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INDUSTRIAL ROBOTS VERSUS COLLABORATIVE ROBOTS - THE PLACE AND ROLE IN NONCONVENTIONAL TECHNOLOGIES

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Abstract: *These days, industrial organizations are moving towards total automation. The scientific paper presents a technical analysis and focuses on technical notions regarding industrial robots and collaborative robots used especially in the automotive industry. These robots bring an important contribution in terms of the productivity of a manufacturing flow, the qualitative fabrication of the product and at a manufacturing cost as low as possible. Industrial robots and collaborative robots are reliable technical solutions and can be considered necessary for intelligent manufacturing. This study presents industrial robots and collaborative robots in terms of their functional quality and technical capabilities. The purpose of this scientific paper is to objectively examine industrial robots and collaborative robots. In this scientific paper, the authors gathered information from multiple sources regarding the existing and successfully implemented solutions.*

Key words: *collaborative robots, industrial robots, quality assurance, manufacturing systems, reliability, automotive.*

1. INTRODUCTION

Before going into the technical details of the integration of the robots, it is necessary to review a short history of them. The emergence of robots is due to a rich history of scientific engineering, entrepreneurial vision and creativity. The history of robots dates back to antiquity and has always revolved around the imagination of inventors and researchers. The progress came from their desire to turn a fantasy into reality.

Industrial robots are programmable and capable automatic systems that can perform complex, repetitive or variable movements depending on the situation. The robot program can be modified as needed without making changes to their physical system. As the name suggests, they are used in industry or manufacturing.

The operating quality of industrial robots in the automotive field is defined according to the application. This type of robot must perform repetitive or non-repetitive operations at the required speed so that the customer's productivity requirements are met. Industrial robots must have high accuracy, be able to lift the payload or mass required, be resistant to the external environment and be able to perform all the necessary movements.

Industrial robots are usually integrated into cells or cages and due to the high speeds and accelerations they can reach, industrial robots must be equipped with safety systems so that the safety and security of the worker are fully ensured.

Compared to classic stationary industrial robots that are strictly necessary to be integrated into a cage or cell isolated from the human workspace, collaborative robots have the advantage of being able to be successfully integrated in order to share the workspace with humans. The collaborative robot can be placed in different positions according to necessity. A collaborative robot can normally be placed horizontally on the floor, can be positioned vertically for example on a wall and can be suspended horizontally on the ceiling, metal scaffolding or metal structure. The difference between a collaborative robot and a classic robot is that the collaborative robot

has been designed so that it can be able to share the workspace with the operator or worker. In the event that a collaborative robot accidentally collides with the operator or any other object, it will instantly enter a protective stop, which ensures high operator safety.

Safety and security systems are very important so that the implementation of industrial robots or collaborative robots can be carried out in a safe environment for humans. The industrial stationary robots are integrated into closed areas, it can be integrated into closed areas with fences or in cells. To facilitate access inside these enclosures, the access doors are equipped with safety or interlock systems and emergency buttons in order to prevent an accident. The industrial robots are equipped with brakes, perimeter scanners and sensors to stop the robot from possible accidents or collisions with humans and the environment. Compared to stationary industrial robots, collaborative robots are provided from the factory with emergency stop systems following a collision with the environment or man. In addition to these systems integrated into the robot joints, collaborative robots can be integrated with auxiliary safety elements such as emergency buttons, perimeter scanners or safety barriers. In the automotive industry, customer requirements can be concretely defined as throughout a specification. The meeting of customer requirements is the most important task book for an organization. The development of a product always starts from a demand that must be fulfilled on the market. The product or service must necessarily achieve customer or market satisfaction.

Industrial organizations evolve and adapt very easily. A very important criterion is also flexibility. Companies need to be flexible regarding the customer requirements and often meet them. A flexible company is an organization open to new solutions and emerging technologies. These companies are studying new technologies and successfully integrates them into manufacturing. Adaptability is a requirement that also belongs to the field of flexibility. A supplier that manages to adapt to customer requirements, adapt to new technologies and integrate them will always occupy the main places on the market.

2. INDUSTRIAL ROBOTS. TYPES AND PLACES OF THEIR USE

Industrial robots are classified according to destination according to Figure 1.

