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**PROPOSAL OF AUTOMATED SYSTEM FOR PRESENTATION PURPOSES**

*The main goal of the article is to design a model of an automated system, which will be used for presentation purposes at the Department of Automation and Human Machine Interactions at the Technical university of Košice. In terms of adequate focus of the presentation, the equipment used in industrial practice was used for designed model. The theoretical part contains an overview of the technologies used for the design of equipment, selection of components and their use in design. The next part contains an explanation of the software part of the work and the electrical interconnection of the equipment used. The last part is devoted to the design of a model of an automated device in a CAD system.*

*The article presents the results of scientific-methodological research.*

**Keywords:** automated model; proposal; presentation; PLC.

*Fig.: 10. Table: 1. References: 10.*

**Urgency of the research.** Automation is a multidisciplinary field that requires specialized study. The Department of Automation and Human Machine Interactions of the Faculty of Mechanical Engineering of the Technical University in Košice provides such education in its study program called Industrial Automation. For the purpose of a better idea of the study program to the public, it is appropriate to create an exhibit that would present the practical content of the study in an engaging way. During the study, students of the Department of Industrial Automation will gain deeper knowledge in such areas as the means of automatic control or operation of automated equipment, their methods of design and implementation. This field of study also offers knowledge of PLC, HMI and industrial communication programming, basics of Python programming, the ability to apply artificial intelligence for control, gaining skills in the implementation of mechanical, pneumatic or other automated systems or practical use of automation solutions in practice using modern technologies.

**Target setting.** The main goal of this work is to design a comprehensive model that will serve for an adequate presentation of the Department of Automation and Human machine interactions for various presentation purposes such as Open day, etc.

The proposed system should document the orientation and content of vocational education at this department. The department is a specialized workplace of the Faculty of Mechanical Engineering of the Technical University in Košice with a focus on industrial automation and communication. The department deals with the teaching of subjects that focus on technical cybernetics, automation, and control, means of automatic control, industrial communication and the use of artificial intelligence.

**Actual scientific research and issues analysis.** An important aspect of teaching in the field of industrial automation at the Department of Automation and Human machine interactions lies in the contribution of new knowledge to students, not only on a theoretical basis, but mostly on a practical basis. Students have the opportunity to try the acquired theoretical knowledge in practice using many available modern technologies [1-3].

Industrial automation is visible in almost every production process, and it is difficult to find a production line in industry that is not at least partially automated. It is used in almost every production plant. Various robots and software are used to replace human labor [8-10]. Technical progress in this area brings constant innovations. The dominant feature today is the extensive digitization of production and the use of industrial communications [3-6]. The subject of industrial automation is the application of automatic control means that contribute to the development of technology. Control and computer technology, regulating elements, pneumatic and hydraulic action variables or various sensors are used. The control of industrial equipment is most often provided by an industrial computer PLC (Programmable Logic Controller) [10].

**Uninvestigated parts of general matters defining.** Automation is a very wide field of study. It includes various specializations and orientation such as electrotechnical knowledge, different programming languages to networking skills etc. The following study may focus on multiple networked devices and other control programs.

**The research objective.** The objective of the article is to propose a model of an automated system that consists of devices that are currently used in the field of industrial automation. Since students of Industrial automation field know the means of automatic control and based on the acquired knowledge, among other things, can program automatic control in a software environment (TIA Portal) using PLC, logically offered the opportunity to demonstrate this knowledge on a suitable exhibit. From the point of view of the technical solution, a suitable size for transport, clear arrangement and safe operation is required. An equally important factor is the requirement to design such a device that will attract and inspire the audience for further study during the presentation.

To achieve this goal it is necessary:

- Use knowledge from selected areas that this department deals with.
- Interpret this knowledge in the design of the model.
- By combining this knowledge and interpreting it into a given model, to capture the main idea, which is to bring the content of the study and the possibilities of application in practice as close as possible to the visitors.

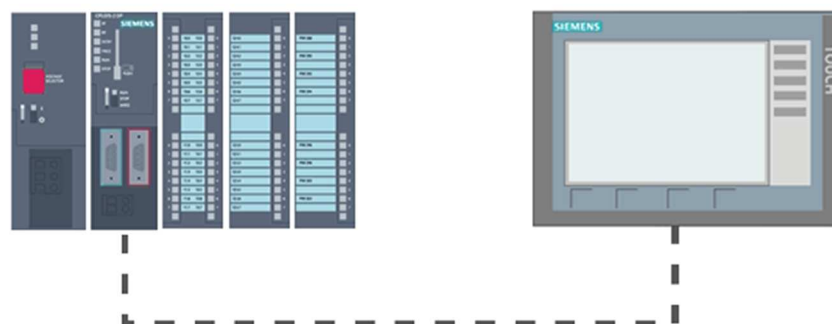
**The statement of basic materials.** The system that is modelled is controlled by and industrial controller, a PLC. A PLC is a robust industrial computer that does not have a keyboard or mouse like a regular desktop PC. It is designed for industrial applications. The control program is prepared in the programming environment using a PC [3; 6].

