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Data Visualization -Augmented Reality

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In recent years, there has been an increasing interest in developing new technologies for automated characterization and visualization of condition monitoring data. Augmented Reality (AR) is a technology that is being developed to improve such data visualization. Augmented reality has been defined as a technology that merges virtual and physical components in real-time, and in three dimensions [1]. Wearable, commercially-available AR devices allow onsite engineers and technicians to perform inspection tasks with significantly more available information such as comparisons of past and present sensor and imager data, onsite data analysis and result displays, and various forms of metadata including technical drawings, previous inspection reports and maintenance histories, operation manuals, codes and standards, and holograms representing data analysis results superimposed onto the *in situ* monitored system [2].

The engineering applications of AR can be traced back to 1960's. However, these early attempts at integrating the real and virtual worlds had major limitations such as low resolution, limited fields of view, and no interactive features, which significantly limited their use in actual engineering applications. Continued research and development of AR over the next 50 years and the availability of commercial AR hardware have now made collecting, analyzing and visualizing data for a variety of engineering applications possible including structural health monitoring [2], online condition monitoring [3] and crack identification, characterization, and tracking [4].

Another use of AR technology is object detection and tracking [5]. However, it should be noted that because of the limited computational power available in current commercially available AR headsets, image-based object detection, characterization and tracking typically requires a supplementary immobile computing device for the execution of the detection and tracking algorithms. Such detection and tracking can be used to evaluate the dimensional and geometrical position of physical objects where, as an example, an AR headset has been successfully used to inspect the column anchor bolt positions before installing a steel column, and to assess its plumbness after installation [6].

As the development of commercially available AR hardware continues to advance and that hardware is integrated with a wider variety of sensing modalities and data analysis algorithms, the use of AR in online condition monitoring is anticipated to grow and provided higher-fidelity and more easily visualized condition monitoring assessments.

References

[1] R. T. Azuma, 'A Survey of Augmented Reality', *Presence: Teleoperators and Virtual Environments*, vol. 6, no. 4, pp. 355–385, Aug. 1997, doi: 10.1162/pres.1997.6.4.355.

[2] D. D. Mascareñas *et al.*, 'Augmented reality for next generation infrastructure inspections', *Structural Health Monitoring*, vol. 20, no. 4, pp. 1957–1979, Jul. 2021, doi: 10.1177/1475921720953846.

[3] Rajan, V., Sobhana, N.V. and Jayakrishnan, R., 2018, June. Machine fault diagnostics and condition monitoring using augmented reality and IoT. In *2018 second international conference on intelligent computing and control systems (ICICCS)* (pp. 910-914). IEEE.

[4] S. Wang, S. A. Zargar, and F.-G. Yuan, 'Augmented reality for enhanced visual inspection through knowledge-based deep learning', *Structural Health Monitoring*, vol. 20, no. 1, pp. 426–442, Jan. 2021.

[5] A. Farasin, F. Peciarolo, M. Grangetto, E. Gianaria, and P. Garza, 'Real-time Object Detection and Tracking in Mixed Reality using Microsoft HoloLens', in *Proceedings of the 15th International Joint Conference on*

Computer Vision, Imaging and Computer Graphics Theory and Applications, Valletta, Malta, 2020, pp. 165–172. doi: 10.5220/0008877901650172.

[6] D. H. Shin and P. S. Dunston, 'Evaluation of Augmented Reality in steel column inspection', *Automation in Construction*, vol. 18, no. 2, pp. 118–129, Mar. 2009, doi: 10.1016/j.autcon.2008.05.00