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Augmented and Virtual Reality for Inspection and Maintenance Processes in the Aviation Industry

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Abstract

Maturity of augmented and virtual reality devices has considerably grown recently. As processes in the aviation industry are error prone and time consuming, efforts are made to implement these technologies to support human workers during inspection and maintenance. Nevertheless, varying process and device characteristics impede the selection of a suitable technology. A concept is presented to evaluate the potential of inspection and maintenance processes in the aviation industry regarding the use of mixed reality systems. Four different use cases are discussed applying augmented or virtual reality devices in an industrial context.

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Keywords: Augmented Reality; Virtual Reality; Mixed Reality; Inspection; Maintenance, Aviation Industry

1. Introduction

Technical advancement has led to the availability of powerful and reasonably low priced augmented (AR) and virtual reality (VR) devices for the consumer market. Moreover, AR and VR devices also have great potential for industrial applications. For instance, efforts are being made to implement AR based support systems for employee

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training, remote maintenance or inspection and assembly processes [1–3]. Due to a high degree of worker centered processes, cognitive support systems in the aviation industry will continue to be particularly important in the future. Although studies show that the potential of AR and VR technologies is promising, an a priori assessment of the potential benefits for a concrete industrial process is difficult. Therefore, concepts for a methodological assessment of the potential are needed.

2. Background

AR and VR both are part of a wider field of technology called mixed reality (MR). MR describes different technologies blending the physical world with the digital world and exists between the extrema of completely real and virtual environments (See Fig. 1) [4]. In addition, MR visualization produces visual stimuli with a higher level of similarity to real-world stimuli compared to standard displays. This allows the user to make use of the abilities learned in the real world, e.g. detection of meaningful patterns, or qualitative judgement [5].

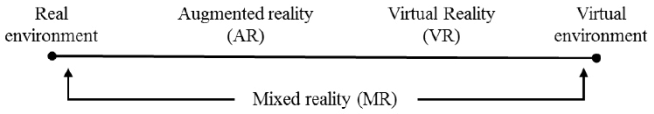

Fig. 1. Mixed reality continuum [4].

A variety of devices exist in the field of MR, such as AR tablets, Cave Automatic Virtual Environments (CAVE), head mounted displays (HMD), or AR projectors. These devices usually provide MR visualization as well as other basic functionalities especially for user interaction. In addition, tracked controllers, object recognition and tracking (e.g. hands) or haptic feedback can be integrated to support intuitive usability. By combining improved control and visualization, MR leads to optimized human-computer interaction.

Regarding the aviation industry, inspection and maintenance processes are characterized by a high percentage of manual work steps [6], small lot sizes, a great variety of handled components and a considerable effort for documentation in combination with the need to reduce inspection and cycle times [7].

The possible application of different MR technologies as cognitive support systems especially for maintenance has been thoroughly investigated [5, 8–13]. Although these studies contribute to the general understanding of applying MR technologies industrially, an a priori assessment of the potential benefit for a concrete industrial process is difficult to determine.

Elia has proposed a performance indicator for the application of AR devices in manufacturing based on technological and organizational criteria [14]. This expert based tool, however, allows only a feasibility study and no a priori estimation of potentials. In addition, the proposed tool does not help in the selection process of a specific MR device.

It is therefore inevitable to further detail methodologies that support the estimation of potential benefits when planning to apply MR technologies for a specific process in order to facilitate human integration in future inspection and maintenance processes.

3. Concept

To estimate the potential of MR systems for inspection and maintenance processes, we propose to classify all involved components into three groups: *object*, *model and human*. *Objects* are all non-human real-world assets (e.g. workpieces, tools, and environment). The *model* contains all virtual assets (e.g. process model, documentation and design drawings). The *human* is the human worker to be supported by the support system. As described, MR provides an enhanced interface between digital data and *human*, due to improved visualization and controls. Therefore, we