

ANALYSIS OF THE EVOLUTION AND PROSPECTS OF INTRODUCING ROBOTS AND ARTIFICIAL INTELLIGENCE IN THE ACTIVITIES OF THE MODERN COMPETITIVE SOCIETY

Iulian Sorin Munteanu¹, Liviu Marian Ungureanu¹, Ioan Străinescu², Andreea Stanciu³

¹“Politehnica” University of Bucharest – FIIR, Romania

²ICPE SAERP, Bucharest, Romania

*³National Institute of Research and Development in Mechatronics and Measurement Technique – INCDMTM
Bucharest, Romania*

Email: munteanu75@gmail.com

Abstract - This paper analyzes and synthesizes the intensification of the addition of robots and artificial intelligence to the crucial aspects of automated production, in a manner that is both useful to society and also specific to Industry 4.0. Then, we evince the foreseeable evolution and development prospects of diversified and customized applications for modern robots and AI, facing continuous expansion, development, and specialization.

Keywords: Robots, Artificial intelligence (AI), Robot evolution and AI, Industry 4.0.

1. Introduction

Over the last decade, there has been a growing combination of artificial intelligence (AI) and industrial or collaborative robotics, which – together – have led to major changes in business models, as technical firms relate to the new conceptual evolution of production called “Industry 4.0.”

The incorporation of artificial intelligence into intelligent robots, but also its embedding in production flows unlocks completely new capabilities for productive robots, but also for intelligent control and monitoring devices, which open a lot of new possibilities to rethink the staging and combination of industrial processes and – at the same time – they are new developments that are highly beneficial to the competitive environment.

Despite the fact that industrial processes are already highly automated in countries with a higher degree of industrialization, there are still many ways (some already intuitively anticipated, but not materialized in practice) by which industrial robots can be improved by adding AI.

2. The Evolution and Perspectives of the Symbiosis between Robots and Artificial Intelligence in Modern Competitive Activities

AI and robotics technology will continue to develop together for many years [1, 2, 3, 4, 6, 7, 8, 9, 10, 12], as shown by several premises and visionary

scenarios already outlined, which can be solid arguments for a successful path and a continuous common improvement of the pair made up by AI and robotics. From the point of view of the evolution and perspectives of the symbiosis between robots and artificial intelligence in modern competitive activities oriented mainly towards the industrial environment 4.0, the following aspects and trends stand out:

✓ **Increased emphasis will be placed on robot training** in the near future: with the help of AI, robots will be easier to train, turning them into a more sustainable investment for smaller companies/SMEs, as installation and training costs will be reduced. There are already real examples of robots that can be quickly thought – through a demonstration by a human operator – to memorize the correct movement itself (example: Baxter and Sawyer robots from Rethink Robotics can be trained by example of arm guidance). It is clear that if ways are found to make sure that a robot learns how to perform new activities easier, then robots will adapt quickly and perform various and complex operations or activities, as their memory can be extended as much as possible.

✓ **Progress is needed in cloud robotics: Deep robotics learning** – based on image classification and speech recognition – is often based on huge data sets with millions of examples. AI requires more data than can be realistically stored on most local robot systems. This way, advances in cloud robotics will lead to the advancement of AI and robotic technologies as cloud robotics allows intelligence to

be shared between all robots connected to a given environment.

✓ A **development of 3D vision** is required: any simple task performed by a robot depends on a realistic 3D artificial vision, which is transferred immediately (instantly) in the form of data to AI technology. Thus, manipulating an object, for example, would be impossible without artificial vision capable of reconstructing a 3D image with exact spatial locations memorized successively and AI capable of translating this visual information into a successful robot action.

Consequently, the future of AI and robotics symbiosis belongs to a strong progress based on the development of these three key aspects: simplification of robot training, development of 3D vision, and development of robotics in the cloud, whether used for industrial or collaborative applications.

AI has a major potential for innovation and maximized competitiveness when we think about changing the way robotic technology works inside and outside factories around the world. Although the artificial intelligence is still in its infancy, there are already significant contributions to how robots can be improved and even how they can make exceptional leaps and can be inter-connected, through innovative new engineering concepts combined with artificial intelligence software and hardware developments.

