Automatic Learning Improves Human-Robot Interaction in Productive Environments: A Review

Mauricio Andres Zamora Hernandez, University of Costa Rica, San Pedro de Montes de Oca, Costa Rica
Eldon Caldwell Marin, University of Costa Rica, San Pedro de Montes de Oca, Costa Rica
Jose Garcia-Rodriguez, University of Alicante, Alicante, Spain
Jorge Azorín-Lopez, University of Alicante, Alicante, Spain
Miguel Cazorla, University of Alicante, Alicante, Spain

ABSTRACT

In the creation of new industries, products and services -- all of which are advances of the Fourth Industrial Revolution -- the human-robot interaction that includes automatic learning and computer vision are elements to consider since they promote collaborative environments between people and robots. The use of machine learning and computer vision provides the tools needed to increase productivity and minimizes delivery reaction times by assisting in the optimization of complex production planning processes. This review of the state of the art presents the main trends that seek to improve human-robot interaction in productive environments, and identifies challenges in research as well as in industrial - technological development in this topic. In addition, this review offers a proposal on the needs of use of artificial intelligence in all processes of industry 4.0 as a crucial linking element among humans, robots, intelligent and traditional machines; as well as a mechanism for quality control and occupational safety.

KEYWORDS
Augmented Reality, Computer Vision, Machine Learning, Manufacturing, Robotics

INTRODUCTION

The fourth industrial revolution is not only trendy, but also defines the new rules to which the current industry must adapt to. Since this subject covers a wide variety of work fields, this research was carried out in order to summarize the ideas and findings of other researchers in this field. Thus, this paper presents a synopsis of the arguments that revolve around integrating robotics with operators in cyber manufactures to improve productivity, supported by the use of technologies such as computer vision, automatic learning, human-robot interaction, which at the same time allows the creation of collaborative and secure environments for humans as well as automated systems.

This paper profusely studies the applications of the fourth industrial revolution in intelligent manufacturing, especially in human-robot interaction through the use of computer vision from the perspectives of “display”, information exchange, level of autonomy and its applications. In addition, it discusses the concepts of artificial neural networks and their use in the different phases of manufacturing.

DOI: 10.4018/IJCVIP.2017070106

Copyright © 2017, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.
TECHNOLOGY APPLICATIONS

Specifically on the topics related to the Fourth Industrial Revolution, an emphasis is being placed on cybermanufacturing systems, also known as “cybermanufacturing”, being the manufacturing interconnection of the various human elements with complex automated systems, involving computer systems for control and the exchange of information from manufacturing operations and robotic systems; in order to create work models supported with artificial intelligence to improve decision making and anticipation of problematic situations in the production flow (Siddique, Mitchell, O’Grady, & Jahanbakhchi, 2011). In this type of environment, the most natural interconnection between humans and robots is sought, since as mentioned by (Meisner, Isler, & Trinkle, 2008) this can generate environments that minimize stress on operators when using complex robotic systems (Meisner et al., 2008).

Such environments -as mentioned by (Hedelind & Jackson, 2011; Hermann, Pentek, & Otto, 2016; J. Lee, Bagheri, & Jin, 2016) – are strongly related to the concept of automation and data exchange as a core in manufacturing technologies, where technologies such as robotics, systems, cyber physicists, Big Data, and Things Internet are the foundation in building a collaborative environment with people (Hedelind & Jackson, 2011; Hermann et al., 2016; J. Lee, Bagheri, & Kao, 2014).

As the complexity of systems increase, the main element to be considered for the construction of these new integrated production environments are humans, who can make use of technologies of interaction with robots and machines, as it is the case of augmented reality (AR). For example, (Tatic & Tešić, 2017) talk about a thermal energy plant in Bosnia and Herzegovina. The aim is to prevent workers from making mistakes and protect their physical integrity through the use of mobile devices that integrate systems AR, which makes it easier for them to use real-time checklists (Meisner et al., 2008). Cases like these can frequently be found in other investigations.

Continuing with the topics of the previous section, computer vision is an important element to consider in this new manufacture era, since its applications in human-robot interaction can be applied to manufacture for quality control, detection of collisions (Wang, Schmidt, & Nee, 2013), navigation (Hornung, Bennewitz, & Strasdat, 2010) and augmented reality (Makris, Karagiannis, Koukas, & Matthaiakis, 2016). However, implementing these applications requires the application of automatic learning as a whole. As mentioned by (Lee et al., 2016), they require the intervention of operators in order to be able to train artificial intelligence using robots. This requires established mechanisms for control and exchange of information to guarantee high quality mechanisms.

CV is also used in automatic inspection processes through supervised learning techniques. For example, (Ferreiro & Sierra, 2012) claim that these can be used in industrial processes where the quality in the workstations needs to be controlled (Ferreiro & Sierra, 2012). These quality inspection processes can be carried out by simple sensors as well as by weight, color, and size sensors (Fast-Berglund, Fässberg, Hellman, Davidsson, & Stahre, 2013). Quality can be assessed according to the shape the products processed at the workstations (Hedelind & Jackson, 2011).

Computer vision can be used to help to protect the integrity of operators, as described by (Xiao, Wang, & Folkesson, 2015). For example, RGB-D cameras can be used as tools that improve the HRI, since they allow the tracing of the operators’ movements so that robots can predict the intentions and recognize the behavior of the people with whom they collaborate (Xiao et al., 2015). This allows the creation of more flexible working environments for human tasks, but this requires automatic learning algorithms to make decisions from data sets coming from environments with a supervised training level. If there are data limitations, unmonitored training can be administered. Thus, (Santoro, Marino, & Tamburrini, 2008) propose the use of a mixed scheme, using supervised and unsupervised learning in which datasets used for training are obtained from the behavioral patterns gathered by a human “trainer” (Santoro et al., 2008). This technique for obtaining information through patterns is also pointed out by (Ericson, Franks & Rohrer, 2016) as a powerful tool in productive environments. On the other hand, we find many contexts in which we do not know the relationships between inputs and
Related Content

Scale Space Co-Occurrence HOG Features for Word Spotting in Handwritten Document Images
[www.igi-global.com/article/scale-space-co-occurrence-hog-features-for-word-spotting-in-handwritten-document-images/171132?camid=4v1a](http://www.igi-global.com/article/scale-space-co-occurrence-hog-features-for-word-spotting-in-handwritten-document-images/171132?camid=4v1a)

Machine Vision Based Non-Magnetic Object Detection and Removal on Moving Conveyors in Steel Industry through Differential Techniques
[www.igi-global.com/article/machine-vision-based-non-magnetic/74801?camid=4v1a](http://www.igi-global.com/article/machine-vision-based-non-magnetic/74801?camid=4v1a)
A Structural Analysis Based Feature Extraction Method for OCR System For
Myanmar Printed Document Images
Htwe Pa Pa Win, Phyo Thu Thu Khine and Khin Nwe Ni Tun (2012). *International
Journal of Computer Vision and Image Processing* (pp. 16-41).
[www.igi-global.com/article/structural-analysis-based-feature-extraction/68002?camid=4v1a](www.igi-global.com/article/structural-analysis-based-feature-extraction/68002?camid=4v1a)

Fuzzy Shape of Objects in Images with Similarity Measure for Image
Retrieval Applications
Computer Vision and Image Processing* (pp. 58-80).