Due to this aspect, stationary robots or mobile robots can be distinguished. Mobile industrial robots in the logistics area are also known by the abbreviation of:

- AGV (Automated Guided Vehicle) or Automated Guided Vehicle;
- AMR (Autonomous Mobile Robot) or Autonomous Mobile Robot.

These robots are intended for the transport of goods from the warehouse to production, the transport of final parts from production to the warehouse and even the loading or unloading of goods on or off existing shelves in the company's warehouse. There are industrial robots for the logistics area designed as a train that can transport wagon parts.

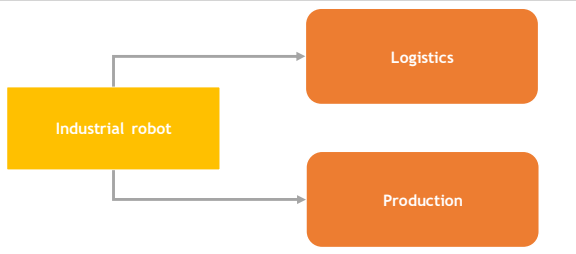

Fig. 1. Classification of industrial robots according to destination

AGV mobile robots can follow a program of simple complexity. The path of AGVs can be guided by sensors, magnetic tapes or wires. Due to this aspect, the AGV is restricted by fixed routes, and any modification of the route could be very costly in terms of modification time and monetary investment. AGV-type robots are able to detect obstacles that block the transport route, but they are not able to bypass these obstacles. In this case, the robots will stop and wait for the obstacle to be removed.

AMR type mobile robots use to navigate maps that are built, learned or drawn in software by the programmer. Depending on the area in which it is located, when receiving an order, it generates a simple route and as fast as possible to reach the

destination. The destination of taking over the goods and handing them over must be learned by the robot in advance. The AMR robot can use cameras, laser scanners and sensors that are integrated to detect the state of the environment and support the AMR robot to easily bypass every obstacle. This type of robot works completely independently of AGVs, and if obstacles appear around it, it will easily navigate around them.

Industrial robots in the logistics area are programmable depending on the location, being taught the routes to follow on the location map, and are equipped with sensors that prevent collisions or allow the automation of the cargo handling system. These robots can open automatic doors, lift from light loads to entire pallets that they can transport to their intended area.

From the point of view of electrical autonomy, they are provided with built-in batteries, and when the battery is discharged, the robots will move to the free charging stations. These robots are very intelligent and can be introduced into a fleet of such vehicles, so that they do not block each other's route, respond to delivery orders and can even speak depending on the situation.

Fig. 2. Types of robots in the field of logistics

These robots speak according to the situation:

• "Open door X" - The robot executes the command to open automatic doors;

• "Please let me through" - The robot encounters an obstacle that should not be there and fails to bypass it;

• "I have taken command X" - The robot has taken command and is moving to deliver it.

Stationary industrial robots in the manufacturing area are the best known, they operate under the name of series robots, and they are also of several types. From a mechanical point of view, these are structures or assemblies of articulated bars comprising translation and rotation couplings.

Stationary industrial robots are used in the manufacturing area, having the role of manipulating parts, tools or devices in order to take them and place them in different necessary locations or executions of production processes. Stationary industrial robots are of several types, can perform complex movements and can be programmed to make decisions depending on the situation. The working accuracy is very high. The classification of manipulator type robots can be done thus, according to Figure 4. - [1].

To ensure the safety and security of workers this type of robot is integrated into cells or enclosed with fences that also include protection systems so that any work accident can be successfully avoided. This is necessary because compared to collaborative robots, they are not provided with protection systems. They can be classified according to destination, the number of axes, type of coordinates used and method of programming.

1. SCARA robots;
2. Articulated robots;
3. Linear robots;
4. Cylindrical robots;
5. Parallel or Delta robots.

Fig. 3. Industrial stationary robots - [2].

SCARA industrial robots can be recognized due to the two parallel joints and precise movements in the x-y plane. They are often recommended and used in industrial assembly applications due to the high accuracy of lateral movements. The word SCARA is an abbreviation or acronym that precisely defines the area of use of the robot, namely Selective Compliance Assembly Robot Arm.

