POSSIBILITIES OF BUILDING ROBOTIC WORKPLACES WITH THE HELP OF EDUCATIONAL ROBOTS

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Abstract

The article focuses on highlighting the possibilities of using educational robots in the creation of automated workplaces. As advancements in robotics and automation continue, simulating robotic workplaces has become an integral part of developing new production processes in various industries. To accurately model such workplaces, it is necessary to utilize educational robots that faithfully represent elements found in real manufacturing operations. The main objective of the presented contribution is to create a functional model of a robotized workplace in a laboratory environment using educational robots and their components. This model serves as a tangible and physical demonstration of logistics flows on a reduced scale.

Keywords: Model system, educational robot, physic model

1. INTRODUCTION

With the passage of time, all sectors of industry in society undergo changes. It primarily concerns the way people work in production and logistics systems. The constant development of new technologies, the introduction of Industry 4.0 and Industry 5.0, as well as societal changes, are the causes of this phenomenon. This type of change, transformation, remains a challenging puzzle for some companies. It is necessary to adapt to the current situation and embrace new challenges in management approaches that can contribute to the advancement of society and logistics as a whole. Authors Fabio Sgarbossa and the collective in the work *"Human Factors in Future Manufacturing and Logistics Systems"* [1] describe how various companies are adapting to automation and the role the human factor plays in it. Other authors focus on the various impacts of the human factor on efficiency and system building. For instance, authors D. Battini, M. Faccio, A. Persona, F. Sgarbossa in the work *"A New Methodological Framework for Improving Productivity and Ergonomics in an Assembly System"* [2] describe a methodology for increasing productivity in the design of a specific system. The involvement of the human factor in the manufacturing process is essential but also brings along errors. Authors V. Di Pasquale, S. Miranda, W.P. Neumann in the article *"Ageing and Human Systems Errors in Production"* [3]. There are many other authors who address this issue, such as 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].

In the implementation of models into real life and in the creation of model systems within a laboratory environment, it is crucial for autonomous systems to exhibit natural behavior. It is imperative for them to be capable of adapting to situations within a simulated system, such as changing direction, performing required actions, initiating, and halting at the appropriate moment, and avoiding obstacles.

2. MEASUREMENT OF MOVEMENT ACCURACY

Elements of educational robots are utilized to create a model system. In the case of this type of physical model, movement accuracy is a crucial criterion. If we want model systems to behave and appear similarly to the real world, it's necessary for their movements to closely reflect real operations. The measurement of movement accuracy of educational robot elements will be conducted only on a robotic manipulator. The demonstration of the precision of robotic arm movement is carried out within the premises of the "Logistics Innovation Robot Laboratory." To obtain measurements, a mat is used, which simulates an inclinometer ranging from 90° to -90°. The robotic manipulator is positioned at the centre of this inclinometer, and a laser is placed at the end of one of its arms, aimed at the inclinometer's values. Measurements are taken in five positions: 0°, 45°, 90°, -45°, -90°. The laser at the end of the manipulator's arm is directed at the mentioned inclinometer-simulating mat, serving to verify how precisely the robotic manipulator responds to movement change instructions from the software interface. The measurement is conducted using a software interface demonstration with a command for position change and photographs of the robotic arm on the inclinometer-representing mat. **Figure 1** depicts the robotic manipulator alongside the inclinometer mat. On the **Figure 2** you can see actual measurement process in the "Logistics Innovation Robot Laboratory" environment [7].

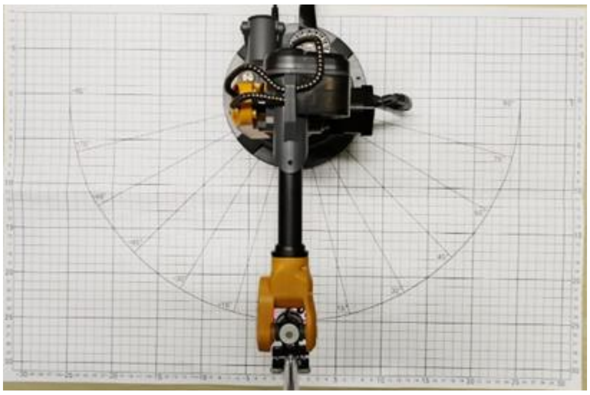
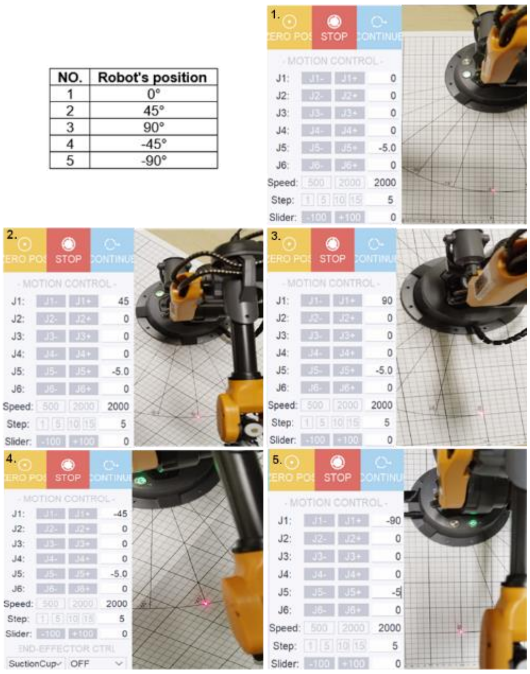


