USING DIGITAL TWINS WITH IMMERSIVE 3D VISUALIZATION IN THE INSPECTION INDUSTRY

Background

The inspection industry plays a crucial role across various sectors, including manufacturing, construction, oil and gas, and infrastructure. Inspections ensure compliance with safety standards, quality control, and maintenance schedules, mitigating risks and enhancing operational efficiency. Traditionally, inspections rely on manual processes and physical presence, which can be time-consuming, costly, and often hazardous. Advancements in reality capture and digital twins are creating a solid foundation for true-to-scale (1:1) immersive 3D visualization in virtual reality (VR), augmented reality (AR), and mixed reality (MR). This combination offers innovative solutions for virtualizing inspector training, enabling real-time collaboration, and visualizing data analysis. These advancements have the potential to revolutionize traditional inspection methods.

Creating and Visualizing Persistent Digital Twins

Inspections generate vast amounts of data, including measurements, photos, and notes. Drones capture detailed lidar data, which can serve as a precise 3D foundation for creating digital twins. Additionally, many industries possess design or CAD drawings that, when combined with lidar or scan data, can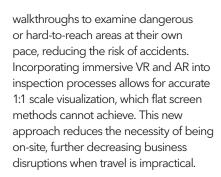 enhance detail and accuracy. Data capture can also include 360° images and videos, which can further enrich the digital twin. Adding documentation and real-time sensor data to the digital twin provides live, actionable information. A digital twin, visualized at a 1:1 scale on immersive reality devices, creates opportunities to virtualize inspection processes that traditionally rely on in-person activities. These digital twins can be accessible 24/7 in a persistent manner for a variety of business applications. Open web-based rendering technologies, such as WebGL and the more advanced WebGPU, offer powerful and scalable solutions for diverse business needs. Additionally, the recent WebXR and OpenXR standards provide a unified, vendor-agnostic approach to supporting VR, AR, and MR devices, reducing key obstacles to business adoption. An example of using web technologies for extended reality (XR), which includes VR, AR, and MR, can be viewed live at https://iq3connect.com/xr.

Opportunities

Enhanced Safety, Efficiency, and Reduced Disruptions

A digital twin environment can significantly enhance safety by reducing the need for physical presence in hazardous areas. It also lowers the costs involved with travel and moving equipment, resulting in increased operational efficiencies and fewer business disruptions. Inspectors can perform virtual walkthroughs to examine dangerous or hard-to-reach areas at their own pace, reducing the risk of accidents. Incorporating immersive VR and AR into inspection processes allows for accurate 1:1 scale visualization, which flat screen methods cannot achieve. This new approach reduces the necessity of being on-site, further decreasing business disruptions when travel is impractical.
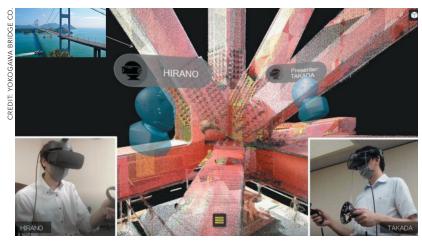
Inspector Training

Digital twins with immersive training environments can simulate real-world inspection scenarios. VR can create realistic 3D environments where trainees can practice inspections without the limitations of physical locations. For instance, a trainee can virtually inspect an oil rig, practicing safety protocols and identifying defects in a controlled setting. AR and MR can enhance on-the-job training by overlaying digital information on physical objects. Inspectors can use AR glasses to receive step-by-step guidance, access technical documents, and visualize internal structures. This reduces the learning curve and improves accuracy.

Real-Time Collaboration with Experts

Similarly, a multiuser environment with digital twins can enable real-time collaboration between on-site inspectors, remote experts, and stakeholders in various locations. An inspector in the field can use AR glasses to share their viewpoint with an expert elsewhere, who can then provide immediate feedback and guidance. This capability is especially valuable in complex or hazardous environments where expert input is critical. Collaborative platforms can enhance this further by allowing remote experts to annotate the inspector's field of view, highlight areas of concern, and suggest corrective actions.

