THE ROLE OF SERVICE ROBOTS IN INDUSTRY 4.0–SMART AUTOMATION OF TRANSPORT

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Abstract: All production processes in the world are implementing Industry 4.0 by using the basic technologies such as robotics & automation, intelligent sensors, 3D printers, radio frequency identification – RFID, cloud computing, Internet of Things and Internet of Services. Implementation of Industry 4.0 in all production processes is not possible without the use of both industrial and service robots, their development and implementation. In addition, there are other technologies on which the fourth industrial revolution is based that will provide us with intelligent devices, intelligent production processes, intelligent logistics in production processes, i.e. intelligent factories. The Cyber-Physical Systems (CPS) in the global environment provide machine networking in production processes and logistics systems. This paper provides an example of the use of service robots and their role in solving smart transport in production processes.

Keywords: ROBOTICS, SERVICE ROBOTS, AUTOMATION, INDUSTRY 4.0, PRODUCTION PROCESSES, SMART TRANSPORT

1. Introduction

It is well known that the WEF - World Economic Forum (held in Davos in 2016) named the changes on the world industrial and digital scene the Fourth industrial revolution. The name “Industry 4.0” first appeared in 2011 at the Hanover Fair in Germany. In 2016 World Economic Forum (Geneva, Switzerland) published a book by professor Klaus Schwab titled “The Fourth Industrial Revolution”. Within the Fourth industrial revolution a new value chain is being formed that relies primarily on Cyber-Physical Systems (CPS), which is also the second name for the Internet of Things, and its associated service most commonly implemented in the cloud (Cloud Computing), as shown in Figure 1.[1,2,3,4,5,6]

Through discussion and analysis of the Industry 4.0, it is imperative to increase awareness of the inclusiveness and speed of the technological revolution and its multiple impact. It is necessary to create a framework for thinking about “Industry 4.0” that outlines key questions and highlights possible answers; in other words, a platform for achieving public-private cooperation and partnerships on emerging issues related to the technological revolution needs to be provided.

There are over 90% of the first-generation industrial robots in the world, installed in all production processes, that need to be separated by fences so as not to injure workers in the process [1]. The use and implementation of the Industry 4.0 basic technologies has led us to the development of collaborative industrial robots and service robots (AGVs), which presents one of the most significant qualitative developments in transport operations, manufacturing, assembly lines, warehouses and other operations which require the transport of certain positions in the production process. It is necessary to enable interaction and collaboration with all researchers in the world dealing with the basic technologies and their implementation, to create a positive shift in the implementation of the Industry 4.0 in all segments of society, in order for society to benefit from the ongoing transformations.

2. The role of industrial robots in the Industry 4.0

Industry 4.0, unlike previous revolutions, brings about changes in exponential function. There has been a major shift in innovation in biotechnology, robotics involving sensory and artificial intelligence, microbotics and nanomedicine, genetic engineering, new findings in quantum physics, and a series of other innovations that are radically changing mode and quality of life. All this is happening thanks to innovations in the Industry 4.0 [7,8,9]. Their trend in the automotive industry, companies, production processes and logistics is shown in Figure 2.

Based on the trend of application of innovations in the mentioned areas of the Industry 4.0 for the period 2000-2016, we can see that the first place in the implementation and application of innovations in the above technologies is held by the automotive industry, followed by companies, and production processes. Their goal is to achieve flexible automation that would lead them to smart production process, which would enable companies to become more competitive in the global market in the world. The fourth place is held by the logistics, whose trend of applying innovative solutions will be more increasing in the future. It is visible that, for all four of these examples, the trend of implementing innovative solutions from Industry 4.0 in the period 2000 to 2016 is constantly growing, and it is expected that the upward trend will continue in the
The advantages of collaborative robots over first-generation robots are enormous, and given in the References [x]. When applying industrial second-generation robots (collaborative robots), companies have the following motives: reduced operating costs, reduced capital costs, improved product quality and consistency, improved quality work for workers, respecting health and safety rules, increased production rates, increased flexibility in product production, saving space, etc.

3. Research Methodology

The statistical data on the implementation of service robots were downloaded from the International Federation of Robotics (IFR), the UN Economic Commission for Europe (UNECE) and the Organization for Economic Co-operation and Development (OECD) [12-16]. Standard statistical analysis methods and software system MS-Excel were used for the calculation of statistical descriptions parameter and graphical presentation of data.

