists of images from the glasses-mounted camera. The bottom row shows depictions of the corresponding data provided by the Intersense devices, which give 9 orientation values in total.

human in an effort to learn the wearable creature changes the human into a humanoid robot.

As an initial exploration into this class of wearable applications, we are creating a wearable system that attempts to learn common-sense about everyday actions as they relate to objects and changes to the environment. As shown in figure 1, the system currently consists of a glasses-mounted camera from which the creature watches the world and 3 Intersense devices, each of which provides an absolute orientation, with which the creature measures the kinematic configuration of the host's dominant arm. The creature will also serve as a high level controller that attempts to co-opt the host's behaviors by requesting actions through headphones. For example, the creature might request that its host repeat an action by uttering, "do that again!", which with a cooperative host should help the creature segment the activity into meaningful parts. Likewise the creature might ask to see an object of interest better, thereby influencing the person to inspect the object more closely. More generally, by requesting actions the wearable creature can test hypotheses it has made about actions and their effect in the world.

Impact: We hope to develop a viable system for the acquisition of commonsense related to everyday human activities. A successful creature would be able to learn and control a set of common behaviors performed by a cooperative human and would be able to relate common action patterns to the visual appearance of objects and to observed changes in the world.

Future Work: The project described in this abstract started recently, so aside from the construction of the research platform and preliminary data processing, this abstract discusses future work.

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