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Criteria definition for the identification of HRC use cases in automotive manufacturing

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Abstract

The study aims at the definition of a methodology for the objective identification of the most suitable applicative use cases for a profitable exploitation of HRC technology. The analysis is based on the preliminary assignment of values to multiple Key Parameters (KPs). The KPs identification is based on a methodological analysis applied to multiple manufacturing cells in production. Core of the process was the identification of the criteria and the KPs. A systematic application of the tool was made to test and fine-tune the developed methodology. Criteria and methodology that were defined in the study are summarized.

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Keywords: Human Robot Collaboration; industrial application; methodology; automotive; use case identification.

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1. Introduction

Human Robot Collaboration is a rapidly emerging technology which is expected to have an important impact on future manufacturing design approach in heavy industries such as the automotive manufacturing. Many reasons concur to create this expectation. First of all there is the possibility to exploit the physical abilities of the robot such as precision, repeatability and force together with the human operator cognitive (intelligence, problem solving, improvisation, immediate vision) and physical (manipulation, dexterity) capabilities. Secondarily it is possible to:

- reduce the ergonomic issues using the robots to carry over heavy operations;
- improve quality by:
  - robot's characteristic repeatability;
  - introduction of controlled adaptive constraints in the operator's activity;
- improve productivity using the robot to perform "Non Value-Added Activities" (NVAA) instead of the operator;
- give support to elderly or reduced work capacity operators and reintroduce them in the workforce, and so on.

While the expectation is thus motivated, both the technology and the regulatory framework matured just recently. The technical regulation was defined in 2011 in the standard EN ISO 10218-2:2011 (Robots and robotic devices. Safety requirements for industrial robots. Part 2: Robot systems and integration) [1], that set the allowed behavior in Human Robot Collaboration applications. Nevertheless the standard itself quoted that "Additional information and guidance on collaborative robot operations will be contained in ISO/TS 15066 (currently under preparation)". The ISO/TS 15066 [2] (Robots and robotic devices - Collaborative robots) has been published just recently in 2016 and it is setting the limits and methodologies for the safety in the workplace in Human Robot Collaboration (HRC) applications. In parallel to EN ISO 10218-2:2011, the EN ISO 10218-1:2011 [3] was published to set the hardware and functional characteristics that a collaborative robot has to fulfil. After the publication of this robot's standard the commercialization of collaborative robots began starting by low duty robots (Universal Robots UR5 and UR10 [4] respectively with a payload of 5 and 10 kilograms; and KUKA LBR iiwa [5] with a payload of 14 kg), and going up to higher payload collaborative robots such as the FANUC CR-35iA [6] (35 kg) and the COMAU AURA [7] (110 kg) introduced at the AUTOMATICA 2016 fair.

The current availability of robotic technologies and the completeness of the regulatory framework allow the implementation of effective HRC application in production. Nevertheless, while the ISO standards are required for the proper design of the workplace and the cell, the design and use of a HRC application in production has to be motivated by a proper benefit analysis. In facts, while currently many use cases are declared and tested, their identification process is often just based on an experience analysis. The different approaches to the workspace and the design of the application itself are inherently modified by the collaboration between human and robot that, up to now, was not allowed to be used in the industrial applications.

The identification and choice of workplaces and applications that can take proper advantage of the HRC technology is not trivial and requires the comparison with the currently used technology which is based to traditional approach where the operator and the robot cannot share the same space and cannot co-operate on the same application.

Other studies cope with the definition of a quantifiable methodology for the identification of suitable collaborative cells; for instance Teiwes, et Al. [8] propose an adjustment of the MTM analysis in which an added overall score is calculated through the assignment of a specific score to each kind of operation defined in the MTM analysis. This work gives an interesting approach to a modified MTM, but doesn't cope with the definition of a proper set of KPIs. On the other hand Grahn, et Al. [9] suggest a set of KPI for the evaluation of potential benefits provided by a cooperative assembly workplace.

The performed study aims at the definition of a methodology for the objective identification of the most suitable applicative use cases for a profitable exploitation of HRC technology. The analysis is based on the assignment of values to multiple Key Parameters (KPs). The KPs identification is based on a methodological analysis applied to multiple manufacturing cells in production. Core of the process was the identification of the criteria and the KPs. A systematic application of the tool was made to test and fine-tune the developed methodology. The paper wants to summarize the criteria and methodology that were defined in the study.