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The perspective of using Industry 4.0 in robotics

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Abstract: The contribution focuses on the identification of new possibilities in the robotization of production and assembly processes. In the first section, theoretical knowledge from the given area is presented. The second section presents various trends in the field of artificial intelligence, autonomous technologies and the possibility of their use in the manufacturing industry. New technologies can help businesses with the implementation of individual technologies that can serve to improve production and assembly processes.

Keywords: Industry 4.0, robotization, new technologies.

INTRODUCTION

As a result of the constant transformation of the process, companies are forced to resort to adapting the industry in order to be able to continue competing in the market. Industry 4.0 differs from Industry 3.0 mainly by the development of new technologies used together with artificial intelligence (*AI*). Manufacturers are constantly integrating new technologies, including cloud computing and analytics, the Internet of Things (*IoT*), machine learning, and AI into manufacturing equipment. Smart industrial factories are equipped with a number of technologically advanced sensors, robotics and also built-in software that collects a lot of data and then analyzes and evaluates it, enabling better decision-making [1-5]. Digital transformation in the industrial environment, including the intelligent connection of machines and processes through information and communication technologies, is changing the way manufacturers do business. The concept ensures immediate access to important data and an overview in real time, enabling faster and smarter decision-making in operations. All mentioned technologies lead to increasing efficiency, predictive maintenance, automation and, above all, improvement processes in industry. It can main objectives of Industry 4.0 are to make manufacturing and related industries faster,

more efficient, and more customer-centric while using automation and optimization to detect new business opportunities and models (Fig. 1).

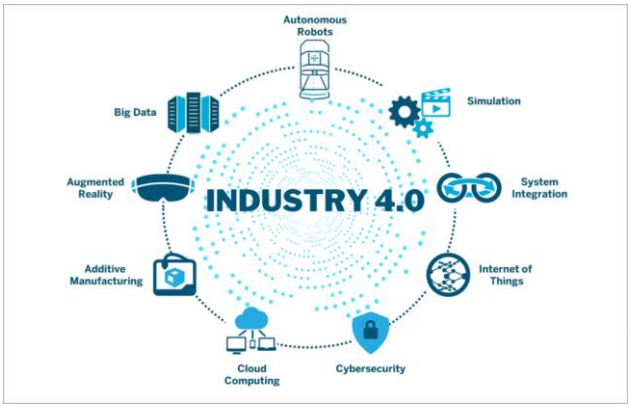

Fig. 1. Industry 4.0 refers to the fourth phase in the Industrial Revolution that focuses on interconnectivity, automation, machine learning and real-time data [5]

2 ROBOTIZATION

New surgeries in robotics are becoming more reliable and safer thanks to advances. Autonomous robots, humanoids, cloud robots, mobile robots, and pick-and-place robots represent the most influential robotics technology. The use of robotics will ensure greater endurance, accuracy and improve the capacity to quickly create personalized robots. Industry 4.0 raises questions about stability, openness and privacy. AI, cloud computing and data processing also increase the operability of industrial robotics. In order to secure the system against a cyber attack, the flow of data and the search for private information must be secured using robotic technology. One of the biggest advances in this area is software ethics and end-to-end protection, which covers privacy-enhancing technologies, smart encryption, and zero-trust security.

Figure 2 shows the directions of using robotics in Industry 4.0 in three different phases. Critical in-depth analysis is the process of analyzing data from different perspectives and summarizing it into useful information. Here, useful information is extracted from databases, from which supporting elements usable in Industry 4.0 are identified and subsequently serve for the overall improvement of processes.

Several main elements apply to robotics in Industry 4.0, including big data and networking. One of the basic pillars is connectivity. This means that the devices are connected and information is obtained from different sensor systems included in the control elements and they subsequently communicate with each other. The aim of the robots is to achieve zero downtime and optimal performance with the support of Industry 4.0. By using more sensors, you get less susceptibility to interference and thus reduce unscheduled downtime, which is one of the most common sources of inefficient production

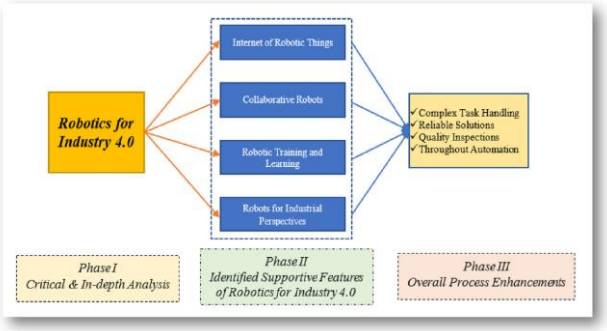

Fig. 2. Phases of robotics for Industry 4.0 [6]

3 PREDICTION OF THE USE OF ROBOTICS IN INDUSTRY

It is clear that the growing shortage of skilled labor in manufacturing firms trying to meet the demands of their customers, together with the uncertainty of time, problems in supply chains and rising energy costs due to the events of the past years, has led to more and more firms is beginning to consider the use of robotics to improve flexibility, resilience and sustainability in manufacturing [7].

