Seeing and Perceiving

- DAVID JACOBS
- YIANNIS ALOIMONOS
- AMITABH VARSHNEY

The eyes are the main way people take in information from computers, and sometimes, it would be helpful if computers could "see" with the kind of understanding that people have. A number of UMIACS researchers work on problems related to vision and perception—how to better represent data visually, how to analyze visual data and help computers deal with the visible world, and sometimes, as a corollary to understanding how computers see, how to better understand how people see.

David Jacobs focuses on using computers to recognize objects in still images and to compare and match shapes. In one project, his team is helping create electronic field guides to identify botanical samples. In the future, a personal data assistant could analyze a photograph of a leaf to suggest the species it matches. Two prototype programs developed in collaboration with computer scientists at Columbia University and botanists at the Smithsonian Institution can give matches for about 250 species each. One of the systems includes all the wooded plants around Washington, D.C.

Interpreting photographs is a challenging problem since images vary depending on point of view, lighting, and the natural variation of things. With funding from Apptis, a company that works

Amitabh Varshney (l), David Jacobs (c) and Yiannis Aloimonos (r)

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with the U.S. State Department, Jacobs is developing ways to compare new passport photos with those on file for the same applicant in the past to try to pick out possibly fraudulent applications. The consistent pose and lighting of passport photos helps simplify the face recognition problem, says Jacobs. But matching the same person across large gaps of time is not easy. Jacobs' programs automatically learn matching rules from the data. In time, computerized photo matching could also be used to sort personal photos or to search the Internet for people. "Doing this really well may be very hard, but even doing a decent job can be useful," says Jacobs.

In collaboration with Amitabh Varshney of UMIACS, Jacobs is also studying how people look at things. They have studied how lighting influences how people view an image and what they perceive as important. Such insights can be used to pick out the important parts of a photograph or video. Peter Belhumeur, a computer scientist at Columbia University says of Jacobs, "David is a terrific researcher. He's very quick to pose the right questions and is unusual in his ability to deliver with the answers. He's a fantastic person to collaborate with."

In experiments tracking the eyes of viewers, Amitabh Varshney has shown that people tend to look most where curvature changes abruptly in a picture. "If you can model how people look at things, you can represent things better for comprehension," says Varshney, and indeed, his work concentrates on helping users interact with data by creating visual models that represent large amounts of data and respond rapidly to user input.

"We're trying to allow real-time exploration, so scientists can examine a lot of what-if scenarios. Interactivity changes how scientists approach problems," says Varshney.

To represent vast amounts of data in interactive ways, Varshney is developing methods that rely on graphics processing units, or GPUs, highly parallel processors developed for video games. Varshney also works to represent complicated shapes in compact ways using a mathematical model called implicit representation. Others have used mathematical models to represent the two-dimensional surfaces of objects, but Varshney is working to represent three-dimensional spaces, such as the insides of parts of the body. "This is a bold step. It should be especially useful for representations in medicine and biology," comments Terry Yoo, a computer scientist at the National Library of Medicine.

Yiannis Aloimonos is the director of the UMIACS Computer Vision Lab. He is widely known for his work on "active vision," a way of analyzing visual information that uses motion to let computers sense depth. "Many concepts are rooted in the body and how the body interacts with the physical world," Aloimonos says. Aloimonos has applied insights from neuroscience to computer vision, to help machines see better, but he is also interested in using computational methods to better understand how the brain processes images and other ideas.

For the last decade, Aloimonos has been inspired by the discovery of mirror neurons in the primate brain that are activated whether an individual is viewing an activity or performing the activity. "The neurons represent actions at an abstract level," he says. Aloimonos likens this ability of the brain to think of action in an abstract way to language and would like to understand the rules of this biological language with as much detail as we have for spoken and written language.

"He is a very original thinker," says Ruzena Bajcsy, a computer scientist at the University of California, Berkeley. "He has been addressing some difficult, basic problems in perception. He is a true basic scientist who pursues his convictions."

— Profile written by Karin Jegalian

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