Articulated industrial robots are similar to the human arm and inspired by the anatomy of the human arm. The increased number of joints allows the robot to perform a variety of movements in the workspace. Due to the similarities in terms of mechanical design with the human arm, they are also known as the manipulation arm or robotic arm.
Linear industrial robots are used in the area of handling, processing and assembly of parts or materials. They can be identified due to specific linear motions. - [1].
Cylindrical industrial robots are characterized by specific revolutionary movements. They consist of three axes. The first axis performs revolving movements around the axis, and the other two joints are prismatic, which can perform translational movements. Even if this type of robot is not very common in today industry, cylindrical robots are recommended for handling and assembly operations.
Parallel industrial robots or Delta are robots positioned in a parallel plane that consists of three arms assembled in a common base. This type of robot is the most often integrated and used in packaging applications in the pharmaceutical, electronics or food industries due to their precise movements.
Depending on the type of coordinates used, they can also be distinguished: - [3].

1. Robots in cartesian coordinates;
2. Robots in cylindrical coordinates;
3. Robots in spherical coordinates;
4. Robots in angular coordinates.

Cartesian coordinate robots are used to perform operations over relatively long distances and loads on materials, parts, tools, etc. Cartesian coordinate robots are typically illustrated by linear robots.

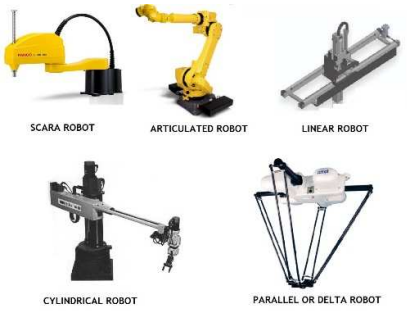

Fig. 4. Types of manipulator type robots

Cylindrical-coordinate robots are constructively made up of two translation couplings and one revolution coupling. This type of robots are used in applications where areas, where side access is required, are required, the robot being a high positioning or assembly precision, and in this situation facilitates the manufacturing of stable and rigid applications. Cylindrical robotic robots are usually represented by robots in cylindrical coordinates.
Spherical coordinate robots are robots that can be constructively formed from two revolution couplings and one translation coupling. Representatives of this category can be considered SCARA robots. The first robot in spherical coordinates was Unimate. - [3].
Angular coordinate robots are machines that can be constructively formed from three or more revolution couplings. Representatives of this class are articulated robots, also known as anthropomorphic robots. They can be successfully integrated into an assembly, welding, painting, picking and placing operations, etc.

3. COLLABORATIVE ROBOTS. TYPES OF COLLABORATIVE ROBOTS

Collaborative robots can be represented as an innovation that appeared in the 21st century. They are mechanically shaped in the form of robotic arms, with articulations similar to those of man. Collaborative robots can be easily integrated into the operator's work environment. - [4]
Collaborative robots promote a safe way of working between humans and robots. - [5] They ensure a safe way of working shared between man and robot, due to automatic protection stops, implemented in their program, in the event of a collision. Certain adjustable safety parameters can be found on the robot's programming interface, which will directly influence the robot's sensitivity to protection stops. There is a possibility that an environment that is set to be very restrictive is not the most recommended for the application because any accidental vibration that the robot detects could influence its protection stop without even a collision having occurred.

Collaborative robots can be set at a very fast pace in the production area. They are very easy to program compared to classic robots. An advantage is a fact that the programming language is also a collaborative one, easy to learn, and due to this aspect an industrial organization will not need highly specialized staff with previous training in the field of programming. This can be considered an advantage because any change that is necessary in the robot's program can be made very quickly by its own staff without resorting to other external suppliers who have a habit of charging the organization every time. - [6]

A collaborative robot can be integrated into any type of process due to its unlimited potential and flexibility. It can perform or assist in the completion of various manufacturing processes such as: screwing, sanding, plastic injection, product picking and placing, dispensing on the product. The collaborative robot or cobot can be integrated into a visual inspection process that is performed through industrial cameras.