3. Analysis and Perspectives on the Evolution of Industrial Robots and Artificial Intelligence 2015-2024

By studying and analysing the annual reports on the use of industrial robots [6], as well as all sources of scientific, credible, and recent information on industrial robots and artificial intelligence (AI) [1, 2, 3, 4, 7, 8, 9, 10, 12], the authors of this paper were able to prepare a well-documented work on the most important and relevant issues related to the recent developments and the evolution trend of the involvement of robots and artificial intelligence in the world of the future – a world full of ambitions and fulminant advances in terms of the engineering conception of products and services directed mainly at industry 4.0., but also embedded in new technologies deemed as ‘revolutionary’ such as: IoT, Big Data, Cloud computing, Blockchain, Digital Twin, Artificial Intelligence, Robotics, Process Management/ Automation Systems, Cybersecurity, thus contributing to the acceleration of the adoption by the international market of these state-of-the-art intelligent solutions.

Thus, in 2021, in terms of industrial robots with integrated AI to a lesser or greater extent, there is a record of 3 million industrial robots operating in

factories around the world – an increase by 10%. Sales of new robots increased slightly, to 0.5%, despite the global pandemic, with only 384,000 units delivered globally in 2020.

This trend was dominated by the positive market developments in China, compensating the contractions of other markets (for details, please see fig. 1).

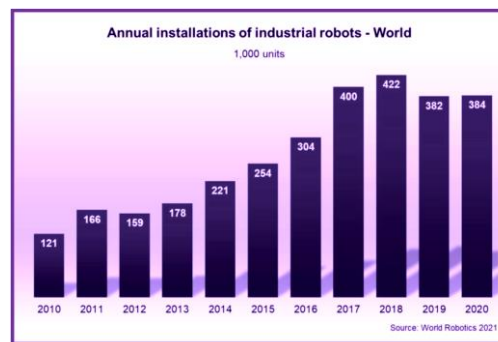


Figure 1: Annual installations of industrial robots years: 2010-2020 (Source: World Robotics 2021)

The forecast for the years 2021-2024 of the annual installations of industrial robots with integrated AI (to a lesser or greater extent) is presented in fig. 2, below.

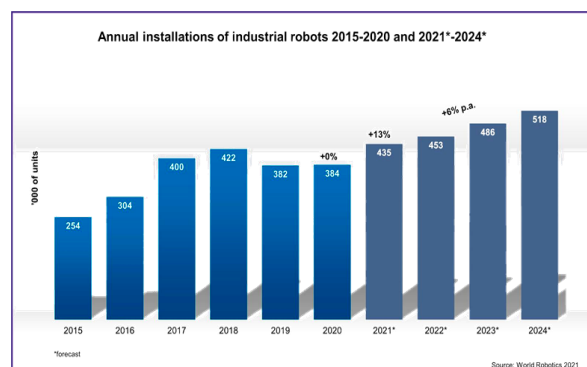


Figure 2: Annual installations of industrial robots and a forecast for the years 2021-2024 (Source: World Robotics 2021)

Milton Guerry, the president of the International Robotics Federation, stated relatively recently that "the economies of North America, Asia and Europe have not faced the serious problems posed by Covid-19 disease at the same time, which is why orders and robot production in China's manufacturing industry began to grow in the second quarter of 2020. Another important aspect was that the North American robot-based economy began to recover in the second half of 2020, and Europe followed suit this example, a little later".

Thus, the installation of robots worldwide is associated with an increase by approx. 13%, meaning approx. 435,000 units in 2021, which

translates into a transgression of the record reached in 2018, according to the same specialist.

Based on extensive analysis – using highly relevant data – some provided directly by world-renowned players in the high-performance industrial robots market, it is clear that the prospect of installing and using high-performance robots in North America will increase by approximately 17%, i.e. about 43,000 units (by the end of 2021), compared to the installation and the use in Europe of high-performance robots, which can be estimated at an increase of about 8% – i.e. about 73,000 units, by the end of 2021. An extended estimate for the installation and use of intelligent robots in Asia aims at a slightly higher threshold of over 300,000 units and thus an increase by 15% over the previous year's result, and in all Southeast Asian markets, the increase in the use of intelligent robots is estimated at double digits in 2021.

