Technology

Using a combination of simple technologies, two artists create an installation that links mobile video robots to the Internet.

by Guy Marsden

Gallery Robots on the Internet

When I met Joel Slayton a year ago, he told me about an idea for a new installation he had been developing. He wanted to build fully autonomous, surveillant "video" balloons that would interact with people in a gallery environment. He envisioned an installation with zeppelins floating 8-10 feet above the ground with video cameras attached at eye level. Using propellers, these mobile zeppelins would be able to follow people as they moved throughout the space. With several of these surveillant balloons working in concert, Slayton wanted to create the appearance of intelligent behavior similar to that of a biological system. He also wanted to transmit video images from the balloons' viewpoints, via radio links, to monitors in or near the gallery.

Slayton is the director of the Computers in Art and Design/Research and Education (CADRE) Institute, an interdisciplinary academic and research program at San Jose State University dedicated to the exploration of computers and interactive media technology. Slayton has collaborated with various individuals and institutions to produce many large and complex performance art works that incorporate innovative forms of interactive media and technology.

Before we began the project, I advised him that it would be impractical to use a heavy battery to run the surveillance balloons all day. The balloon size required to loft the battery would be too large to fit in the gallery. I suggested an alternative in which the balloons would be tethered to mobile robotic platforms. In this way, the heavy battery and equipment would stay on the ground, yet the balloon concept would be maintained. (There is a history of military tethered balloons being used as observation platforms that goes back over a century.) After he adjusted to this idea, and after exploring the possible forms the robotic platforms might take, he asked me to build three units. We also expanded his concept to include the distribution and remote viewing of video output from the installation on the Internet.

Creating the Robots

The basic robot platform is a round wooden board with two motorized wheels at the sides and casters in the front and rear, which allow the unit to rotate in place. In the center of the platform is a large, 12-volt gel cell battery (about the size of a car battery) that has more than enough power to operate the robot for 10 hours. The cover is a 24-inch clear acrylic dome painted black on the inside. By tethering two wires to the balloon, we could control camera orientation while also feeding power to the miniature video camera and transmitter package. A clamp would hook the balloon to the center of the one-half-inch wooden dowel to support the video camera. Slayton did some tests with helium balloons and found that an eight-foot balloon filled with air to six feet would keep the package afloat for about two days. He also found a way to refill the balloons by slipping the nipple over a piece of rubber tubing and securing it with tightly wrapped tape. When the tube was sealed with a small stopper, the balloon could easily be refilled as needed.

While radio control could have been used to enable the robots to track people, it would have required a hidden operator to continuously run each robot. Instead, we used on-board computers to operate the robot and manage the tracking function. I was able to design a unique "radar" system that locates people near the robot and turns the robot to follow selected people within its range of view.

The tracking sensor is mounted above the battery and protrudes from the center of the dome. This "radar" operates on two fairly simple technologies. Mounted to a rotating head is a passive infrared motion sensor,[1] like the type used in burglar alarms, and a Polaroid ultrasonic ranging sensor,[2] similar to the kind used in automatic-focus cameras. The lens of the infrared sensor is masked down to a slit, so it is triggered only when pointed directly at a person (it reacts to warm temperatures). The trigger causes the Polaroid unit to determine the distance to the person being tracked, up to 30 feet away. A small computer known as the

Basic[3] controls the motor that rotates the sensor head. The angular position is determined from an encoder that optically counts the slots in a metal disk attached to the motor. This allows the computer to differentiate eight different "vectors." When the sensor "pings," the computer pauses, records the vector and sends it to the other Basic Stamp computer, which controls the robot's movement and collision-avoidance sensors. While it was not necessary to stop the head rotation, doing so provided a nice visual indication of "intelligence" and served as a diagnostic of the sensor's function. The main computer uses the vector information to turn the robot so it points toward the person being tracked.

I designed a collision-warning sensor system based on an item called "Back Up Scan," which is available on the electronics surplus market.[4] Originally intended for automobile use, it consists of two sensors that can be mounted to a car's rear fender and wired to a display that clips onto the car's rearview mirror. Using a bar graph and a readout in feet, the device shows how close you are to objects behind the car as you back up. I mounted these sensors under the front and rear of the robot platform and powered them from the 12-volt battery. At surplus prices these sensors were very affordable, and only minimal modification was required to connect them to the computer.

