Above: Margrit Betke, an investigator in the NSF-funded Sensorium project, is developing computer interfaces for people with severe physical limitations. Betke has combined easily accessible video technology with sophisticated image processing software so that even small children can learn to use a computer by employing whatever movement abilities they have available.

Facing page: A young child and her mother play an educational computer game using CameraMouse, a computer interface developed by Margrit Betke. The child controls the mouse by moving the tip of her nose and pausing to create a click.

Extending Our Senses

New Technologies Expand Our Horizons

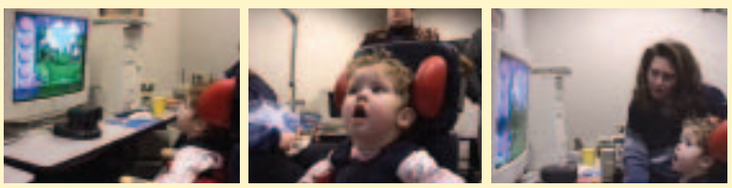
From opening up the possibility of communication for severely handicapped children to watching the basic processes of life unfold, engineers and scientists at Boston University are developing new technologies that expand our ability to experience the world in a multitude of ways. These efforts are supported by a number of interdisciplinary centers and programs funded by the National Science Foundation (NSF) including: CenSSIS (Center for Subsurface Sensing and Imaging Systems), CISE (Center for Information Systems and Engineering), and Sensorium—an effort that is creating networks of inexpensive video sensing elements to facilitate assistive environments for people with disabilities.

Overcoming Barriers

Fortunately for us, Stephen Hawking, one of the most brilliant physicists of our time, despite his lack of speech and inability to make more than the tiniest of movements, continues to communicate via computer. Hawking is not alone. According to the Christopher Reeve Paralysis Foundation, there are more than 250,000 people paralyzed by spinal cord injuries in the U.S.—and many more hundreds of thousands of adults and children with severely limited movement resulting from disease, stroke, or birth defects.

Margrit Betke, an expert in computer imaging and a co-principal investigator of the NSF-funded Sensorium, is working to bring greater ease of communication to those with even the most limited range of movement. Betke's aim is "to develop computer vision systems that respond to a user's natural communicative cues such as gestures, facial expressions, and gaze direction."

Children as young as three years old have used Betke's CameraMouse to control computers and explore the Internet, spell out messages, or play educational software or games. CameraMouse employs a video camera to track the movement of a small body part—such as the tip of the nose or a finger—and translate the motion into onscreen mouse movement. The program generates mouse clicks based on "dwell time"—if the pointer stays within a 30-pixel radius for half a second a click is generated. Unlike previous assistive technologies CameraMouse requires no helmets, electrodes, goggles, or mouthsticks, which many users find intrusive and uncomfortable. Also, because it can track various body features, CameraMouse can be adapted to work with the motions that are most comfortable for the person using it. And, as home computers have become more powerful, and video cameras smaller, the system has become more compact and easier to set up in a home or school environment.



BlinkLink and EyebrowClicker are two additional interfaces that Betke and her associates are developing for people with only the ability to blink their eyes or move their eyebrows. Like CameraMouse they rely on acquiring video images of small movements and translating them via algorithms into instructions to move a pointer and generate a click. BlinkLink extracts information about the location and duration of a blink by tracking the motion of eyelids and changing appearance of the eye. Short, involuntary blinks are filtered out and only long, voluntary blinks cause a click. Because the computing power required is small, both BlinkLink and EyebrowClicker can be easily used in tandem with other programs such as CameraMouse.

A program still in development, called EyeKeys, has the potential to help people who only have the ability to move their eyes. In this computer interface a video camera looks at the differences between the right and left eyes to detect if the computer user is looking at the camera, or off to the left or right side. The detected eye direction can then be used to control applications such as spelling programs or games.

The impact of these technologies on the lives of people has been profound. The mother of a three-year-old girl with cerebral palsy says, "CameraMouse has given her a way to communicate her thoughts, it gives the school that she is attending a way to adapt the curriculum so that she can participate in a regular preschool, and it puts her in a situation where people can see her abilities, rather than her disabilities."

For more information about Margrit Betke's research, see *www.cs.bu.edu/fac/betke/*.