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A Decision Support System for the Selection of Imaging Technologies to Detect Undergraound Utilities: IMAGTECH

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The Need

Utility demand in the United States is projected to expand three percent annually to 183 million feet of utilities in the year 2003, with a valuation exceeding $7 billion (Sterling 2000). The urban underground has become a spider's web of utility lines, including phones, electricity, gas, cable TV, fiber optics, traffic signals, street lighting circuits, drainage and flood control facilities, water mains and waste water pipes.

Damage to underground utilities during construction results in undesirable consequences to contractors, project owners and citizens. These consequences include construction delays, design changes, claims, property damages, service breakdowns, disruption of neighboring business and even injuries and lost lives. Subsurface utility mapping is becoming an essential process to reduce the adverse effect before construction starts. Since records about utility positions are virtually nonexistent, or often incomplete and inaccurate with errors as high as 15-30% (Stevens and Anspach 1993), the ability to physically determine on-site the location, nature and depth of underground utility services is critical.

However, a wide variety of geophysical imaging technologies and different application conditions pose challenges in selecting appropriate imaging technologies for the successful identification of underground utilities. Hence, it is necessary to design a decision tool in order to provide site engineers/technicians, who do not have good knowledge about the theory and applications of each imaging method, with a user-friendly tool for selecting appropriate imaging technologies.

The Technology

A prototype computer decision tool, named IMAGTECH, was developed to assist in selecting the most appropriate imaging technologies to locate underground utilities. This dialog based computer application in a Microsoft Windows environment is an output of the research “Imaging and Locating Buried Utilities” under the Joint Transportation Research Program (JTRP) at Purdue University, IN, funded by the Indiana Department of Transportation (INDOT). The major objectives of this study were (a) to identify, through literature review and case studies, the state-of-the-art and

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the state-of-the-practice imaging technologies that have potential for being applied in locating underground utilities, and (b) to analyze the conditions under which the use of these technologies is most appropriate because not all technologies can locate all types of utilities, or be used in all types of soil or at all depths.

Figure 1 displays the system architecture of IMAGTECH.

