

Digital Twins for Critical Infrastructure Inspection

Human-Machine Interfaces: Integrating Augmented Reality and UAV-Based 3D Scanning and Analysis

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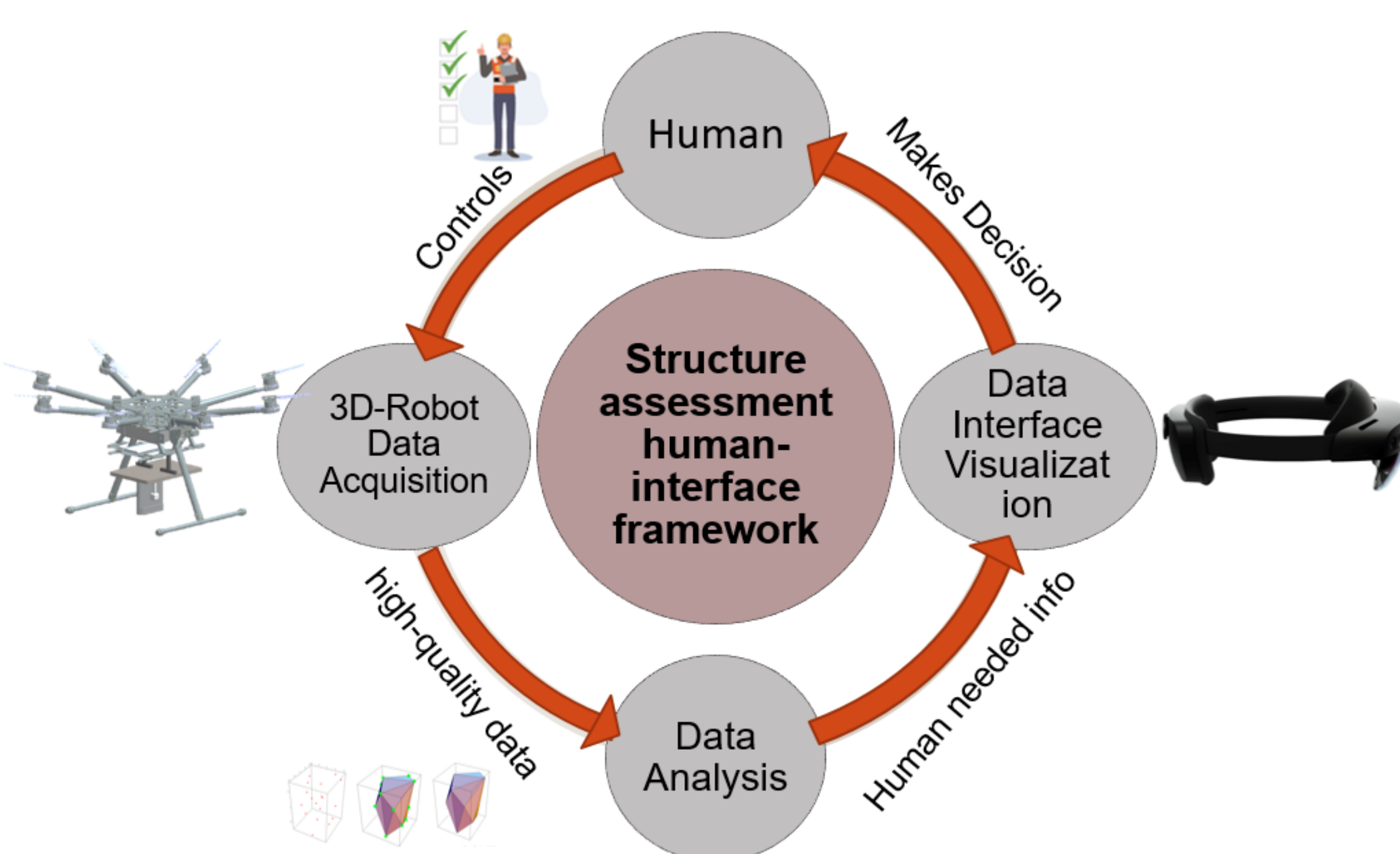