Programming "Intelligence"

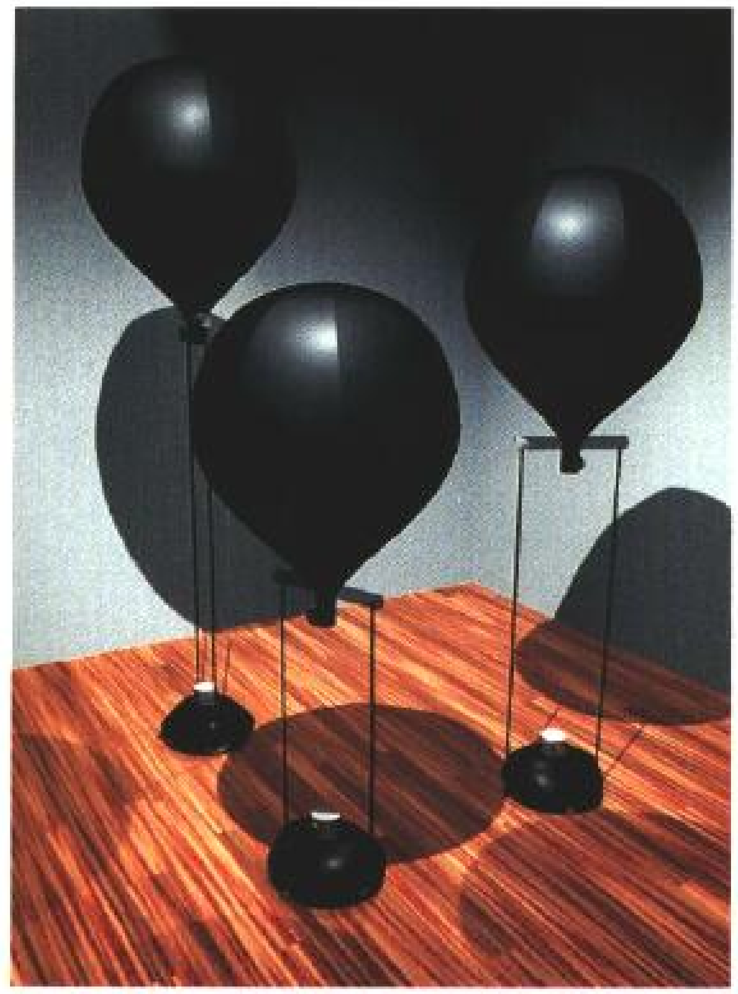
Each of the robots has a different sensing range: one tracks only nearby people and ignores the others; another follows only people who are four to eight feet away. The remaining unit looks only at more distant targets. Rather than actively following people, the robots mostly turn to point the camera at them. If the robots do not sense a presence for several minutes, they are programmed to roam. We spent time programming different behaviors for each robot, ranging from slow and cautious to a faster "explorer" style of movement. One remains virtually in place when not tracking someone, slowly rotating one-eighth turn every minute or so to scan the space, then moving to a new location. Another robot is programmed to act like an explorer, moving about six feet every 15 seconds. This robot covers a lot of ground. All of the robots back away from anything closer than three feet, so they spend some time getting out of people's way and staying clear of walls, etc.

For the cameras, we used ultra-miniature black-and-white video cameras,[5] which measure about two by three inches, and wired them to miniature transmitters, which I assembled from kits. We also tested an inexpensive video transmitter system[6] designed for home use but found it could not handle the continuous movement of the transmitters. These parts had to be small and light (about one-half pound) to keep the balloon size reasonable. The transmitted video is received at a station in the gallery, where the different camera views are displayed on monitors. A computer digitizes the video for transmission via modem to the CADRE Institute's World Wide Web site on the Internet. I also built a small video switcher that would allow the computer to select which video source to digitize. CADRE Institute staffer Bruce Gardner created a computer graphic previsualization of the robots. Gardner also worked with artist Steve Durie to create the World Wide Web page and the custom-designed software that sends the images from the site to San Jose, where they are shown on the Internet. The Internet images from the gallery are updated every minute, and visitors to the site can access quick-time movies compiled from various time periods.

In the installation, the robots were contained within a 25-by-25-foot "corral," which consisted of a six-inch-high barrier within the center of the museum gallery space. Museum visitors were encouraged to interact with the robots, which appeared shy because of their collision-avoidance behaviors. We hoped to see an emergent collective behavior develop as these robots interacted with viewers, each other and their environment. Conceptually, the idea of surveillance via the Internet by viewers all over the globe is most intriguing. **S**

This installation was exhibited in the "Art as Signal" exhibition at the Kranert Art Museum at the University of Illinois at Champaign-Urbana from November 17, 1995, through January 21, 1996. The Web site remains active for viewing the installation and shows the history of the project. The World Wide Web address is <http://surveil.sjsu.edu>.

Guy Marsden lives in Oakland, California, where he runs ART TEC and consults with artists of all types on technology. He exhibits electronic kinetic light sculpture.



Computer-generated image showing mobile surveillance robots. Image by Bruce Gardner.

Notes

1. Available from Radio Shack for $39.99.
2. Polaroid sells these systems to engineers, as a kit with parts for two systems with manuals, for $100.
3. Programmed in Basic language from an IBM computer and only the size of a postage stamp. Made by Parallax Inc. for $34. (916) 624-8333.
4. Available from All Electronics for $24.95, catalogue #ED-100, (800) 826-5432.
5. Available at many electronic parts stores for $120-250.
6. Made by Rabbit systems, retails for about $40.