In addition to control, the PLC can also record or monitor data. An example is monitoring the operating temperature or generating alarms for possible machine faults. Thanks to these features, the PLC is a very flexible device. Its robust construction ensures operability in various working conditions such as excessive noise, temperature or a change in mains voltage [7].

The PLC receives information via input devices and sensors that are connected to the device inputs. Then this information is stored in this device as bits. The information taken from the PLC device is processed on the basis of a pre-prepared control program and triggers the required output of the device [7; 9].

HMI panels are used for monitoring and control of processes in industrial automation. It is an interface between man and machine. Process representation is provided by a graphical touch screen and function keys. These screens can be used for all compact machines and plants that are monitored and controlled locally. The use of these panels in almost every operation that requires it allows for 32 configuration languages and five online languages. Sets of Asian and Cyrillic characters are also included.

The PLC and the HMI must be able to communicate with each other, ie they must be compatible. They can communicate via industrial networks. We can imagine them as a home network with multiple computers or other devices. Common protocols for communication between PLC and HMI are Profibus, Modbus and Ethernet / IP [7; 8].

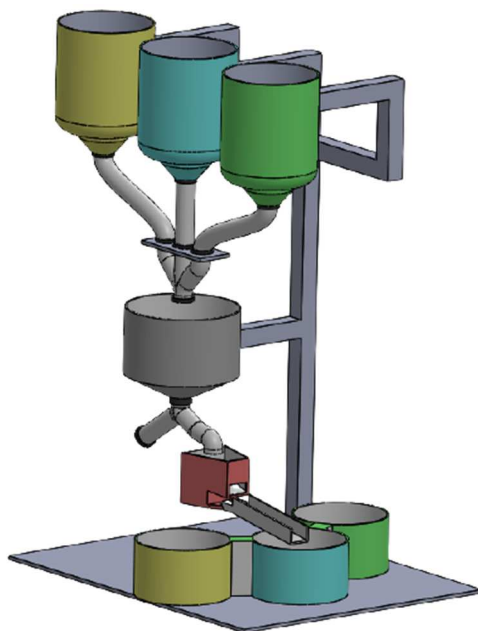


*Fig. 1. PLC and HMI panel*

### Selection of solution variant.

Based on the variant approach, several principal variants of the solution were proposed, which would meet the specified requirements. All the proposals had to meet perhaps the most important idea of this task, which is to use automation, its means and knowledge gained from the study to design a device that will interest all participants in the presentation. In SOLIDWORKS, using industrial components, three basic models of automated equipment have been designed. These proposals, which are the basic principle, are described in more detail below.

1. The first variant of automated equipment - equipment for mixing and sorting components by color



*Fig. 2. First variant- color sorting machine*

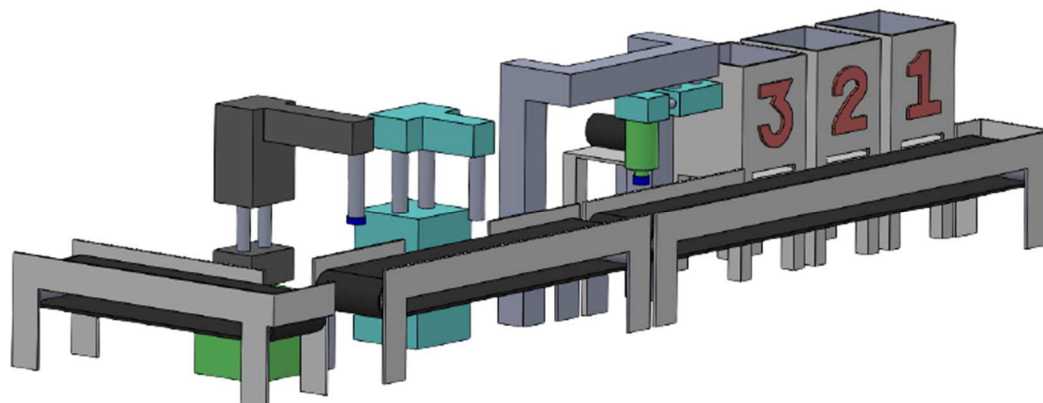
This automated device design is designed to mix and sort components by color. The task of this device is to mix three different colored components in the required ratio into a container (gray). Subsequently, the mixture of components can be poured into any container or into a sorting mechanism by means of a guide pipe, where the mixture of components is sorted according to color. The device would be controlled by a PLC.

