New Technologies Improve Video Surveillance

December 14 2006

Surveillance cameras are sprouting up in more and more places, forming an ever more powerful tool for solving crimes after they happen. But what about using them to prevent or stop criminal and terrorist acts? This requires that someone, or something, watch these rapidly multiplying video feeds 24-7.

And that's the problem. Paying people to adequately monitor dozens, or even hundreds, of surveillance cameras can be highly expensive. Plus, humans tend to get bored and lose focus staring at security TV monitors hour after hour, day after day. Computerized monitoring would seem to be the obvious answer, but creating software programs that can recognize suspicious activities or suspect individuals has proven highly difficult.

However, Rama Chellappa, a professor in the department of electrical and computer engineering of the University of Maryland's A. James Clark School of Engineering, is developing a real-time computer monitoring system that provides some answers to this problem. Chellappa's artificial intelligence system can reliably monitor surveillance images to detect certain suspicious movements or suspect individuals and alert human security personnel.

A pioneer in the development of pattern recognition and computer vision software, Chellappa and some of his associates recently demonstrated the system for military leaders at the 25th Army Science Conference. This event was the latest of numerous presentations on his system that

Chellappa, who is also an affiliate professor in the university's computer science department and a researcher in the University of Maryland Institute for Advanced Computer Studies (UMIACS), has made this fall. In October, he delivered a plenary lecture on this emerging technology at the Institute for Electrical and Electronics Engineers (IEEE) International Conference on Image Processing in Atlanta.

Chellappa's technology could have widespread applications in security surveillance, as well as non-security applications in elder care and video indexing. It could be particularly helpful as part of the security measures for sensitive locations, such as military bases, public transportation terminals and other areas that need high levels of security.

It's in the Way You Walk

Using video data from digital surveillance cameras and corresponding algorithms, Chellappa and his research assistants have developed a compact, digital signature for characterizing human gait and corresponding activities, such as humans carrying objects like backpacks, handbags, or briefcases.

When a person's limbs are unencumbered, gait movements are symmetrical. Represented graphically, these movements form a twisted helical pattern resembling a 'figure 8' called a double helical signature. Chellappa and his team call this pattern, which is slightly different in each individual, "human gait DNA." An individual's gait pattern is changed by any activity that changes the symmetry of the movements, such as carrying a package. By defining these signatures, the system can recognize unique patterns in human gait and automatically detect asymmetric movements like an individual walking with a hidden object tied to an ankle or wrist. Hidden objects secured to the body in ways that don't affect movement symmetry, for example, a fanny pack that is belted around the waist, aren't currently detected by this technology.

Chellappa and his team have integrated human gait DNA into a real-time video surveillance system and used it to study and locate pedestrians. The experimental results have demonstrated the effectiveness of the system under lighting changes, shadows, camera motion, various viewing angles, as well as significant obstacles in the cameras' viewing angles. The results also indicate that the approach is superior to many existing methods in terms of accuracy and reliability.

"These capabilities are extremely useful in creating a surveillance system intended to address security concerns," said Chellappa.

His research team is also 'teaching' their gait recognition system to identify individuals by their unique gait. This is a much more difficult task, since subjects may deliberately attempt to walk in an uncharacteristic manner in order to try and cheat the system and avoid detection. If the suspect is unaware of the surveillance system, their normal walking style is more easily identified.

Chellappa and his assistants also study the geometric constraints that are useful in matching gait signatures across different viewing directions and individuals. The optimal camera angle for recognizing human gait is a sideways, 90-degree profile perspective, but Chellappa and his team have created automatic, corrective algorithms that can, within a certain range, compensate for different viewing angles.

Combining Gait, Face and Other Recognition Technologies

The Maryland team has also developed advanced face recognition software that can be combined with their gait recognition technology. This face recognition technology can be used to watch for known terrorists, spies or criminals and help to identify unknown individuals

who might turn up repeatedly in sensitive locations or who have been present during multiple criminal or terrorist acts. Chellappa's team recently developed two other recognition technologies that can add to the capabilities of automated video surveillance systems. Through work supported by the department of Homeland Security, Chellappa and one of his students have developed an algorithm to accurately estimate the heights of subjects in the field of view of a camera. This provides an important additional way to recognize and track subjects in crowded settings. The team has also developed a program that detects unattended packages using a structured representation known as attribute grammars. Both of these technologies were demonstrated at the recent Army Science Conference. The live demonstration of the height assessment program, in particular, attracted much interest and many volunteers, including many high-level army officers. Chellappa and his team now are working to integrate their patent-pending technologies into a comprehensive surveillance system for use in security-sensitive locations.

Source: University of Maryland