4. Results

The second-generation robots have created new demands for productivity gains and outperformed first-generation industrial robots. There are many reasons for this: facilitating the programming and use of robots, improving the ability to manipulate (various tasks), reducing the size and cost of robots, robots work in a wide range of dynamic environments with humans.

All mentioned technologies are responsible for the development of robot technology, thus initiating an enormous upward trend in the development of service robots for professional use, as shown in Figure 3. The analysis of the trend of implementation of service robots for logistics shows that until 2014 the implementation of these robots was negligible in the world, and in 2014 only about 3,404 units of service robots for logistics were implemented. The growth trend has enormously increased, and in 2018 about 114,000 units of logistics service robots have been implemented.

The statistical data on the implementation of service robots in comparison to the first-generation industrial robots are enormous [8,9,17,18]. The trend of application of service robots for logistics is a result of the aforementioned technologies on which Industry 4.0 is based and its implementation in production processes. The upward trend in the implementation of logistics service robots is expected in the coming years, and it is expected that in 2022 around 520,490 units of logistics service robots will be implemented in the production processes.

As we have already stated, the advantages of implementation of service robots into production processes are enormous [8,9,17,18]. Some of them are:

- The ability to automate certain operations in the production process, so that tasks can be partially automated in cases where full automation is too complex or not cost-effective;
- Reduction of capital costs;
- Continuous improvement of product quality;
- Improving the quality of work for employees, while respecting health and safety rules;
- Increased production rate and profitability;
- Increased flexibility during the production;
- Reduction of material waste and increase of productivity;
- Transformation of rigid automation into flexible automation;
- Saving space in production areas;
- Robots, both industrial and service, play the most important role in Industry 4.0 that connects the real-life factory with virtual reality, which opens up greater prospects for deployment in the global production.

Non-ergonomic workstations can be significantly improved with the help of robots, where we must keep in mind that worker safety is an absolute prerequisite.
- Increased product diversity and reduced product lifecycle require flexible automation, which will result in increased use of collaborative robots, etc.
The goal of every company present in the global market today is to realize and obtain benefits that are gained by implementing next-generation industrial and service robots.

Lately, we are witnessing a trend toward increased data sharing, and automation of production processes by introducing industrial and service robots, smart sensors, the Internet of Things, etc. It may seem that Industry 4.0 only serves large companies with many facilities and departments stationed in different locations and perform large and complex operations in production processes. However, this is not the case, since small and medium-sized companies can also benefit from Industry 4.0. By using the technologies mentioned in this chapter, they can process and store data, and improve the design, production and delivering of their products more efficiently. Currently, small companies can compete with large companies in ways they never could before. Here are some of the many benefits that Industry 4.0 gives to companies:

- Lower operating costs,
- Improved business communication processes,
- Increased productivity of companies,
- Expanded access to the global economic market (broad customer base)
- Provides companies of all sizes with greater outsourcing capabilities (external cooperation),
- Improved collaboration between companies, departments, and individuals, thanks to the availability of new communication tools,
- Advanced developments, such as blockchain technology, greatly increase the security of business and personal information.

As we have seen, the advanced technologies such as robotics, IoT (Internet of Things), Cloud Computing, smart sensors, Radio Frequency Identification, Cyber-Physical Systems and Big Data, are crucial in the application of the Industry 4.0 concept, as they imply the complete digitization of all production processes, including the process of creating a product idea, product engineering, production organization, process control, and the provision of industrial services.

**Conclusion**

The Fourth industrial revolution ‘Industry 4.0’ is already present in all industry branches, from production to selling finished products. The Fourth industrial revolution brings disruption to almost every industry in the world, as it has an impact greater than we think. The impact is reflected in all sectors and companies, large, medium-sized and small companies. Industry 4.0 relies on advances in the use and sharing of information, and has the potential to merge almost anything on the web, thus drastically improving the efficiency of the company’s business. This paper presents a growing trend in the use of personal service robots and service robots for logistics, which happens by an exponential function. Service robots for logistics are mostly applied in production processes and warehouses of companies. Applications for fully autonomous service robots for logistics have been developed, which enabled implementation of smart transport in production processes and warehouses of companies.

**Literature**