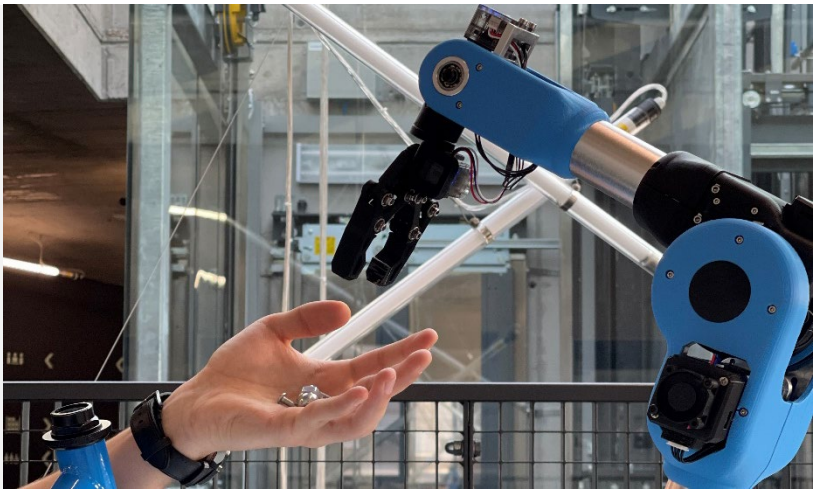
SUCCESS STORY

Pro²Future :: Products and Production Systems of the Future

Programme: COMET – Competence Centres for Excellent Technologies

Programme line: COMET-Centre K1

Type of project: CobotInsight multi-firm / internship



ADAPTIVE EXPLAIANABILITY FOR HUMAN-ROBOT COLLABORATION IN MANUFACTURING

A QUALITATIVE USER STUDY TO SUPPORT CONTEXT-AWARE, USER-CENTERED EXPLANATIONS IN HUMAN-ROBOT COLLABORATION

The rapid adoption of collaborative robots (cobots) in industrial settings has introduced new opportunities for enhancing efficiency, precision, and workforce flexibility. However, their autonomous and adaptive behaviors can also lead to uncertainty, mistrust, and decreased fluency in human-robot interactions. These challenges highlight the growing importance of explainability in cobot systems, specifically, the need for clear, timely, and accessible explanations of cobot actions. While previous research has addressed isolated aspects of explanation design, such as content or timing, a holistic understanding encompassing the when, what, and how of explanations remains underexplored.

The concept of adaptable explainability in human-robot interaction within manufacturing environments was explored during a FemTech initiative funded by the Austrian Research Promotion Agency (FFG). During this project, the participating researcher initiated foundational work by investigating how collaborative robots (cobots) can tailor their explanations based on situational context and user needs. This early-stage research laid the groundwork for a broader study into designing dynamic, user-centered explanation strategies that enhance trust, understanding, and teamwork in human-cobot collaboration.

The goal of this work was to develop a system in which cobot explanations, regarding their actions and underlying reasoning, can be dynamically adapted to the specific situation and context of interaction. This includes tailoring the content, timing, and communication channels of the explanations to best support human understanding, trust, and task performance.

Bundesministerium Innovation, Mobilität und Infrastruktur

Bundesministerium Wirtschaft, Energie und Tourismus

Version 05/2025

As a first step, a qualitative user study was conducted to systematically investigate the explainability needs of users during collaboration with a cobot. This study served as an exploratory foundation to understand when users expect explanations, what kind of information they find most helpful, and how that information should be presented. The user study design was inspired by participatory design approaches and included a simplified industrial collaboration scenario with a cobot that occasionally exhibited unexpected behaviors, such as delays, incorrect part delivery, or ambiguous movements, designed to provoke moments of uncertainty. Using a combination of think-aloud protocols, structured interviews, and physiological measurements (including pupil dilation and heart rate), the study captured participants' cognitive and emotional responses in real time. A Pupil Labs Neon eye tracker was used to determine the pupil diameter and its dilation during the execution of the different tasks. Additionally, the heart rate of the participants was captured using the E4 Empatica wristbands.

The analysis revealed consistent user demands for transparent cobot status updates and situation-dependent guidance, with preferences for simple, accessible explanation formats such as textual prompts and light signals. This initial study provided critical insights into user expectations and laid the groundwork for developing adaptive explanation mechanisms in future cobot systems.

Impact and effects

The findings from this study have important implications for the design of future human-robot collaboration systems. By highlighting users' strong preference for timely, context-aware, and easy-to-understand explanations, the research underscores the necessity of integrating adaptable explainability into cobot interfaces. Such enhancements can significantly improve user trust, task efficiency, and overall collaboration fluency in industrial environment

Pro2Future GmbH
Altenberger Straße 69
4040 Linz, Austria

T +43 (0) 732 2468 – 4783
office@pro2future.at
www.pro2future.at

Scientific Director
Univ.-Prof. Dr. Alois Ferscha
alois.ferscha@pro2future.at

Success Story by
DI Dr. Ouijdane Guiza
Area Manager
ouijdane.guiza@pro2future.at

Verena Szojak, BSc
verena.szojak@pro2future.at

Center Communications Manager
DI Dr. Markus Jäger, MLBT
markus.jaeger@pro2future.at

Project partner

- JKU LIT Robopsychology Lab, Austria

This report was released for publication at the FFG website by the centre management and its project partners. Pro²Future is a COMET Centre within the COMET – Competence Centres for Excellent Technologies Programme and funded by BMIMI, BMWET, Upper Austria and Styria. The COMET Programme is managed by FFG. Further information on COMET: www.ffg.at/comet. FFG FemTech internship funding number: 915105

Federal Ministry
Innovation, Mobility
and Infrastructure
Republic of Austria

Federal Ministry
Economy, Energy
and Tourism
Republic of Austria

Austrian Research Promotion Agency
Sensengasse 1, A-1090 Vienna
P +43 (0) 5 77 55 - 0
office@ffg.at
www.ffg.at