From blueprint to reality: Advanced 3D scanning ensures precision in assembly
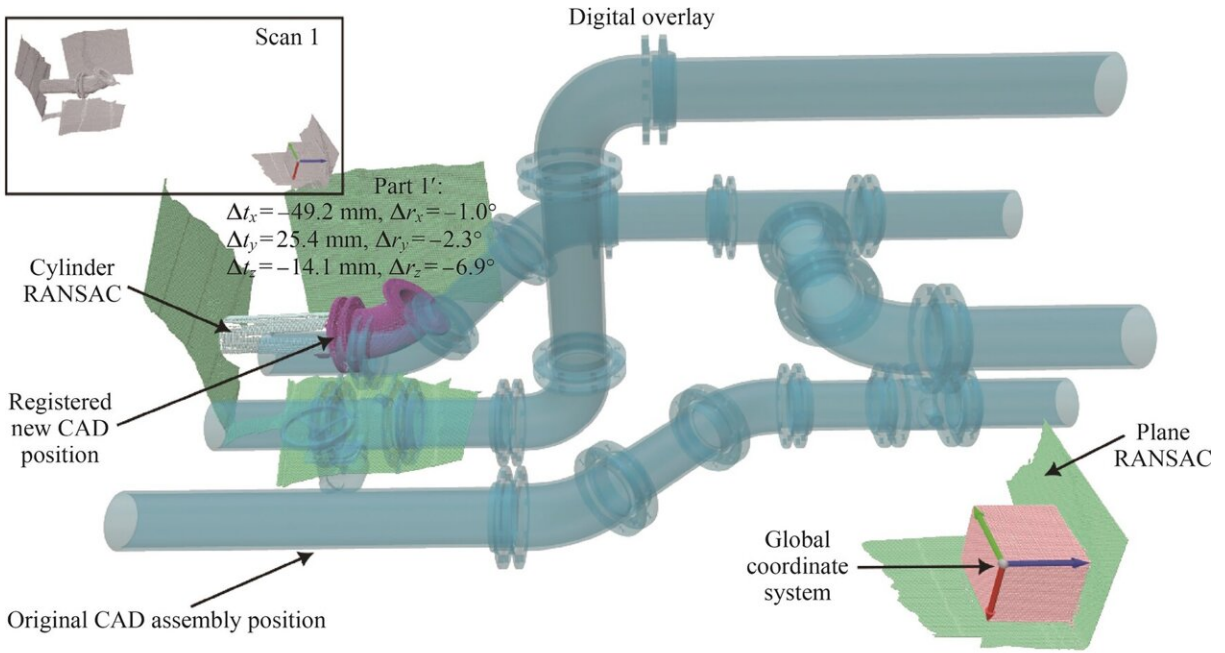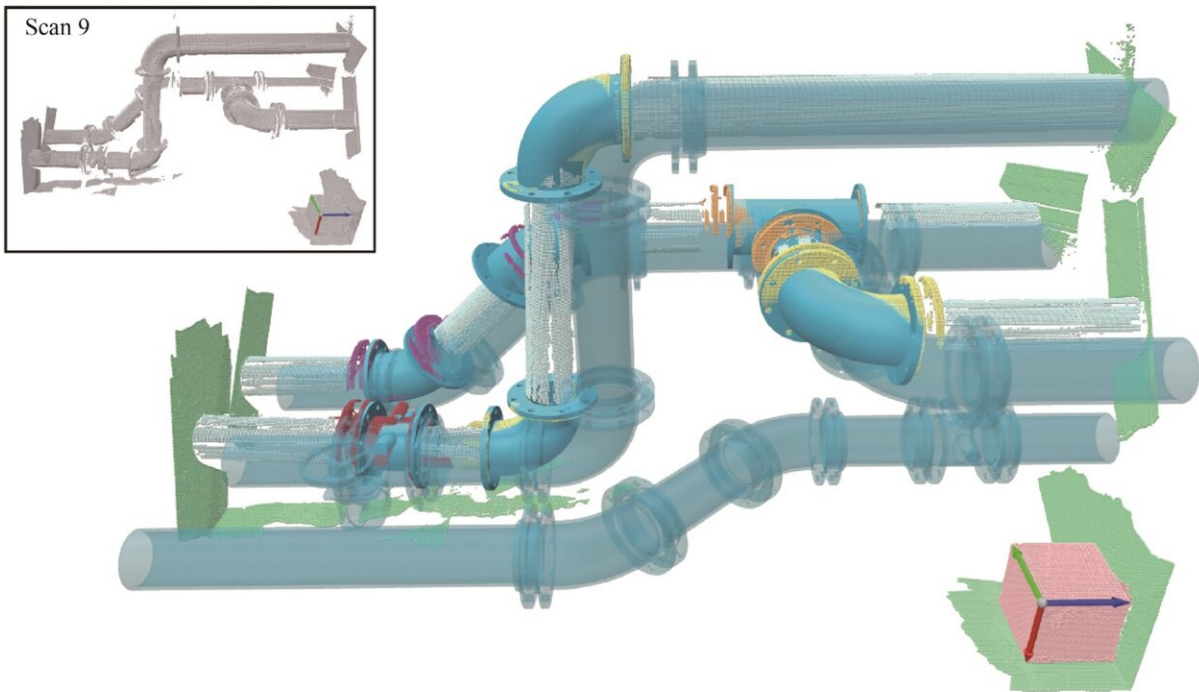
September 10 2024

