Criteria for VRML-based Tools Supporting Intelligent Agents and Their Environments

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VRML can provide a basis for creating virtually embodied intelligent agents who are able to have real-time interactions within a 3-D virtual environment. VRML provides an object level description of a virtual world that is scriptable. Yet, VRML is a low level tool, requiring specialized tools for supporting agents and agent environments to be designed and built on top of VRML, extending its capabilities.

Agents within VRML obviously need bodies. Any body, at the most basic level, is a hierarchical collection of body parts and body joints. The parts may be deformable; the joints should have range of motion limitations. The current efforts to define humanoid body standards (for models of parts and joints) are being proposed by The Humanoid Animation Working Group of the VRML Consortium (Roehl 1998) and the MPEG-4 Standards Development Group (Koenen 1998). Although these standards are defining structure, the bodies lack models for basic sensory-motor control. The IMPROV system (Perlin and Goldberg 1996) provides scripting for agent motor control, including action compositing and inverse kinematics models for generating realistic VRML animations. None the less, sensation needs to be taken into account in order to create bodies for VRML agents.

Agents need to sense their environment in order to display autonomous, intelligent behavior. The VRML format provides an object-level description of a 3-D environment, allowing agent sensors to bypass low-level image processing and some of the other low-level sensory processing that is necessary in agent architectures for physical robots. This environment can support agent embodiment work that focuses on solutions to higher level problems in perception, cognition, communications, and interaction. Tools developed for supporting intelligent VRML agents and avatars need to address mechanisms for defining sensory input, particularly the senses of sight and touch. The integration of sensation with motor control and body definitions can provide a powerful tool for implementing intelligent, autonomous agents in VRML environments.

The environments supporting agent interactions need to simulate object interactions. To enable this, a reduced model of mechanical physics is needed. With a model of physical interactions, objects can display believable and consistent behaviors. A tossed ball could fly in an arc and then land on the ground. An agent who jumps up in the air will be subject to the pull of gravity, eventually pulling her back down. Likewise, once a mechanism for supporting a physics rule set is created, alternate physics can be implemented, allowing for the creation of virtual worlds subject to laws that are very different from reality.

Physical laws that effect all objects could be implemented as part of a physics server, a server that is responsible for handling the low-level mechanics of object interactions. This server would be responsible for providing laws that all objects must obey and would augment all requests for moving objects and for setting object attributes. In this way, the physics server would impose a consistent set of rules for all objects within a given world.

Agent interactions within a virtual environment are more interesting when multiple agents exist within the environment. Although VRML can currently support multiple autonomous agents within a single VRML environment, support for multiple users within the same environment is still rudimentary. Multiple user support is important for intelligent agent research. When a user within a VRML space uses an avatar within a virtual space, that user is relying on an agent to represent her self. Realistic avatar interactions require the avatars to have a sense of body and space, and be controllable by the user. We can think of avatars as intelligent puppets controlled by a puppeteer – the user, or as improvisational actors taking direction from the user. If avatars are going to provide satisfying representations of ourselves when we meet in virtual space, they need to be able to take direction from users and act out the direction accordingly. This requires the ability to connect VRML agent bodies, particularly their sensory-motor control, to higher level control systems providing intelligent behaviors and simulated cognition.

Multiple user support will require several layers of encapsulation. Not only will each user have their separate view of the shared environment, but will also need to be aware of events occurring in the world. This information will need to be distributed in a timely and efficient manner. This means that forms of data filtering will have to be considered carefully.

References

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