USE OF INNOVATIVE PHYSICAL MODELS FOR THE NEEDS OF EFFECTIVE EDUCATION

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Abstract

The development of modern technologies under the designation Industry 4.0 or Industry 5.0 brings new possibilities in terms of logistics management and implementation in practice as well as independent autonomous systems. The use of innovative systems composed of physical models brings new opportunities in the teaching process. The aim of our contributioon is to point out the use of such innovative systems in practice. The main element is the use of educational robots which represent a huge potential in the teaching process. There is currently a research institute at the BERG Faculty that has such educational robots and where we try to bring opportunities to use these educational robots effectively in connection with research and to be of benefit to the teaching process. In terms of the technological part of the research, our goal is to create autonomous systems with the help of such educational robots, and to model and create workplaces that correspond to real workplaces in various areas of industry in the real world. The project plan is to build a new laboratory for the simulation of robotic workplaces with the help of educational robots.

Keywords: Innovative system, education robotics, teaching process.

1. INTRODUCTION

Over time, all industries in society change. It is mainly about the way people work in production and logistics systems. Constant development of new technologies, introduction of Industry 4.0. but also, the social change is the cause of this phenomenon. This kind of change, transformation is still a difficult nut for some companies. It is necessary to adapt to the current situation and to accept new challenges in management approaches that can help advance the company and logistics as such. Author *Fabio Sgarbossa* and team in *Human factors in production and logistics systems of the future* [1] describe how different companies adapt to automation and what role the human factor plays in this. Other authors address the various impacts of the human factor on efficiency and system building. For example, the authors *D. Battini, M. Faccio, A. Persona, F. Sgarbossa* in *New methodological framework to improve productivity and ergonomics in assembly system design* [2] describe a methodology for increasing productivity in the design of a certain system. The involvement of the human factor in the production process is inherent, but it brings with it errors. Authors *D. Pasquale, S. Miranda, W.P. Neumann* in the article *Aging and Human-System Errors in Manufacturing: A Scoping Review* [3] Human Factor Errors in Manufacturing. There are many other authors who deal with this issue, for example*: C.H. Glock, E.H. Grosse, W.P. Neumann* [4] *E.H. Grosse, C.H. Glock* [5] *M.Y. Jaber, Z.S. Givi, W.P. Neumann* [6].

When implemented in real life and in our project, it is important that autonomous systems behave naturally. It is necessary that they can adapt to situations in the simulated system, such as changing direction, performing the necessary action, start and stop at the desired moment, avoiding obstacles. This last problem is mentioned by the authors *Wang Shaobo, Zhang Yingjun, Li Lianbo*, in *A collision avoidance decision-making system for autonomous ship based on modified velocity obstacle method* [7], where they deal with the collision avoidance system in an autonomous ship. Other authors in this field *are D. Bareiss, J. Van Den Berg [8], T. Degré, X. Lefèvre* [9] *, Z.Y. Zheng, Z.L. Wu [12].*

For the needs of building an autonomous logistics system based on small physical models used for educational purposes, it is necessary to focus on industrial robots and then on educational robots

2. MAIN FUNCTIONS AND TRENDS OF AN INDUSTRIAL ROBOT

In the literature, the term industrial robot refers to devices that can independently solve various handling tasks. At present, although an industrial robot is defined according to ISO, there are several other definitions with different interpretations, but they all have the same essence. The main functions of an industrial robot include:

- Handling ability to grasp objects, transfer, orient and position them, including technological tools
- Versatility, which means that the robot serves not only one purpose, but after changing the program, end effector or tool, it can be used for other purposes in other conditions and iterative relationships of the applied environment.
- Perception, the ability to perceive the work and operating environment from internal and external sensors to control the functions of the target program.
- Autonomy, the ability to independently perform the required sequence of tasks, according to the specified program, respectively. in combination with a certain degree of self-determination on the choice of procedure for the implementation of the task
- Integrity, the ability to concentrate the functional groups and the main subsystems (including the control subsystem) in terms of software and hardware, if possible, in one compact unit [10]

The basic trends in robotics for the future are robots are learning new tricks, robots are working in smart factories, robots are entering new markets, robots are reducing their carbon footprint, robots are helping to secure supply chains.

