



Technology Out of the Blue

One place to find high-flying technologies under development by the U.S. Air Force is Rome, New York.

One place to find technologies being brought out of the blue and down to earth for use by law enforcement and corrections is also Rome, New York, at the National Law Enforcement and Corrections Technology Center (NLECTC)-Northeast's Law Enforcement Analysis Facility (LEAF).

LEAF was established in 1996 to evaluate, test, and demonstrate technologies developed by the U.S. Air Force Research Laboratory Information Directorate (AFRL/IF). At LEAF, engineers are using real-world investigative and criminal data to demonstrate how these Air Force technologies can be modified to benefit law enforcement and corrections.

Roy Ratley, LEAF senior program manager, says that law enforcement and corrections agencies submit audiotapes and videotapes to the facility for audio/video enhancement, noise reduction, and speaker identification. In addition, LEAF personnel analyze electronic databases using information extraction technologies for data mining, and database populations and timeline analysis to visualize and recognize event patterns. Ratley says to date, LEAF has completed more than 500 demonstrations to local, State, and Federal agencies.

Speech Enhancement. Developed by the Air Force to clarify pilot communications, the Speech Enhancement Unit (SEU) can automatically identify and eliminate audio interference due to impulse and tonal corruption and wideband random noise. Input signals are processed in real time, with a maximum system delay of 300 milliseconds. Originally using "black box" hardware, the SEU is now software driven and resides on a desktop or laptop computer. John Sargent, LEAF program manager, says the SEU is being used to make law enforcement patrol communications, body wire and other monitored surveillance recordings, and suspect interview and interrogation recordings more intelligible. The enhanced audio signal also reduces listener fatigue and communication errors.

LEAF provided an analysis demonstration to the Middletown (Connecticut) Police Department regarding a homicide investigation. An audiotape that contained information about the homicide had been damaged and the voices made incomprehensible. On reviewing the tape, LEAF engineers determined that the tape had been incorrectly rethreaded during a previous repair attempt. As a result, the audio played back backwards and at high speed. The audio was reversed and slowed, restoring normal speech. LEAF also provided an analysis demonstration to the Iowa Division of Narcotics Enforcement in Denison, Iowa, regarding a narcotics investigation. A noise-corrupted audiotape that contained information about the case was submitted for enhancement. Noise was reduced and the data amplified to improve its intelligibility. The conversation of interest was recovered and the tape became a deciding factor for the jury in convicting the defendant.

Speaker Recognition. Automatic speaker recognition technology identifies a speaker from a segment of his or her speech. Given a speech sample from an unknown speaker and a database of speech samples for which each speaker is known, the software compares the unknown speaker against the database to find the closest match. This capability is independent of the speaker's language or choice of words. Identifications can be made on as little as one word (approximately one-third of a second of speech). Sargent says law enforcement has used this technology to identify telephone speakers in sexual harassment cases, false reports of fires, and other illegal activities. The technology may also limit the intrusion of wiretap surveillance into private conversations.

LEAF provided an analysis demonstration to the Minnesota Department of Corrections (DOC) in an official misconduct investigation. The DOC wished to compare voice samples from an unknown speaker and a known suspect to confirm that both speakers were the same person. LEAF engineers used the speaker identification

technology to analyze the data provided by the DOC. The analysis gave administrators additional confidence in their evidence, and the individual charged was administratively removed from State service.

Timeline Analysis. Timeline analysis (TAS) renders events as graphic icons to show event patterns. In this technology area, AFRL/IF created WEBTAS (Web-based timeline analysis system) to analyze sensor intelligence regarding enemy aircraft and ground troops, according to James Hepler, lead TAS analyst. When utilized by civilian law enforcement, WEBTAS allows a user to plot and analyze criminal events along a timeline. Behavior patterns can be modeled from past events to show future probabilities of occurrence. Because WEBTAS can display data in graphs, maps, tables, and timelines, it is being evaluated as a courtroom presentation tool.

LEAF provided an analysis demonstration to the Oneida County (New York) District Attorney's Office for a homicide investigation. The district attorney's office wanted to construct a timeline depicting the critical events in the death of a 4-year-old child. Prosecutors wanted to show the jury that the pattern of physical abuse correlated with dates and times from statements made by the defendants. Timeline analysis enabled the district attorney to display to the jury the complex events relating to the homicide. The jury found the defendants guilty of criminally negligent homicide and endangering the welfare of a child.

Information Extraction. Converting paper documents to an electronic form, automatically extracting information, and then presenting the information in meaningful ways that capture patterns is the idea behind information extraction technology. Sargent says this process is called "named-entity extraction." It involves identifying words and word sequences in a document that form names and then categorizing them by their meanings. These words and word sequences are called "named entities." In the sentence, "Michael has worked for XYZ since 1987," Michael would be identified as a named entity and categorized as a person. XYZ would be identified as a named entity and categorized as an organization. Although nouns are not usually used to refer to times, dates, and monetary amounts, these can be spotted as well. Therefore, 1987 would be a named entity and categorized as a date.

In conjunction with an Arizona law enforcement agency, LEAF demonstrated that information extraction was technically feasible even when applied to 6,600 seized documents related to a money laundering investigation. LEAF is now demonstrating and evaluating

how to apply information extraction technology to meet other law enforcement and corrections requirements.

Also under research and development at LEAF for use by law enforcement and corrections:

Automatic Gisting. Automatic "gisting" is the capability of a computer to monitor speech for keywords that indicate certain activities. Gisting produces a "gist" or synopsis of the information in the communications. AFRL/IF has developed a real-time prototype gisting system which, in monitoring communications between pilots and air traffic controllers, can maintain a list of aircraft flight activities in which the aircraft are engaged (takeoff, landing, ground control). Sargent says automatic gisting of conversations may someday be useful for law enforcement and corrections surveillance. Because the gist of conversations can be acquired by a computer without a human listener, conversations could be monitored for indications of illegal activities with little manpower and without interfering with the basic rights of privacy.

Automatic Spoken Language Translation. Automatic spoken language translation is the translation of human speech by computer. A user speaks into a device that translates the speech into another language, and then outputs (speaks) the translation. Originally used by the AFRL/IF in military field interrogations, this device allows civilian law enforcement and corrections personnel to communicate with non-English speakers in their own languages, eliminating the time needed to locate an interpreter. It also makes the collection of critical information at crime scenes more efficient and makes interrogation easier and less costly. "ELSIE," a computer laptop program available for demonstration at LEAF, recognizes speaker-independent, continuous speech input within limited military and law enforcement domains. This device is unique in that it uses speech rather than type-written words as input to the translator, Sargent says. Future initiatives call for developing multilingual, multi-application capabilities as well as handheld models.

For more information about technology initiatives and assistance for law enforcement and corrections offered through the National Law Enforcement and Corrections Technology Center-Northeast, a program of the National Institute of Justice, and the Law Enforcement Analysis Facility, call 888-338-0584 or log on to JUSTNET at www.nlectc.org, the website for the National Law Enforcement and Corrections Technology Center system.

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