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INTEGRATION AND PERSPECTIVES OF COLLABORATIVE ROBOTS

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Abstract. The Industry 4.0 industrial revolution is moving at high speed and covers more and more segments. Technologies are constantly improving and help to do work faster, safer, cheaper and simpler. Many industrial robots are implemented in industry, and collaborative robots that can work safely alongside humans, replacing some or all of their actions, are becoming more common. This raises the question of the ethical and moral principles of implementing such systems, which can make a person feel redundant and replaced. This paper examines why the implementation and availability of these systems to users requires a responsible strategy.

Keywords: collaborative robot, integration of robots, cobot, implementation of robots, Industry 4.0

INTRODUCTION

The industry is constantly moving forward, evolving and changing. The aim is to achieve the highest possible standards of efficiency and quality. Currently, the Industry 4.0 strategy is being widely implemented in production, which was first mentioned in 2011 by the German government, and currently the European Commission has announced plans for Industry 5.0 (Xu at al., 2021). As a result, the industry is constantly introducing new lines of automation and robotics to achieve its goals. One branch of robotics is collaborative robots.

Collaborative robots are devices that can work in a shared workplace together with humans. Usually, workers are separated from industrial robots by physical barriers according to valid specific industrial standards, but these barriers become unnecessary for properly implemented collaborative robots (Franklin at al., 2020). The collaborative robot market is expected to grow at a CAGR of 34,3%, which means that even more people will have to share their jobs with these machines, and this raises certain ethical and moral principles. The main risks perceived by current employees are: losing their jobs, working slower than a robot, fear of the future, work safety.

The objective of the research to review the current situation in the market and analyses how the implementation of collaborative robots in workplaces responds to ethical and moral principles, what is the impact on the social environment and what are the best methods to apply the collaborative robot in industry.

Research methods: analysis of scientific literature and data analysis.

COLLABORATIVE ROBOTS MARKET OVERVIEW

Collaborative robots are one of the fastest growing areas of the robotics market. According to different sources, in 2020 the value of the collaborative robot industry was approximately 539,3 million Euros, but in 2022 began to rise due to the impact of COVID and reached the value of 744,3 million Euros by the end of the year, it is assumed that by 2030 market value will reach 1817,65 million Euros on average (see Figure 1), accounting for 30% of the total industrial robot market. This rapid growth can be linked to the pandemic situation and fears of a possible repeat of the restrictions, where social contact has been limited and factories have introduced additional shifts to prevent people from meeting each other, e.g. replacing two workers at one workplace with one worker and a collaborative robot.

The market for these robots is also segmented based on payload, application, and end users (Patil at al., 2023):

- Based on payload, the collaborative robots market is categorized into three categories: up to 5kg, up to 10kg & above 10kg robots. The largest part of this market consists of robots up to 5 kg, this accounted for 44 percent of the collaborative robot market in 2022. They are lightweight, easy to transport, easy to program and safe;
- By end user, the collaborative robot market is segmented into: automotive, electronics, metalworking, and food. The largest part is the car market, where it is used for safety equipment control, quality control, and assembly of components. restate research problem;
- The application segment has been divided into packaging and palletizing, gluing and welding, injection molding, screw driving, quality inspection, pick and place, industrial assembly, lab analysis applications. The distribution of this segment is similar in all the listed areas.

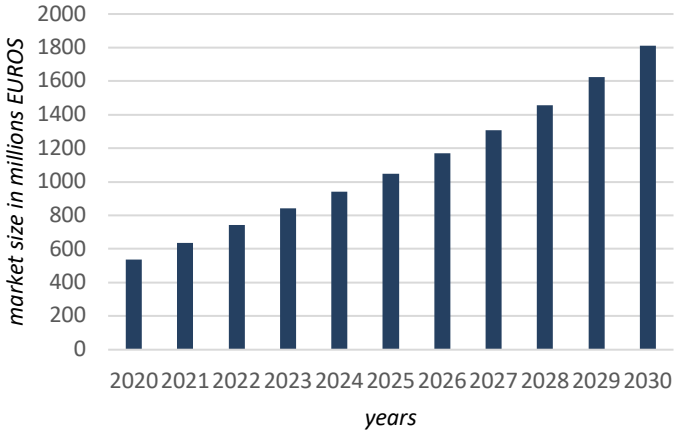

Figure 1 Collaborative robots market growth trends

The first collaborative robots were offered to the market in 2003, they were started to be serially produced by the KUKA robot manufacturer (Hameed at al., 2023). After that, more manufacturers was added to the market, and now almost all major robot manufacturers can make collaborative robots (see Figure 2).

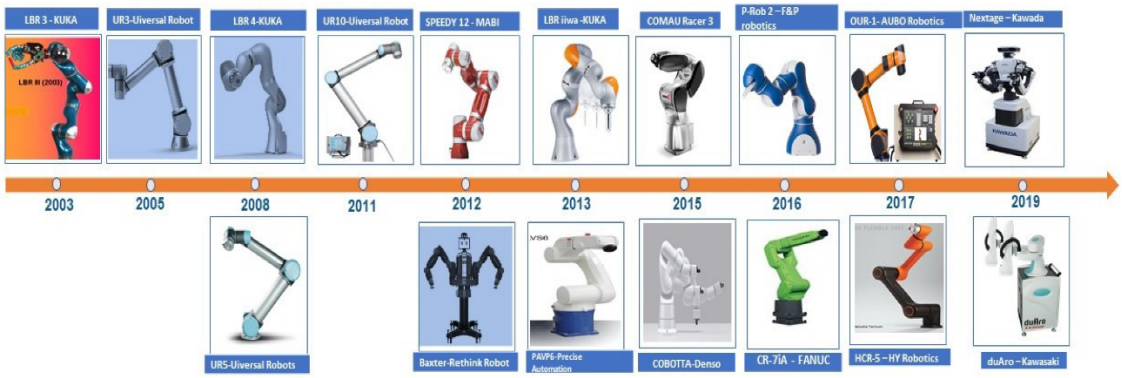

Figure 2 Development of collaborative robotic system (Hameed at al., 2023)