Equipment elements:

- containers (yellow, blue and green) - serve as containers for components,
- container (gray) - used to capture the mixture,
- hopper (red) - hopper of the sorting mechanism of the mixture of components,
- containers (yellow, blue and green) - containers for capturing sorted components,
- guide pipes for components,
- capacitive sensors for tanks - detecting the number of components in tanks,
- PLC - industrial computer for device control.

2. The second variant of automated equipment - a line for the production of keychains

This automated device design is designed for the production of keychains. The device is designed for the production of a given component from three parts. Pneumatic elements could provide movement of the individual functional parts, by means of which the individual parts of the product would be lifted and carried. The movement of the individual components of the product from point A to point B on the conveyor belt could be ensured by electric motors.



*Fig. 3. Second variant - keychains production line*

Equipment elements:

- containers for individual parts of the product,
- pneumatic elements,
- conveyor belts.

The control of the whole device would be provided by an industrial computer. The movement of the individual functional parts would be largely ensured by pneumatic elements. Therefore, a compressor to generate compressed air is required for the operation of the device.

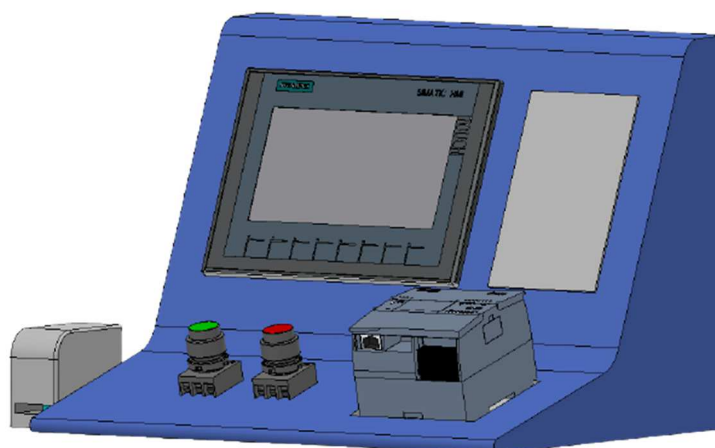
3. The third variant of the automated device - an interactive automaton

The third design of the automated device is designed and intended for entertainment purposes. The device would use industrial components for control. The controller may include an entertainment game program that will be controlled and displayed by the HMI panel.

Equipment elements:

- PLC - industrial computer,
- HMI screen,
- Rewards bin
- Buttons to turn the device off and on.

The device design consists of an HMI panel located in the upper left part of the device and a PLC control element located in the lower right part of the device. The game would be displayed and controlled on HMI panels. The buttons (green and red) are designed to turn the whole machine on and off. Next to the device there is a magazine (white), in which there would be a kind of reward for a great result in the game. There is a device information table on the device in the upper right corner.



*Fig. 4. Third variant- Interactive automatic system*

After considering all aspects of the task and all the proposed solutions, we decided that the design of the third variant (interactive automaton) will be the most appropriate choice for the task, for the following reasons:

- Although all design variants are based on industrial components, the third proposal differs from the previous two in their use. It is this difference that we would like to attract viewers. At various presentation events focused on this area, we often come across facilities that are very similar. In most cases, spectators will encounter various manipulators or other industrial equipment to present this area. Since mostly young people come to the Open Day and our goal is to attract them, that is why we have chosen the third variant of the proposal as a solution. This device will not only entertain viewers, but will also introduce them to the world of automation from a different perspective.

- This device ensures direct contact of the spectator with the device, where after playing an entertaining game on this device, the spectator receives a material reward after reaching the set goal. In particular, the possibility for the viewer to have direct contact with the equipment and the possibility of obtaining a material reward should contribute to the viewers' interest in the equipment. The presentation would thus have a more entertaining and personal character than classic presentations.

- Other aspects that were taken into account when selecting the equipment were the size of the equipment, the need for additional equipment (compressor, etc.) and the need for a source of input energy for the equipment. The size of this device is suitable for easy carrying and for its functionality it is necessary to have only access to a source of electricity.