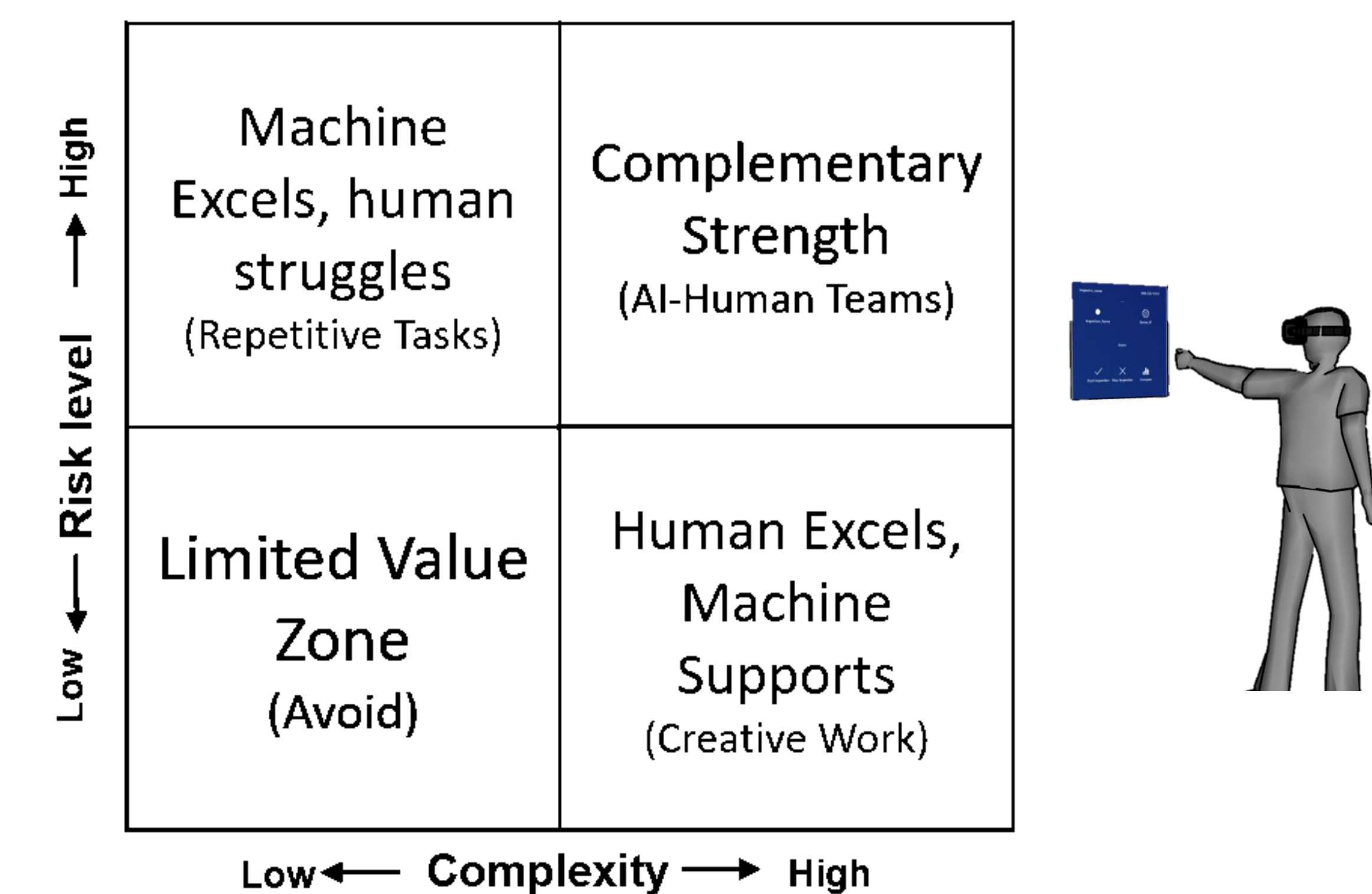
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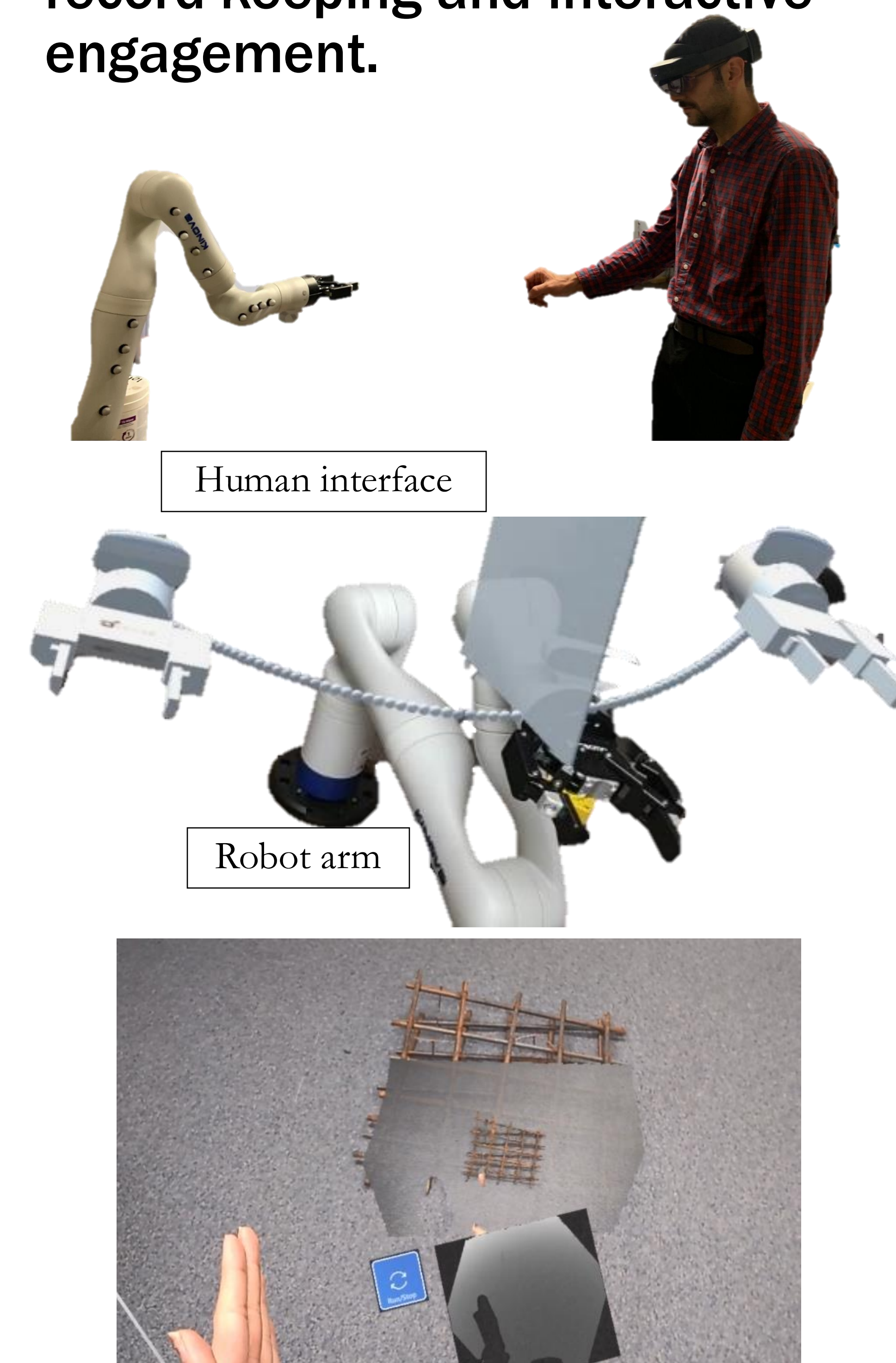
Motivation

- Over 600,000 bridges in the U.S. require regular inspection to ensure public safety.
- Traditional inspections are time-consuming, subjective, and pose safety risks for inspectors.
- Machine analysis and AR visualization can help manager and engineers for making informed decision.