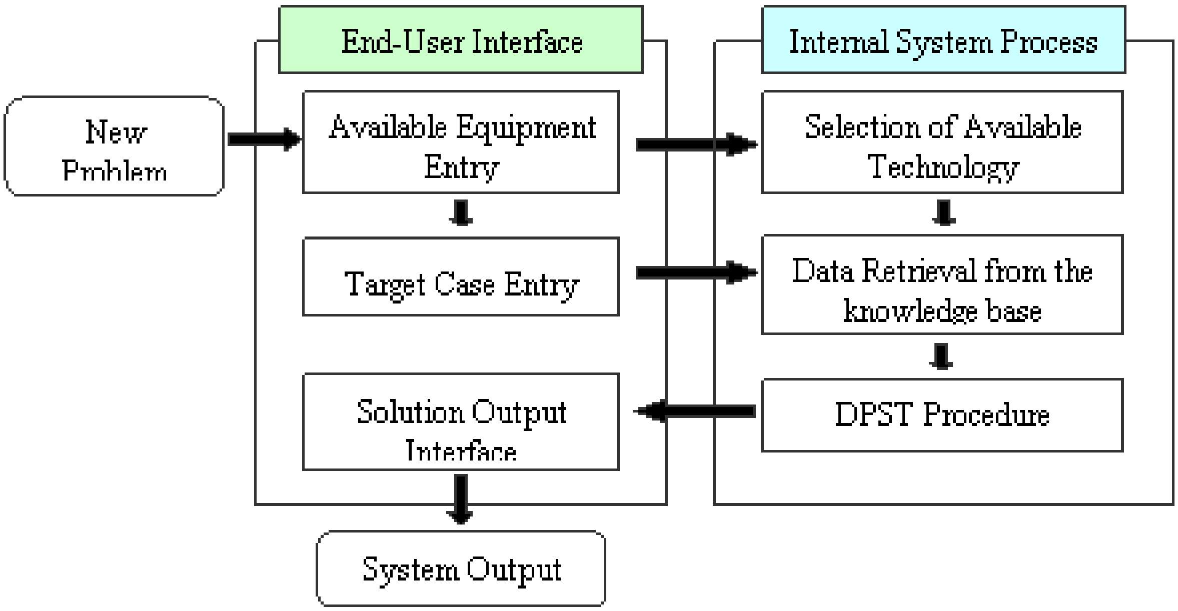

FIGURE 1 SYSTEM ARCHITECTURE OF THE IMAGETECH

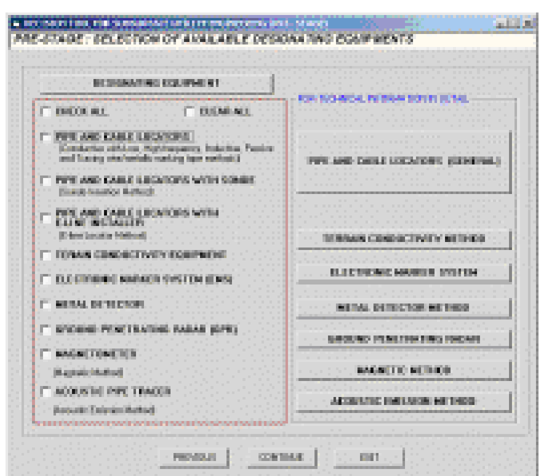

FIGURE 2. SAMPLE INPUT SCREEN FOR IMAGTECH: PRE-STAGE

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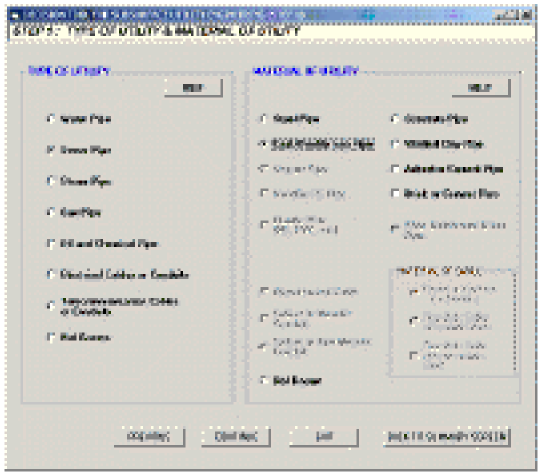

FIGURE 3. SAMPLE INPUT SCREEN FOR IMAGTECH: STEP 1

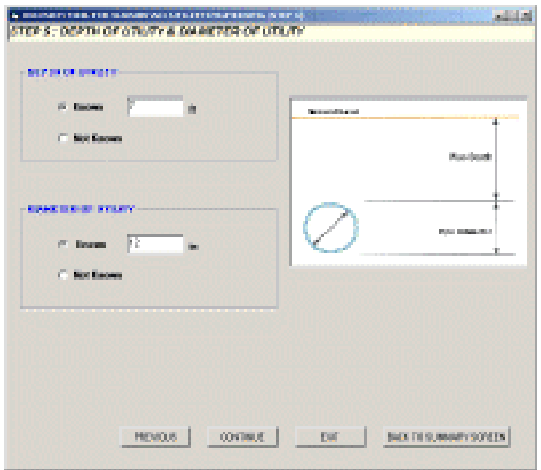

FIGURE 4. SAMPLE INPUT SCREEN FOR IMAGTECH: STEP 5

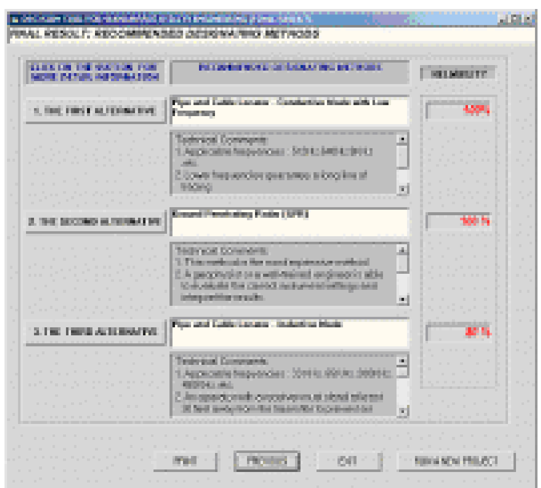

FIGURE 5. SAMPLE IMAGTECH SCREEN SHOWING FINAL RESULT

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The first stage in this process seeks information about the available type of equipment by the utility locating team. This process enables the system to limit candidate imaging technologies to only selected equipment based methods. Site conditions and utility features are also specified during the target case entry process. A comprehensive analysis of the characteristics of each imaging technology and available information that site engineers can obtain from as-built drawings and site visits led to identification of ten significant criteria that are fundamental for the selection of appropriate imaging technologies. These criteria include:

- Type of utility
- Material of utility
- Joint type of metallic utility
- Special material for detection
- Access point of utility
- Ground surface condition
- Internal state of utility
- Soil type
- Approximate depth of utility
- Diameter/depth ratio

The "not known" option can be selected for each criterion if specific data regarding that criterion is not available to the user. In such cases, the Reliability Index (RI) for each case is lowered since a neutral value is assigned to the criterion.

Some criteria are correlated with other criteria. For instance, the type of utility governs the range of materials used for the utility. In such cases, the selection of the former criterion activates or inactivates each entry in the latter criterion. Based on the input values and the knowledge base, IMAGTECH suggests the most appropriate imaging technology and two alternatives. The RI is also presented for each proposed imaging technology. Sample input and final screens are shown in Figures 2 and 3. For detailed description and discussion about the decision process and IMAGTECH, please refer to Jeong and Abraham (2003).

Benefits

IMAGTECH can be used in practice for training incoming engineers within DOT to upgrade their knowledge of the imaging technologies. This tool can be also employed to check on a SUE project to see if they are following a logical sequence in their field work. From the perspective of SUE consultants, IMAGTECH can be an excellent tool to select the most appropriate technology for novice engineers in field who are not familiar with the technical specification of the different imaging technologies or to ensure that their utility imaging technology chosen is comprehensive and accurate.

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Status

IMAGTECH is a partial output of the research "Imaging and Locating Buried Utilities" under the Joint Transportation Research Program (JTRP) at Purdue University, IN, funded by the Indiana Department of Transportation (INDOT).

Barriers

Imaging technologies are not magic wands. The complexity existing in the selection of the most appropriate imaging technology stems from the inherent shortcomings of each imaging technology. There have been strong efforts in industry for a new and robust imaging technology which can overcome these drawbacks. Since IMAGTECH is knowledge based, if new technical specifications of imaging technologies are not incorporated properly and timely, the decision made through the IMAGTECH may not be the most appropriate one.

Points of Contact

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