Digital Imaging for Characterizing Pipeline Defects

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Abstract

A new application that uses digital subsurface imaging technology was recently introduced to the pipeline industry for the inspection and assessment of pipelines.♦♦ This technology uses a high-resolution, digital optical scanner, a continuous, directionally-oriented, 360-degree scanned visual image so that the interior surface of the pipe is recorded.♦ The 360-degree scan of the interior pipe wall provides an accurate record of the pipe condition that is critical for effective pipeline condition assessments and rehabilitation recommendations.♦ The system also provides accurate inclination and meander data via on-board sensors to characterize the vertical and horizontal deflection of the pipe.♦ Images are recorded in the field and sent to the office for analysis and reporting, which reduces the impact to field conditions that affect traffic and access.♦

Pipeline repairs and rehabilitation using trenchless technologies can be cost-effective alternatives to open trench replacement.♦ However, the cost savings realized from using these methods can be reduced, completely negated, or cost more because of inaccurate condition assessment data.♦ Erroneous or incomplete condition assessment data has resulted in the use of more expensive lining methods when only point repairs were needed and, conversely, point repairs when full rehabilitation or repair was required.♦ Accurate, comprehensive, and reliable condition assessment data is essential for the recommendation of cost-effective, appropriate rehabilitation methods that result in lower change orders during construction to public agencies.

The commercial version of the digital imaging technology, called Sewer Scanner and Evaluation Technology, SSET™, includes the field data acquisition using patented equipment and software, and data analysis and interpretation using licensed analysis software that allows multiple user views of the data, a customizable defect coding system, and user-defined reporting options.♦

This paper describes the equipment and software features, presents a history of the digital optical scanning technology in the pipeline industry, and compares the advantages of SSET to conventional closed-circuit television inspection.♦ Details of recent projects are provided where SSET was selected due to some of the unique features offered by this system.♦ For example, a storm drain inspection project in Los Angeles required the ability to scan and measure the width of joint separations that resulted in FEMA funding to repair the defective joints.♦ Another project on the east coast required accurate documentation of all defects for an agency under ♦Cease and Desist♦ order and the 360-degree side scan provided the desired level of accuracy and documentation.♦

Introduction

The need for the SSET technology was driven by the inconsistency of CCTV data and to take pipeline inspections beyond CCTV in features and adaptability of the data.♦ Data is used these days for a multitude of applications including rehabilitation analysis, facility maintenance, GIS mapping, hydraulic modeling, and inventory control, just to name a few.♦ Therefore, the collection and transfer of data must be accurate and flexible for a variety of applications.

Advantages Of Sset

In general, digital tools have numerous advantages over analog tools and pipeline inspection tools are a no exception. The benefits of the digital scanner over the conventional analog CCTV include consistent, high-quality images, are amenable to computer-assisted quantitative analysis and easy and compact archiving.

The qualities of the captured images are consistently higher and less dependent on the varying ability of field operators because of the way in which optical scanners proceed through the inspection process.♦ Because the data captured by SSET are all in digital form, they are readily amenable to computer-assisted and/or automated analyses. A Java-based computer-assisted analysis program is already in use. Digital

images can be compressed and stored on CDs or DVDs, unlike the video cassette tapes that are necessary to store analog CCTV images. The efficient nature of the side scan image allows for the larger volume of stored data on one disc.

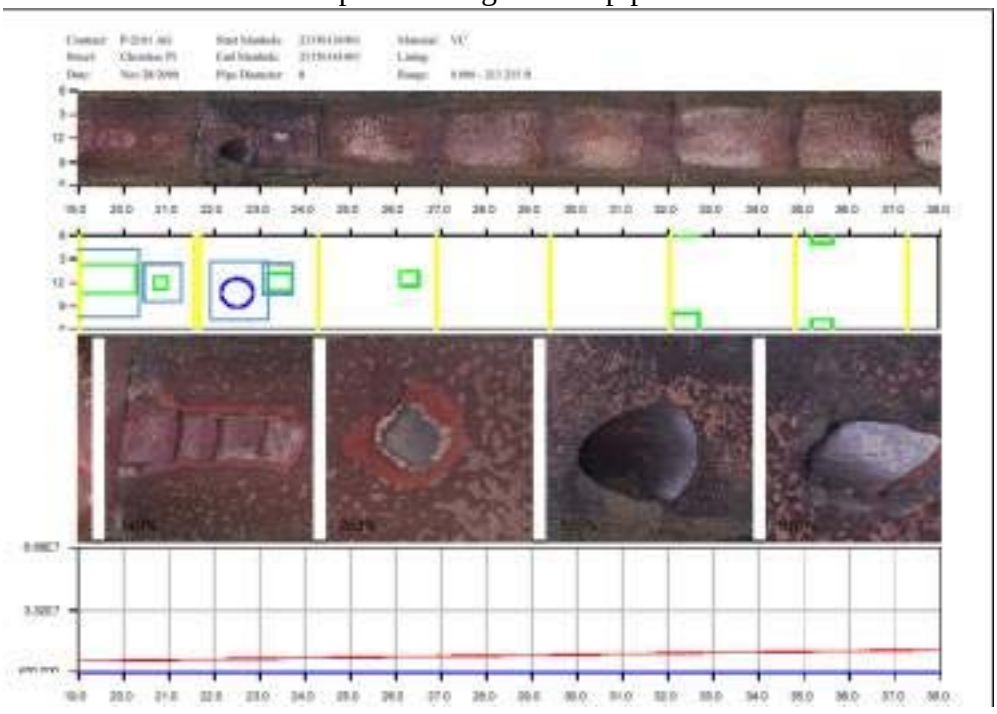
Equipment and Software Features

A significant improvement from the first- to the second-generation SSET was the change to no moving parts.&#65533; This greatly improved performance reliability and image scanning.&#65533; The second-generation probe also moved from CCTV for forward image to 3CCD and integrated the forward view in data capture. A fish-eye lens is used to capture the hemispherical, 360^{o} side scan view, an annular segment of the image that crosses the preset scanning region is sequentially scanned in, digitally cut, flattened and concatenated to provide the unfolded picture of the entire length of a pipe.

The 3rd generation equipment design also incorporates white LEDs as the light source. It is interesting to note that LED technology had not advanced to their current state until after 1998, so halogen lamps were still used in the second generation SSET. The white LEDs emit very high color temperature light that is close to the sunlight, which means that the colors of the captured image are close to the true colors and are extremely energy efficient and produce very little heat. LEDs have a much longer operating life than halogen lamps and are commonly used with conventional CCTVs that give yellow tint to the image.

Conclusions

Digital optical scanning technology has come of age in the pipeline inspection industry. After rigorous testing and prototyping development, the present commercial version of the SSET system has been extensively field-tested. SSET continues to take advantage of the advancement of digital and optics technology. Digitization is the key for consistent and standardized inspection/diagnosis of pipelines.



If you have any questions, please contact **Dr. C.Vipulanandan**