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REMOTE SITE SURVEY AND CHARACTERIZATION FOR THE NATIONAL ER&WM PROGRAM USING THE SRIP VEHICLE

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ABSTRACT

A significant number of Department of Energy (DOE) production and research sites will require remediation of buried waste sites during the coming years. An important first step in cleanup, restoration, and decontamination activities is burial site characterization. An early field demonstration of buried waste site survey and characterization will be conducted using a remotely operated vehicle equipped with sensors, a manipulator system, and a vision system. This demonstration will be conducted in July 1990.

INTRODUCTION

A significant number of Department of Energy (DOE) production and research sites will require remediation of buried waste sites during the coming years. The volume of buried waste and contaminated soil to be excavated, characterized, and repackaged will total hundreds of millions of cubic feet. Buried waste includes many hazardous materials including asbestos, pyrophorics, explosives, and inorganic chemicals in addition to radiation contaminated materials. Because of the variety and extent of hazards, remote excavation, segregation, handling, and perform subsurface characterization, repackaging are required. A wide array of sensors are required to environmental monitoring,control of robotics equipment, dig face characterization, and task planning. Preliminary investigations of waste sites have demonstrated that dumping manifests are of limited use in determining locations of buried items due to settling and shifting of trench boundaries.

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Burial site characterization is an important first step in cleanup, restoration, and decontamination activities. An early field demonstration of buried waste site survey and characterization will be conducted using a remotely operated vehicle equipped with sensors, a manipulator system, and a vision system. The use of remote technology provides a means for initial identification of potential hazards before personnel enter the site. The demonstration will provide a means for evaluating the applicability of sensor systems to remote operation and for improving productivity through future automation.

SRIP VEHICLE

A vehicle developed by the U.S. Army for the Soldier Robot Interface Project (SRIP) will be utilized for the demonstration. The SRIP vehicle (Fig. 1) was developed as a research testbed to be used as a tool for studying mobile robotics with respect to military applications. The vehicle is an eight-wheeled, skid-steered utility vehicle powered by a 15-hp diesel engine. The vehicle was modified extensively from its purchased configuration to accommodate the addition of a manipulator and the onboard electronics required for remote operation as a research testbed. The manipulator consists of a 3-degree-of-freedom (DOF) arm (Fig. 2) developed by Odetics, Inc. and a 3-degree-of-freedom wrist designed by ORNL. The arm has a 2.4-m reach and a 136-kg capacity. The wrist, which will not be fabricated in time for this demonstration, will provide a lift capacity of 100 kgs while weighing 36 kgs. Being a research vehicle, an onboard power conversion system with 110 V ac and a number of dc voltages is available. The vehicle control system is based on the National Institute of Standards and Technology (NIST) remote control structure (RCS) architecture. The RCS has been implemented on VME busses (two on

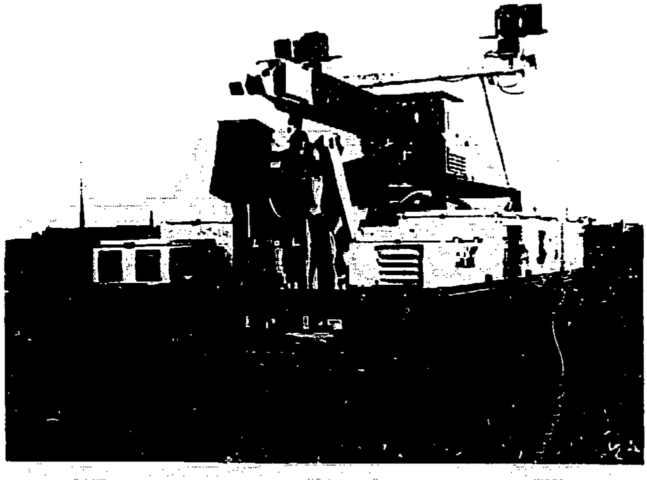

Fig. 1 The SRIP Vehicle.

Fig. 2. The Odetics 3-Degree-of-Freedom.

board and a third at the control station) using Motorola 68020 processors. A radio-frequency communications link has been added to replace the original fiber optics data and video link. The bidirectional data link operates at 416.25 MHz at 19.2 kilobauds. The two video links operate between 1.710 and 1.850 Ghz.