Considerations

While the adoption of immersive technologies in the inspection industry is highly promising, several considerations must

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Immersive 3D visualization of a digital twin of a steel bridge facilitates real-time collaborative design, inspection, and training.

DISCUSSING DIGITALIZATION AND HOW IT'S CHANGING NDT

The evolving role of digitalization and advanced technologies in the nondestructive testing (NDT) industry was the focus of the ASNT 2023 Annual Conference and the main topic of a discussion **INSPENET TV** had with **ASNT CEO Neal Couture, CAE**, which is now available online. In the interview, recorded during the final night of the ASNT event last fall, Couture talks about digitalization as it pertains to NDT and shares how ASNT has managed to unite the community of NDT experts, highlighting the organization's efforts and achievements in creating a space for discussing technical and business challenges in the sector. Watch the full interview at https://inspenet.com/video-tv/industry-non-destructive-testing/.

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FREE DOWNLOAD OF ULTRASONIC TESTING UT TRAINING BOOK

A revision of the practical exercise book and field guide **UT of Thin-Walled Steel Pipe Flaws** by Jimmy Ellis is now available as a free PDF book download. The book covers manual detection, characterizing, and sizing of thin-walled steel pipe flaws, with links to 57 YouTube videos. The previous edition has been downloaded over 2600 times in the past five years. The latest version is expanded to be applicable to more industry segments. The book and its accompanying videos are appropriate for beginners just starting to learn how to do manual UT but progresses to many advanced techniques the experienced UT technician could find useful. Navigation is enhanced for the experienced user, with detailed contents and subject tables.

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NEUTRON IMAGING TECHNOLOGY CONVENTIONAL RADIOGRAPHY

A new analysis from Phoenix Neutron Imaging comparing neutron radiology to more commonly used NDT techniques is now available for free online. The **2024 Non-Destructive Testing Industry Report** first examines the current state of the NDT market and the trends driving NDT adoption before delving into head-to-head comparisons of neutron imaging with other NDT techniques, including photos. "While neutron imaging is most commonly practiced within the aerospace and defense industries," the report states, "other markets are incorporating it into their processes to improve quality, safety, and accuracy in a variety of applications." The report may be downloaded at https://go.phoenixneutronimaging.com/industry-report.

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be addressed to fully realize their potential. VR, AR, and MR technologies are advancing rapidly, with current hardware limitations—such as resolution, field of view, and battery life—being improved with each new iteration. Integrating immersive tools and digital twins with existing inspection workflows and data management systems is paving the way for faster adoptions of digital inspection capabilities. This integration directly enhances operational efficiency and boosts business return on investment (ROI). Furthermore, the cost of VR, AR, and MR technology is decreasing rapidly as the technology matures and more device options become available. Finally, cloud computing and 5G networks are making these technologies more accessible, even in remote areas, which is crucial for accelerating business adoption.

Adopting new technologies involves a learning curve and requires effective change management. As inspectors and users become more familiar with immersive technologies and digital twins, adoption will accelerate, necessitating changes at various levels within the industry. The inspection industry operates within a framework of strict regulations, and aligning new technologies with these standards is essential. Regulatory bodies are beginning to recognize the advantages of VR, AR, and MR technologies and are working toward developing guidelines and standards to facilitate their use. As the benefits of these technologies become more evident, regulatory acceptance and standardization will inevitably be addressed.

Concluding Remarks

Digital twins created from inspection data can be utilized repeatedly across multiple applications. When combined with immersive 3D visualization, they offer significant opportunities to transform the inspection industry. Continuous advancements in technology, improved business integration, cost reduction, regulatory acceptance, and innovations in AI will inevitably drive faster adoption in the inspection industry. As key barriers to entry are eliminated, digital twins combined with VR, AR, and MR are poised to become integral tools in ensuring higher safety, quality, and efficiency of inspections across various sectors. ME

AUTHOR
Ali Merchant, PhD: Founder and CEO, iQ3 Connect, Woburn, MA; ali@iq3connect.com