Figure 1 Inclinometer and robotic manipulator [7].



NO.	Robot's position
1	0°
2	45°
3	90°
4	-45°
5	-90°

Figure 2 Robot´s position [7]

In previous measurements, it was demonstrated that the accuracy of the robotic arm is sufficient for executing model systems within the "Logistic Innovation Robotics Laboratory" environment. In these instances, it concerns the movements of the robotic arm in its own axis-coordinate system [7].

3. WOKPLACE MODEL

The model system "Mining Operation" was created in the environment of the "Logistics Innovation Robotics Laboratory" with the aim of demonstrating the versatility of industrial robots and their ability to replace traditional mechanisms in mining operations. To achieve this goal, certain modifications were necessary in the laboratory environment. However, the current state of the laboratory and the technical parameters of robotic arms do not allow for the programming and synchronization of the operation of both workstations on a single computer. Therefore, the model system "Mining Operation" was divided into two parts, referred to as "Station 1" and "Station 2" see **Figure 3**. This arrangement presents a challenge when it comes to launching both workstations simultaneously. Nevertheless, the software support provided by WLKATA STUDIO allows for delaying the start of one of the stations. With proper timing, it is possible to start both stations simultaneously, with robotic arms and conveyor belts performing their tasks without the need for additional human intervention

"Station 1" has the objective of picking up material from a prepared and filled container using a robotic arm with an end effector - a scoop. Subsequently, the robotic arm moves over the conveyor belt and empties this material into a prepared container. The conveyor belt transports the material to a processing unit. The next step involves simulating the processing of the simulated material [7].

After a certain period, "Station 2" is automatically initiated. The conveyor belt transports the material in its processed form beneath the robotic arm. This robotic arm then initiates its program and transfers pairs of wooden blocks, the simulated material - bricks, to a prepared plastic pallet on a stand.

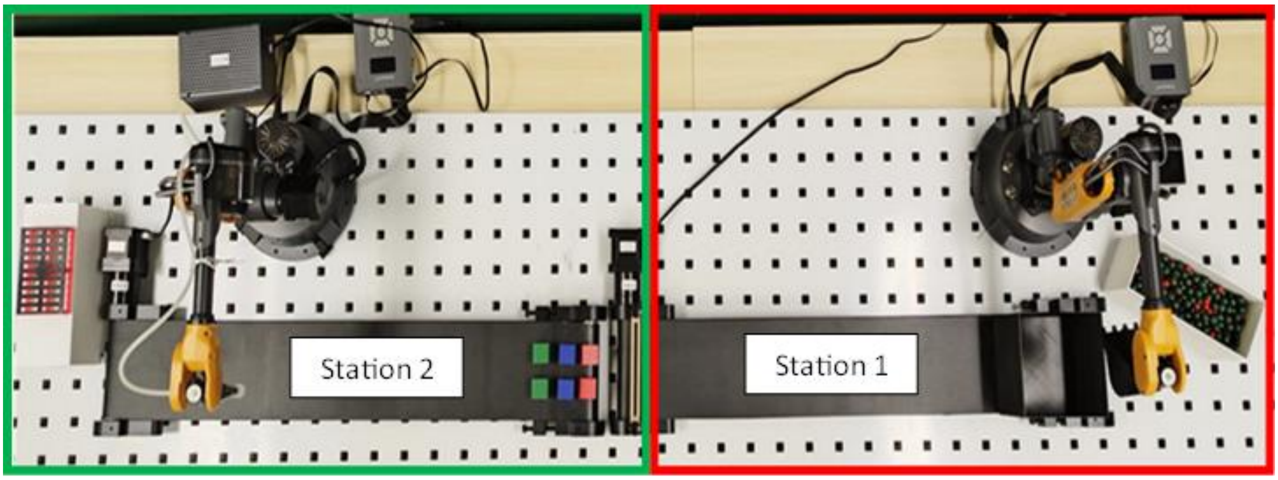


Figure 3 Model of mining operation [7]

