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MAINTENANCE OF THE MANUFACTURING MACHINE VIA AUGMENTED REALITY

Ema NOVÁKOVÁ-MARCINČÍNOVÁ – Anton PANDA – Ľudmila NOVÁKOVÁ-MARCINČÍNOVÁ

Abstract: Manufacturing companies should be producing innovative products at low cost and reduced time to market. High product mix with low volume, customization to me et the individual demands of the customers, increasing legislation of environmental and other issues have further made manufacturing processes more complex and demanding. In addition, the increasing trend of globalized manufacturing environments requires real time information exchanges between the various functional units in a product development life cycle, e.g., design, setup planning, production scheduling, machining, assembly, etc., as well as seamless task of collaboration among them. Manufacturing processes have to be more responsive and systematic in order to be efficient and economically competitive. On top of that, the increasing demand for goods results in an increasing demand for natural resources and energy.

Keywords: Manufacturing, Parallel Tracking, Maintenance Systems, Augmented Reality

Introduction

Maintenance activities, e.g., preventive and corrective maintenance, are performed according to pre defined procedures of the maintenance tasks. Maintenance workers need to be trained in the respective procedures, and they sometimes need to seek help from Supporting systems and experts when they are on site. The training of maintenance tasks can be achieved using traditional 2D printed materials and Virtual Reality based simulation systems. However, Virtual Reality technologies cannot be applied for maintenance guidance where interactions with real machines are required. Augmented Reality technology shows merit in the maintenance applications in two aspects. Firstly, user interfaces can be rendered in a ubiquitous manner so that the worker perceives the instructions with less effort. Secondly, user in teractions in the AR environment can facilitate maintenance data management and allow remote collaboration to be achieved intuitively.

Augmented reality system for industrial maintenance

The tracking system is comprised of a camera fitted with an infrared filter and infrared markers which are projected onto the scene. Since the markers are infrared and thus, invisible to the naked eye, there is no visual disturbance for the user. One of the presented applications is the maintenance of the gear box of a milling machine. Through Augmented Reality, gear models are overlaid on the images to indicate the function of the real gear-box, and the actions that the technician must do are presented through animated 3D models. The most noticeable challenge presented by the authors is the jitter when the line of sight of the marker projector is blocked. Henderson and Feiner developed an opportunistic control model and applied it in the development of a TUI for maintenance applications. According to their user study, the opportunistic control-based user interface improves the performance with shortened task completion time. Lee and Rhee developed a ubiquitous car service system using Augmented Reality technology with three layers for the manipulation of interaction, context and service, respectively. User context, such as the preference profile of the user, was considered. Marker based tracking and information retrieval from product technical information system was applied in the system. The system was implemented for the scenario of a user who needs to repair his mal functioning car on the road. Authoring is an important step in remote collaboration applications as experts need to provide instructions to the maintenance worker. Zhu et al. developed an online authoring tool where online authoring is performed by the experts on still key frames. Using PTAM as the tracking and registration framework, the highlighted objects in the environment can be tracked so that the authored information can be displayed in consistency with the objects (Fig. 1).

Fig. 1. An AR-assisted remote maintenance system

Parallel Tracking and Multiple Mapping

Parallel Tracking and Mapping (PTAM) is a notable platform for estimating camera pose in an unknown scene. Through the methods of processing the two tasks, namely, tracking and mapping, in parallel threads and key frame based mapping, detailed maps of the unknown environment can be reconstructed with many landmarks. With the detailed maps, virtual objects can be registered onto the real world. This platform only supports the tracking of static and limited environments. Parallel Tracking and Multiple Mapping (PTAMM) was developed as an extension of PTAM. PTAMM is able to use multiple independent cameras and create multiple maps in which different applications can be created in individual maps. In this platform, the cameras can switch automatically between maps by comparing the descriptors between the key frames and the camera image. With this scheme, PTAMM supports the exploring of large environment with multiple mapped workspaces.

