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Gunshot Location Systems

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Over a recent New Year's holiday, Gary, IN decided to do something about the proliferation of illegal weapons. Using the ShotSpotter Gunshot Location System (GLS), the Gary Police confiscated 27 semi-automatic handguns in a single night: one revolver, seven assault rifles, eight shotguns and two rifles. New Year's was chosen because of the city's previous experience with celebrations that could take a violent turn when shots were fired into the air. The large number of gunshots provided a great opportunity for the GLS to do its job. As fast as bullets were fired into the air, police were arresting shooters.

While gunshot location systems can use one of several sensing technologies to detect and locate the source of the gunfire, acoustic sensors are most often used in law enforcement applications. Other sensing technologies, some used by the military, use optical or infrared sensors to detect the muzzle blast. The military often refers to its systems as counter-sniper systems.

Gunshot Location System (GLS)

The ShotSpotter GLS uses a network of weatherproof acoustic sensors to locate and record gunshots and other loud noises. When a gun is fired, spherical sound waves radiate up to 2 miles. The sensors detect the sound and identify it as a possible gunshot, then transmit the recording to a server at police headquarters, along with the direction from which the sound came, the time it was detected, the sensor's location, and the current temperature. When at least three sensors have detected the sound, the server triangulates the exact location based on time-of-arrival readings from the sensors.

This information is issued as an alert over the police department network. The alert includes the recording, aerial photograph of the area, the time and place the incident occurred, and number of shots fired. A dispatcher relays the alert to on-duty officer. Alternately, squad cars carrying mobile ShotSpotter displays receive the alert directly. The police unit responds, arriving in seconds or minutes, often fast enough to catch the perpetrator with the "smoking" gun and help victims.

The ShotSpotter system is based on technology used by geologists to pinpoint an earthquake's epicenter. Indeed, the original concept was conceived by Dr. John C. Lahr, a U.S. Geological Survey seismologist, to help the Menlo Park, CA Police locate gunshots when it was besieged with gunshots related to drug traffic. Based on the success of Lahr's initial demonstration, Dr. Robert Showen, an expert in acoustics, founded ShotSpotter.

When the sensors pick up a sound in the appropriate frequency range, the system ties into a geographic information system (GIS) and generates a colored dot on a city map. Gunshots show as red dots; firecrackers and other loud noises have their own colors. The marked map shows the dispatcher the location of the gunfire. The dispatcher can then listen to a WAV file of the report, verify it as a gunshot, and dispatch officers. The entire process usually takes no more than 6 to 10 seconds. The recording of the incident can also provide important evidence for prosecuting gunshot related cases.

The ShotSpotter system can be integrated with virtually any controllable surveillance camera. Cameras can be located anywhere within the coverage area and do not need to be co-located with sensors. ShotSpotter can control multiple surveillance cameras.

Besides long-term deployment systems, namely Metro GLS for large cities and Muni GLS for smaller municipalities, ShotSpotter offers the Rapid Deployment System (RDS). This portable, plug-and-play version of the ShotSpotter GLS is ideal for SWAT teams, during sniper outbreaks, for large events or other tactical applications. It is ready to use in a matter of hours and can be set up by ShotSpotter trained members of a law enforcement agency.

RDS features lightweight individually worn sensors—about the size of a PDA and weighing about a pound—that listen for gunfire and report back to a system center. Other components include a ruggedized laptop that contains the location server, notification engine and public safety console (PSC). The RDS can be used

as an independent gunshot location system or combined with a Metro or Muni GLS to create a comprehensive, multi-layer GLS. In addition, the RDS allows communities with Metro or Muni GLS systems to quickly and easily extend their coverage area to accommodate changing requirements.

ShotSpotter systems have been deployed for 10 years with more than a dozen installations across the U.S. This includes installations in Washington, DC; Oakland, CA; Minneapolis, MN; Rochester, NY; Charleston, SC; Glendale, AZ; Redwood City, CA; Los Angeles, CA and Gary, IN. According to the company, ShotSpotter has reduced violent crime rates by more than 30% and reduce gunfire by 60% to 80% in certain installations. During the 2003-04 Ohio Highway Sniper case, a ShotSpotter system was deployed by FBI and the Franklin County, OH Sheriff. The system provided material assistance in the apprehension of the sniper.

SECURES® Gunshot Detection and Localization System

Planning Systems' SECURES is another acoustic gunshot detection system. Its battery-operated sensors can distinguish gunshots from other sounds, including engine backfires and fireworks. The standard system includes at least 100 sensors for 1 square mile in the area of interest. Sensors are generally located at every intersection and can be mounted on utility poles, street lights and buildings.