Asia has the highest industrial robot uptake rate in the world, making it the world's largest market for industrial robots. Thus, 71% of all newly installed industrial robots in 2020 belonged to Asia (in 2019, the value of industrial robot installations was of 67%).

Installations of intelligent robots in China – the largest integrator in the region – have grown sharply by 20%, translating into approx. 168,400 units delivered and installed.

This is the highest value ever recorded for a single country – China (see fig. 3).

Therefore, the operational stock of robots reached 943,223 units (+ 21%), making it clear that the value of 1 million robotic units will be exceeded in China by the end of 2021.

This high growth rate indicates the rapid speed of robotization in China, as well as the openness to digitalization and digital technology, including Industry 4.0 and artificial intelligence solutions.

Japan (fig. 3) preserves its second place, after China, as the largest market for industrial robots, although the Japanese economy has been hit hard by the Covid-19 pandemic: sales fell by 23% in 2020, with as little as 38,653 units installed. This was the second year of decline after a peak value of 55,240 units in 2018, for Japan.

In contrast to China, demand for robots from the electronics and automotive industries in Japan was weak.

Japan's operating stock was of 374,000 units (+ 5%) in 2020. But, the fiscal year 2021 brought about a recovery for Japan, with an estimated GDP growth rate of 3.7%.

The Japanese robotics market is expected to grow by 7% in 2021, and by 5% in 2022.

The demand for Japanese robotics is based on already identified and loyal export destinations.

Even though the major share of robot production goes directly to China, there are other preferential markets for Japan.

Thus, 36% of Japanese exports of robotics and automation technology went to China, but another 22% of exports were shipped to the United States.

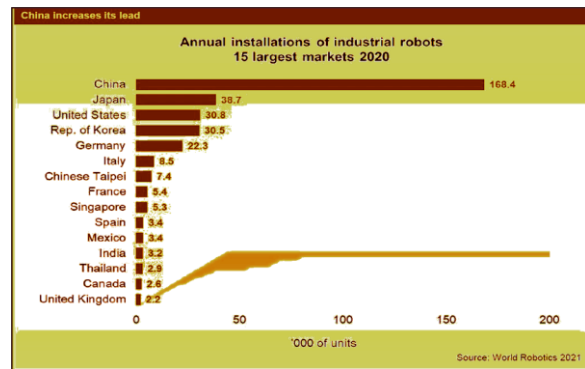


Fig. 3. Annual installations of industrial robots in the 15 largest markets¹ (Source: World Robotics 2021)

The Republic of Korea can thus be considered the fourth largest robot market in terms of annual installations, after Japan, the USA and China. The export-oriented economy has coped remarkably well with the pandemic so far. In 2020, GDP fell by only 1%, and for 2021 and 2022 a strong GDP growth of +4% and + 3% is expected. The electronics and the semiconductor industries, in particular, have invested heavily in robot acquisitions.

An investment support program, launched in May 2021, aimed to substantially stimulate investment in smart cars and equipment. As a consequence, the demand for robots – from both the electronics industry and car suppliers – was estimated at + 11% in 2021 and + 8% annually on average over the next few years.

In Romania, a study conducted on the subject of industrial robots and AI we have directed together with our collaborators of the CERMISO Centre of INCDMTM Bucharest highlighted that – despite the international trend – the attitude regarding the implementation of robotic lines in most of the production lines of the enterprises/ SMEs that feature mainly Romanian capital is rather cautious. One reason behind this attitude comes from the insufficiency of maintenance and programming engineers for industrial robots, while another reason could be the high cost that these modern technical solutions generate in the medium and long term, in a fluctuating domestic market in which the purchasing power is below the EU average. These can lead to

¹ first score countries in Asia (China, Japan, Republic of Korea) but also the United States, followed by Germany, Italy, Chinese Taipei, France, Singapore, Spain Mexico, India, Thailand, Canada and the United Kingdom

"sabotage" of the robots' implementation – on large scale – in Romania. Unfortunately, these aspects are misunderstood in Romania. A robotic system increases productivity and facilitates the work of operators. But, end-users have come to the conclusion that – in order to provide a robot with all the necessary components in a timely manner – it auxiliary staff and qualified employees play a critical role.