- **Robots learn new tricks**

Artificial intelligence software combined with vision and other sensing systems allows robots to handle challenging tasks. One such task is picking up the trash, which in the past was only possible by human hands. New generations of robots are easier to install and program and are connectable. Advances in communication

- **Robots work in smart factories**

The automotive industry has pioneered solutions for smart factories that use industrial robots on assembly lines that have dominated traditional automotive manufacturing for more than 100 years. The future belongs to the networked interaction of robots and autonomous controlled vehicles - or rather autonomous mobile robots (AMRs). Equipped with the latest navigation technology, these mobile robots are much more flexible compared to traditional production lines. Bodies are transported on driverless transport systems. They can be disconnected from the assembly line flow and redirected to assembly stations, where it is possible to assemble individually equipped variants. When completely changing the models, it is only necessary to reprogram the robots and AMR, and not to dismantle the entire production line. Thanks to the integration of workstations for cooperation between humans and robots, it is gaining momentum, robot suppliers state that robots work hand in hand with people without fencing.rotocols seamlessly integrate robots into Industry 4.0 automation and strategies.

- **Robots enter new markets**

Breakthroughs in connectivity are contributing to the increased adoption of robots in manufacturing sectors that have only recently turned to automation, such as food and beverages, textiles, wood products and plastics. The ongoing digital transformation will lead to completely new business models, as manufacturers can diversify more easily than ever before. In an intelligent factory, different products are gradually assembled on the same equipment - a traditional production line no longer exists.

- **Robots reduce carbon footprint**

Investments in modern robotic technologies will also be driven by the demand for a lower carbon footprint. Modern robots are energy efficient, which directly reduces energy consumption in production. Thanks to higher accuracy, they also produce less low-quality goods, which has a positive effect on the ratio of input sources and outputs. In addition, robots help in the cost-effective production of renewable energy equipment, such as photovoltaics or hydrogen fuel cells.

- **Robots help secure supply chains**

The situation in the world has highlighted the weakness of globalized supply chains. Manufacturers can reconsider the offer with a completely different outlook. When productivity is offset by automation, manufacturers have increased flexibility, which may not be available in high-wage countries such as most of the European Union, North America, Japan, or the Republic of Korea. Robotic automation offers productivity, flexibility, and safety [11].

3. EDUCATIONAL ROBOTS

In addition to industrial robots in manufacturing companies, there are small versions of industrial robots. As the use of robots is increasingly taking place daily in today's modern world, these small educational robots are becoming increasingly popular. Robots replace humans wherever routine and repetitive work is needed - in performing diagnostics, production, data collection and the like. According to experts, these tasks took people up to 75% of the time. Now that robots can be used for these tasks, attention can be focused on activities and problems that require cognitive skills, creativity, and the like. Therefore, the abilities and skills that have been required of people in the past in job positions are gradually changing. It is necessary to develop a curriculum regarding this rapidly changing world, in which people must exercise their abilities using robots. In today's world, initiative, planning, flexibility, commitment, resilience, empathy, and appreciation of the ideas of others are needed more than ever before. It is therefore appropriate to talk about the implementation of several robotic learning tools that will prepare people for different industries and not just industry. Robotic learning tools are gaining popularity because:

- intelligent stands take over all routine and monotonous work,
- job applications now require complex problem solving, creative thinking, broader knowledge, communication, and collaboration,
- with the use of new robots and technologies, students must learn to code and program [12].