The collaborative robot has a human-machine interface, and this is developed so as to allow the robot to communicate easily with the operator. - [7] Thus, in the operating program of the collaborative robot can be introduced certain warnings that the operator must take into account or according to which the operator can command the robot what movement to execute depending on the situation. Collaborative robots are also friendly with other machines in the manufacturing flow, they benefit from a wide range of communication protocols and can be used to communicate with other equipment. Due to this aspect, collaborative robots can easily communicate with other external equipment in several ways such as electrical input-output signals or various industrial communication protocols such as: MODBUS, TCP-IP or Profinet.

The integration of collaborative robots is recommended especially in hazardous work areas. - [9] They can be easily integrated into any area, and they can be adapted to take on responsibilities in areas where the operator could be at risk of injury. Collaborative robots can also take over the old non-ergonomic and repetitive activities that the robot was forced to perform in the past, thus significantly reducing workplace accidents. Replaced operators will be able to take on more important functions that add quality in terms of products.

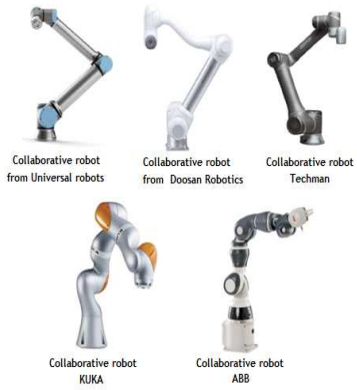

Fig. 5. Collaborative robots - [8].

The pioneer in launching these types of collaborative robots is Universal Robots Company. However, due to high demand, other competitors have appeared on the market such as Techman Robots, ABB Robotics, Doosan Robotics, Kuka and many other companies that offer this type of solution.

Collaborative robots are selected depending on the application. – [10] The main factors according to which a collaborative robot is selected are:

- Cargo to be transported (Payload);
- Range of the collaborative robot;
- Repeatability accuracy.

Range, payload and accuracy are not standardized, and thanks to this aspect each supplier develops robots according to their own creativity at will.

The range of collaborative robots marketed by Universal Robots can be seen in Figure 6.

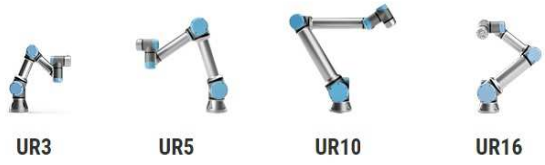

Fig. 6. Collaborative robots from Universal Robots - [11].

There are four types of collaborative robots marketed by Universal Robots. The acronym UR comes from the name Universal Robots, and the number of each type of robot comes based on the mass it can handle. The general

characteristics of each type of UR robot can be seen in Table 1:

Table 1

Types of collaborative robots marketed by UR

UR robot type / Features	UR3	UR5	UR10	UR16
Transport mass or payload	3 kg	5 kg	12.5 kg	16 kg
Robot weight	11.2 kg	20.6 kg	33.5 kg	33.1 kg
The range of the robot	500 mm	850 mm	1300 mm	900 mm

In the past, the UR10 collaborative robot could lift only 10 kg, the area from which its name was provided. Universal Robots has increased its payload since 2021 so that it can lift a total of 12.5 kg. The authors consider that this technical modification was made so that the robot can lift 10 kg without taking into account the gripper that comes with extra weight.

Collaborative robots produced and marketed by Techman Robot, a company also known by the acronym TM Robots, have the advantage of being marketed with a vision camera with which various applications can be developed. These applications can be some of taking over and placing the product or part, identifying the product or part and also can be used in the inspection area of certain defects that in the past could be detected by a visual inspection performed by an operator or quality control. Collaborative robots produced by TM robots also have certain buttons present on the robot that can unlock its joints for movement and position memorization.

The general characteristics of each type of robot from Techman Robots can be seen in Table 2:

Table 2

Types of collaborative robots marketed by TM

UR robot type / Features	TM5-700	TM5-900	TM12	TM14
Transport mass or payload	6 kg	4 kg	12 kg	14 kg
Robot weight	22.1 kg	22.6 kg	33.3 kg	32.6 kg
The range of the robot	700 mm	900 mm	1300 mm	1100 mm

A controller connection is required to program a Techman Robot. This can be done via a laptop, or peripheral input devices (keyboard, mouse) or output peripherals (monitor).

Fig. 7. Collaborative robots from Techman Robots

There are four types of collaborative robots sold by Techman. These can be seen in Figure 7.

