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A Jacobs School of Engineering professor is developing a system to monitor and respond to traffic incidents via robotic agents and remote surveillance.

According to the **U.S. Department of Transportation**, urban traffic congestion costs the nation and its motorists more than \$100 billion per year in lost productivity, wasted fuel, and pollution, as stress, anxiety, and inefficiency plague the veins connecting our cities and communities. Costs are highest in California where **Caltrans** reports that freeway congestion costs the city of Los Angeles alone in excess of \$10 billion annually.

The **University of California, San Diego** has received a \$3 million research award from Caltrans and the state of California through the **Digital Media Innovation** matching grant program to help resolve this dilemma.

Headed by **Mohan Trivedi**, professor of electrical and computer engineering at the Jacobs School, the project, entitled **Autonomous Transportation Agents for On-Scene Networked Incident Management**, will strive to create a powerful and integrated traffic-incident detection, monitoring, and recovery system to reduce congestion.

“It will make travel safer, smoother, and more economical, and will reduce wasted fuel and pollution,” says Trivedi, who foresees it beginning to take effect in the next two to three years.

The goal of this program is to detect and cleanup traffic incidents more quickly. Utilizing clusters of video and acoustical sensors, mobile robotic agents, and interactive multimedia workstations and user-interfaces, connected via high bandwidth communication links, traffic will be continually monitored and altercations automatically detected. Both omnidirectional and rectilinear video sensors will be used to provide customized, synthetic, real-time imagery to remote viewers in multiple locations. While an omnidirectional camera produces a 360-degree perspective of lower resolution, a rectilinear one offers zoom capabilities and a greater detail from a single vantage point. ATON will merge all of the video and audio input together from all sensory devices in order to construct a three-dimensional environment into which one can travel and maneuver according to his/her specific needs (e.g. a doctor may focus on an injured driver, while a police officer may be interested in the overall accident scene, including physical evidence and traffic flow).

By accurately assessing the situation beforehand, Trivedi emphasizes that “only the essential personnel will be deployed on-site, reducing delays, costs, and additional traffic congestion.” Information gathered may also be used for law-enforcement purposes. and will also be stored in databases for future analysis and decision-

making.

Although initially all information will go directly to the California Highway Patrol for verification, and any assistance efficiently deployed according to their criteria for judging incidents, Trivedi and Caltrans envision a typical scenario eventually playing-out as follows:

- **10:00 a.m.** A truck carrying drums of chemicals loses control and broadsides a small sedan. Video and acoustical sensors strategically planted on freeway lampposts automatically detect the incident and alert remote operators (Caltrans, CHP, medical, fire and rescue, hazardous waste, etc).
- **10:05 a.m.** The “Mother Ship” robotic devices travel like monorails along the freeway, stopping to become traffic signs and bringing sensors, including teleconferencing equipment, directly to the accident. These remote agents send and receive transmissions from operators and in turn communicate with the devices at the scene. In this instance, Caltrans deploys a sign warning drivers of slippery road conditions due to the chemical spill. It also sets up signs alerting travelers of slowing, an upcoming lane merge, and the fact that there is an accident ahead.
- **10:07 a.m.** Shortly after the “Mother Ships” arrive, small, inexpensive motorized robots are deployed by Caltrans to direct traffic, becoming cones navigated by the mother ship and its operators. This enables them to close down lanes and stop traffic as needed.
- **10:12 a.m.** Outside help is contacted based on the specific needs of the situation. Medical crews determine that the driver of the sedan has sore neck and minor facial lacerations. One of the small inexpensive motorized robots also contains teleconferencing equipment and travels directly to the injured driver’s car to take a police statement and better assess her situation. An ambulance is sent. The hazardous materials team confirms that the chemicals are dangerous and dispatches a clean-up crew. The CHP is able to do the majority of its investigation remotely. They use the teleconferencing equipment on one of the “Mother Ships” to take a statement from the truck driver and give a Breathalyzer test, which he passes. A single officer is sent to supervise the scene due to its severity, but most of the work is handled from a remote location, including all documentation. Caltrans sends out a clean-up crew and tow-trucks for the vehicles.
- **10:25 a.m.** Freeway lanes open again.

In addressing potential concerns, Trivedi says that “in the integrated system, there will be changeable message signs deployed one to two miles upstream to caution the drivers about the incident mitigation work being performed ahead and asking them to slow down and move into the lanes which are open. However, we can never assure full compliance and should anticipate some collisions with the little robots. That is exactly why our ‘blind’ small and inexpensive robots are needed. In bulk, we do not expect them to be lot more expensive than the orange cones which are currently used.”

Some of the challenges foreseen by Trivedi and his team include developing an architecture that works effectively in multiple environments and geographical settings to accurately deploy the robotic agents and management traffic, and efficiently sharing public communication channels to utilize as little bandwidth as possible.

The ATON system will be developed in stages. The first prototypes are likely to appear on the UC San Diego campus and in Santa Barbara where the Caltrans Testbed Center for Interoperability is located. Trivedi is collaborating with the Caltrans Center and with the UC Santa Barbara Center for Research in Arts and Technology.