

Non-destructive testing with data-based measurement for structural safety

: toward real-time measurability with reliable accuracy

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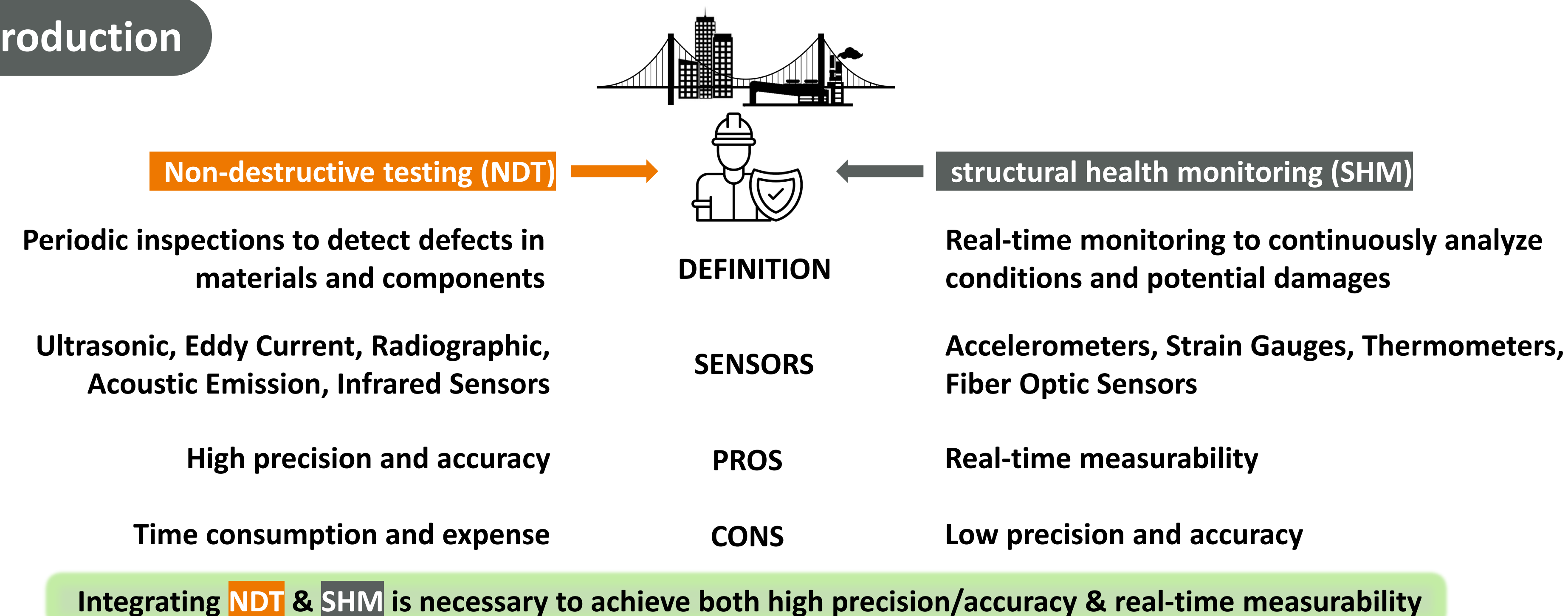
Abstract

The increasing deterioration of structures, mechanical systems, and critical facilities necessitates accurate condition measurement to ensure safety and prevent failures. **Non-destructive testing (NDT)** and **structural health monitoring (SHM)** technologies have been developed to address these concerns. However, conventional approaches often face limitations in achieving both **real-time measurability** and **high precision/accuracy** due to their independent evolution.

To overcome these challenges, it has been actively researched on **integrating NDT and SHM** by leveraging **artificial intelligence (AI)** and **digital transformation (DX)** technologies, which can result in reliable measurement with high accuracy. However, challenges such as the need for high-quality training datasets and model interpretability still need to be addressed for AI. **Standard Reference Data Center for NDT of Defects** can be a promising approach to create standardized reference data for defect detection. In addition, high computational costs and the complexity of accurately modeling physical phenomena remain challenges for DX. To overcome the issues, it has recently been developing computational frameworks to enhance cost efficiency while maintaining high precision with digital calibration to sensors.

