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Würth Elektronik successfully completing research project of assistance system with adaptive human-machine interaction

Power assistance „third arm“ for craftspeople brought ahead in decisive ways

To make physically strenuous works easier was one of the aims. To give to the crafts-people additional information about the upcoming works, was another aim. The „third arm“ for craftsmen makes both possible: Effective support of the craftsman on the one hand and computer-generated additional information directly in the place of action on the other hand. After three years of research project to the „3rd arm“ the promising results are given.

„Getting technology to humans.“ – Under this heading, a research project for developing a craftspeople – power – system with adaptive human-machine interaction started in 2014, promoted by the German Federal ministry of Education and Research.
That “third arm” for support during physically demanding work should fulfil specific functions as an overall system, namely : power assistance for load reduction and lowering fatigue, merger of different measurands for position monitoring and projection of relevant information into the workspace (augmenting), intuitive handling and adaptive customization to the behaviour of different users and working environments. The augmenting function, following the concept of augmented reality systems AT as key component of the “third arm” , transfers additional information about the work to be performed to the craftsman via fade-ins.

The research project, based on a three-year period, has now been successfully completed. Coordinator of the project was the company Würth Elektronik Circuit Board Technology (CBT), project partners were the Karlsruhe institute for technology (KIT), the Centre of mechatronics Hannover (MZH), Robert Bosch GmbH in Renningen and other stakeholders from industry and craft trade.

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„Würth Elektronik CBT, in its role as general project coordinator and technology provider had responsibility for the technical realization of the sensor systems, the development and production of electronics as well as for the provision of demonstrators", explains Dr. Jan Kostelnik, Head of Research & Development at Würth Elektronik CBT.

During the project and as an initial step, various options had been analysed to realise printed- circuit based strain gauges with flexible carbon paste variations on flexible substrates. A multi- axle force sensor built in that technology was supposed to measure the kind of forces acting on the exoskeleton during every move of the craftsman. "That happens by relating the bend of a flexible polyimide – circuit and the external forces to each other", illustrates Dr. Jan Kostelnik.
Farther-reaching actions included the development of a complex sensor and actuator concept, in concrete terms the design of an appropriate drive on the influencing factors expected, for example on the weight forces emerging from heavy machines which so far had to be endured by the craftsman. The specification of the sensor and actuator concept was set in cooperation with the project partner MZH.
Moreover, the multitude of various sensors collecting and transferring measured data from different places of the „third arm" implied the necessity to design a communication bus system. For that purpose, USB3.1 type C connections were deployed for the physical data transmission. Energy supply to the sensors can be provided via the physical bus system as well. Würth Elektronik implemented USB 3.1 type C cables and plug connectors in a robotic project for the first time in the world, thus could represent a ground-breaking new standard for robotics and other systems.

In addition, power electronics had been designed and produced for the electronic actuators' power supply. A mainboard - realized in cooperation with Bosch- contains all interfaces provided in the sensor and actuator concept. A 36- volt battery had been integrated to autonomise the „third arm". Another focus of electronics development was the battery management system.

The work-related assessment of the demonstrator was carried out by the ifab-institute of the Karlsruhe Institute for Technology. „ Our approach were three use cases in practical application : Working overhead with power tools, chiselling work with heavy electric

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devices and repetitive work with a long-neck sander in dry walling“, summarises Dr. Kostelnik the relation to craftspeople work practice.
In trials with the test persons, the systems‘ fitness and interaction schemes were evaluated by analyses and assessment of the use cases.

„Working in the project of the Federal Ministry of Education and Research brought us essential steps forward. Especially MZH’s work on an augmenting function, means the collection of spatial data by a camera and the itself adapting projection of work schedules like e.g. drill holes imposed great demands. Of course, we have not yet reached the target of serial production, but the findings obtained will be incorporated in new research projects”, recapitulates Dr. Jan Kostelnik of Würth Elektronik CBT.
His conclusion: „ We would appreciate if our work could bring a notable advancement of USB3.1 type C and the sensor fusion for robotics applications and generally in the sphere of wearables. “

About the research project background:

The megatrend „ageing society“ presupposes the extension of people’s working lives which – coupled with continuously increasing demands on work quality and efficiency – calls for new technical solutions. In the domains of crafts business and industrial manufacture / assembly, assistance systems turn out being expedient, for example for power assistance, augmentation, and increased safety. Physically demanding activities often lead to signs of exhaustion, thus leading to accumulating health issues. An assistance system allows on one hand the long- term preservation of work ability , on the other hand it prevents occupational consequential damages, above all musculoskeletal disorders. Workflows in the sphere of assembly, building and handicraft are hardly standardized, posing a specific challenge for the development of technical assistance systems.

About Würth Elektronik Circuit Board Technology (CBT):

Würth Elektronik Circuit Board Technology was founded in 1971 and has established itself as one of the leading PCB manufacturers in Europe. Developers are able get standard circuit boards, new and innovative technologies and even complete system solutions all from one source. Here at Würth Elektronik, we cover the entire product life cycle, from the initial idea for a design, for example during early R&D projects, to the production of

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prototypes on the online shop WEdirekt and finally, manufacturing of medium and large volumes in Germany or Asia. Knowledgeable specialists are not just located at our German plants. Internationalization is an important strategic aspect for Würth Elektronik. We have numerous sales teams set up across many European countries.
Every day more than 120 new PCB designs enter our production. We have over 4,700 customers, ranging from large corporations to one-man designers. In addition to the personal care provided through our dense network of over 100 internal and external sales people, customers also have the option to purchase printed circuit boards online through the easy to use online shop, WEdirekt.

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Text Photos: Assistance for load reduction and lowering fatigue, merger of different measurands for position monitoring and projection of relevant information into the workspace (augmenting) are main functions of the “third arm”. Photo: Würth Elektronik

Videos: https://www.youtube.com/watch?v=xfCkHD-lwoA
https://www.imes.uni-hannover.de/3armvideos

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