Obstacle Detection During HDD Operations

Kiran Kothari, Gas Technology Institute

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Obstacle Detection for Horizontal Directional Drilling (HDD)

- Significant increase in the use of HDD for laying pipes
- Knowledge of various objects in front of drill head is critical to avoid hits
- Horizontal drilling heads can penetrate other obstacles such as sewers, plastic gas pipes, electric lines, or fiber optic cables
- Presentation will discuss progress on detecting obstacles during HDD operations

Obstacle Detection Technologies

- Ground Penetrating Radar (GPR)
- Integrated Acoustic - Electromagnetic
- Differential Impedance

Objectives

- Sensitivity to obstacles 6 to 10 feet ahead
- Package sensor for testing on or with drilling rig
- System cost ($5K-$8K), i.e., cost no more than 10% of the entire drilling machine
**GPR Concept**

- Gas pipe
- Forward looking GPR
- 6-10 ft

**GPR for HDD**

- **Radar**
  - Small and robust electronics packaging
  - Size started at 26", then to 19" currently at 17"
  - Easily used operating software
  - Improved display
- **Antenna**
  - Increased power transmission into ground
  - Improved clutter suppression for clearer images
  - Better coupling reduction for improved target detection
- **Mechanical**
  - Improved downhole communication system

**Acoustic/EM System**

- Detect and locate underground utilities using sonics and electromagnetic sensors
  - PE, sewer and water pipes
  - Metallic pipes
  - Telephone, cable, fiber optics and electrical conduits
- Integrate sensor technologies with horizontal directional drilling (HDD) operation

**Acoustic/EM status**

- Design, fabrication, and testing of acoustic system complete
- Wireless interface for active detectors installed
- Acoustic system with data fusion delivered for testing
- Design, fabrication, and testing of noise maker complete
- Test fields of pipes installed
- All electronics and non-magnetic jet head designed and assembled
- Factory testing of FFT detections complete
Differential Impedance Sensing

> Obstacles in the soil cause changes in the soil impedance

Differential Impedance

> Advantages
  - High sensitivity to plastic pipe
  - Use of drill head to inject signal current minimizes modifications to drill
  - Eliminates any blind spot dead ahead
  - Low frequency of operation allows lower cost electronics
  - System self-contained, requiring no sensors on the surface and no "walker"

> Disadvantages
  - Poor imaging compared to GPR
  - Has to improve for false positives, e.g., dry voids in soil

DI Results

> Sensitive to sense 4" plastic pipe through 3 feet of intervening soil
> Orientation of the pipe to the sensor resolved
> Sensitivity to objects greater on the sides of sensor than dead ahead
> Effects of soil characteristics on field lines greater than originally anticipated
> Additional improvements with the use of finite element simulation technique

Conclusion

Parallel path approach for the challenging development on obstacle detection technology for HDD operations

Questions?