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Democratization of Industrial Cobot Technology

Project Testbed Exchange | online | 2022/08/11

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Sebastian Schlund (Institute of Management Science)

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Agenda

1. Motivation
2. Democratization of Industrial Cobot Technology
3. Research Projects / Examples
4. Conclusion and Outlook

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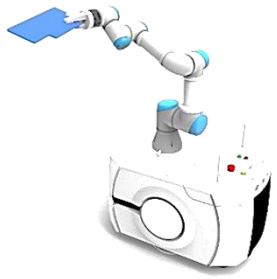
Research Unit Human-Machine Interaction at TUW

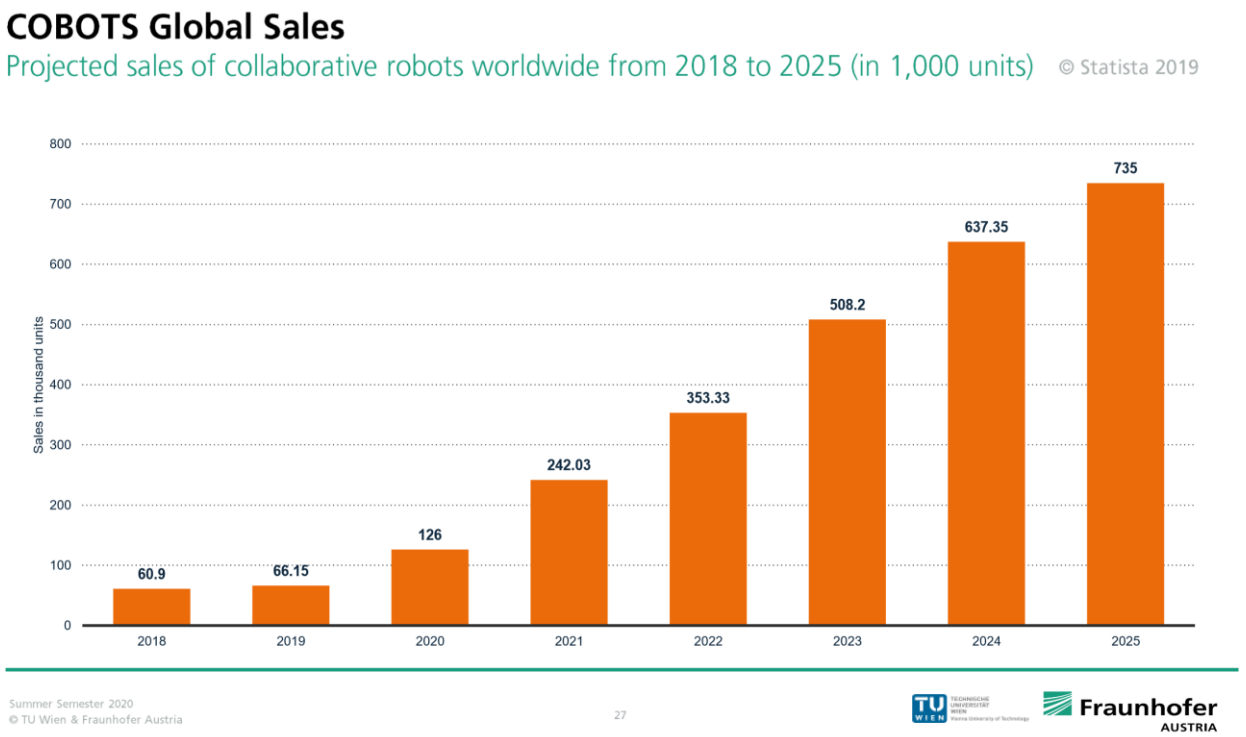
Human-Machine Interaction

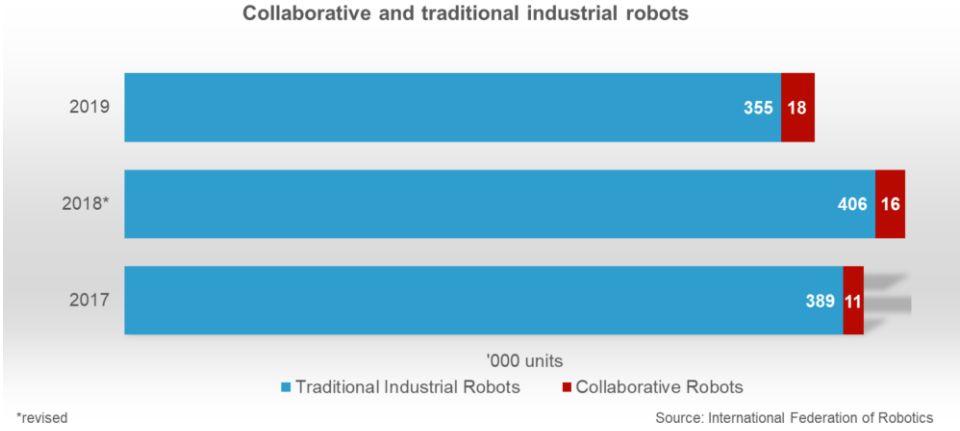
Attractive, Adaptable and Accessible Work Systems



We shape future work for a competitive industry and sustainable society.

Cobots on the rise but far behind expectations





Cobot use in Austrian Industry

- Use of Cobots (n=84)
  - Company-wide: 0%
  - Partially: 30%
  - Pilot areas: 11%
  - Application planned: 15%
  - No application: 44%
- Main Challenges (n=77)