Scan 1

Digital overlay

Part 1′:
$\Delta t_x = -49.2$ mm, $\Delta r_x = -1.0°$
$\Delta t_y = 25.4$ mm, $\Delta r_y = -2.3°$
$\Delta t_z = -14.1$ mm, $\Delta r_z = -6.9°$

Cylinder RANSAC

Registered new CAD position

Original CAD assembly position

Plane RANSAC

Global coordinate system

(a) Scan 1 with overlay of original CAD locations and registered new CAD locations of 45° flanged elbow (sub-assembly "A" installation)

Scan 9

(b) Scan 9 with overlay of original CAD locations and registered new CAD locations (sub-assembly "A" and "B" installation)

Digital overlay of real life scan point clouds over CAD sub-assemblies. Credit: *Advances in Manufacturing* (2024). DOI: 10.1007/s40436-024-00515-y

Pipeline installations are often plagued by challenges such as design deviations and unexpected clashes during assembly, leading to costly corrections and project delays. Conventional quality control measures are usually implemented after fabrication, missing the opportunity for early error detection. This situation underscores the urgent need for integrated methods that provide continuous, real-time quality control throughout the entire assembly process.

Researchers from the University of Edinburgh, in a study published on August 7, 2024, in *Advances in Manufacturing*, have integrated three-dimensional (3D) scanning technology with computer aided design (CAD) models to track and monitor pipeline assembly progress.

By comparing real-time scans with as-designed models, this approach empowers operators to spot potential issues early, preventing them from escalating into major problems. The study's findings, validated using both real-world and synthetic datasets, demonstrate the effectiveness of this innovative approach.

The research presents a novel system that merges 3D scanning with CAD models to enhance quality control during pipeline assembly. The process leverages unorganized point clouds from 3D scans to detect deviations and component clashes early in the installation phase.

A deep learning model, trained on synthetic datasets that replicate real-life conditions, classifies pipeline components with high accuracy, allowing for the precise identification of misalignments. This approach was tested on a downscaled prototype, showcasing how automated

classification and CAD comparisons significantly reduce manual inspections and error rates.

By providing real-time feedback, the system enables operators to address issues immediately, cutting down on rework and improving overall assembly efficiency. This seamless integration automates quality control, ensuring that critical deviations are detected early.

Dr. Nan Yu, Senior Lecturer in Digital Manufacture at the University of Edinburgh, emphasized the impact of this technology, "This approach represents a significant step forward in pipeline installation and quality control. By leveraging the latest in 3D scanning and AI technologies, we can detect errors before they become critical, saving time and resources in the assembly process."

The study's implications extend across industries that rely on complex pipeline installations, including oil, gas, and shipbuilding. By facilitating early detection of deviations and potential clashes, the method not only minimizes costly rework but also enhances overall assembly efficiency. This technology can serve as a valuable addition to current quality control protocols, seamlessly integrating into existing manufacturing workflows to improve productivity, reduce downtime, and ensure the accuracy of complex installations.

Provided by University of Edinburgh

Citation: From blueprint to reality: Advanced 3D scanning ensures precision in assembly (2024,