Unfortunately, Techman collaborative robots do not have a graphics programming tablet-like Universal Robots robots, but an important plus is the camera that is integrated into the robot. The acronym for collaborative robots produced by Techman Robot comes either from the payload for the medium-heavy payload series or from the range that the collaborative robot can reach for the regular payload series.

Doosan Robotics is also a well-known company producing collaborative robots. Collaborative robots from Doosan Robotics are sold classified in several classes, namely:

- Series M - Masterpiece;
- Series A - Almighty;
- Series H - High-Power.

Collaborative robots marketed by Doosan Robotics can be seen in Figure 8.

Fig. 8. Collaborative robots from Doosan - [12].

The characteristics of the collaborative robots produced by Doosan from the M series can be seen in Table 3.

There are two more types of A-series robots, namely: A0509s and A0912s. They have the same specifications in terms of repeatability, payload and range but, in addition, are equipped with force sensors.

Table 3

Types of collaborative robots marketed by Doosan. M series

UR robot type / Features	M0609	M0617	M1013	M1509
Transport mass or payload	6 kg	6 kg	10 kg	15 kg
Robot weight	27 kg	34 kg	33 kg	32 kg
The range of the robot	900 mm	1200 mm	1700 mm	1500 mm

The characteristics of the Doosan series A collaborative robots can be seen in Table 4.

Table 4

Types of collaborative robots marketed by Doosan. Series A and series H

UR robot type / Features	A0509	A0912	H2017	H2515
Transport mass or payload	5 kg	9 kg	20 kg	25 kg
Robot weight	21 kg	27 kg	74 kg	72 kg
The range of the robot	900 mm	1200 mm	1700 mm	1500 mm

Doosan robots can be configured with a wireless programming tablet, with buttons to store positions that are placed on the joints and many other options. There are many companies producing these collaborative robots. In addition to the existing technical criteria, the breakdown criteria are the price, the duration of the warranty and the service benefits that the company offers. Also, an important criterion is the level of training of employees regarding the integration of a type of robot. Although they are similar, there are certainly different ways to program and integrate them depending on the manufacturer.

4. QUALITY ASSURANCE OF ROBOTS IN THE AUTOMOTIVE INDUSTRY

Before reviewing certain aspects regarding the quality assurance in the operation of industrial robots, it is important that they meet two important criteria that do not necessarily belong to the field of robotics, namely:

- Industrial robots must be reliable;
- Industrial robots must meet customer requirements and ensure the quality of technical operating parameters.

Thus, it is important to define the two terms: the term reliability and the term quality assurance.

Reliability is the probability that a robot, equipment, or system will successfully perform the intended function, within specified technical parameters, over a specified period. - [13].

Quality assurance is the tool by which an enterprise ensures its market competitiveness and customer confidence. This is presented as an existing concept in a qualitative system that consists of a whole set of activities implemented systematically and planned. - [14].

The robot is an automatic, complex, and universal machine with the ability to perform a variety of repetitive operations. - [15]

Robots used in the automotive field are of two types:

- Mobile robots (Automatic Guided Vehicle or Autonomous Mobile Robot);
- Stationary robots.

Mobile robots perform transport operations and are used in internal logistics in the automotive field. These are robots that respond to material orders. Mobile robots must avoid obstacles, avoid any type of collision with any object or person on the route that is often variable, communicate with production equipment, be integrated into a fleet of mobile robots, could open automatic doors and, depending on the situation, makes sounds or even speaks. In the case of autonomous mobile robots, the route may be variable due to the obstacles that the mobile robot may encounter in its path, and it must be able to avoid them and bypass them successfully. These types of mobile robots must adapt their route to successfully bypass any obstacle encountered on the road, stop in time so as to avoid collision, electrical autonomy and must be integrated into a fleet of similar vehicles with which they must communicate so that it waits one after the other and bypasses as needed. To perform these functions, this type of robot is equipped with sensors that can detect these obstacles in time, are connected to the company network to detect its map and communicate with equipment, automatic doors and other

automatically guided vehicles. They can also make short sentences: "Please clear my way", "I open the warehouse door". Mobile robots must also communicate with the loading and unloading equipment. It must be able to wait for confirmation that the loading has taken place and confirm that it has been loaded.
Stationary robots can be divided into:
- Industrial robots;
- Collaborative robots.