The same study revealed that Romania needs around 10,000 industrial robots until 2024, to remain competitive in the region. This value represents an implementation percentage of robots with A.I. of about 11% – a lower percentage compared with developed countries but still a plus for our country, at least for the time being. At the same time, the study showed that the pandemic period has accelerated the need for automation and robotics in Romania. New challenges borne by the pandemic, such as social distancing, fluctuations in production, cases of COVID-19 or employee quarantine, have made it much more difficult to ensure a proper product/ customer planning on the long-term, and has led to sudden increases or decreases in the workflow. Under these conditions, automated solutions such as robots and AI become the necessary tools in fighting back the unpredictability or critical events that can occur in production processes.

4. The Role of AI and Robots in the Modern Industrial Supply Chain - a Focused Look at the North American Market (Leader in the use of Robots and AI)

Robots, smart machines, IoT devices and software applications used throughout the supply industrial chain create a wave of structured and unstructured data. This has led to the emergence of advanced solutions based on artificial intelligence (AI) and machine learning, designed to make sense of all this information and turn it into actionable perspectives for industry.

Supply chain technologies powered by artificial intelligence bring order to the data captured from supply chain links.

The benefits of applying artificial intelligence to complex industrial operational data are clear: improved supply chain visibility, faster decision making, shorter cycle times, predictive big data analysis, improved quality, productivity and throughput, higher chain strength supply and the ability to continuously adjust and improve processes based on real-time information about system performance.

Artificial intelligence also allows companies to make intelligent predictions about items as diverse as the demand for a particular product or the date when stocks of raw materials used in production processes need to be renewed. In addition, AI can be used to significantly reduce the time that supply chain professionals have to spend collecting data from different systems and then using business intelligence tools and spreadsheets to develop strategies.

The contribution of AI to the industry can be reported as low costs and high revenues, as a direct result of the introduction of AI to all processes and aspects – including supply chains, which also generates low costs of transporting stocks, stock reductions, and finally high savings of money.

Not surprisingly, the supply chain industry is adopting technologies based on artificial intelligence and machine learning at an unprecedented rate.

The global supply chain AI market is expected to reach \$ 10,110.2 million by 2025, as compared to \$ 527.5 million in 2017, according to recent research.

The emergence of artificial intelligence solutions for supply chains could not come at a more crucial time, as supply chains are still suffering from the effects of pandemic restrictions and are trying to cope with the growing uncertainty of the supply chain.

However, supply chain AI remains at the beginning of Gartner's Hype 2020 cycle, which means it could be another decade before the technology reaches full maturity.

California - based Flexible Vision has developed an artificial intelligence-based hardware and software platform based on machine learning that is designed to help solve difficult inspection tasks, such as correctly identifying items to choose from by a robot or identifying product defects. Demonstrating that the implementation of artificial intelligence solutions does not necessarily require advanced technological knowledge, Flexible Vision can be operated by any technician, regardless of his or her level of qualification. This system, which is compatible with multiple camera and lens settings, can be displayed in a built-in auto-inspection cell.

Geek+ is a global logistics technology company that provides advanced robots – including autonomous mobile robots (AMRs), automatic forklifts and its RoboShuttle lifting solution for humans, and artificial intelligence-based systems for warehouses and factories.

In 2020, Geek+ and eStore Logistics implemented the largest AMR launch in Australian history. The company's Smart Warehouse product provides a comprehensive, real-time view of warehouse operations throughout the process, based on artificial intelligence.

For example, when goods enter the logistics centre, they are immediately monitored and analysed. This information is compared with historical inventory data to determine the optimal storage method and location, and the system chooses which robots will be used, where, and at what time. Smart Warehouse is also responsible for assigning tasks to human workers.