  - Costs/RoI 30%
  - Task Allocation 27%
  - Safety 21%
  - Employer Acceptance 13%
  - Other 9%

PATSCH, J., KAMES, D., MAYRHOFER, W., & SCHLUND, S. (2021). MADE IN AUSTRIA: PRODUKTIONSARBEIT IN ÖSTERREICH 2021.

A universal tool.

Does this look like a universal tool?

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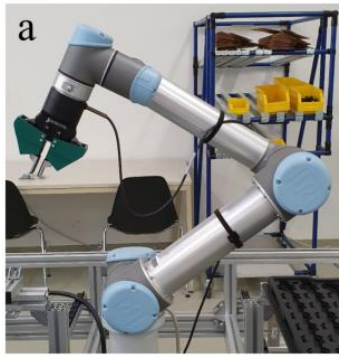
Assumptions for the Democratization of Cobots

- Cobots have the potential to improve each workplace in terms of ergonomics and productivity.
- Therefore, they have to become tools that everybody is able to use…
- … intuitively.

- (In a safe and secure way.)



Universal Robot UR5
Usability score
(SUS): 55%

Fanuc CR-7iA
Usability score
(SUS): 52%

Franka Emika
PANDA
Usability score
(SUS): 71%

SCHMIDBAUER, C., KOMENDA, T., & SCHLUND, S. (2020). TEACHING COBOTS IN LEARNING FACTORIES–USER AND USABILITY-DRIVEN IMPLICATIONS. PROCEDIA MANUFACTURING, 45, 398-404.

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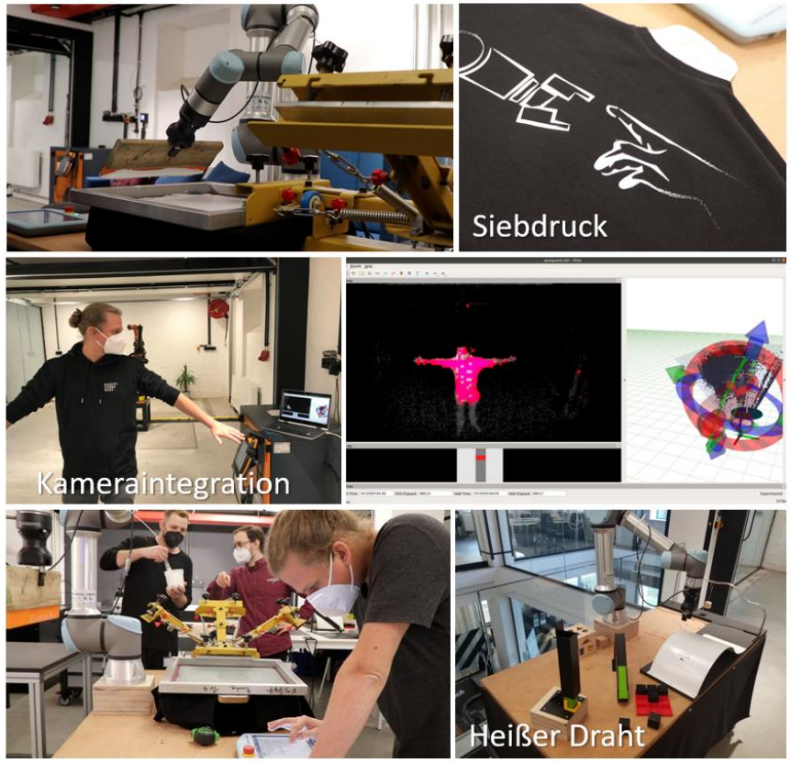
Notion of Democratization