The operating quality of industrial robots in the automotive field is defined according to the application. - [16] Industrial robots must perform repetitive operations at the required speed so that the customer's productivity requirements are met, have high accuracy, can lift the required mass, are resistant to the external environment and can perform all necessary movements.
Industrial robots are usually integrated into cells or cages and due to the high speeds and accelerations they can achieve, industrial robots must be equipped with safety systems so that the safety and security requirements of the worker are fully ensured. Depending on the requirements of the customer and the working environment, industrial robots must be made of compliant materials. If it is a chemical environment, robots must be made of materials resistant to the chemicals in the atmosphere. If the electrostatic discharge requirement must be met, they must be constructed of materials that prevent electrostatic charging and facilitate electrostatic discharge. Depending on the application, the precision is selected, in the automotive field, it is of the order of microns. To successfully avoid accidents at work, automotive industrial robots are integrated into cages or cells equipped with safety devices so that humans are protected. Due to the fact that there is a wide range of industrial robots, they can be selected according to the necessary criteria.
Collaborative robots are integrated into the automotive field so that they can share the workspace with humans. The main requirements that a collaborative robot must meet are the following:
- Performing functions that make a robot collaborative;
- Sales;
- Easy programming.

In order to ensure the quality of operation of collaborative robots, they must fulfil their main quality, namely, to be collaborative. Due to this aspect, it is provided with limited speeds and the possibility to stop instantly when it encounters a collision. For these types of robots, safety devices have been developed, such as safety radars that constantly check the working perimeter of the robot. Also, the movements they perform when the work perimeter is penetrated can be programmed. Collaborative robots can stop instantly when the perimeter is violated or can operate at low speeds.

5. FINAL CONCLUSIONS

Automotive companies have to be flexible, they continue to adapt to a constantly changing market. The industrial organizations that have survived so far on the market have understood that flexibility and adaptability to customer requirements are two major criteria.
Currently, an important criterion today and an important goal is total automation and digitization. An important role in this area is played by industrial robots and collaborative robots that represent important viable tools, tools that make it possible to achieve this goal.
Industrial robots and collaborative robots were objectively analyzed. Industrial robots can be classified into two major groups: mobile industrial robots and stationary industrial robots. Their place and role were presented, the mobile industrial robots being used in the transport of components, parts or goods inside the company, while the stationary industrial robots being destined for the production areas.
Stationary industrial robots were briefly presented. For those who were presented two classifications, the first being made depending on the destination, the number of axes, programming mode, and respectively the second classification being made depending on the type of coordinates used by them.
A presentation of a wide range of collaborative robots from several suppliers was also made. These were distinguished by specific technical criteria, such as the useful mass that the robot can lift, the physical weight of the robot and its range. Certain aspects and differences between

suppliers were highlighted. It was concluded that in addition to the technical criteria presented, an important criterion in terms of purchasing a collaborative robot is its price, warranty duration and benefits in terms of service that the company producing collaborative robots can offer.

Another important criterion is the way or language of programming that can be different from one manufacturer to another. At the moment there is no standard programming language to be used by all collaborative robot manufacturers.

Although articulated stationary industrial robots are similar to collaborative robots, the latter has the advantage of free integration in a workspace that can be shared or shared with the worker. In addition, the articulated stationary robot will always be much more expensive in terms of acquisition cost and integration cost.

The integration cost can be divided between the cost of manufacturing the cell or station in which it will be integrated and the programming of the industrial robot. There are certain standards for programming industrial robots, and the programming language is much more difficult than the collaborative robot. Due to this aspect, it will be necessary for the programming action to be performed by a robot programmer.

Both industrial, mobile and stationary robots and collaborative robots are automatic systems with high reliability. Even if there are stationary industrial robots that need maintenance after a few years of operation, due to the fact that it is specified as preventive maintenance, it can be considered a reliable system.

Mobile robots and collaborative robots have the advantage of zero maintenance, they work without problems.

Finally, it can be concluded that, at this moment, if the technical parameters of the stationary industrial robot and the collaborative robot are comparable, it will always be much more feasible to acquire and implement a collaborative robot compared to an industrial one due to a low cost of acquisition and integration, respectively of the reduced time of its implementation and setting.

