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Wlkata educational robots used in simulation in the laboratory conditions

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Abstract: Wlkata Mirobot is a portable robotic arm that is suitable for robotics-oriented projects. Practical education in the field of robotics in laboratory conditions is of great importance from the point of view of acquiring competence in the field of soft robotics, digitalization, simulation, etc. The cost and size of the equipment limits the use of real industrial robots in laboratory conditions. The connection of specific elements that Wlkata offers and when combined with artificial intelligence, it is possible to fully use the potential of this technological solution when testing digital twins in laboratory conditions.

1 Introduction

Only the digitalization of production and products is not the only driving force of digitalization, it is also the possibility of networking technical systems in real time. Such an environment in connection with digitization creates a new business ecosystem. Creating partnerships, open networking of manufacturers with suppliers and customers, or even with competitors (opening up opportunities for customer involvement in the product development process, i.e. shifting certain activities to the customer) creates the basis for the development of new business models, and this can be considered revolutionary [1-4].

For implementing educational robots in research laboratories is primarily that they copy the functionality of a real robot, and it is also possible to work with its internal structure and logic. The disadvantage is that, even though researchers can learn how to control a robot, they do not have the opportunity to work with process algorithmizing. There are several options on the market for choosing educational robots, e.g. Wlkata Mirobot, Lego Mindstorms, mBot, Robobloq, Fanuc Corporation, Yaksawa Motoman, Abb, Kuga AG Kawasaki Robotics GmbH, etc. Educational robotics is included in the so-called STEM education (Science, Technology, Engineering and Mathematics), a teaching model designed for the joint teaching of natural sciences, mathematics and technology, in which practice takes precedence over theory [5-7].

Potential of creation and testing elements of digital factory in laboratory conditions [8-13]:

- Reconfigurability: industrial robots supported by an experimental platform through their own configuration of control systems, simulation of digital twins, modeling of various robot activities (visual sorting, writing, drawing, laser engraving, etc.) form an integrated solution from basic programming, through applications, training to integrated development.
- Modular combination: each module is relatively independent and can be used individually or combined links, each module uses digital signage and the integration of an intelligent control unit.
- The system is easy to maintain, develop and train without losing industrial characteristics, supporting the development and application of industrial IoT professionals from the equipment level to the intelligent factory management level, which includes teaching, research and training of special technologies and professional core technologies in many professional fields such as electronic information, computers, industrial robots, etc.
- Digital twin: the system is equipped with a 1:1 digital twin system that allows you to create a real production line through virtual simulation and further test and

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optimize it in a virtual environment and then send verified information to the physical model.

2 Wlkata Mirobot in laboratory conditions

Wlkata robots are created for education and teaching of programming and robotics. Various activities can be performed with these robots, including [14-16]:

- Motion programming: controlling the robot's movements using programs, with the possibility of setting different routes and movements.
- Interacting with sensors: exploring the sensors that are part of the robot, such as line tracking sensors, ultrasonic sensors, or ambient detection sensors.
- Problem solving: creating programs to solve various tasks and problems, which helps develop creativity and analytical skills.
- Programming education: Wlkata robots often support different programming languages, which allows us to learn the basics of programming and algorithmic thinking.

Wlkata Mirobot is a 6-axis mini industrial robotic arm manipulator developed by Beijing Tsinew Technologies Co., Ltd. This is a desktop Mirobot suitable for use as an educational device for various types of courses and research in the field of robotics. Basic characteristics of Wlkat Mirobot [17-19]:

- Lightweight fully assembled device: Mirobot is a portable robotic arm that is great for robotics projects in conjunction with artificial intelligence.
- Various control methods: Mirobot supports control by PC, Mirobot Bluetooth controller and APP.
- High accuracy: Repeat positioning accuracy is 0.2mm, making it ideal for educational purposes and light tasks.
- Multifunctional box: The robot has a communication interface that supports WIFI and Bluetooth communication protocols.