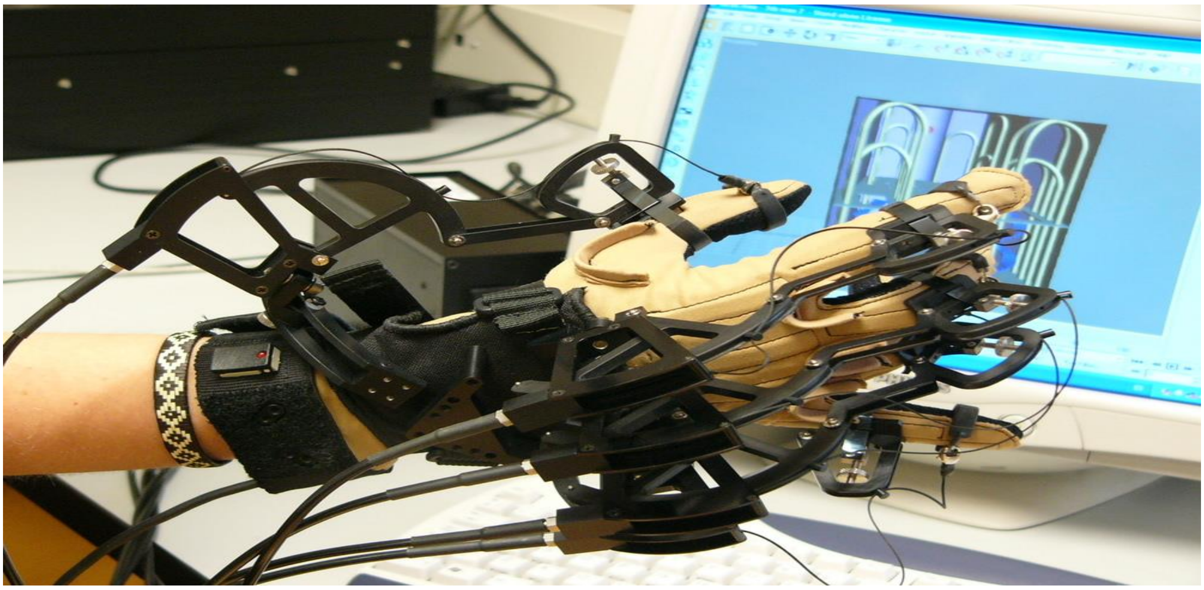

Fig. 2. CyberGlove – CyberGrasp

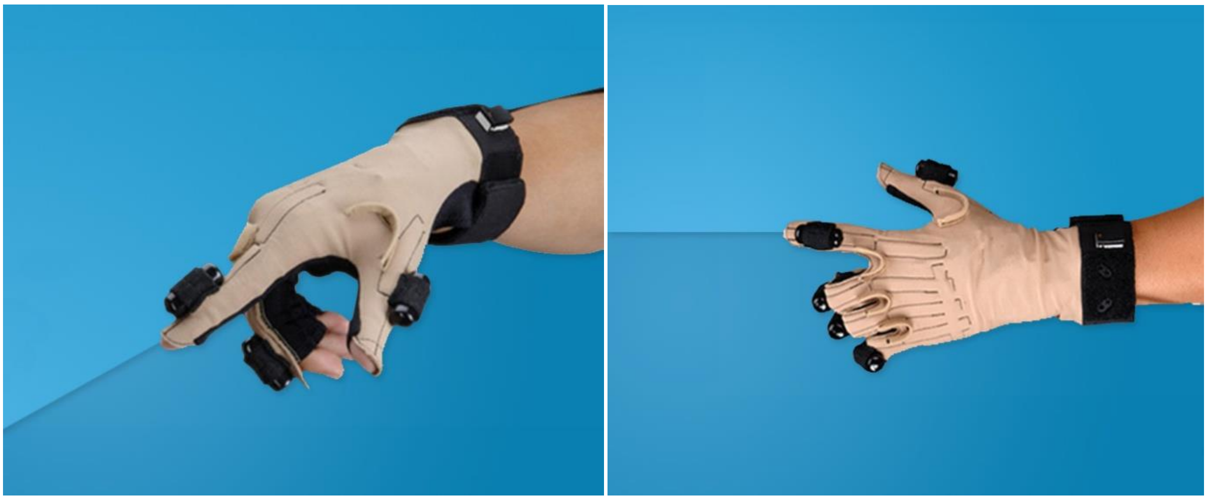

Fig. 3. CyberGlove – CyberTouch

Haptic and force feedback

Haptic and force feedback have been considered in Augmented Reality applications to enhance the immersive and interactive sensation for the user. Researchers have applied wearable data gloves for mobile applications and for desktop operations, such as in assembly, design, etc. Valentini focused on the interaction mechanism using a data glove during virtual assembly in an AR environment. The research focused on the grasping and manipulation of virtual assembly components based on the identification of three typical manipulation gestures. Haptic devices have also been applied for path planning of a virtual robot. Table 1. lists several haptic devices in the market.

Tab. 1 Summary of haptic devices in the market

COMPANY – PRODUCT MODEL	TYPE	PROS	CONS
CyberGlove – CyberTouch	Vibro-tactile actuators	Actuators on each finger and the palm to provide tactile feedback	Expensive
		Flex sensors to provide real-time joint-angle data	
		Wearable and light in weight	Only tracks finger flexing motion; no hand movement data
		Wireless connection	
CyberGlove – CyberGrasp	Exoskeleton	Adds on to CyberGlove to provide force feedback to each finger	
		Lightweight	
Sensable – PHANTOM OMNI	Exoskeleton	To touch and manipulate virtual objects using the handler	Need fire wire connection
		Provide force feedback	
		Small in size and lightweight	

Future trends and directions maitance system with support AR

Although much progress in AR has been made in the recent two decades, potential AR manufacturing applications are still in exploratory and prototyping stages. A much desired direction will be in the development of highly interactive and user-friendly interfaces. The interfaces would need to be customised according to a particular type of application a user is expected to perform. The need is not only in the development of novel AR devices, but to convince users that they will forego traditional methods and opt for AR-assisted solutions. However, it must be borne in mind that not all applications are well suited for AR implementation. The crucial factor is therefore to identify applications which will benefit users in terms of ease of learning new tasks, error-free job execution, reduced cognitive load, etc. Eventually, a user should be a happy worker, equipped with better skill and technology, and able to carry out his work much more efficiently.

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Contact address
(1.) Ing. Ema Nováková-Marcinčínová
Technical university in Košice, Faculty of manufacturing technologies with the seat in Prešov, Štúrova 31, 080 01 Prešov, Slovakia,
e-mail: ema.novakova- marcincinova@tuke.sk
(2.) prof. Ing. Anton Panda, PhD.
Technical university in Košice, Faculty of manufacturing technologies with the seat in Prešov, Štúrova 31, 080 01 Prešov, Slovakia, e-mail: anton.panda@tuke.sk
(3.) Ing. Ľudmila Nováková-Marcinčínová, PhD.
Technical university in Košice, Faculty of manufacturing technologies with the seat in Prešov, Štúrova 31, 080 01 Prešov, Slovakia,
e-mail: ludmila.novakova- marcincinova@tuke.sk