3.1 Procedure of creating the model

The procedure for creating a functional model is limited to "Station 1." As mentioned earlier, the goal of this station is to collect material from a prepared container, then move over the container placed on the conveyor belt and empty the material from the spoon into the container. This process is repeated twice by the robotic arm. Subsequently, the conveyor belt is started, and the container with the material is moved along the conveyor belt, followed by a simulated activity where the material is processed. We will begin by displaying the program from the WLKATA STUDIO software interface, and then each line of the program will be presented through a photograph of the position of the robotic arm and other elements of the simulated "Mining Operation - Station 1" system. Each program line will be paired with a photographic record, where the colour frame around the line in **Figure 4** corresponds to the colour frame on the **Figure 5** depicting the manipulator's position. The lines that are not displayed using a photo are used for correcting the manipulator, so it is not necessary to depict them using a photograph [7].

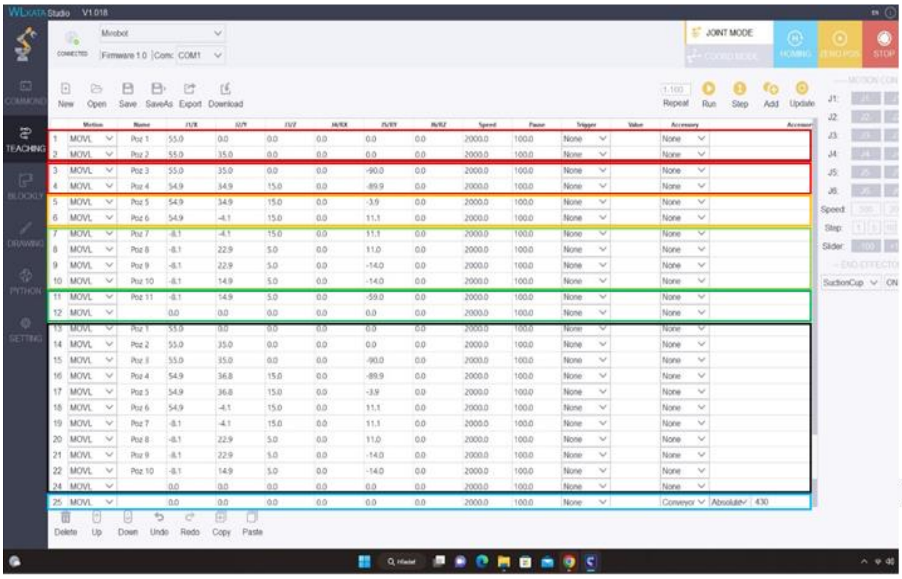


Figure 4 Series of moves “Station 1” [7]

Figure 5 Position of the robotic manipulator on “Station 1” [7]

The purpose of the “Station 2” is to transport processed material, namely wooden blocks simulating, for example, bricks, along a conveyor belt to a designated location. Subsequently, the robotic arm, using a pneumatic device and a double silicone suction cup, moves the material from the conveyor belt onto a prepared plastic pallet on a stand. The double silicone suction cup can relocate 2 such wooden blocks in a single motion. The material, which consists of wooden blocks, forms three pairs on the conveyor belt. Therefore, it is necessary to repeat the above-mentioned cycle three times. The procedure is the same as in the previous station. Firstly, it is necessary to display the program from the WLKATA STUDIO software interface, and subsequently, each line of the program will be captured through a photograph of the robotic arm's position and other components of the simulated system "Mining Operation - Station 2." The colour border around the line in **Figure 6** corresponds to the colour frame on the **Figure 7** depicting the manipulator's position [7] .