RESPONSIBLE IMPLEMENTATION STRATEGY

Considering the huge and constantly growing market of collaborative robots and the widely covered areas of implementation, it is very important not to forget a friendly and responsible strategy for their implementation, because very often the question is raised about the ethical and moral aspects of implementing such systems.

T. Sorell (2022) emphasize that collaborative robots present at least three kinds of ethical and moral challenges:

1. Collaborative robots are not fenced or otherwise separated from humans, which may affect their physical contact with human personnel. These robots are usually small, light and fixed. However, their safety depends to a large extent on the design solutions chosen and the actions taken.
2. Collecting and reporting data on work performance to management. The robot can be programmed to collect data about the worker's work performance, how quickly he cooperates with the robot, and how quickly he completes tasks assigned to him. This may subject the employee to fines or dismissal.
3. The role of robots in facilitating and eventually replacing the work done by humans. This is especially important if the robot was first introduced as a helper, and then the employee was fired or reassigned.

A similar opinion is also held by J. Wallace (2021), collaborative robots are marketed as uncaged, safe and human friendly as well as being easy to install and program. They are introduced as helpers to workers, but often replace them in workplaces. From this comes the fact that a sustainable strategy is needed to move from human labor to automated systems.

The following steps are suggested to reduce the stress associated with new equipment and to keep staff motivated and confident:

- Good acceptance of new equipment in the company can only be achieved if employees are properly introduced to it, included in its planning, properly trained and motivated.
- Improve the qualifications of production workers, teach programming skills, and delve into existing systems. Unqualified staff members must also be empowered to perform mini-line service or program changes.

- It is very important to involve all relevant employees in the design and planning of the new system. This can take away unnecessary stress from workers in the future if they are familiar with the new robots.

SAFETY OF COLLOBORATIVE ROBOTS

Workers often face the fear that collaborative robots will injure them, or just the opposite, people believe that robots are completely safe and forgot about basic self-protection. For this reason, when choosing a working tool for a robot (Franklin at al., 2020), it is very important to take into account all safety requirements:

- the tool must be certified, the tool must be adapted to work with a collaborative robot;
- the tool must have as few moving parts as possible;
- the tool must have as few sharp corners as possible;
- the parameters of the tool must be very accurately guide the robot;
- additional safety measures in robot work zone (safety plane, safety radars, etc.).

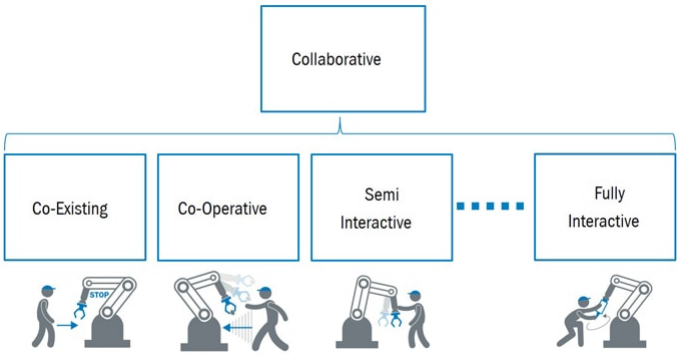

Figure 3 Types of human-robot cooperation (www.sick.com)

M. A. Mariscal (2023) emphasize that the best way to avoid physical human-robot contact is to limit their work areas as much as possible, but this is quite difficult to do when working with collaborative robots. During the last year, due to the particular increase in the market of collaborative robots, certain standards were introduced to regulate the implementation and production of robots.

The main standard for all collaborative robots are ISO/TS 15066, this standard was released at 2016 by The International Standards Organization. It provides basic guidelines for safety requirements for collaborative industrial robot systems and guidelines for the safe operation of this type of robots. A robot built to this standard will have specific safety-enhancing features, such as an integrated safety sensor, speed limits, and force limits (torque). The safety standard ISO 10218 is also applied, which defines the maximum safe robot speed at which a working cobot can move, it is 250mm/s.

Human-robot cooperation can be at different levels (see Figure 3), starting with separate work, so-called co-existing and ending with full cooperation working in one work area, so called fully interactive work. Therefore, security concepts for such a wide range can be very diverse, so each case of collaborative robot implementation needs to be approached differently and separate security assessments must be made.

CONCLUSIONS

Summarizing all the collected and analyzed information, it can be seen that collaborative robots are one of the main sources of work in the industry of the future, requiring responsible and analyzed integration.

These include:

1. All relevant employees must be involved in the implementation process, and their suggestions and opinions must be taken into account.
2. Correct and thoughtful information must be communicated to the employee, avoiding ambiguous phrases.
3. When installing robots in production, it is necessary to choose equipment responsibly and assess all possible security problems.
4. This area requires further analysis, but all authors agree that it has some negative impact on employees.

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