Government, criminal justice
- *LabVIEW®*
- *DAQ*

Redwood City Police use Virtual Instrumentation to Curb Illegal Gunfire

by Jason Dunham, Software Engineering Manager, Trilon Technology LLC

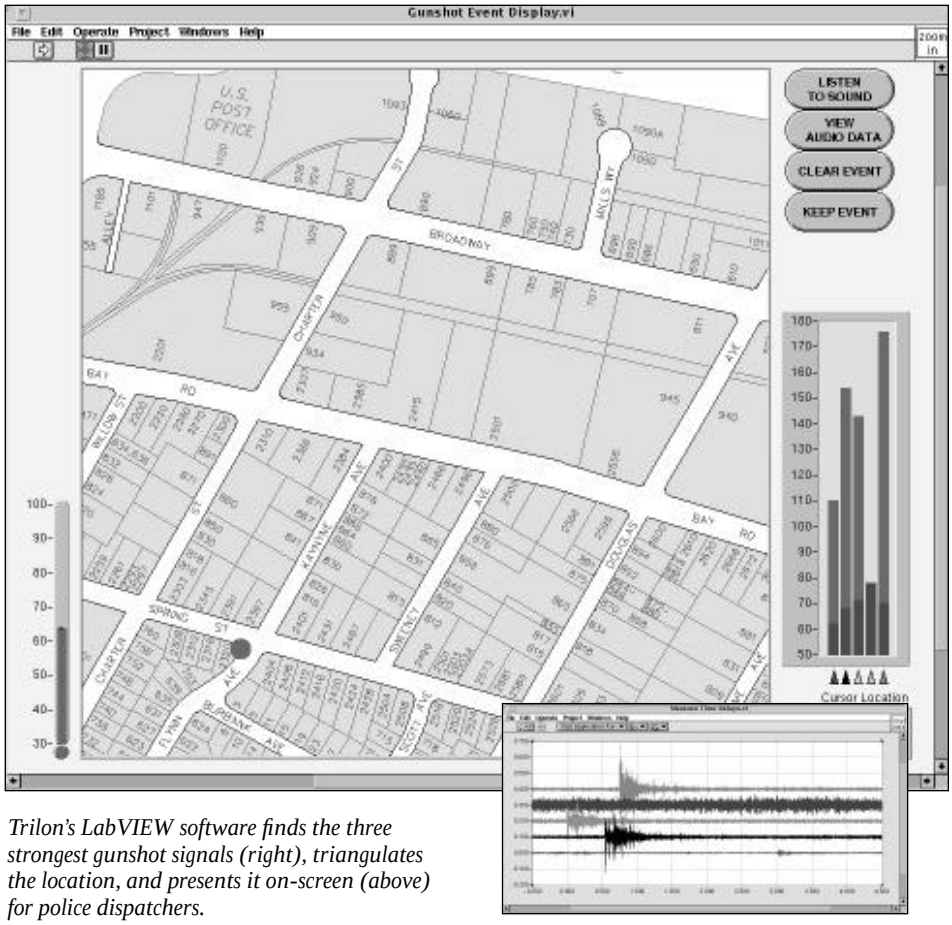
The Challenge: Creating a system that can electronically ascertain the location of gunshots.
The Solution: Using a LabVIEW-based DAQ system, Trilon Technology created a system that leads officers to the scene of gunfire.

Illegal gunfire troubles many cities in the United States where guns are readily available. Gunshots occur not only during crimes but also with people (often intoxicated) who are doing it just for the "thrill" of it who know they are not likely to get caught. People shooting their weapons know that they can easily leave the scene in the time it takes for police to respond to citizen reports and search for the source of trouble.

It is very difficult for the human ear to determine the direction from which a gunshot originates. Local police forces are often unable to respond appropriately to citizen emergency calls because the callers cannot locate the source accurately. If a victim is wounded by the shooting, the delay in arriving with medical attention increases the chance of serious injury or death.

To address this problem, Trilon Technology, of Los Altos, California, has developed an instrumentation system to assist the police by listening for gunshots electronically and triangulating it to find the source of the noise. This system is based on preliminary research performed in 1992 by a seismologist at the U.S. Geological Survey, who found that the technique of triangulation, which is often used to locate earthquakes, could also locate gunshots in the nearby community. Late in 1995, Trilon installed a pilot system installed for the Redwood City (Calif.) Police Department. Gunshot events are displayed within about 15 seconds on a computer map in the police dispatch center. Preliminary tests have shown that the accuracy is usually in the range of 3 to 30 meters.

LabVIEW was a natural choice for the tasks at hand – the built-in DAQ library provided a great starting point for creating a DAQ system that operates 24 hours per day, responds to triggers on any channel, and constantly monitors background noise.



Trilon's LabVIEW software finds the three strongest gunshot signals (right), triangulates the location, and presents it on-screen (above) for police dispatchers.