- Democratization: “non-discriminating access to the design, development and use of technology”
- Somehow important as cobots are supposed to be used in very close interaction with people.
- Today’s underlying paradigms set high access barriers in terms of prior knowledge and experience and limit/restrict potential use cases.
- ‘Democratization’ does not refer to the majority-based decision making, rather to the access to vote and to create sth. and to a certain extent also to pluralism in the sense of an open competition about the best ideas.

CoMeMak (Cobots meet Makerspace)



cobot meets maker +space

JOANNEUM RESEARCH

GRAND GARAGE

RIC REGIONALES INNOVATIONS CENTRUM

TU WIEN imw Institut für Managementwissenschaften
Human Centered Cyber Physical Production and Assembly Systems

Bundesministerium
Klimaschutz, Umwelt,
Energie, Mobilität,
Innovation und Technologie

FFG

FFG (Grant Nr. 871459)

ASSEMBLY – Web-based Cobot Simulator

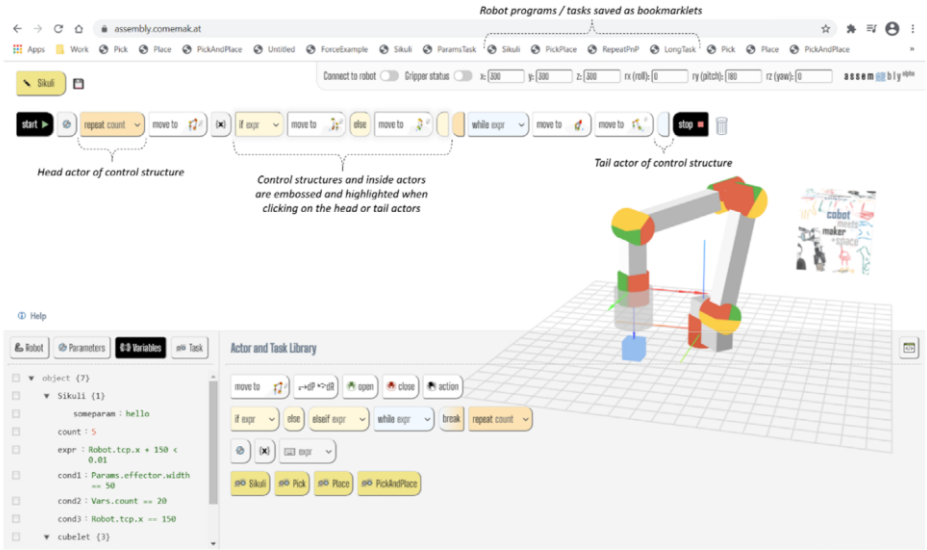
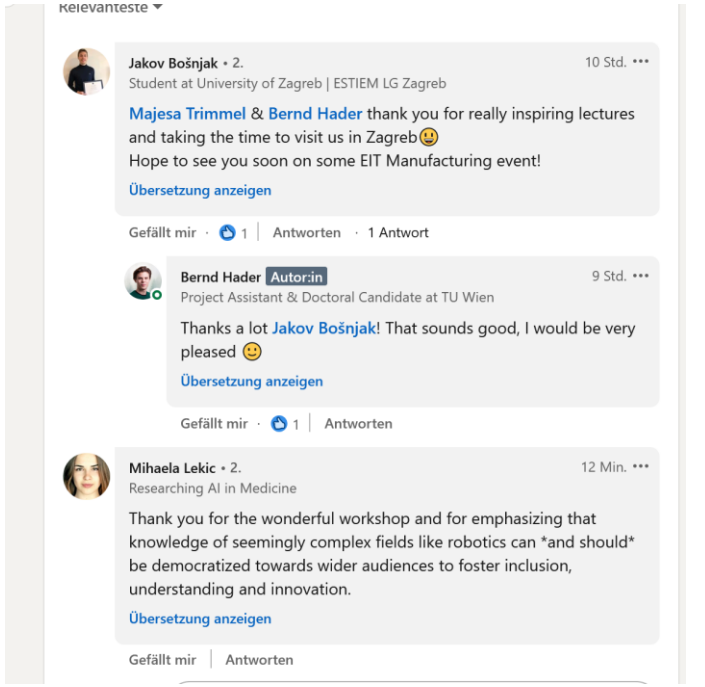


