Efficient Division of Labor between Humans and Robots in Assembly Systems

In early September, the EU project »LIAA – Lean Intelligent Assembly Automation« started

Robots are meant to increase productivity, improve safety at work, and relieve people: The application-oriented EU project LIAA was kicked off on 2 September 2013. In a European consortium led by Fraunhofer IPA, scientists will develop cost-effective robot systems and applications for assembly. The collaboration between humans and robots will help to combine the cognitive abilities of humans with the strength and repeatability of robots. It will not only increase productivity and relieve workers but also reduce the costs for automation solutions.

The LIAA project brings together leading European research institutes, component makers, technology providers, and end users. The project aims at developing a standard software framework for assembly systems, combining the strengths of humans and robots. Depending on the process and the workload of the worker, the assembly workstation can be used simultaneously by both robots and humans. While the robot handles, for instance, repetitive and heavy work, the worker can concentrate on cognitively demanding tasks that require fine motor skills. The project focuses on the following aspects:

Intelligent symbiosis between humans and robots

Intelligent algorithms are used to divide the assembly process into individual steps and assign them to workers or robots, based on their particular suitability and workload. Then, the tasks of the process step are described according to the needs of the individual resource. Hence, the robot is sent machine-readable commands or state diagrams, while the worker receives multimedia-based assembly instructions created on-site and presented via head-mounted displays (HMD) or tablets. Efficient cooperation requires each party to know which step the other performs. While the assembly process is carried out, the worker is informed about what the robot is doing or will do next, using augmented reality technology. For example, it visualizes the trajectory data or displays workplace areas that are blocked. Camera-based information systems and intelligent perception and prediction algorithms ensure that the robot recognizes what process step the worker is currently performing. As a result, it can adjust its own behavior and, e.g. in case of delay, take over additional process steps.

Lean and low-cost

Within LIAA, five industrial pilot cases have been defined in collaboration with European end users. A crucial factor contributing to the cost-effectiveness of assembly processes is the use of low cost components. »LIAA aims at developing a framework that allows for the cost-effective use of robot assistants on the assembly shop floor, based on lightweight robots available on the market, low-cost sensors, and open-source robot control software«, says Martin Naumann, LIAA project coordinator and group manager in the Robot and Assistive Systems Department at Fraunhofer IPA. The key advantage is that—based on the framework—system integrators can implement low-cost robot systems using lightweight robots. With the various standardized interfaces and a library of program modules to be parameterized and interlinked for the robot and the sensors, it is sufficient to configure the framework to the specific assembly application.

Worker safety

One of the research priorities of LIAA is to ensure the safety of humans. This is done, on the one hand, by performing (semi-) automated risk assessments of the assembly system at the design stage and, on the other, by taking adequate safety measures at the execution stage. It is based on LIAA's staged safety concept, which, depending on the risk assessment, selects and combines preventive, soft and/or hard safety measures. The LIAA framework supports the integration of the necessary safety technology. The active involvement in relevant standardization and certification bodies ensures that the experience and

insights gained from the project find their way into new regulations of safety standards for collaborative robots.

Focus on application

The research project LIAA is coordinated by Fraunhofer IPA, one of the leading organizations for applied research in the field of robotics. Other project partners are Universal Robot A/S (lightweight robots), Visual Components OY (simulation technology), InSystems Automation GmbH and LP Montagetechnik GmbH (assembly solutions), as well as Penny AB and EON Development AB (AR hardware and software). With the internationally renowned research organizations Fundacion Tecnalia Research & Innovation, DTI Danish Technological Institute, and the Laboratory for Manufacturing Systems and Automation LMS at the University of Patras, LIAA commands the technical expertise and wide technological know-how to achieve the desired project objectives.

The integration of five end users (Adam Opel AG, Dresden Elektronik Ingenieurtechnik GmbH, SPINEA s.r.o., Fischer IMF GmbH & Co. KG, and TELNET Redes Inteligentes SA) from different industrial sectors and with different assembly applications allows the developed framework to be put to the test in five technology settings while the project is in progress.

Contact and more information:

Dipl.-Ing. Martin Naumann, Project Coordinator
Robot and Assistive Systems Department
Fraunhofer IPA
Nobelstr. 12, D-70569 Stuttgart
Telephone +49 711 970-1291
Fax +49 711 970 1008
martin.naumann@ipa.fraunhofer.de
www.project-leanautomation.eu

LIAA Partner	Country	Type	Contact
Fraunhofer Gesellschaft Institute for Manufacturing Engineering and Automation	Germany	Technology transfer	Martin Naumann martin.naumann@ipa.fraunhofer.de
Universal Robots A/S	Denmark	Robot manufacturer (SME)	Esben Østergaard esben@universal-robots.com
Visual Components Oy	Finland	Simulation technology (SME)	Fernando Ubis fernando.ubis@visualcomponents.com
InSystems Automation GmbH	Germany	System integrator (SME)	Uwe Müller mueller@insystems.de
Penny A.B.	Sweden	AR hardware (SME)	Erik Lundstrom erik.lundstrom@penny.se
EON Development AB	Sweden	AR hardware/ software (SME)	Nils Andersson nils@eonreality.se
LP-Montagetechnik GmbH	Germany	Assembly solutions (SME)	Edwin Lotter e.lotter@lp-montagetechnik.com

Danish Technological Institute • Robot Technology • Certification and Inspection	Denmark	Technology transfer	Anders Beck anbb@teknologisk.dk Claus Kudsk cek@teknologisk.dk
Fundacion Tecnalia Research & Innovation	Spain	Technology transfer	Damien Salle damien.salle@tecnalia.com
University of Patras Laboratory for Manufacturing Systems and Automation	Greece	University	Nikos Papakostas papakost@lms.mech.upatras.gr
Adam Opel AG	Germany	End user	Benjamin Kuhrke benjamin.kuhrke@de.opel.com
Dresden Elektronik Ingenieurtechnik GmbH	Germany	End user	Mike Ludwig mike.ludwig@dresden-elektronik.de
Spinea, s.r.o.	Slovakia	End user	Vladimir Cop vladimir.cop@spinea.sk
Fischer IMF GmbH & Co. KG	Germany	End user	Daniela Eberl daniela.eberl@fischer-imf.de
TELNET Redes Inteligentes SA	Spain	End user	Jose San Millán jvsanmillan@telnet-ri.es