Robot Action Anticipation for Collaborative Assembly Tasks

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INTRODUCTION & FRAMEWORK

The concept of Human-Robot Collaboration (HRC) involves the study of processes in which humans and robots work together to achieve a shared goal. Research on collision avoidance, human-aware planning of robot motions and control of physical contact have brought significant advances to the field of HRC[a]. However, an essential requirement in the control of collaborative actions is the ability to anticipate the partner's movements and intentions. The robot should not only be able to model and predict the human's movements but, more importantly, must anticipate them. This dissertation proposal aims to tackle these questions using state-of-the-art Machine Learning (ML) techniques.

OBJECTIVES & TASKS

This dissertation aims at the development of an action anticipation system to enhance human-robot collaboration in industrial settings (see Fig.1) under the AUGMANITY mobilizing project. The main tasks to be carried out can be summarized by the following points:

1. **Overview of the state-of-the-art.** To provide an up-to-date review of the definitions and algorithms adopted for action anticipation in collaborative environments.
2. **Action anticipation in a human-robot collaborative scenario.** To formally define how to anticipate an action in the context of the collaborative task under study using RGB-D images as input. ML models, such as recurrent neural networks (RNNs), are at the forefront of the algorithms to explore.
3. **Robot control of joint actions.** To develop anticipatory robot controllers that consider the human partner movements and intentions and use these inferences to make appropriate decisions during the execution of a sequential assembly task.
4. **Metrics and performance evaluation.** To provide performance metrics used to evaluate the action anticipation models and the add-value of the anticipatory controller (e.g., in terms of cycle time).
5. **Writing the master dissertation and other detailed documentation.**

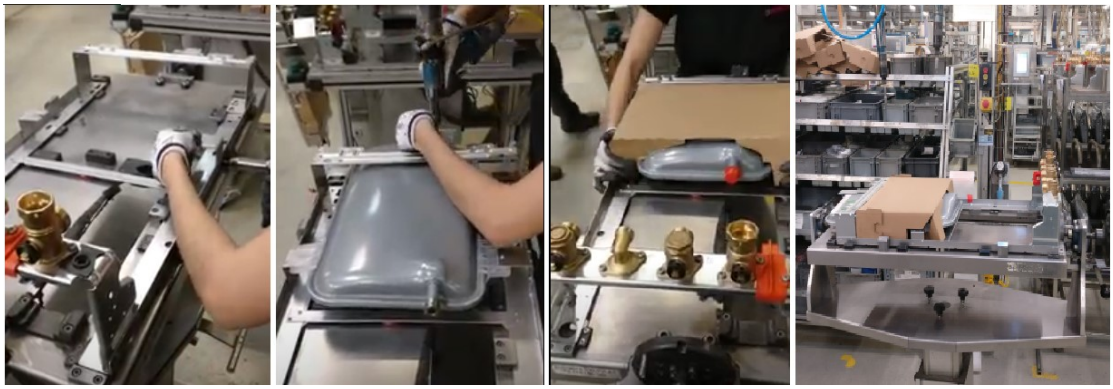

Fig. 1: Example of a real workstation where the structure of a gas boiler for water heating is manually assembled. The collaborative robot may assist the assembly task by placing the parts in the jig, while coordinating its actions with those of the human who is focused on the riveting process.

[a] Castro, A.; Silva, F.; Santos, V. Trends of Human-Robot Collaboration in Industry Contexts: Handover, Learning, and Metrics. *Sensors* **2021**, *21*, 4113. https://doi.org/10.3390/s21124113