Figure 2. *Assembly* screenshot showing the workflow of a generic robot program. The tool is available online at: https://assembly.comemak.at. See the "Supplementary Materials" section for source code availability.

IONESCU, T. B. (2021). LEVERAGING GRAPHICAL USER INTERFACE AUTOMATION FOR GENERIC ROBOT PROGRAMMING. ROBOTICS, 10(1), 3.

DeCoTe (Democratizing Cobot Technology)



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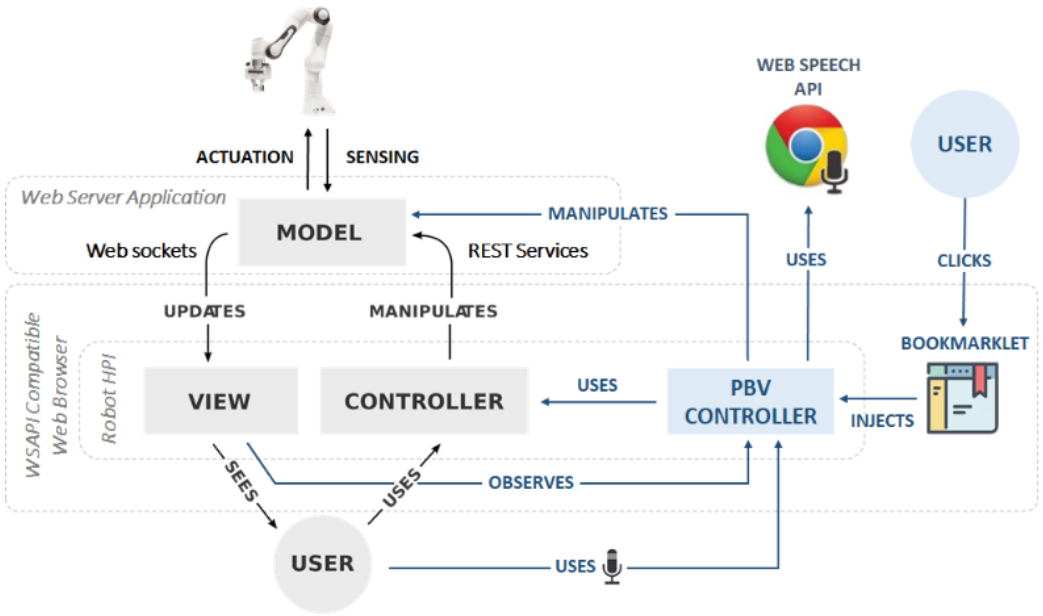
Collaborative Robots Applied in Open Spaces

CRAOS has received funding through a COVR Award. COVR is granted by the European Union's Horizon 2020 research and innovation programme under grant agreement No. 779966