The advantage of using robots in the learning process is less intervention by adults in students' learning, greater control of students over the process, and thus a feeling of satisfaction and good results. The Education for Robotics is an Italian curriculum in which students and children develop just the above. They work in groups on a certain robotic project and then present their projects to others. There are even competitions where, in addition to the feedback from their co-students, they also must get feedback and advice from experts. The Robotics Education program has been running for several years, schools are interconnected, and teacher support is provided. The OECD report from 2020 approved this Italian model as a model that others should follow. This is also recognized by companies that manufacture industrial robots. They also make sure that they provide training courses and things that support education in these areas. In fact, awareness of robots is such that they replace people, and many people lose their jobs, but this is not always the case. Some robotic applications require more staff than they did before production automation. They therefore design industrial robots that have a smaller scale, from toys that do not work, and certain parts can only be adjusted manually, to mini-industrial robots that have full functionality and equipment. It's getting easier and more affordable to get to these robots. One of these robots is an educational set of robotic arms, which is purely intended for such educational purposes. It has 6 degrees of freedom, has the advantages of an all-metal robotic arm, a high-quality lower joint and stable operation. The base is fixed with an all-steel bearing, so there is no shaking of the arm. All joints have bearing joints. It uses 5 metal servos and 2 metal gear servos. The lower joints are secured with two servo drives, which are twice as powerful and stable. The size of the robotic arm can vary slightly, depending on the production batch, but is suitable for teaching and testing. The design concept is taken from ABB palletizing robots. The main structure is the same and the range of motion is greater than for robots of similar sizes. The frame material is a thick hard aluminium alloy. The end effector can be different depending on the properties - it can be an electromagnet, a fork, a gripper, a suction cup, and the like. They provide service, a one-year warranty, a manual and the remaining parts for this robot. It is available for 84 to 167 €.

Another example of these educational robots is the WLKATA Mirobot educational kit. It is also suitable for industry for logistics purposes. This set is already at a slightly higher level, available for around 1300 €. It is a 6-axis robot that has been awarded as the best rated by universities and schools in more than 40 countries. It provides the perfect robotic educational platform for higher education, research laboratories, manufacturers, and professional training. It handles 250 g load, repeatability 0.5 mm and horizontal reach 428 mm. This robot is capable of applications such as palletizing, picking and laying, assembly, and the like. The set includes a Mirobot robotic arm, power supply and high-speed USB cable, pneumatic kit including end effectors such as suction cups, two-finger gripper and soft three-finger gripper, multifunction box, pen holder, microscopic actuator module, manual and stickers. Even with this robot, it is possible to create a mini production line, and thus better prepare for the time when it will not be just such small robots, but robust industrial robots [12].

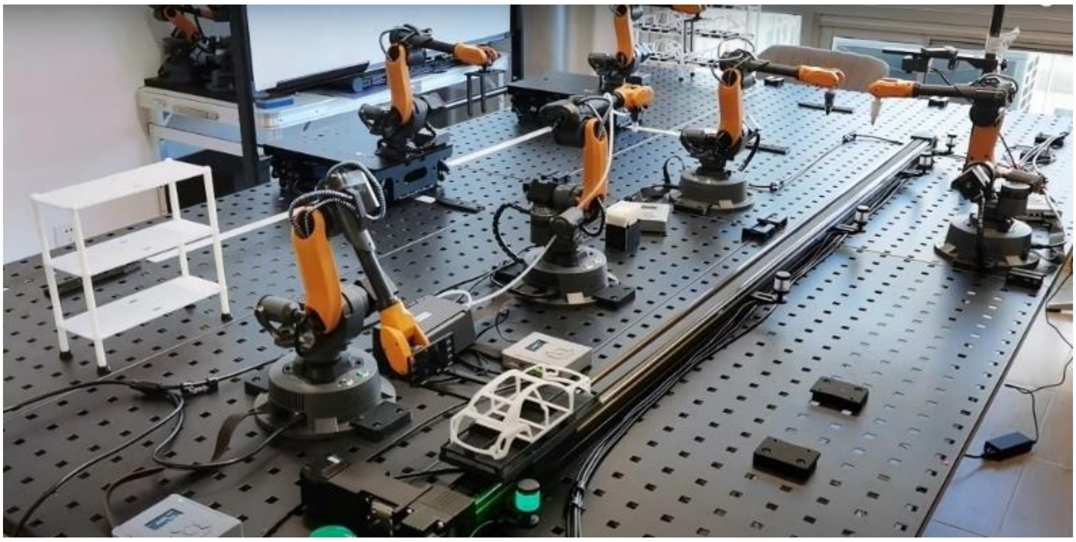

Figure 1 WLKATA MIROBOT production line [14]