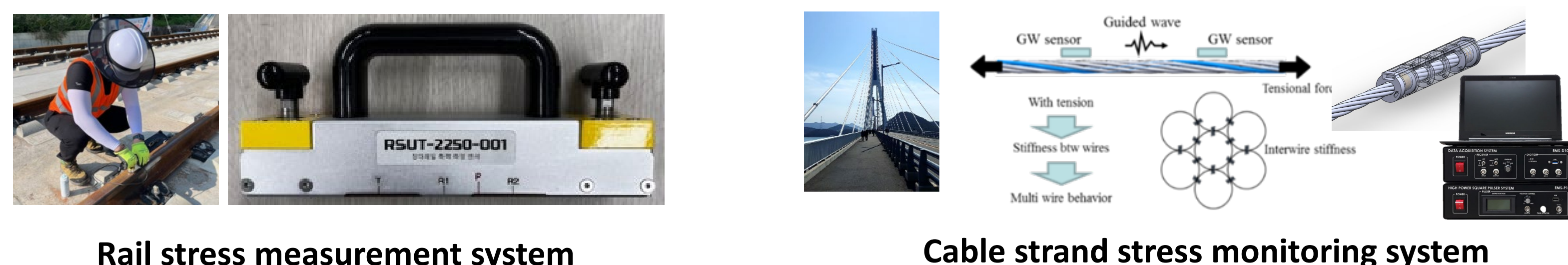
By continuously conducting research on reference data standardization and AI/DX technology development, it is highly expected to achieve reliable in-situ measurability and high precision/accuracy across various engineering fields, including civil structures, mechanical systems, and facilities. As this research explores a novel approach, ongoing discussions are needed on reliability and accuracy evaluation methods based on measurement uncertainty to establish measurement standards.

Introduction



NDT & SHM technologies

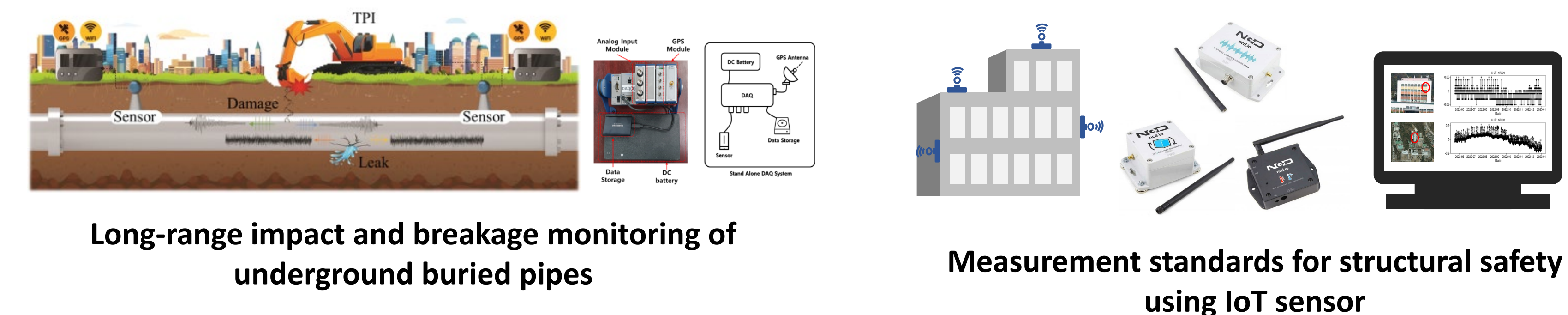
- Micro/macro behavior monitoring and critical member inspection technologies are important to maintain the structural safety of infrastructure.
- NDT** & **SHM** technologies at KRISS have been advanced for measuring physical quantities related to structural safety and working to establish measurement standards.



