

Jim Davis: Vision for the Future of Surveillance

The future of video surveillance and monitoring is currently taking shape at The Ohio State University. **Jim Davis**, Associate Professor, is developing a new automatic video surveillance system that uses Computer Vision and Artificial Intelligence to analyze video camera feeds to detect and track people, and also to analyze their actions and behaviors.

Recently on July 10th, several buildings (including Dreese Laboratories) on the OSU campus were evacuated after a suspicious unattended briefcase was reported. The Columbus Bomb Squad retrieved and detonated the briefcase (above). A similar incident of another suspicious package found on campus had been reported just the previous day. In both cases, the packages turned out not to be a threat.



Davis' goal is to build an intelligent video surveillance system that would have the ability to automatically detect an unattended package and to immediately alert security of its presence. In addition to detecting the threat, the system would continue to track the person who left the package, thus giving more information to security personnel.

One of the central themes and concepts behind this research project is "preemptive analysis." Rather than using surveillance cameras as a forensic tool to examine recorded video after something nefarious occurs, Davis aims to use surveillance cameras and computers to look automatically for suspicious behavior, and also try to predict particular types of events before they happen. The key is to have the computer first analyze surveillance videos and automatically discover the human activity patterns that typically occur in an area. Having determined what is considered normal behavior in a certain area, the system can then detect any abnormal activity.

"We want the system to learn as much as possible,"

Davis says. However, there will be times when a human operator may want to give particular guidance or "rules" to the system. For example, the system may be instructed to send an alert if a person enters an area that was labeled as "secure – do no enter." The main research challenge is to create a system that can accurately and automatically learn most of the necessary information needed to model and detect behavior patterns, but still provide a means for user input.



Jim Davis,
Associate Professor

The purpose of this intelligent video surveillance system is to help, not replace, security personnel. Currently in a security control center, there may be only one or a few people trying to watch a very large number of television monitors showing the surveillance video feeds (below). Because people can only focus on a few monitors at a time, much of the surveillance area is left unattended. With the smart surveillance system proposed by Davis, computers with automatic video analysis capabilities could look

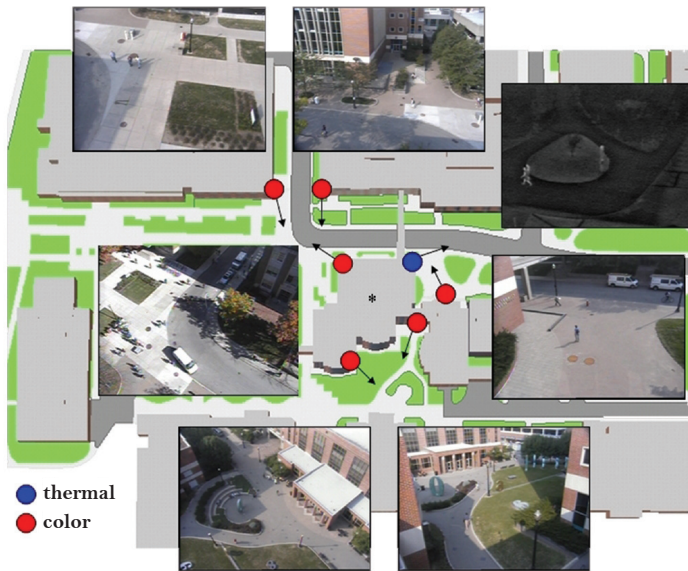
simultaneously across multiple video cameras for abnormal behavior patterns. If an unusual pattern is detected, the system could alert the security personnel. "You can think of it as moving from cognitive and perceptual overload to cognitive and perceptual management," Davis says.

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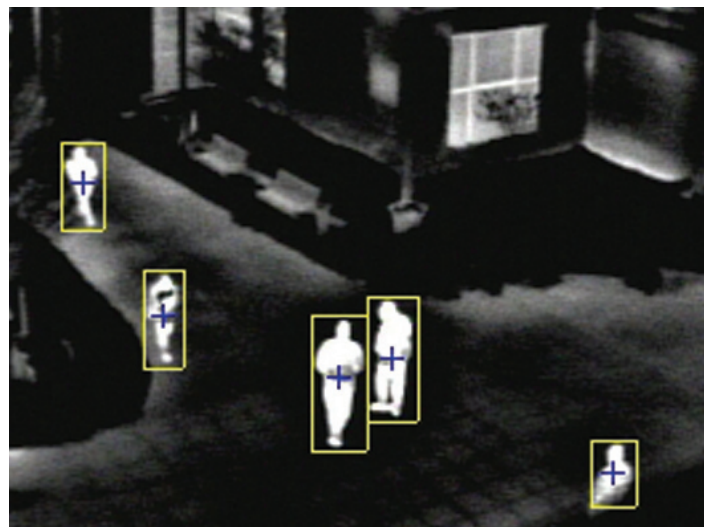
A network of video cameras has been mounted on various buildings around Dreese Laboratories on the





OSU campus as a testbed for the project (above). Central to the research is the use of both color and thermal video cameras. The color cameras are standard commercial cameras that can orient to different areas using pan, tilt and zoom control. Thermal cameras detect the amount of thermal radiation in the scene and convert the information into an image showing hotter objects with brighter pixels. For example, the figure below shows the warmer bodies against the cooler background. The main advantage of using thermal cameras is that they can see in the daytime as well as in complete darkness. Together, the color and thermal cameras provide a complementary means of 24-7 persistent sensing.

Naturally, any video surveillance system will have to deal with issues related to privacy. A benefit to the proposed automatic surveillance system is that it is based on analyzing human activity and behavior patterns; therefore, issues related to person identification are reduced. Davis adds, "I don't care who you are; I care about what you do." Such an activity-based system will also eliminate issues related to racial profiling.



Davis's research plays an important role given the heightened Homeland Security needs for technically advanced surveillance systems. The research also has much broader implications, and may be applicable to search and rescue, border patrol, law enforcement and many other types of military applications. Davis' work has already been featured in various media outlets (including multiple TV and print interviews). Support for Davis' research has been provided by the National Science Foundation and US Air Force Research Laboratory. He has published multiple papers on this research and has presented several lectures on the topic to both academic and industry audiences.

Overall, Davis' research on designing "smart surveillance cameras" is a continually growing project. He expects the project to lead to new technical capabilities, which will also bring a safer future.

Extending the reach of this Computer Vision research, **Vinay Sharma**, graduate research assistant to Davis, will be graduating in December, 2007 and joining CSE Alumni **Bruce Flinchbaugh** ('80) at Texas Instruments in the Vision R&D group.

Although Davis dedicates himself to this important research project, he still makes time for his other passion, drumming. Playing since age 12, he freelances as a drummer in Columbus and enjoys listening to and playing jazz. Who knows what's next, video analysis of musicians?



Jim works with his students on the continually growing research of creating "smart surveillance cameras."



An example of the dome cameras currently used on campus. Many cameras such as this already exist, and could be linked with the surveillance system rather than be replaced.