The advantage is the use of 3D printing technology to design, manufacture and manufacture the structural parts of the robot. It is equipped with a forward speed control algorithm to perform a smooth trajectory of movements. He uses the geometric method and the Euler angle transformation method to solve the inverse kinematics problem. It ensures high accuracy of movements of 0.2 mm. Modeling and simulation of movements is ensured through software that can be controlled via computer, laptop and as an application via mobile phone and remote control via Bluetooth. Wlkata's offer of Mirobots and accessories makes it possible to use the modularity of individual elements and thus create a mini-line according to the requirements of researchers, university teachers and students. Wlkata's laboratory training platforms make it possible to implement an interactive and practical educational process, which has technologies such as PLC Bus-mastering, open-source API with support for further research in the field of robotics and the use of robotics in industry.

Robotic arm Wlkata Mirobot, Figure 1, consists of a base, connecting frames, gear stepper motors and limit switch sensors. The robot has connecting frames and an appearance similar to an industrial robot and consists of six joints.

Figure 1 Wlkata Mirobot with 6 degrees of freedom designation

Wlkata Mirobot can be programmed and controlled in the Wlkata Studio software environment, Control software, Figure 2. The computer enables to realize the robot arm's single-axis movement function, Cartesian mode position control function, Teaching function, Blockly function, Python programming function and Drawing function. These functions of Wlkata Mirobot are designed for the implementation of qualified teaching or research in a specialized laboratory, Figure 3, accessories for controlling the Wlkata Mirobot.

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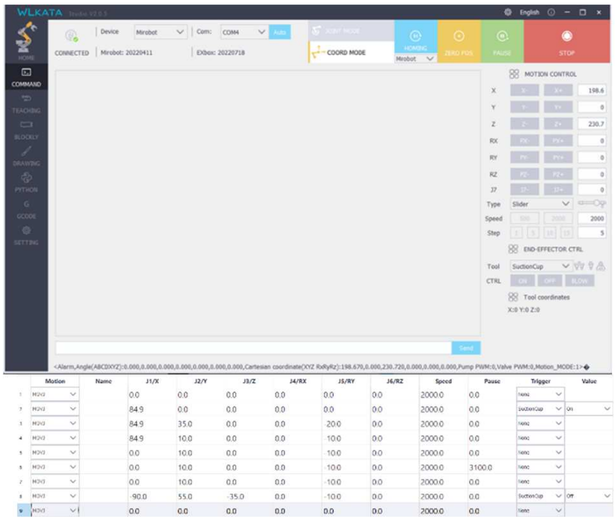

Figure 2 Basic software environment for controlling Wlkata Mirobot

Figure 3 Accessories for controlling the Wlkata Mirobot (controller of the robot, universal controller for the robot or lunar vehicle via Bluetooth, control of movements via an application on a tablet and phone)

Wlkata Mirobot represent dynamic elements for the creation of a physical model with the aim of creating a digital model of the production, or assembly line, Robot movements are programmed using our own Python programming language, and also through block diagrams Blockly function, which allows programming movements even without knowledge of the Python language., Fig. 4. It is about programming a robotic arm for the purpose of transporting building block blocks. In the individual images, it is possible to see how the robotic arm transfers the cube from point A to point B.

Wlkata Mirobot hardware and software support allows you to design, create and test potential manufacturing and assembly processes. It is possible to create a dynamic system that can also be completed with elements from other manufacturers that allow connection via Arduino.