2.1. Introduction to WLKAT MIROBOT

As described in the previous chapter, there are many robust industrial robots on the market, as well as small scales under the name educational robots. When assessing the individual solutions, we decided to use the WLKARA MIROBOT set for educational purposes. This set proved to be an unequivocal winner in the comparison of the parameters of price-quality-learning opportunities. Another great advantage of this set is that its appearance is best reflected by real robust industrial robots. WLKATA Mirobot is a six-axis mini-industrial robotic arm manipulator independently developed and marketed by Beijing Tsinew Technologies Co., Ltd. The WLKATA Mirobot manipulator is primarily developed for higher education purposes. It represents a new generation of lightweight six-axis table robot model that integrates several practical functions, such as drawing, manipulation, folding, painting, writing and machine vision. Users can easily control the Mirobot using the remote control, graphical programming, tutorials, and games. It has a rich I / O interface that allows connection to various end effectors. By the I / O interface we mean that only the basic program can work in different modes. For advanced operation, users must master the Python programming language. The input interface means coordination mode only by means of joint movement, coordination mode by means of a rectangular system, learning mode of individual steps, drawing mode, suction pump mode, etc. The output interface is the possibility to connect various devices to the end effector, such as: pump, gripper, drawing holder, laser, etc. [15]

WLKATA The Mirobot consists mainly of a base, six swivel joints, a lower arm, an upper arm, and an end effector connection plate, as shown in the **Figure 2** In Mirobot there are a total of six joints of the robot, see the **Figure 3** to familiarize yourself with the name of each of the six joints [15].

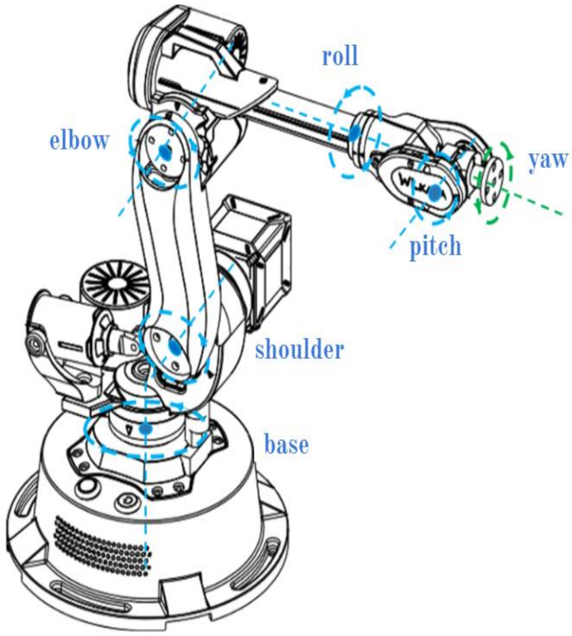

Figure 2 Composition

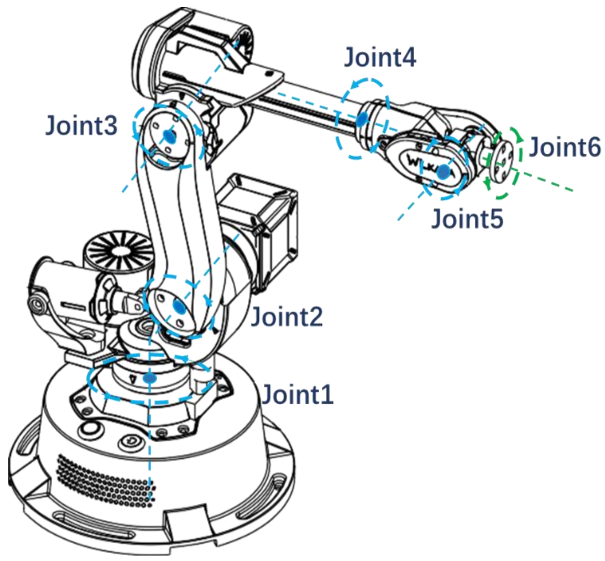

Figure 3 Joints on WLKATA MIROBOT

4. CONCLUSION

The project is currently in the research and development phase of small physical models. These small physical models have huge potential in teaching and research at the faculty. However, behind the huge potential of this technology is many shortcomings that this problem hides. Further research and development of small physical models and subsequent construction of an autonomous logistics system is necessary. During the research of the system so far using elements of educational robots, many obstacles have been identified that need to be removed to fulfil the goal. Despite these shortcomings, we are well on our way to building a functional laboratory where such innovative systems and especially educational robots will be used. With the help of research, our priority is to bring a new methodology to the teaching process and thus make teaching in the field of not only industrial logistics but also innovative systems more attractive.

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