Rail stress measurement system

Cable strand stress monitoring system

- The quality of the measured status data such as deformation, stress, vibration, crack, and corrosion directly affects the reliability of the structural diagnosis.
- AI** technology can integrate intermittent NDT measurements with continuous SHM data to provide a more comprehensive and high-quality assessment of conditions.

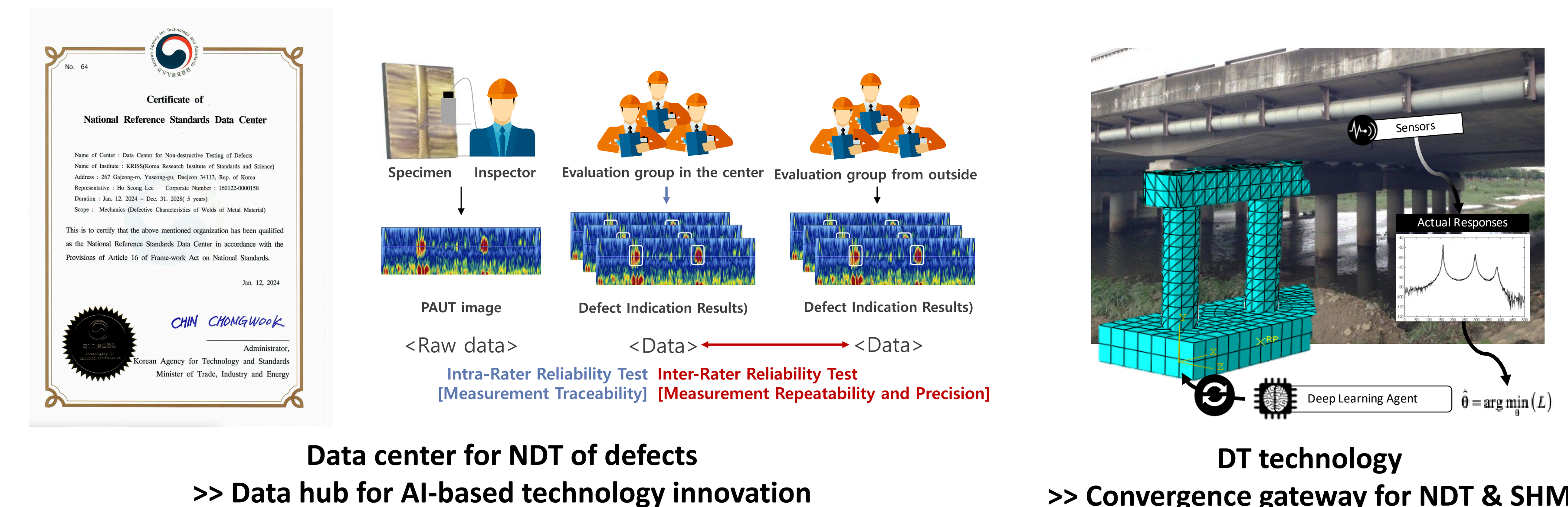


Long-range impact and breakage monitoring of underground buried pipes

Measurement standards for structural safety using IoT sensor

AI & DX-based Innovation

- KRISS recently established the **Data Center for NDT of Defects** to create standardized reference data for defect detection, which aims to provide high-quality, standardized training data, improving the reliability and performance of AI models.
- DX** technology has also been investigated as a complementary approach, offering a physics-based simulation environment for real-time monitoring and in-situ digital calibration.
- Virtual replicas enable synthetic data generation to supplement real-world datasets, addressing the issue of limited training data for AI models.



Concluding Remarks

- By continuously conducting research on reference data standardization and AI/DX technology development, We aims to achieve real-time measurability and high precision/accuracy across various engineering fields, including civil structures, mechanical systems, and facilities.
- Ongoing discussions are needed on how to evaluate reliability and accuracy based on measurement uncertainty and in-situ calibration to establish measurement standards for structural safety.

References

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