8. REFERENCES

[1] Vemula, B. R., Evaluation of robot structures. Västerås, Sweden: Arkitektkopia, (2015).

[2] ****, Top Industrial Robots Exporters | Industrialin. (2021). Retrieved from | Industrial Buyers and Suppliers: https://industrialin.com/news/top-industrial-robots-exporters, (16.10.2021).

[3] Telea, D., Sisteme flexibile de producție. Sibiu: Editura Universității Lucian Blaga, (2014).

[4] Knudsen, M., & Kaivo-Oja, J., Collaborative Robots: Frontiers of Current Literature. Journal of Intelligent Systems: Theory and Applications. Volume 3, 13-20, (2020).

[5] Vysocky, A., & Novak, P., HUMAN – ROBOT COLLABORATION IN INDUSTRY. MM Science Journal, (2016).

[6] Poór , P., & Basl , J., Processes of innovations implementation into Industry 4.0. automotive industry standards. Acta Innovations, 21-28, (2020).

[7] Gihleb, R., Osea, G., Luca, S., & Tianyi, W., Industrial Robots, Workers' Safety, and Health. IZA Discussion Papers No. 13672, (2020).

[8] Gusan, V., & Țîțu, M. A., Management of cost reduction and process improvement. Implementation of industrial robots versus collaborative robots. Review of Management and Economic Engineering, 195-209, (2021).

[9] Fryman, J., & Matthias, B., Safety of Industrial Robots: From Conventional to Collaborative Applications. ROBOTIK 2012 7th German Conference on Robotics, Munich, Germany, 1-5, (2012).

[10] Gopinath, V., Johansen, K., Derelöv, M., Gustafsson, Å., & Axelsson, S., Safe Collaborative Assembly on a Continuously Moving Line with Large Industrial Robots. Robotics and Computer-Integrated Manufacturing. Volume 67, (2021).

[11] ****, Retrieved from Braţe robotizate pentru roboţi colaborativi industriali | roboţi Cobot de la Universal Robots: https://www.universal-

robots.com/ro/?gclid=Cj0KCQiA7YyCBhD_ARIsALkj54qsCnxQNzqQ7yKtTwa98wFi5LmCbMhrDRoj3SiTLugvHpfEaMPChLoaAjshEALw_wcB
[12] ****, Overview of Doosan's cobots versus Universal Robots. Retrieved from FAuDE Tec GmbH - Factory Automation Service Engineering: https://faudetec.de/cobots-from-faude/?lang=en, (11.10.2021).
[13] Dhillon, B. S., Robot Reliability and Safety. New York: Springer, (1991).
[14] Oprean, C., & Ţîţu, M., Managementul calităţii în economia şi organizaţia bazată pe cunoştinţe. Bucureşti: Editura AGIR, (2008).
[15] Engelberger, J. F., Robotics in Practice: Management and applications of industrial robots. Springer Science & Business Media, (2012).
[16] Fragapane, G., Ivanov, D., Peron, M., Sgarbossa, F., & Strandhagen, J. O., Increasing flexibility and productivity in Industry 4.0. Annals of Operations Research, (2020).

Roboți industriali versus roboți colaborativi - locul și rolul in tehnologii neconvenționale

Rezumat: *În zilele noastre, organizațiile industriale se îndreaptă către automatizarea totală. Lucrarea științifică prezintă o analiză tehnică și se concentrează pe noțiuni tehnice privind roboții industriali și roboții colaborativi utilizați în special în industria auto. Acești roboți aduc o contribuție importantă în ceea ce privește productivitatea unui flux de producție, fabricarea calitativă a produsului și la un cost de fabricație cât mai mic. Roboții industriali și roboții colaborativi sunt soluții tehnice de încredere și pot fi considerate necesare pentru producția inteligentă. Acest studiu prezintă roboții industriali și roboții colaborativi în ceea ce privește calitatea lor funcțională și capacitățile tehnice. Scopul acestei lucrări științifice este de a examina în mod obiectiv roboții industriali și roboții colaborativi. În această lucrare științifică, autorii au centralizat informații din surse multiple cu privire la soluțiile existente și implementate cu succes.*

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