Natural User Interfaces



GRP	CMD	Functionality
1	*Speed / Force/ Load / Speed-up <#>*	Sets the velocity / grasping force / gripper load / acceleration of the arm for all subsequent apps to the specified integer value <#>. A subset of these parameters are required by the movement and gripper apps.
2	*Grasp*	Initializes the "Gripper Grasp" app which allows users to manually set the opening of the gripper so as to grasp a certain object. After triggering this app, the users are able to use the buttons on the robot's head or to manually set the gripper fingers to the desired position.
	Hand	Initializes the "Gripper Move" app which allows users to set the opening of the gripper using the buttons on the robot's head or by manually moving the gripper fingers.
	Motion	Initializes the "Cart Motion" app, which allows users to teach in a movement of the arm using several waypoints. Waypoints are set by driving the robot's arm to the desired pose and then pushing the OK button on its head.
3	*Okay*	After having set all the parameters of an app by using the buttons on the robot's head and/or manually moving the robot's arm and fingers, this command will auto-complete all the information requested in the subsequent dialogues of the app-specific wizard (e.g., velocity, force, acceleration, load).
	Start	This command starts the execution of the task being programmed.
	Stop	This command stops the execution of a task.

IONESCU, T. B., & SCHLUND, S. PROGRAMMING COBOTS BY VOICE: A HUMAN-CENTERED, WEB-BASED APPROACH. 8TH CIRP CONFERENCE OF ASSEMBLY TECHNOLOGY AND SYSTEMS, ATHENS, 2020

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Adaptive Task Sharing

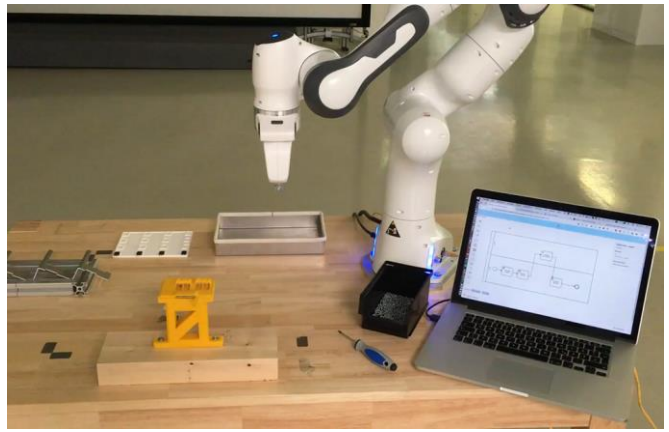
Static task allocation

Human	Shareable	Cobot
Tasks not-executable by a cobot (leftover) or effort for automation is too high (compensa-tory)	Not foreseen	Tasks executable by a cobot at reasonable costs or tasks that are disadvan-tageous for humans

Adaptive task sharing

Human	Shareable	Cobot
Tasks not-executable by a cobot (leftover) or effort for automation is too high (compensa-tory)	Tasks executable by humans and cobots that can be shared adaptively according to decision criteria	Tasks executable by a cobot at reasonable costs or tasks that are disadvan-tageous for humans

Fig. 1. Static task allocation vs. adaptive task sharing.



SCHMIDBAUER, C., SCHLUND, S., IONESCU, T.B., HADER. B.: ADAPTIVE TASK SHARING IN HUMAN-COBOT-INTERACTION. IEEE IEEM, SINGAPORE, 2020