USRADS

The Oak Ridge National Laboratory (ORNL) ultrasonic ranging and data system (USRADS) will be used to determine xy position on the test site and to transmit sensor data by radio to the USRADS control station. The USRADS was developed to facilitate collection of radiological and geophysical data at hazardous waste sites. It consists of a surveyor's backpack with an ultrasonic transmitter and instrumentation interfaces, a portable computer (PC) with an rf link to the backpack, and up to 15 stationary ultrasonic receivers. An ultrasonic signal emitted by the backpack triggers the receivers to send a radio signal to the PC indicating reception of the signal. The time-of-flight data from the receivers is used to determine the position of the surveyor in the test site, which is correlated with the sensor data transmitted from the surveyor's backpack. A real-time plot showing the position of the receivers and the surveyor is displayed on the PC screen, and sensor readings above a predetermined threshold are highlighted on the screen. A major advantage of USRADS over conventional geophysical surveys is the ability to analyze data in the field. Fig. 3 shows a surveyor carrying the USRADS backpack and the Geonics EM-31 terrain conductivity meter during a field survey.

DEMONSTRATION

Extensive modifications to both SRIP vehicle hardware and software have recently been completed. The modifications were necessary to integrate the manipulator and improve system reliability and maintainability. Integration of the USRADS with the SRIP involves integrating the surveyor's backpack and the vehicle and setting up communications between the SRIP console and the USRADS PC. The xy-position data from the USRADS console is passed to the SRIP console through this communications link. The positioning data will be utilized to update the on-board position data, which in turn will be utilized in implementing autonomous path generation and following.

Fig. 3 Surveyor Carrying the USRADS Backpack and Terrain Conducting Meter.

As stated previously, a wide array of sensors are required to characterize the site and identify potential hazards. Instrumentation to identify the presence of surface radiation, gas vapors that might present explosive or breathing hazards, and buried metallic objects and geological anomalies have been chosen for this demonstration. The instrumentation to be used is

1. Victoreen gamma survey meter with a NaI detector
2. photoionization trace gas analyzer
3. Geonics EM31 terrain conductivity meter for detecting buried metallic objects and geological anomalies.

Future demonstrations may also utilize an x-ray florescence spectrometer and/or magnetometer for measuring the presence of heavy metals (e.g., lead, arsenic) in soils.

The demonstration will be conducted on ORNL's Solid Waste Storage Area Four (SWSA 4) (Fig 4). The site, which is 23 acres, served as a national burial ground from 1951 to 1959. During that time 2 million cubic feet of low-level waste including equipment, depleted uranium, and animal carcasses was buried in SWSA 4. Cesium, cobalt, strontium, and plutonium have been detected on the site. The demonstration will be run on portions of the site that have no surface contamination.

For the demonstration the SRIP and USRADS consoles will be placed in a truck parked outside the SWSA 4 fence with a portable generator to provide power for the two systems. The two consoles will be positioned side by side and will have a serial link for passing the vehicle position from the USRADS to the vehicle control system. Otherwise the two systems will operate independently with an operator for each.

The demonstration scenario will begin with placement of the USRADS stationary receivers around the perimeter of the test site. Four receivers will be placed at the corners of an area ~ 200 feet square. The vehicle will be driven in a teleoperation mode to a corner of the test site. The location of the corners of the test site will be calculated by the USRADS system and downloaded to the vehicle for use in on-board navigation. The vehicle will survey the site in a semi-autonomous mode while its position is updated from the

Fig. 4 Aerial View of SWSA 4.

USRADS once every second. The speed of the vehicle will be limited to 3 to 5 km/h while the ground in front of the vehicle is scanned with the sensor package. A slow vehicle speed is required because of the update rate from USRADS. The arm will be used to scan the ground in front of the vehicle while holding the gamma detector and gas vapor detector. The terrain conductivity meter, due to sensitivity to orientation with respect to the vehicle, will be held in a fixed position, relative to the vehicle, by the arm. The vision system will scan the test site for possible obstructions. In the event an obstruction is detected, the operator will take control of the vehicle and teleoperate the vehicle around the obstruction before restarting the autonomous survey. The USRADS display will indicate the presence of the vehicle with respect to the test site boundaries. If any preset safety or control limits are exceeded during the survey, the operator will have the option to pause and evaluate the situation, abort the survey, or continue.

The results of the survey will give personnel an indication of potential hazards and the locations of buried materials. These results will be compared with results of previous surveys of the test site.

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