THE CYBER PHYSICAL ASSEMBLY SYSTEM OF TU WIEN PILOT FACTORY INDUSTRY 4.0

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INTRODUCTION

Cyber Physical Systems (CPS) realize a connection between the physical and the digital world. CPS are based on embedded systems that use sensors to acquire data from the physical environment, process these data by using a microprocessor and act on physical processes via actuators. Different CPS are connected to each other via digital networks (vertically and horizontally) and can access available data and services worldwide. CPS are defined as (technically) unenclosed systems and are characterized by a high degree of networking between physical, social and virtual worlds [1]. The integration of CPS into assembly systems results in so-called Cyber Physical Assembly Systems (CPAS). It is predicted that CPAS will be able to meet the challenges of volatile markets economically and at the same time they will respond ergonomic and age-appropriate work practices [2]. The integration of intelligent communication and information technologies into assembly work systems increases human-system and human-machine interaction significantly. Thereby the direct functional and informational distance between human and work system increases [3]. The scientific literature shows that in work systems of the future, the human workload will increase in a cognitive and physical way mainly. The reasons are primarily due to short-cycle change of work tasks, increasing of complex problem-solving activities and the necessity of flexible staff deployment [4].

Figure 1: Collaborative robot assistance systems

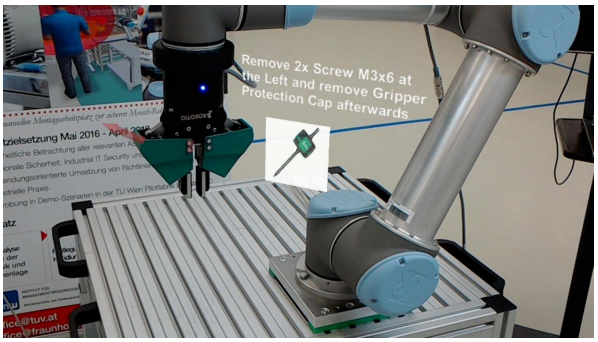

Figure 2: Digital assistance systems (Augmented Reality)

MAIN IDEA AND RESEARCH FIELDS

Based on the concept of a CPAS, in the project "TU Wien Pilot Factory Industry 4.0" a corresponding assembly system is currently developed for in-depth research and industry-oriented demonstration purposes. The assembly system is based on four separate mobile assembly stations, along different variants of a 3D printer are assembled, focusing batch size 1 – according to the principle of a mixed model assembly system (MMAS). Auto-ID technologies such as passive and active RFID (radio-frequency identification systems) enable a decentralized coordination between the adjacent logistics area and material transport. In this complex assembly system, the operator is supported on the one hand by cooperative and collaborative robotic systems and on the other hand by digital assistance systems. The assistance systems are adaptive. The functions of the assistance systems are adaptable to order load-specific requirements and individual human needs. Therefore, a “Human Motion Capture“ system and various local positioning sensors record ergonomic stress situations of the operator. The gained information are also used to analyze synergy effects between

the productivity of the assembly work system and ergonomic situation of the operator. In addition the gained information are used for the objective of incorporating gained knowledge into optimized production planning and control algorithms [5].

RESEARCH ACTIVITIES AND RELEVANZE

The specific research and development activities, which are pursued in the context of CPS are focused on methods to plan and to evaluate assistance systems, referencing the use of (a) digital assistance systems and the use of (b) technical assistance systems, like human-robot collaboration systems in assembly environments [6] [7].

Digital assistance systems support the operator in a cognitive way by carrying out his activities and guarantee a sustainable and productive interaction between the operator and the information system. Furthermore, the operator is supported by digital assistance systems by an adequate interaction with auxiliary and operating resources of the peripheral assembly equipment that interacts with the human situation – e.g. intelligent screw systems [8]. Beyond digital assistance systems, technical assistance systems address operator support in regard to physically stress situations [9]. Sensitive and collaborative robot assistance systems provide context-sensitive and situational support for the workers. Digital and technical assistance enable ergonomic, age-appropriate and productive work systems [6]. In addition to business-oriented and human-oriented planning and evaluation methods, within the TU Vienna Pilot Factory Industry 4.0 Cyber Physical Assembly System we also research and develop integrative safety and security concepts for these new forms of assistance systems in industrial assembly environments.

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