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Augmented Reality in Aircraft Maintenance

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1 Abstract

The maintenance of aircraft is crucial to ensure continued airworthiness. Inspection is an important task and there are many processes that require a significant amount of work for the inspector, especially when localizing and documenting damages. Visualizing data, such as detected dents or ultrasonic data directly at the corresponding location on the aircraft or an aircraft part can be beneficial in order to make complex data easier to grasp, to improve maintenance processes, or to ensure a high data recording quality.
We present two works on augmented reality (AR) approaches with the HoloLens 2 in the aircraft maintenance domain, and discuss their respective usage scenarios.

Keywords: Augmented Reality, Visualization, Head-mounted Display, Maintenance, Aircraft, Ultrasonic testing

2 Visualization and Tracking

AR is a broad term, covering several technologies that add visuals to the real world. This can be achieved using different technologies, such as projectors, specialized head-mounted displays (HMDs), or handheld devices. HMDs, such as the HoloLens 2, localize themselves in the environment using inside-out tracking by detecting the surrounding via cameras. In contrast to inside-out tracking systems, outside-in tracking systems use external, stationary sensors or cameras to track the movement and position of an object (e.g. markers or interaction tools) in space. In the following, we present two different approaches for such AR systems and discuss their respective usage scenarios in aircraft maintenance.

3 AR in aircraft maintenance

3.1 Outer skin inspection

We developed an HoloLens 2 application to support the inspection process of the aircraft's fuselage documenting the detected dents and buckles [1]. Figure 1, left, shows the conventional visualization on an aircraft, using an erasable pen directly on the aircraft surface, which needs to be removed after the inspection, and copied to the documentation files. Using a HMD offers the possibility to directly record the data digitally and to easily revisualize the data whenever needed. However, the accuracy and reliability of such a system highly depend on the surrounding conditions, such as lighting and reflection properties of the area of interest.

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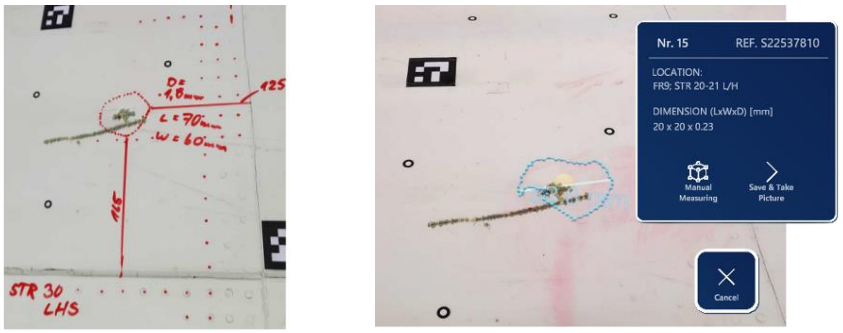

Fig. 1. Visualization methods for dent and buckle data. Left: Conventional method using an erasable pen. Right: AR approach [1].

3.2 Ultrasonic inspection

In ultrasonic testing processes a higher accuracy of an AR system is necessary in order to improve the process [2]. We developed an approach that utilizes markerless tracking for the component, allowing it to be freely moved without the need for attachment, and combined it with marker-based tracking for the ultrasonic sensor to ensure a high degree of tracking reliability and accuracy. However, this system requires fixed external tracking cameras that have an unblocked line of sight onto the area of interest. It is also possible to interact with robots or to visualize the recorded data directly onto the part, as it can be seen in Figure 2.

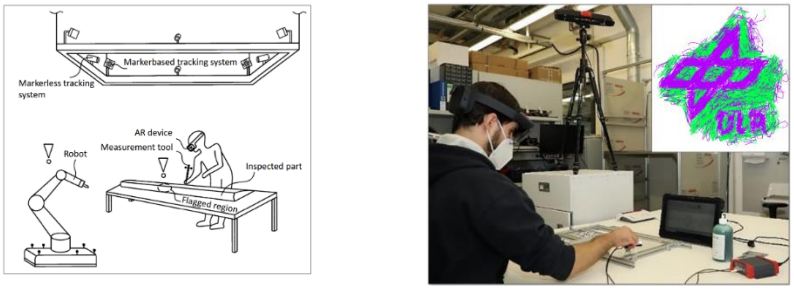

Fig. 2. Ultrasonic testing with AR [3] [2].

4 Conclusion

Two aircraft inspection process can have very different requirements, depending in the technology, the environment or the part of the aircraft. AR HMDs are relatively easy to use and portable, which makes them suitable for use in various locations, including different areas of the aircraft, both inside and outside. However, their tracking capability is still limited. Outside-in tracking systems, on the other hand, often provide a higher tracking accuracy, but require installed cameras and thus have higher spatial requirements.

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