Vol 14 #1 OST.

Averting Excavation Disaster

Catherine Carver, Leonhard E. Bernold, Member, ASCE, and Steven J. Lorenc

Accidents do not have to cause loss of life or limb to make headlines or to put a company out of business. Damage done to underground utilities is a case in point.

In one such incident, a North Carolina gas pipeline was cut accidentally and was out of service for six hours. A local newspaper reported the cost of repair at $15,000, but when the actual cost was analyzed by the Construction Automation and Robotics Laboratory (CARL) at North Carolina State University, the total amounted to over $300,000, or more than $50,000 per hour of repair time, not including legal fees resulting from the incident.

Not many businesses can sustain such an appallingly high cost for long. Naturally, it makes sense for contractors working around utilities to avoid causing and being financially liable for damages to utilities in the first place.

CARL, under the direction of Leonhard Bernold, has focused its attention since 1990 on developing a tool to detect underground utilities before accidents happen. Working with graduate student Xiaodong Huang, Bernold has created an instrument capable of scanning a work site for utilities that contractors can attach directly to digging equipment.

The instrument, named the Buried Utility Detection System (BUDS), acts as a second-tier system that can be deployed after local utility company personnel have marked all known underground lines.

The system gives excavator operators the ability to check marked areas on their own in order to reevaluate a work site for utility lines that may have been marked incorrectly or that were not known to exist in the excavation area. As a backup safety measure, the system can help reduce or eliminate damage to underground utilities and the resulting costs of such damage.

The detection system technology

Bernold began the development of the detection system eight years ago by adapting a specialized metal detector to scan for buried utilities. Most metal detectors operate poorly in the presence of extraneous pieces of metal, so the challenge in creating a tool suitable for the excavation industry was solving the problem of attaching a metal detector to equipment composed almost entirely of metal, such as a backhoe, and still having it retain the ability to sense the proximity of other metallic objects buried in the ground. At an annual meeting of the Aggregates Association, Bernold found a solution in the quarry industry's metal detectors, patented by Pulse Technology Inc. of Abingdon, U.K.

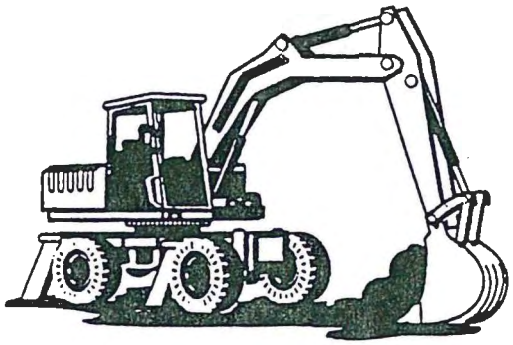
Quarried rock is sometimes sent to a crusher for processing. The costly crushers are designed to process only rock, and their bearings can be destroyed if they encounter scrap metal instead, which can happen when power shovels lose teeth during a quarrying operation and the broken teeth, mixed with rock, are sent onto the conveyor belt to the crusher. To prevent such expensive mishaps, the industry has designed metal detectors for the conveyor belts passing to the crusher. The quarry metal detectors operate on a coil system, with the coil generating its own magnetic field under pulse induction to sense the presence of ferrous and nonferrous materials.

Bernold and Huang used the coil principle to construct a metal detector system specifically for buried utilities. Working with scrap and the donation of one controller unit from Pulse Technology Inc., they devised a system that consists of an active metal detector, a controller, an analog-to-digital converter and PC-based software to process and analyze the controller signals.

The analog output of the controller is digitized and plotted on the computer screen, and the detector is initialized to filter out the effect of existing metal. Contractors can retrofit the system to a backhoe excavator or other digging equipment, as well as to tools such as trench-

A UTILITIES LOCATION AND DETECTION SYSTEM CAN DECREASE ACCIDENTS AND THE COSTS THAT GO WITH THEM.

Catherine Carver is spokesperson and technology transfer expert for the Construction Automation and Robotics Laboratory (CARL) at North Carolina State University, Raleigh. Leonhard E. Bernold is associate professor of civil engineering at North Carolina State University, Raleigh. Steven J. Lorenc is associate director of technology development at CARL.



ers, and can opt for simpler warning devices if it is not possible to attach a computer monitor to the equipment.

DuPont Co., of Wilmington, Del., offered financial support for the transfer of the technology for commercial use, and the city of Raleigh, N.C., awarded a contract for the system to Bernold and Huang. Once the city's system was built, field tests demonstrated the coil's ability to detect buried pipe successfully when mounted on either a backhoe or a trencher, and also offered some insight into how the system's design could be changed to make it easier for operators to use in the field.

Status and future developments

Although there have been some problems in establishing intellectual properties, CARL, in conjunction with North Carolina State University's administrative body, has committed itself to the development and the future transfer of the utility detection technology to industry. The university has formed a consortium with BellSouth, Birmingham, Ala., with the goal of producing an experimental prototype for locating and detecting a variety of buried utilities. The consortium also has the aim of receiving feedback from users in the field and making improvements in the applicability and reliability of the technology.

Because the consortium's view is that the present system represents only a primitive, but working, prototype, its members are working to refine and expand its capabilities. Further testing by excavation operators is planned, with the intent of adding new capabilities as the feedback is analyzed.