Comparison of specifics and needs of design variants of automated equipment:

- electricity demand: For all designs, the equipment needs to be connected to the mains for operation.

- need for compressed air: Only in the second variant of the design of an automated device is compressed air required for its operation. This implies the need for a source of compressed air - a compressor.

- contact of spectators with the device: The first and second variants of the design are intended exclusively for presentation. This means that only an authorized person can operate and control the device. In the third design, the device is controlled by the viewer, and so he himself comes into not only optical, but also direct contact with the device.

- Size is an important aspect in terms of carrying the device. The advantage of the third variant is its compactness and small dimensions. Compared to this device, the device of the first variant is too high and the device of the second variant is too wide.

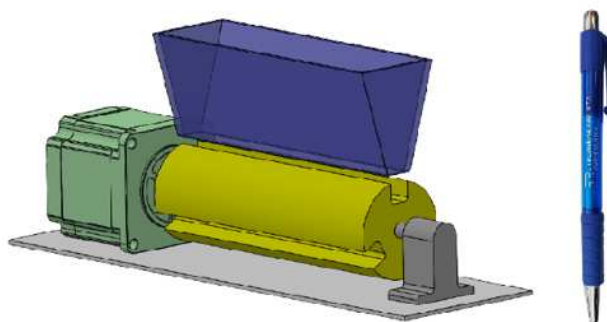
*Table 1 – Comparison and evaluation of proposed variants*

Criteria	Variants of automatic device		
	Variant no.1	Variant no.2	Variant no.3
<b>The need for electrical connections</b>	yes	yes	yes
<b>The need for compressed air</b>	no	yes	no
<b>The need for additional equipment</b>	no	yes	no
<b>Contact of spectators with the device</b>	no	no	yes
<b>Device size</b>	High	Wide	Optimal
<b>Overall rating</b>	2.	3.	1.

In total the third variant provide the most suitable basis as solution, but it has to be added that an additional device is proposed. This part will release a reward for the user.

In the following section variations for release device are discussed.

1. Mechanism for pens

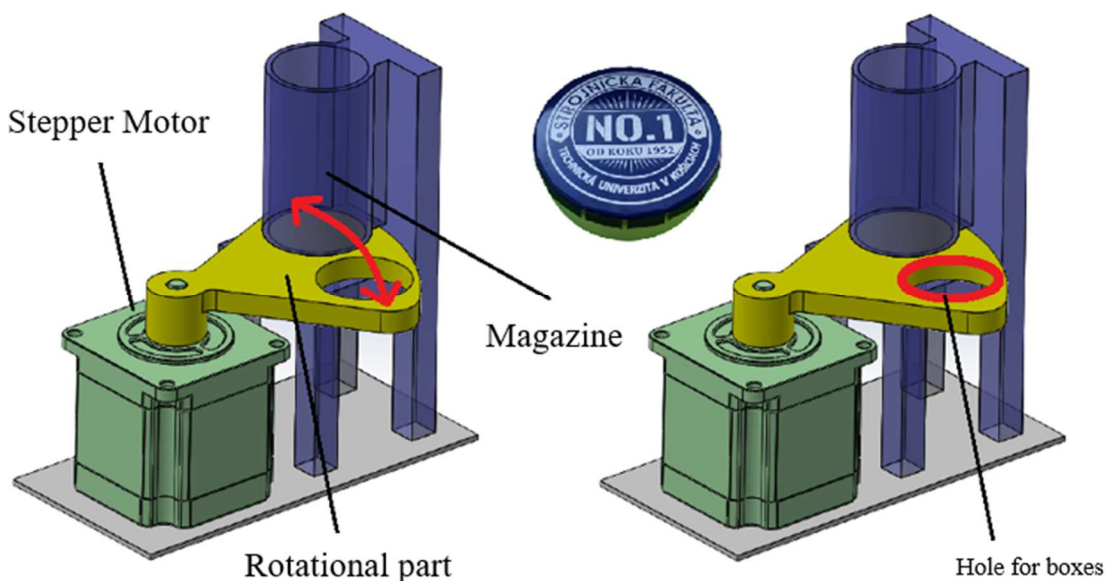


*Fig. 5. Automatic pen magazine*

Equipment elements: stepper motor, jig, tank, inductive sensors.

The stepper motor ensures the rotary movement of the jig. It contains grooves into which the pens from the magazine fall. The electric motor always rotates the jig to a position so that the tongue groove on the jig is in the correct position under the magazine. The tongues fall out of the groove by gravity after rotation. Inductive sensors are built into the walls of the tank. They are located in three different height positions, in the highest part of the container, in its center and the lowest part. They will scan the current status of whether the tray is full, half empty or empty.