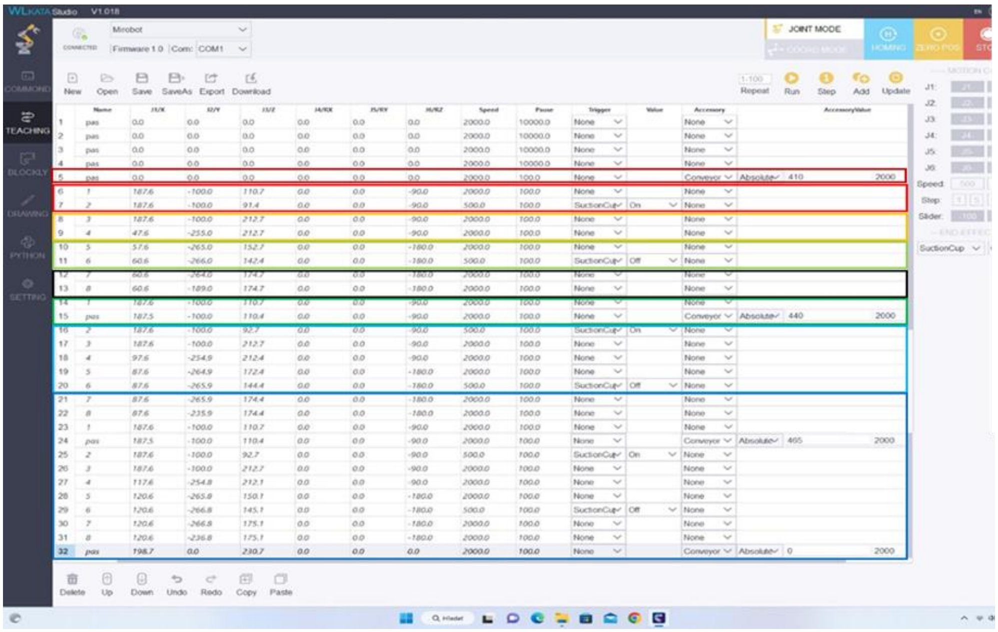


Figure 6 Series of moves “Station 2” [7]

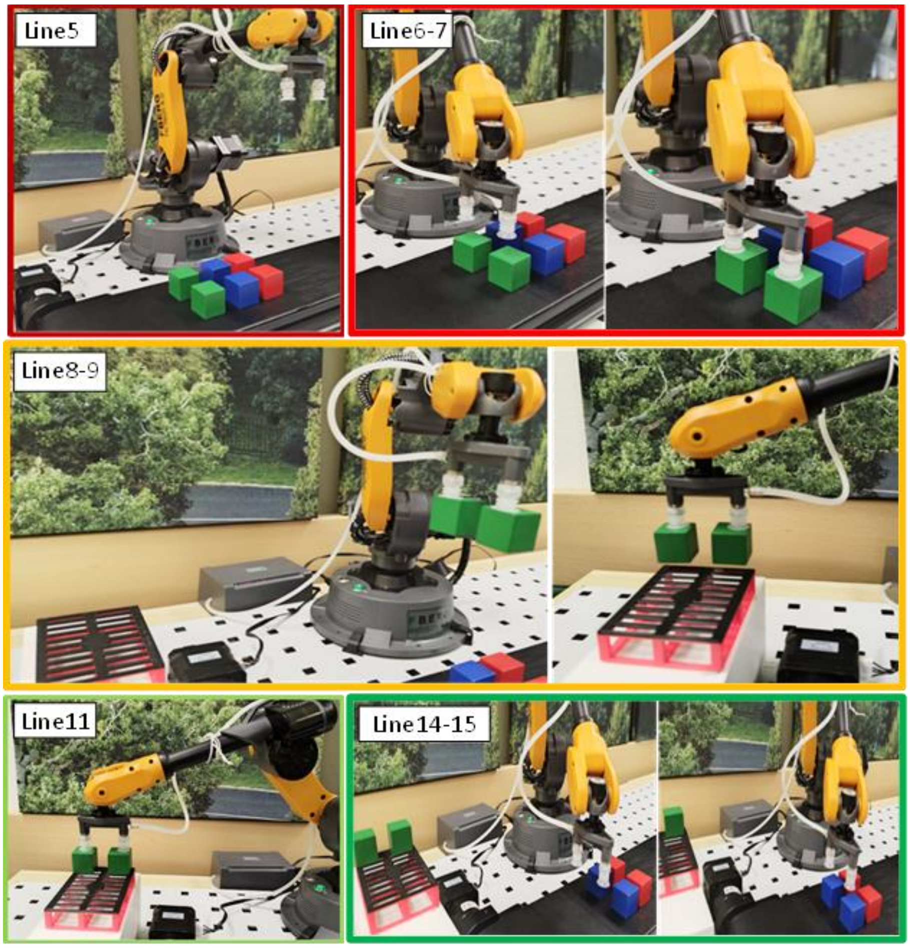


Figure 7 Position of the robotic manipulator on “Station 2” [7]

Figure 8 depicts the position of material groups - wooden blocks, after completing the cycle at "Station 2".

Figure 8 Position of the material group [7]

4. CONCLUSION

The model system "Mining Operation" is somewhat more complex, demanding to assemble, more challenging to program, and primarily demonstrates the possibilities of constructing an almost complete logistics system within the "Logistics Innovation Robotics Laboratory" environment. The goal of this model system was to showcase the versatility of using the educational kit WLKATA MIROBOT and highlight the possibilities of collaboration among various elements of the logistics system. This method of assembling an autonomous logistics system forms the basis for subsequently creating a methodology for building an autonomous logistics system.

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