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Adaptive Task Sharing

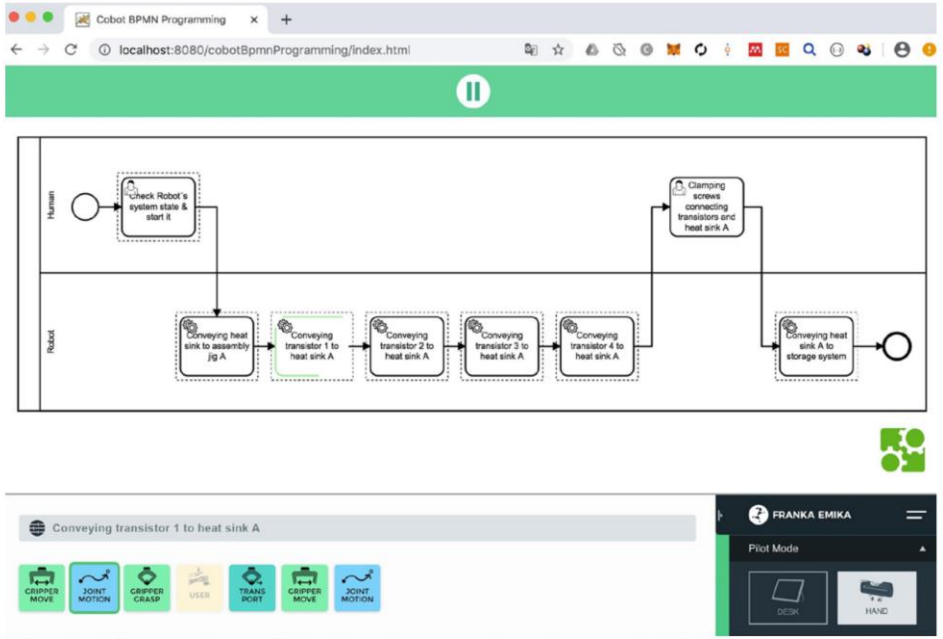

Fig. 2. Screenshot of the implemented and tested UI to control a Franka Emika Panda cobot.

SCHMIDBAUER, C., HADER. B., SCHLUND, S.: EVALUATION OF A DIGITAL WORKER ASSISTANCE SYSTEM TO ENABLE ADAPTIVE TASK SHARING BETWEEN HUMANS AND COBOTS IN MANUFACTURING . CIRP CONFERENCE ON MANUFACTURING SYSTEMS, ATHENS, 2021

