IMPACT PROFILE
RESEARCH AT THE UNIVERSITY OF MARYLAND

RAMA CHELLAPPA AND LARRY DAVIS

Seeing with Computers

Cameras watching public spaces, laser radar detectors measuring distances around them, infrared sensors surveying the dark, satellites gathering images from the sky ... all of these technological advances leave us awash in surveillance data. Some researchers, however, believe the main challenge often lies not in recording suspicious incidents, but in alerting people to them.

That's where Rama Chellappa and Larry Davis come in. The longtime collaborators at the University of Maryland are members of the Computer Vision Lab in the university's Institute for Advanced Computer Studies, or UMIACS. Chellappa, a professor in electrical and computer engineering, and Davis, professor and chair of computer science, work together on the problem of pattern recognition in video. "We're trying to provide computers with the ability to see," says Chellappa.

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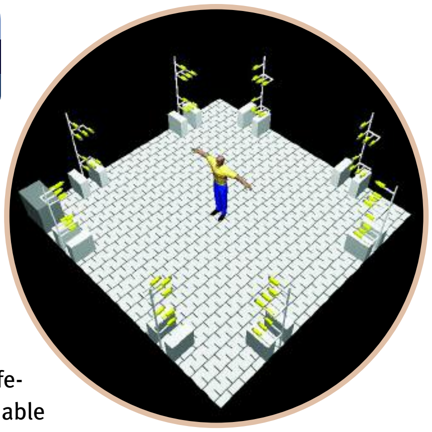
Computer Vision



In research funded largely by the Department of Defense, the Maryland researchers are developing algorithms to interpret data from security cameras so as to automatically raise alarms in dangerous situations. However, applications of computer vision extend beyond surveillance. "A robot should be able to move without bumping into the wall. It should also be able to recognize that Chellappa is here today and that he's working," says Chellappa. He and Davis work on problems such as designing computer interfaces that can interpret users' gestures, designing monitoring systems that allow kinesiologists to measure subtle changes in how a patient moves, and they have collaborated with biologists to interpret the waggle dances of bees, used to communicate the location of food sources.

One chief challenge is in analyzing human movement. For example, Chellappa and Davis are developing ways to recognize and track individual people through large settings, such as airports, that are monitored by many cameras. The researchers are working to analyze cues like appearance and walking style, or "human gait DNA" as Chellappa says. By measuring stride, body angle and the swing pattern of people's arms and legs, the researchers hope to tag individuals and also detect people who are carrying objects. The analysis should also show if someone drops off an object. "Our approach to detecting change is to superimpose images on top of each other and detect differences," says Davis. Even if cameras don't capture the moment when someone unloads their burden, algorithms should be able to deduce the event.

Davis and Chellappa, collaborating with Honeywell, have recorded sample videos in the Minneapolis-St. Paul airport to use as material for interpretation. In a separate project done in collaboration with Siemens and using the Munich airport as staging ground, the researchers are working to develop algorithms for detecting unattended baggage.

One of the challenges in interpreting video is that the same thing can look different depending on the angle at which it's filmed and how light hits it. People's appearance changes all the time in subtle ways. The trick is to figure out what data are revealing and what can safely be ignored. "We want to be able to model the normal patterns and then be able to say, 'Hey, there's something wrong there.' We're looking for anomalies," says Chellappa. In some settings, modeling how objects are supposed to move is relatively straightforward. For example, a fairly simple computer program could send out a warning if a fuel tanker fails to show up next to an airplane that needs to be refueled. More sophisticated analysis of human movement should be able to detect dubious behavior in a bank, such as two people moving unusually close together toward a bank vault, which could indicate a robbery in progress.

In addition to analyzing video overlooking relatively large spaces, Davis and Chellappa analyze videos recorded at close range. They are developing algorithms to recognize faces, so as to allow approved people inside secured spaces. Chellappa says that their team can so far match videos of faces to a set of about 30 people. "We can place a virtual grid on each face and model light distribution," he explains. The Defense Advanced Research Projects Agency, or DARPA, is funding a project to test face recognition among larger numbers of people and to enable face recognition at a distance.

The applications for computer vision extend into industrial inspection and even highway safety. For example, a video camera can be used to track where a person is looking. This could be useful whether someone is sitting at a computer or driving a truck. In a project funded by the Department of Transportation, the researchers developed ways to tell when a truck driver is no longer watching the road and is probably dozing off.

Chellappa and Davis credit their collaboration for much of their productivity. "We almost always write joint proposals," notes Chellappa. "We complement each other."

—*Karin Jegalian*

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Impact Profile is a supplement to *Impact*, a quarterly research digest from the University of Maryland. To learn more about research at Maryland, go to www.umresearch.umd.edu.

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