Karlsruhe Institute of Technology

Division II – Informatics, Economics, and Society

High-performance Humanoid Technologies (H^2T)

Division III – Mechanical and Electrical Engineering

Institute of Industrial Information Technology (IIIT)
Institute for Human and Industrial Engineering (ifab)

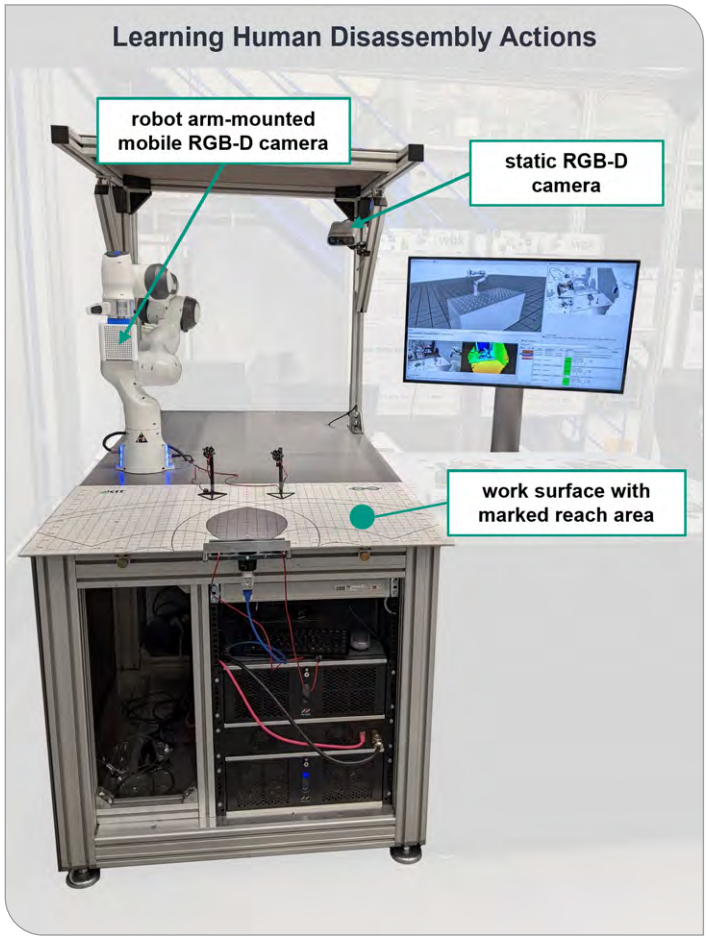
AgiProbot – Learning from Humans

Capture and Interpretation of Disassembly Processes

How can a factory autonomously adapt to constantly changing conditions? This question is studied under the research project **AgiProbot – Agile Production System Using Mobile, Learning Robots with Multi-Sensor Technology for Uncertain Product Specifications** of Karlsruhe Institute of Technology (KIT). Remanufacturing represents an ideal use case: An unknown quantity of used products in an unknown quality state are discontinuously returned to the remanufacturing facility. These products are to be disassembled automatically, if possible, and selected components are reprocessed and will be reused in production processes again.

The Remanufacturing Process

Remanufacturing is an **industrial process** for the disassembly, reprocessing, and reassembly of **used products** to make their quality reach that of new products, and to enable **reuse**.



In this way, remanufacturing contributes to **resource-efficient and sustainable circular economy.**

Disassembly Station that Learns from Humans

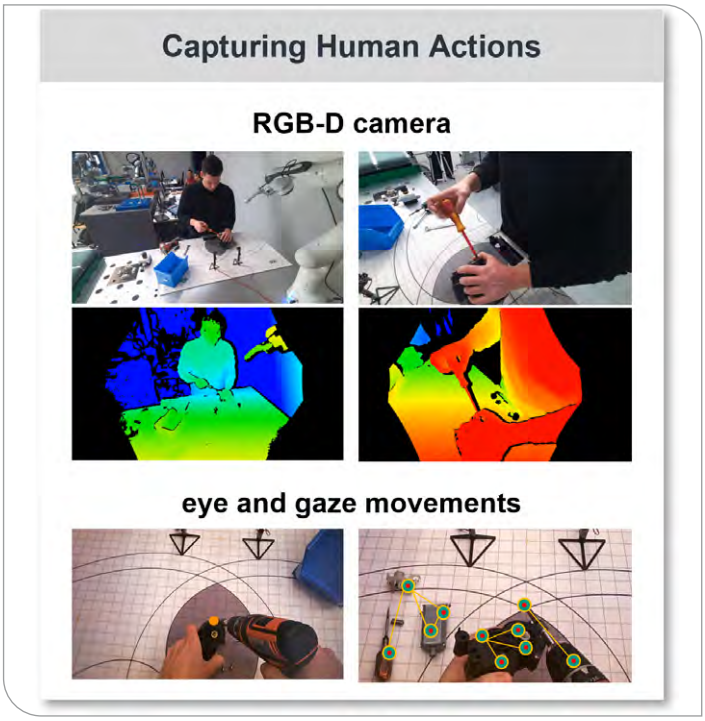
Robots are inexpensive means to automate remanufacturing processes, such as disassembly. However, it is often unprofitable due to the high programming expenditure. An intuitive method to program robots also for non-specialists is programming by demonstration. First, it is required to **capture and interpret human actions.** The approach is to watch humans disassemble products and handle uncertain product specifications, such as rusty or soiled components. Within the framework of the AgiProbot project, we built a station to observe humans manually disassembling components.

The human body posture is captured by a static and a mobile RGB-D camera. A collaborating robot arm moves in response to human hand movements for permanent close-up tracking of human actions. In addition, a head-worn eye tracking system is used to capture the human eye and gaze movements.

Station to capture and interpret human disassembly processes.
(Photo: AgiProbot/KIT)

The sensors capture eye and gaze movements as well as the posture, arm and hand movements in combination with the used tools and product components, and the objects lying on the working mat. Apart from the human body posture, the direction of view is an indicator of human action and problem-solving strategies that can be used to transfer human expert knowledge to robot systems. The station is used to study a variety of topics, such as learning by human demonstrations and the reproduction and adaptation of learned skills (H²T). Empirical view direction analysis serves to externalize human acting knowledge and cognitive processes (ifab).

The data collected is used for programming. The goal is an automatic disassembly by a robot at a factory that adapts autonomously to constantly changing remanufacturing conditions.



Sensors capturing human actions. (Photos: AgiProbot/KIT)

Automatic disassembly is studied at the AgiProbot factory. (Photo: wbk – Institute of Production Science/KIT)

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