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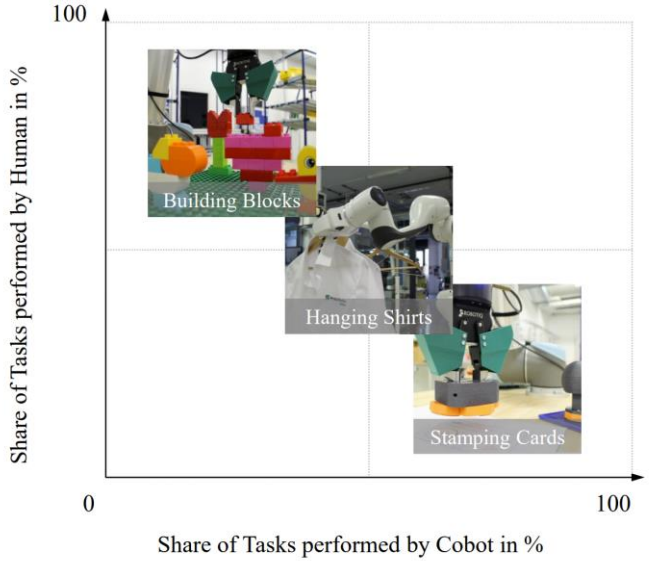
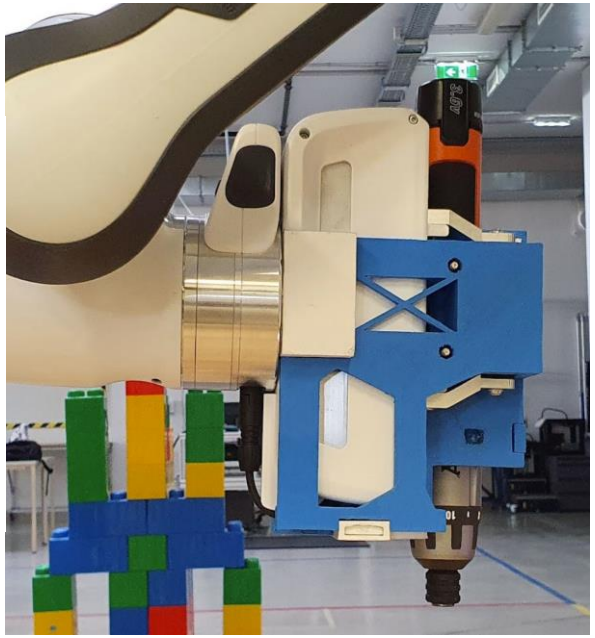
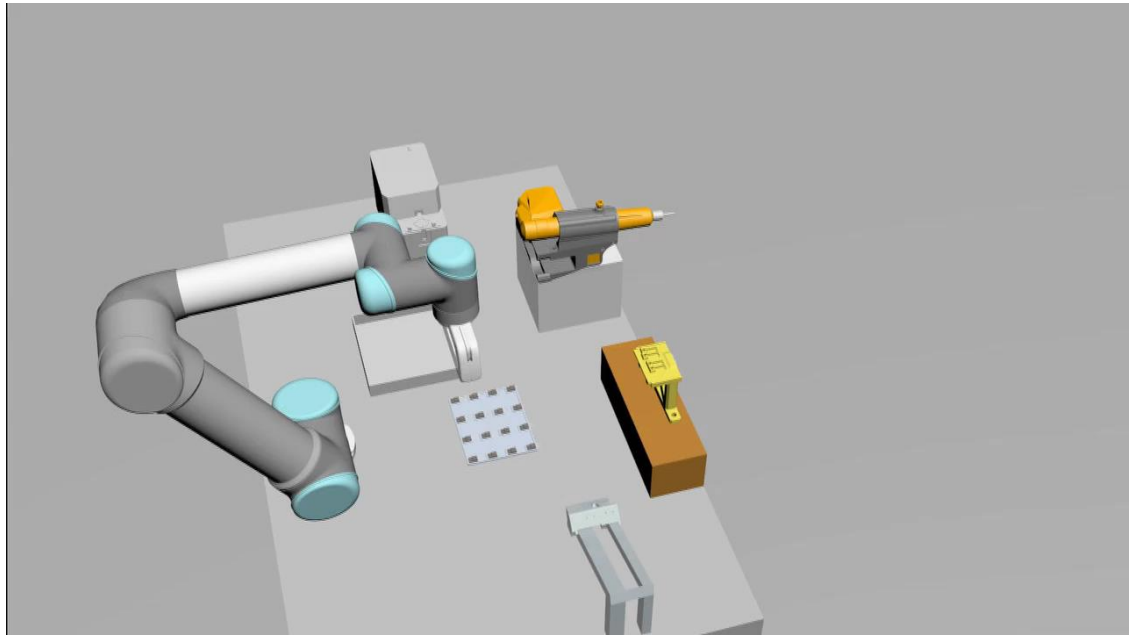
Learning to Share



KOMENDA, T, SCHMIDBAUER, C., KAMES, D, SCHLUND, S.: LEARNING TO SHARE - TEACHING THE IMPACT OF FLEXIBLE TASK ALLOCATION IN HUMAN-COBOT TEAMS. CIRP CONFERENCE ON LEARNING FACTORIES, 2021

