

An Integrated Solution based on Augmented Reality for Smart Inspection in Semiconductor Manufacturing

A modern semiconductor fabrication plant (fab) occupies a large area with various types of equipment densely scattered. On-site fab inspection remains a manual process because of its high complexity and uncertainty. Inspection personnel visually detects abnormalities of important devices and undertakes needed maintenance or repair while moving in narrow passages between equipment. Human errors frequently occur due to a high physical and mental workload involved in the inspection process. Occurrence of the errors can either interrupt the current production or cause serious occupational safety issues at worst. To overcome these difficulties, this research aims to develop an integrated solution based on augmented reality (AR) technology for smart inspection in semiconductor sub-fab. Three "smart" functions will be proposed and deployed in an AR HMD (HoloLens 2) for verification and validation of the solution. First, the HMD will capture real-time running data from a scrubber under inspection via IIoT (Industrial Internet of Things) interface. A PHM (Prognostic and Health Management) model estimates the remaining useful life (RUL) of the machine based on the running and past data. This function helps transform an inspection routine into a proactive preventive action. The AR HMD will give inspection personnel instructional guidance to perform necessary maintenance or repair operation. Next, a user interface supported by eye tracking and hand gesture recognition in HoloLens 2 will be developed to monitor the personnel's action during the operation. It is designed to timely initiate warning messages that stop manual operation errors. Finally, a trained deep learning model will be introduced to estimate the 6D pose of a fluid valve switch from a color image captured by HoloLens 2 on-site. The model, deployed in an edge computing device, determines if the status of the valve switch is correct. This function can reduce human mistakes only based on visual inspection. In summary, the main contribution of this research is to realize the idea of smart inspection enabled by real-time collaboration between human and artificial intelligence through AR. A functional prototype will be implemented to validate the advantages of connecting multiple devices with low latency and high interaction offered by AR. The prototype will provide an effective solution for improving the efficiency and quality of manual inspection in semiconductor manufacturing. This work is also expected to demonstrate practical values of AR technology in industrial settings and a future development opportunity.

Keywords: Augmented reality, Human errors, Industrial Internet of Things, PHM, Smart inspection, Deep learning, semiconductor manufacturing