Labor shortages are currently evident across all industries and are expected to persist for years to come. This shortage is the result of the aging of the population, but also the reluctance to accept jobs that are low-paid and therefore unattractive. By 2030, the number of vacant jobs is expected to increase to 85 million, which will not only slow down economic growth, but also force manufacturing companies to look for new strategies to solve this problem.

Demand for robotic technologies will be significant in countries where companies intend to relocate manufacturing operations to improve the resilience of their supply chain. The analysis carried out by *ABB Robotics* in 2022 among 1610 *American* and *European* companies shows that 74 % of *European* and 70 % of *American* companies plan to move production abroad. Of this number, 75 % of respondents in *Europe* and 62 % in the *US* indicated that they plan to invest in robotics and automation over the next three years.

Collaborative robots with higher payloads and advanced functions that enable safe collaboration with humans provide companies with new opportunities to use existing workforces more efficiently. Robots will also be gradually integrated into new industries such as gastronomy and healthcare, especially in laboratories and clinics. Currently at the *Univesity of Texas Medical Branch* (*UTMB*) in the *USA*, where, thanks to the automation of the laboratory testing process, they have increased the number of tests performed per day from 15 to

1000. Due to the existing shortage of manpower, it is expected that robots will operate in similar workplaces in the coming years more and more operations [8-10].

4 ARTIFICIAL INTELLIGENCE AND AUTONOMOUS TECHNOLOGIES

Currently, we observe a trend where more and more companies are investing in robotic solutions or looking for new ways of using them in various applications, it is crucial that the programming, operation and maintenance of robots are as simple as possible. Using the latest navigation technologies, a range of autonomous mobile robots can be significantly increased in speed, productivity and flexibility. Such innovative solutions help manufacturers move from traditional production lines to integrated, scalable and modular production cells while optimizing the handling of materials, parts and final products between different production sites [11].

Defective products often occur in production. One of the reasons is, for example, a missing or unidentifiable barcode, which results in downtime. In order to prevent the number of such cases, they try to implement various quality controls. The possibility of improvement is thanks to computer vision, where areas from *AI* are implemented, which trains computers to interpret and understand the visual world.

One solution is to place several cameras in strategic locations where people are usually placed to perform visual inspection. Using digital images from cameras and videos, it is possible to train computer vision models that allow analyzing scenes based on learned models. The cameras are programmed to accurately identify and classify objects. Subsequently, the device can consume each frame, perform analysis and generate output according to the learning model.

A schematic representation of the functioning of the inspection of pieces on the production line using *AI* is shown in Fig. 3.

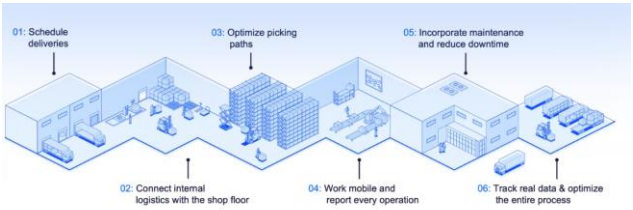

Fig. 3. Manufacturing processes with dozens of applications dedicated to *ERP* system

Using these images and videos, the model can be trained to identify defects in real time within hours. The checks can be repeated at any time, and the data obtained can then be used to react to what the camera sees.

CONCLUSIONS

At the intersection of production and development, the *German* automaker *BMW* tests the concept of vehicles and their design using prototypes. However, the production of accurate prototypes is financially, but also time-consuming and often requires lengthy processes. Using virtual reality (*VR*) *Hololight Space* and augmented reality (*AR*) *HoloLens* 2 from *Hololight*, real-life vehicle components such as bodywork and fenders are superimposed on true-scale holographic 3*D CAD* models. Within *Hololight* Space, engineers have the ability to visualize, manipulate and share 3*D CAD* data in a real-world environment. In the first step, the *CAD* files of the components from the online database are loaded directly into the *VR Hololight* Space application with a simple drag-and-drop. Using a head-mounted display such as *Microsoft's HoloLens* 2, intermediate results, possible variants or final concepts can be displayed in 3*D*.

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