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The “Dual-Array” project sponsored by the United States Department of Transportation (U.S. DOT) has developed a new mobile system for underground mapping that combines an array of broadband electromagnetic induction (EMI) sensors with an array of ultra-wideband ground-penetrating radar (GPR) antennas. The system was designed for mapping infrastructure (utility networks) over large areas, but will also be useful for environmental surveying to detect leaks or map hazardous wastes. The specifications were based on applications such as subsurface utility engineering (SUE), which require accuracy on the order of centimeters in mapping utility networks that extend over kilometers. These specifications represent a dramatic increase over previous capabilities in geophysical mapping of infrastructure and have become feasible recently with the availability of rugged, affordable EM sensors, fast data acquisition electronics, and accurate position measurement systems.

The project was part of the Pipeline Safety Research and Development Program of the U.S. DOT Research and Special Programs Administration and was one of seven research contracts awarded in October 2002 in a new competitive partnership with industry. Several utility companies, including Consolidated Edison Company of New York and Regional Water Authority of South Central Connecticut, participated in the project.

The combination of radar and induction sensors enables better underground mapping in nearly all soils. Radar can detect and map both plastic and metal pipelines with high resolution down to depths of about 2 meters in normal (sandy-clay) soils; EMI sensors can track individual (metal) pipelines down to depths of 10 meters in all soil conditions. Radar and induction measurements taken together can often identify areas of unusual soil saturation.

The main new technology developed in the project is an EMI array consisting of 16 highly sensitive vector magnetometers (induction coils) with a flat frequency response from about 1 to 100 kHz. The sensors are normally arranged in two linear arrays, about 2 m wide and offset vertically by about 50 cm. The EMI array works with two types of transmitters: (1) “clamp-on” transmitters which inject current at discrete frequencies onto individual pipes for tracking by the sensors and (2) a 3-axis induction coil which rides “on-board” with the transmitters and induces currents remotely on underground pipes. The GPR array is based on the *CART Imaging System* developed earlier by Witten Technologies and Malå Geoscience. The CART has 16 independent radar channels and can operate with two different antenna sets: one set, at 200 MHz, produces 3D underground images with 10 cm resolution; the other set, operating at 400 MHz, produces images with 5 cm resolution. The system uses a laser theodolite to monitor position during surveys. A complete software package has been developed to process data from the sensor arrays to produce underground maps in either CAD or GIS formats.

Two large surveys were conducted with the dual-array system during the project. One survey in April 2004 successfully mapped a complex network of subsurface water, electrical, gas and telecommunication lines in Connecticut for a local water utility. This survey covered over 2000 sq m with radar traces on a 10 cm grid and EMI data on a 30 cm grid. A second survey done in July 2004 mapped lines emerging from an electrical substation in New York.

The final project brief will take place at the U.S. DOT offices in Washington, DC, on January 12, 2005, and will also be webcast. The agenda and instructions for participating are posted on the project website: <http://www.wittentech.com/DualArray.html>.

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