Mobile industrial robots and autonomous mobile robots have already gained an important role in the industry, in the stages of transporting semi-finished products, components and/ or subassemblies/ or even small assemblies necessary in the manufacturing process involving high volumes and weights. Thus, companies / SMEs now use robots (type MiR) for more than just moving material to production lines or moving goods from the end of the line to the packaging area.

In Europe, companies / SMEs continue to face a shortage of labour for certain tasks in the industry. Therefore, moving goods/ components and / or subassemblies that can weigh up to 15 kilograms, for example, can be unsafe and undesirable for human employees, and in these cases, robots offer an excellent alternative that allows companies to ensure the storage or the movement of burdens, while workers remain safe.

Automation based on robots and AI has also been introduced in the EU (in earlier stages in some countries outside the G7 countries), ensuring improvements in labour productivity and an increase in competitiveness through strategies aimed at substantially increasing the production quality, along by rigorous quality monitoring and verification, generating, thus, positive reactions among users.

In fact, European companies have set a short-term goal of increasing industrial competitiveness by integrating robots and AI with the establishment of strategies adopted by the European Parliament to increase the digital skills of EU citizens from as early as school and high school levels, but also in universities or through continuous training studies that allow employees to become more competitive. This will add more value to the products and services provided by EU companies / SMEs, and as far as the G7 countries are concerned, they are already well ahead of the rest of the EU countries in terms of implementing assisted industrial robots in production processes of artificial intelligence to a varying – yet not very advanced – extent.

5. Conclusions

Dumitrescu Alina L. and Prisecaru Petre [13] undertook their own valuable research and analysis on the role and impact of the Fourth Industrial Revolution - "INDUSTRY 4.0", which increasingly integrates industrial robots and artificial

intelligence, using reports and data provided by the World Economic Forum, combined with a comparative analysis of Eurostat data from the perspective of European integration and the reduction of disparities between Member States. They have come to the conclusion that the Fourth Industrial Revolution has a major impact on the evolution of labour markets in EU member states, generating the emergence of new "jobs of the future", which will be easy to adopt by people with digital skills, in the increasingly obvious perspective of expanding the implementation and use of robots and artificial intelligence in the near future.

But, on the contrary, a study by the McKinsey Global Institute on eight hundred job categories in nearly 50 countries found that more than 800 million jobs (20% of the global workforce) could be lost due to intelligent AI-assisted robotics by the year 2030.

According to the same study by the McKinsey Global Institute, the effects could be even more pronounced in rich industrialized countries, where robots and AI are successfully implemented, such as the United States and Germany, where researchers expect up to a third of the workforce to be affected. By 2030, the report estimates that 39 to 73 million jobs could be eliminated in the United States.

As a general conclusion, it can be unequivocally stated that the future will face a sharp and ascending trend of usage of smart robots in the industry and that these machines will be controlled by AI in the decades to come.

However, there are specialists like Josep L., Carlos J.F.R., Caroline L., Jonathan P., Petropoulos G., Pichler D., Rodriguez J.M. [5, 11, 13, 14] who also emphasize the issue of the risk of having to reshape the profile of broad categories of employees in industry, services, and even accounting, marketing or other repetitive activities currently performed by people, as a direct result of the introduction of robotics and the strong development of AI, but it is becoming increasingly clear that this is the toll that has to be paid by society for the implementation of the smart progress developments in industry 4.0. Consequently, human staff will have to undergo an important technological re-training in order to avoid being laid off and to adapt to the new demands of the labour markets. In turn, employees will have to focus more on acquiring programming and digital skills to be able to keep up with the inevitable changes in future society.

Acknowledgement

The authors would like to thank all the members of the CERMISO Center from INCDMTM, including Dr. Eng. Zapciu Aurel – 1st degree Scientific Researcher from the Management Team of the CERMISO Center,

who helped the authors by providing them with useful technical documentation and relevant databases to penetrate deeply in the phenomenon studied and analyzed in this scientific article.

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