Gunshot Location System Design

The system is comprised of a network of acoustic sensors distributed across a square mile (2.5 km^2) of a test area in which illegal gunfire is a growing problem. Eight microphones are mounted in weatherproof enclosures and installed on the tops of various buildings. Although the microphones are not sensitive enough to monitor street conversations, they can detect gunfire from several blocks away.

Telephone lines transmit the sensor signals to a Sun Microsystems SPARCstation 5 at the Police Department Headquarters. The Sparc 5 contains an SB-MIO-16E-4 multifunction board from National Instruments and runs the Trilon software, which is written using LabVIEW software.

The system monitors all channels for gunshot sounds, then computes the relative time delays between the detections on the different sensors. Then, the computer triangulates to find the gunshot location and displays it on a neighborhood map using the LabVIEW Picture Control Toolkit. A workstation and monitor are located in the police dispatch center so that operators can view the gunshot location and send officers to investigate the possible crime.

Technical Challenges

The technical challenges involved with this project included:

- Development of a robust and flexible data acquisition (DAQ) system.
- Design of a triggering system that would check all loud noises for gun

A Redwood City (CA) police officer tests the Gunshot Location System by firing blank ammunition while the SB-MIO-16E-4 card monitors nearby microphones.

shot but would quickly discard false events without disturbing the data acquisition.

- Creation of algorithms that can discriminate probable gunshots from the wide variety of urban noises reaching the sensors.
- Construction of a graphical user interface (GUI) that was useful both for the technical development and for use by police dispatchers. Although the dispatchers are familiar with computers, they are very busy. They require a simple user interface that remains separate from the data acquisition process.

LabVIEW was a natural choice for the tasks at hand – the built-in DAQ library provided a great starting point for creating a DAQ system that operates 24 hours per day, responds to triggers on any channel, and constantly monitors background noise. The noise measurements set trigger levels to confirm that the sensors and communication lines are operational.

The user interface capabilities of LabVIEW also helped us create a system that the dispatchers could easily use.

The triggering system responds when any channel crosses a level threshold and then checks the event for characteristics of a gunshot sound, such as a short rise-time. The locating software does not analyze the other channels unless the trigger signal could be a gunshot.

LabVIEW also proved essential to the process of creating useful discrimination algorithms. Urban and suburban environments contain many different sounds that resemble gunshots. Gunshot sounds may also have different characteristics, depending on local vegetation, the structures in the immediate area, and the sound path to the sensors. We tried several approaches; LabVIEW made it very easy to "wire" them right into our existing system. With its graphing capabilities, LabVIEW gave us the ability to visually observe how well the new algorithm performed.

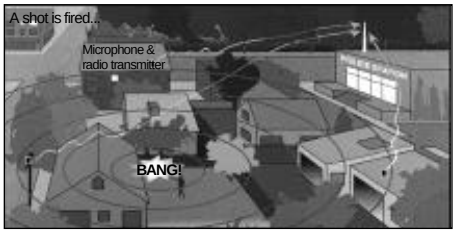
The user interface capabilities of LabVIEW also helped us create a system that the dispatchers could easily use. We converted AutoCAD maps of the city for use with the Picture Control Toolkit and used them to display the gunshot location on the monitor screen. Using global variables, we created a queue of events, so each gunshot remains visible on the map until cleared by a police dispatcher.

Project Status

Since the end of December 1995, Redwood City police officers have been firing blank ammunition from .38 caliber pistols and 12-gauge shotguns to test the system. For both types of weapon, the system can usually pinpoint the officer's location to within 15 meters. "So far, they have been able to locate us down to the intersection of where we are," said Sergeant Frank Wilkins of the RCPD. "If this takes off, it is going to be a great tool for law enforcement."

The major challenge has been to keep the system from spending too much processing time looking at other loud events, such as barking dogs. Occasionally, loud noise would occur on several channels, resulting in a false alarm.

Recent improvements have solved these problems and the system is now undergoing "real-world" testing. The test system had been set up in a separate room at the police station in order not to disturb the dispatchers but has now been moved into the police dispatch center. Police officers no longer shoot blank ammunition to perform the testing; rather, the system monitors for illegal and unpredicted gunfire.



Distributed sensors receive the sonic event at different arrival times, permitting LabVIEW to compute a precise location by triangulation.

After the system passes this advanced test, it will be ready for marketing to other cities that need help reducing their urban gunfire. The technology will pay for itself as businesses move back into the revitalized neighborhoods and increase the tax base. With the proper tools for enforcing the laws, police, residents, and businesses can work together to make these communities safe once again.

Jason Dunham is the Software Engineering Manager of Trilon Technology LLC of Los Altos, California, which is developing and marketing the Gunshot Location System. He can be reached at (415) 285-4391 or dunham@netcom.com for more information.