According to Bernold, if special sensors are added, the system has the potential to expand from basic metal detection to the ability to locate and detect tracer wires and distinguish between different utilities, such as gas and electric power lines. Another potential application, demonstrated by Bernold and colleague Steven Lorenc in 1996, is the detection of unexploded ordnance. If the application is refined, the system could be used on military firing ranges or in former war zones.

To test reliability and accuracy and to determine the markets it should target when the system is made available commercially to the industry, CARL is soliciting feedback on the operating system from excavator operators and other engineers in the fields of robotics, ergonomics, mechanical and electrical engineering and geophysics. The consortium hopes to make a marketable prototype for a variety of applications by 1999.

Disseminating information

For safety reasons and because of the enormous threat utility accidents pose to businesses, the consortium is working to educate the public on all ways of preventing utility damage in addition to disseminating information about the new detection system. In November 1995, CARL hosted the annual Underground Damage Prevention Seminar for contractors that carry out this type of location work. The seminar brought over 150 industry employees and vendors of underground locating devices to North Carolina State University for information on the latest equipment and legal efforts meant to protect underground utilities. The laboratory showed video footage of the detection system research site to those assembled and explained how the system worked.

As a follow-up to the seminar, Catherine Carver of CARL organized bimonthly workshops on underground damage prevention throughout 1996. Technicians doing location work, utility owners and utility operators were able to earn one CEU (continuous education unit) credit for each workshop they attended. These workshops, led by Gary Guthrie of Utility Technical Services of Wilmington, N.C., continue to be held and the current calendar is available from CARL upon request.

The CARL office is available to take comments and fill requests for information at 919/515-3677. The laboratory's Web site can be reached at http://www2.ncsu.edu/ncsu/CIL/CARL.

Title: JOURNAL OF MANAGEMENT IN ENGINEERING
Status: Active
Subject: ENGINEERING
Abbrv Ttl: J. manage. eng.
Added/Corp: American Society of Civil Engineers. **Engineering Management** Division.
Date/Vol: Vol. 1, No. 1 (Jan. 1985)-
ISSN: 0742-597X
Ser type: Periodical
Country: US
Language: English
Frequency: Six times a year
Price: $162.00
Publisher: American Society of Civil Engineers / ASCE
345 East 47th Street
New York, NY 10017
Telephone: (212)705-7539, (800)548-2723, EMAIL: pubsful@ny.asce.org, Fax: (212)705-7300
Subs Addr: American Society of Civil Engineers, Publisher Fulfillment Agency, Box 828, Somerset, NJ, 08875. Telephone: (800)548-2723, (212)705-7539.
Ind/Abstr: Academic Search FullTEXT Elite., Academic Search FullTEXT Elite [EBSCOhost]., Academic Search FullTEXT Premier., Academic Search FullTEXT Premier [EBSCOhost]., Academic Search FullTEXT Select., Academic Search FullTEXT Select [EBSCOhost]., Canadian Magazine Article Summaries [EBSCOhost]., Current Citations [Computer File]., Ei Page One., **Engineering** Index Annual., EP Collection [Computer File]., Expanded Academic Index [Computer File]., International Development Abstracts., Social Sciences Citation Index. (Select Cov.), Telebase [Computer File].
LC Class: TA
DD Class: 620
UDC Class: 62
CODEN: JMENEA
CONSER: 10381678
Ind Avail: (Index available)
Cum Indx: Yes
Bk Review: No
Advertise: No
Circulation: 4,900
Reg CCC: Yes
Other formats: on microfilm and microfiche from University Microfilms International (UMI), on CD-ROM from American Society of Civil Engineers
Descript: Topics include project **management**; department, branch and office **management**; financial **management**; marketing; computer systems **management**; productivity **management**; budgeting; and **management** development.

Field Studies with Innovative Safe Excavation Technologies

Leonhard E. Bernold, Ph.D.
North Carolina State University
College of Engineering
Department of Civil Engineering
Raleigh, North Carolina 27695-7908

Control Technology and Personal Protective Equipment
5 R01 CCR413051-02
09/30/96 – 09/29/99
$105,744 ($318,653 Cum)

Publications

Lorenc SJ, Lee J, Bernold LE: Tele-Operated Pipe-Laying Attachment. Robotics, p. 188-194, 1998

Lorenc SJ, Bernold LE: Smart Attachment for Utility Damage Prevention. Robotics, p. 140-146, 1998

Carver C, Bernold LE, Lorenc S: Averting Excavation Disaster. Journal of Management in Engineering, p. 29-30, 1998

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service
Centers for Disease Control
and Prevention (CDC)

Memorandum

Date August 19, 1998

From Stephanie L. Shack, Grants Program Assistant _____
Office of Extramural Coordination and Special Projects, NIOSH

Subject Publication(s) Submitted for Entry into NIOSHTIC Data Base
NIOSH Grant 5 R01 CCR413051-02

To William D. Bennett
Information, Acquisition and Data System Section (IADSS), TIB, DSDTT, NIOSH

The attached publication(s) have been received from the principal investigator on the subject NIOSH grant. Please determine if this document should be entered into the NIOSHTIC data base.

Attachments
Publication(s)
List of Publications