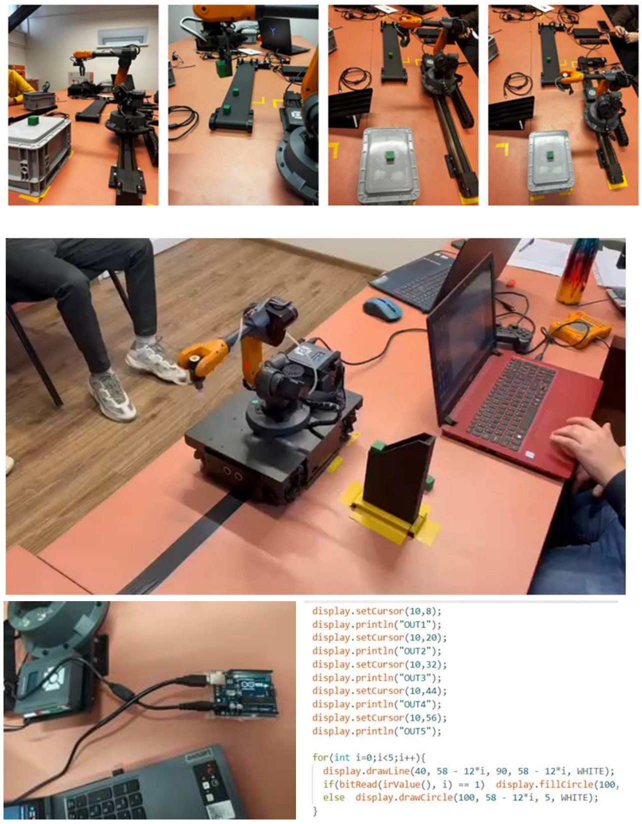

Figure 4 Demonstration of work with Wlkata Mirobot in a specialized laboratory

In this way, it is possible to create a functional line that will serve for research and development of other work possibilities in this direction. It is also possible to complete the physical environment through 3D printing of specific elements, Figure 5.

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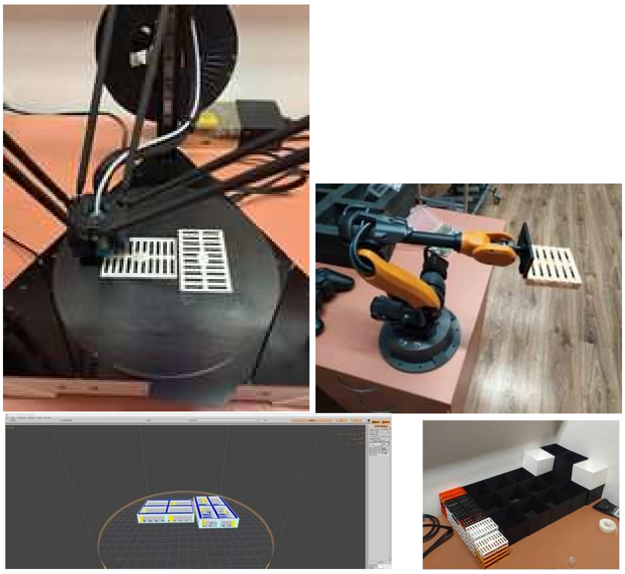

Figure 5 3D printing of components for creating a physical model of processes

3 Conclusions

As part of the submission process, Manufacturing continues to become more flexible, the associated robotic control and digital twins will need to be able to adapt quickly to change. Advanced real-time adaptive control software provides the ability to model and control any robotic system while automatically updating the virtual model based on real-time telemetry from the robotic hardware. The captured information can then be used to render a digital twin for representation through Augmented Reality/AR. Through the IOA Digital Twin platform, Fig.6., it is possible to test and acquire competences within the entire life cycle and personalization of orders.

It is a software that supports a fully automated online ordering process, enables the realization of production order analyses, process planning, intelligent storage, flexible reconfiguration of production processes, laser engraving and three-dimensional assembly. It goes through the entire information pyramid from personalized orders on mobile phones, through digital data on the decision-making process at the MES/Manufacturing Execution System level to unattended production of digital production lines and remote digital SCADA/Supervisory control And Data Acquisition monitoring.

Figure 6 IOA Digital Twin - intelligent production integrated simulation and design platform

On the technological side, the information pyramid is important in merging the virtual and real worlds through data that is available in real time. Architectural changes in technical systems are aimed at networking and creating platforms based on cyber-physical elements in the system. With these influences and changes, the classic information pyramid expands:

- to horizontal cooperation - through IOT/Internet of Things/Internet of things and IOS/Internet of Services/Internet of services in the company's value chain,
- into vertical integration - through changes in the product architecture by introducing CPS/Cyber Physical Systems/Cybernetic-physical systems,
- the use of structured and unstructured data in real time in the design and optimization of the complex value chain of the company.

With increasing digitization in companies, interest in Cloud applications is increasing, which will contribute to the transformation of investment costs into operating costs through the so-called Outsourcing. The data are stored on central servers, from which it is possible to import, process, evaluate, use artificial intelligence software, etc.

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