When a gun is fired, the sensors automatically detect the gunshot acoustic signature and transit related detection information wirelessly to a receiving station. The system tags the time and date. Once several sensors have relayed the information, the differences in arrival time are used to triangulate the location of the gunshot. Within three- to-five seconds, an audible and a flashing icon on a GIS map on the dispatcher's display shows the location, usually the nearest street address and building. The wireless, portable, IP-based system, allows access and monitoring by dispatchers at police stations, by officers in patrol cars, from aircraft, and via handheld devices.

Localization is usually within 10 feet. The dispatcher can zoom in on the location display that also shows time and date tags and lists geographical coordinates. The system's sensor grids and networks can be customized for precincts, districts or neighborhoods. They can also be modified for high incident areas. Data can be maintained and used to help identify trends and develop crime-fighting strategies.

Information can be sent to video surveillance systems where SECURES can act as an event detection alert and provide information for remote operation of video surveillance cameras. The system can also be embedded into OptiSoft Intelligent Traffic Signal (ITS) Platform.

According to the company, SECURES has significantly deterred violent crime and reduce calls for service by as much as 85%. A half-dozen cities are using the SECURE system with many applying it in a covert manner. For example, it is used by police in East Orange, NJ and recently it was selected for deployment by the Dauphin County District Attorney's Office for deployment in Harrisburg, PA.

Safety Dynamics SENTRI

SENTRI listens like human ears, then processes the information like the human brain. SENTRI uses Dynamic Synapse Neural Network (DSNN) technology developed by the Department of Biomedical Engineering at the University of Southern California. DSNN is based on neurobiological principles of brain signal processing. Like the human brain, it can accurately perform pattern recognition of acoustic signals, even in the presence of high noise. Once the sound of a gunshot has been recognized, standard triangulation methods used to pinpoint its source.

SENTRI sensors operate as individual recognizers that can be mounted on poles, fences or buildings. The units communicate wirelessly to a central command center and optionally to send alert data and video to laptops in police vehicles. A grid of SENTRIs is not required for installation because localization is determined within each individual unit. For example, a single SENTRI sensor can be installed at a chokepoint.

Acoustic recognition occurs for a radius of about 600 feet from the gunshot, but is caliber dependent. Recognition is performed in about 1/3 of a second. Range and bearing data are sent to the PTZ (pan, tilt, zoom) video camera in 1/2 of a second. Thus the location appears instantaneously on displays. Location accuracy is +/- 1 degree.

Video images are transmitted by high-speed wireless to the control center with a large split-screen monitor showing the activity of all cameras. Seven days of video data can be stored at one time. A digital video

recorder archives on electronic media for longer storage for forensic investigation or as court evidence.

SENTRI was first used by Chicago in its "Operation Disruption" project in 2003. During the first seven months of Operation Disruption, which included gunshot recognition and video cameras, statistics showed that serious crime in the area was down 17%, other miscellaneous crimes were down 46%, and arrests for narcotics-related violations were up by 61% in the surveillance area.

The city of Tijuana, Mexico has contracted with GlobalSight, an integrator in Mexico, to install 411 Portable Overt Digital Surveillance Systems (PODSS) that have integrated the SENTRI system within each PODSS for urban crime prevention. To date, there are 111 units throughout key crime areas in Tijuana.

Safety Dynamics is currently working with the Los Angeles Sheriff's Department to test SENTRI as a possible application for the Advanced Surveillance and Detection (ASAP) program. ASAP incorporates a number of technologies to detect crimes as they happen and collect video evidence. Cameras equipped with acoustic recognition would provide intelligence for sheriff units before their arrival at crime scenes. It would increase the ability to interrupt crimes in progress, apprehend fleeing suspects, and for other public safety and Homeland Security surveillance needs.

Finally, SENTRI is sold as an accessory for ESi Companies' SKYCOP surveillance system. SENTRI and SKYCOP are contained in a Kevlar-lined steel box, which is placed on a hitched cart and towed by truck or golf cart. The system wirelessly communicates with SKYCOP software, and SENTRI itself has been interfaced with remote controls for a digital video recorder.

Like the brain, SENTRI can learn and adapt. For example, it has "learned" to differentiate between different types of weapons by their sound characteristics.

Safety Dynamics has trained DSNNs to recognize gunshots from such weapons as .22 caliber, .38 caliber, .40 caliber, .45 caliber, and 9 mm handguns and not to respond to other loud noises, e.g., backfires, bus engines. Further training added classes for AK series assault rifles, .308 caliber, .762 caliber, .410 and 12-gauge shotguns, and RPG and mortar launching. Now, DSNN technology is being adapted to recognize security-breaching sounds, like the climbing of a chain-link fence, the sound of a vehicle engine approaching a perimeter, and the sound of footsteps in a location where access is restricted.

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