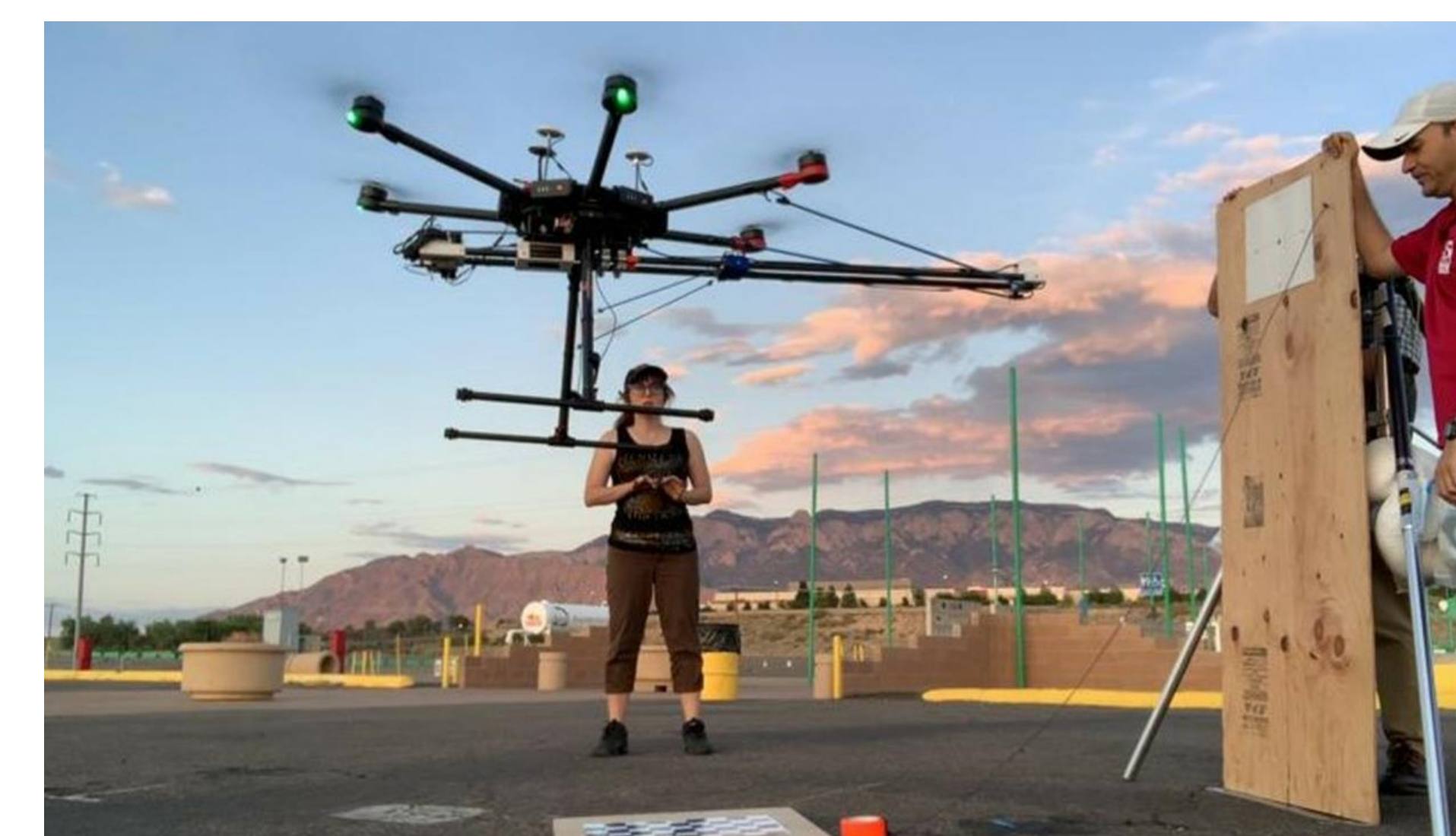
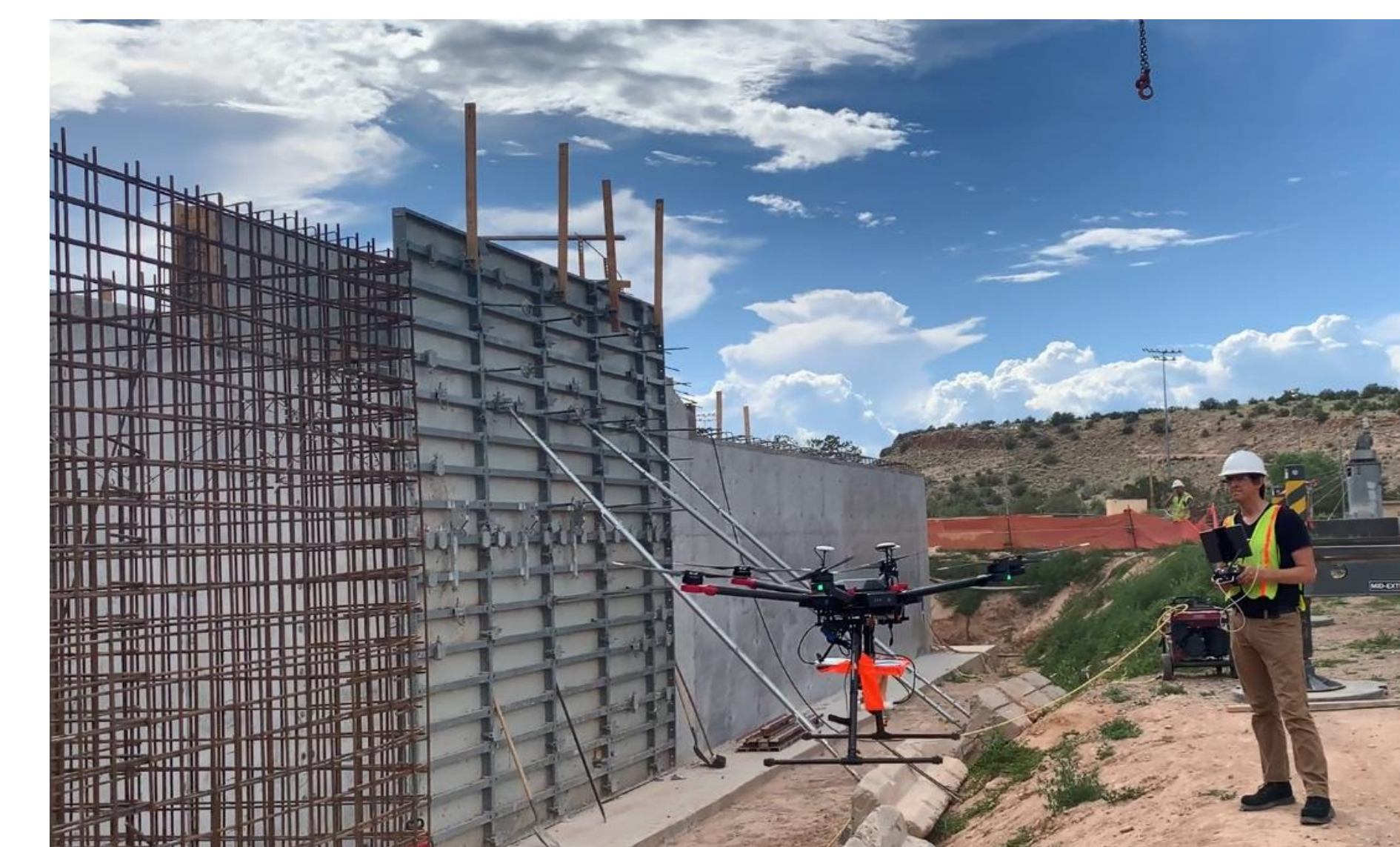
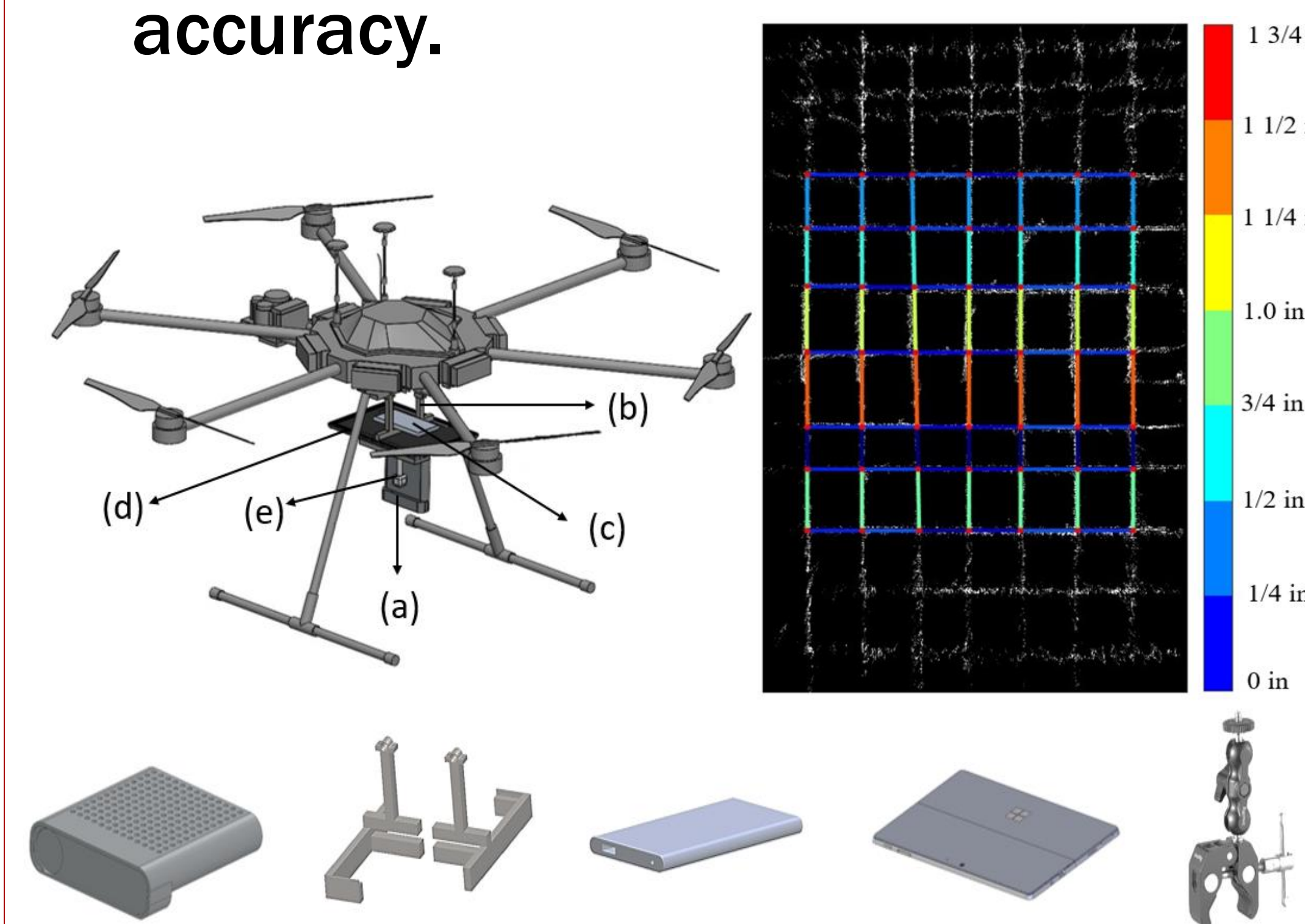
Developed system

- Using UAV, cameras, and robot to help human with data and automated analysis.
- UAV-Based automated 3D scanning using Azure Kinect, a low-cost RGBD camera for data acquisition.
- Using Augmented Reality (AR) for enhanced digital twin visualization, enabling permanent record-keeping and interactive engagement.



Method

- Integrating edge detection algorithms and Hough Transformation for identifying individual rebar and computing rebar spacing with millimeter accuracy.



Results and future work

- Integration of AR for real-time computer vision and robotics to enhance human-machine interactions.
- Improving model efficiency and quality through down-sampling, disk rendering, and selective frame registration.
- Future AR-enabled human-machine collaboration will automate inspection and refine algorithms through human feedback.

