ClaXon

Improving the interaction between people and collaborative robots in factories

For safety reasons, robots in a manufacturing environment are typically shielded from humans. However, humans and robots have very complementary skills. Combining the dexterity, flexibility and problem-solving ability of humans with the strength, endurance and precision of robots, the quality of industrial production can be improved – as well as people's working conditions.

Yet, introducing so-called 'cobots' (collaborative robots) to flexibly assist human personnel in a range of tasks faces several technological and acceptance hurdles.

"We explored how uncaged cobots can more effectively be used in factories," explains An Jacobs (imec - VUB). "One challenge we looked into, was how to make cobots sufficiently robust for use in manufacturing settings – leveraging for instance multimodal sensor input and vision technology to enhance human-machine interaction in noisy environments. Secondly, we investigated the human side of the equation: how do machine operators want to interact with robots? And how do they expect robots to help them with their daily operations?"

THE OUTCOMES

1. New adaptive control software that increases flexible robots' accuracy by 60%

Introducing flexibility and suppleness in a robot is called 'compliance'. A non-compliant robot will follow the exact same path each and every time – no matter what kind of external force is exerted (even if it touches a human co-worker, for instance). As a result, for the sake of human safety on factory floors, non-compliant robots must operate in cages.

"A prerequisite to increase the interaction between robots and operators at a production line is the use of compliant robots. By equipping them with features such as springs, we avoid that swaying robot arms can hurt nearby people. This compliance, however, typically comes at the expense of robots' accuracy," explains Tim Waegeman, Robovision. "That was a first challenge that was successfully addressed by ClaXon, as it resulted in new adaptive control software that increases the accuracy of compliant robots by 60%."

2. Novel ways to tell a robot what it needs to do – using multimodal sensor input, and based on extensive living lab user research

Today, telling a robot what it needs to do – and changing instructions in function of the production process – is a complex and time-consuming exercise that typically requires specialized programming skills. As a result, making quick and on-the-fly adaptations to a robot's actions is out of the question.

Tim Waegeman: "But what if we could come up with novel ways to quickly instruct robots what they need to do? An intuitive and highly efficient method that can be used by every machine operator, and that allows them to flexibly cope with on-the-fly and complex production changes?"

To achieve this, the ClaXon approach puts the concept of 'observation' center stage. Using multimodal sensor data (from heat, depth and color cameras and electrical current sensors – as well as a newly developed cheap torque sensor), the robot observes in great detail the operator and the factory environment. And thanks to a facial and gesture recognition engine, it is capable of recognizing its human co-workers and interpreting the operator's gestures and movements; input on which it can then act.

3. Putting the ClaXon learnings into practice at Audi Brussels

The project has already resulted in a spin-out project that involved a number of ClaXon partners, and that led to a fully operational

MRK robotic system at the Audi Brussels production plant; featuring a cobot at one of Audi's production lines that receives instructions via operators' gestures.

"The use of gestures as a way to interact with cobots is actually one of the approaches that makes this research project really unique. Extensive living lab user research has allowed us to map what works and what doesn't. It also helped us experiment with the technology – using actual prototypes, real machine operators, and a real-life setting," says An Jacobs.

NEXT STEPS

"Even though some important steps forward have been realized to improve the collaboration between cobots and their human co-workers, a number of hurdles remain," says Ilse Ravyse, SoftKinetic. "Due to a lack of standards, for instance, it is not possible yet to 'just' deploy a standard cobot with standard sensors in a production environment. The role of so-called robot integrators thus remains very important. The project also taught us that we first need to refine concepts such as depth camera resolution – before looking into actual interaction requirements."

ClaXon's newly developed camera software can be used to teach the robot what to do by demonstrating the process. To bridge the gap between the existing industrial robot technology and the new 'cobot' concept, AMS has developed an interface that enables existing installations to be retrofitted with the ClaXon software. The developed interface can also be used in other software applications other than the ClaXon system, enabling more complex algorithms to be used by industrial robots.

Robovision as well has been able to derive some valuable knowledge from this project, including the direct feedback from operators on programming robots and the limitations of current depth cameras (which struggle with the reflection generated by metal surfaces). Moreover, the MRK spin-out project provided them with a very positive commercial experience.

For Audi, the MRK robot is no longer just a proof-of-concept. They have seen which benefits cobots can bring to the production process, and are keen to further explore how cobots and operators can complement one another in the best possible way.

AGENTSCHAP INNOVEREN & ONDERNEMEN | Vlaanderen is ondernemen | innoviris.brussels

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FACTS

NAME	ClaXon
OBJECTIVE	Improving the collaboration between people and robots in industrial production facilities
TECHNOLOGIES USED	collaborative robots, depth sensing, magnetic torque sensing, servo gripper, thermal camera, face recognition, gesture recognition, trajectory learning, multimodal interaction recognition
TYPE	imec.icon project
DURATION	01/01/2015 – 31/12/2016
PROJECT LEAD	Ilse Ravyse, SoftKinetic
RESEARCH LEAD	An Jacobs, imec - SMIT - VUB
BUDGET	1,317,000 euro
PROJECT PARTNERS	AMS, Audi Brussels, Melexis Technologies, Robovision, SoftKinetic
RESEARCH PARTNERS	Robotics and MultiBody Mechanics Research Group (VUB)
IMEC RESEARCH GROUPS	EDM - UHasselt, SMIT - VUB

WHAT IS AN IMEC.ICON PROJECT?

The imec.icon research program equals demand-driven, cooperative research. The driving force behind imec.icon projects are multidisciplinary teams of imec researchers, industry partners and / or social-profit organizations. Together, they lay the foundation of digital solutions which find their way into the product portfolios of the participating partners.

ClaXon project partners:

Audi Brussels | Melexis INSPIRED ENGINEERING | SoftKinetic | RoboVision INTEGRATED SOLUTIONS NV | AMS Automation & Manufacturing Services

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