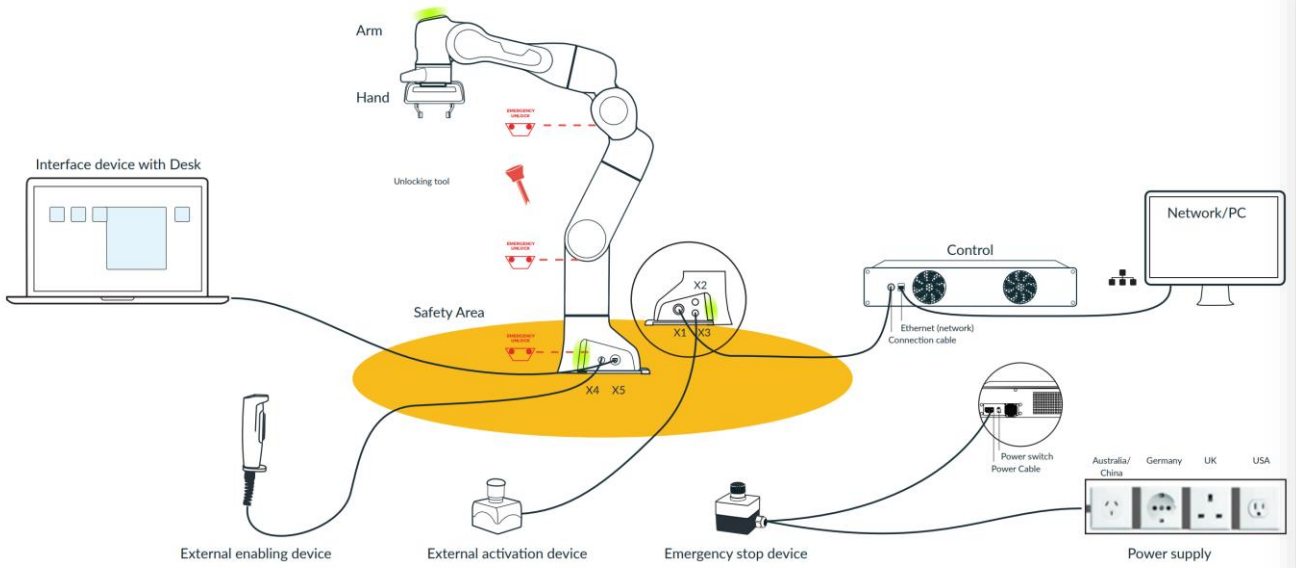
Low Cost Cobot Grippers





ONROBOT ,TU WIEN: WERKZEUGHALTERUNG ZUR LÖSBAREN VERBINDUNG MIT EINEM ZWEI-BACKEN-GREIFER AN EINEM ROBOTERARM, PATENT NUMMER: A 50571/2020, ANMELDEDATUM: 03. JULI 2020

Cobot Attack



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10th CIRP Sponsored Conference on Digital Enterprise Technologies (DET 2021) – Digital Technologies as Enablers of Industrial Competitiveness and Sustainability

Cobot attack:
a security assessment exemplified by a specific collaborative robot

Siegfried Hollerer[a,*], Clara Fischer[b], Bernhard Brenner[c], Maximilian Papa[b], Sebastian Schlund[b], Wolfgang Kastner[a], Joachim Fabini[c], Tanja Zseby[c]

Abstract

The market for cyber physical systems, such as collaborative robots (cobots), continues to grow fast. Primarily this is driven by megatrends, such as smart factories, which include interconnected machines and human-robot interaction. These new technologies lead on the one hand to flexible manufacturing and a higher level of automation. However, on the other hand, it drives the demand for the safety and security of the systems, as harm to human beings is increased in such collaborative scenarios. Therefore, in the case of a cobot increased awareness of the cyber security aspects and their relations to the safety of the system is advisable. A security assessment for the Franka Emika Panda has been performed in this paper. For this specific cobot, potential attack surfaces and their possible impacts on safety relevant parameters are analyzed. Furthermore, the defined attack surfaces of Panda are tested in a systematic penetration test based on the Open Source Security Testing Methodology (OSSTM) and the OWASP testing guide. For each of the findings countermeasures are provided, to prevent a cyber attack which can lead to a safety impact for the human worker.

1. Introduction

HOLLERER, S., FISCHER, C., BRENNER, B., PAPA, M., SCHLUND, S., KASTNER, W., ... & ZSEBY, T. (2021). COBOT ATTACK: A SECURITY ASSESSMENT EXEMPLIFIED BY A SPECIFIC COLLABORATIVE ROBOT. PROCEDIA MANUFACTURING, 54, 191-196.

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Kontakt

Univ. Prof. Dr.-Ing. Sebastian Schlund
Technische Universität Wien
Institute of Management Science | Research Unit Human-Machine Interaction
Theresianumgasse 27
1040 Wien
Telefon: +43 664605 88 2401
sebastian.schlund@tuwien.ac.at | sebastian.schlund@fraunhofer.at
www.tuwien.at