2. Container mechanism for dispensing boxes of candies



*Fig. 6. Automatic magazine for boxes*

Equipment elements: stepper motor, jig, tank, inductive sensors.

By means of a stepping motor, the movement of the preparation is ensured, in which there is an opening for a box with candies. The box falls into the hole of the preparation and after it is turned to the next position, the box falls out of the opening of the preparation by gravity. Inductive sensors are built into the walls of the tank in three different height positions, namely in the highest, middle and lowest part of the tank. They will scan the current status of whether the tray is full, half empty or empty.

3. Container mechanism for shirts



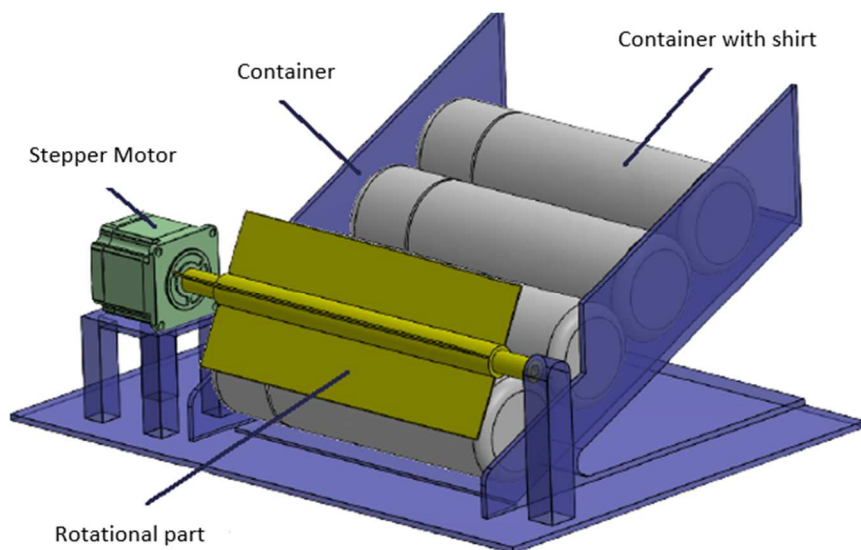


Fig. 7. Automatic magazine for shirt release

Equipment elements: stepper motor, jig, tank, inductive sensors.

After considering all aspects as size, weight, complexity and price of the three proposed variants of the interactive device for the interactive vending machine, the second design of the device was chosen (automated container for dispensing boxes of candies) as the most suitable solution for presentational purposes.

The final solution is represented on the following scheme, with the main parts.

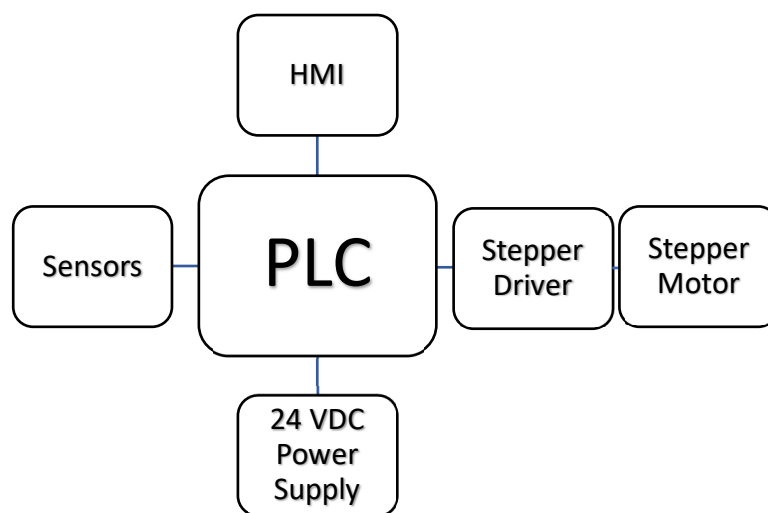


Fig. 1. System scheme

The control program was created in the TIA Portal programming environment. The main parts of the control program include memory variables to save temporary values and to control the ongoing „game“, timer to define the time limit of the game and program parts for the stepper motor.

The visualization of the interactive game was created also in the TIA Portal. The game window includes a time bar, the actual question, question number, buttons to select an answer. Also, a starting and result window are created. The following figures show a window with the ongoing game on the HMI panel.

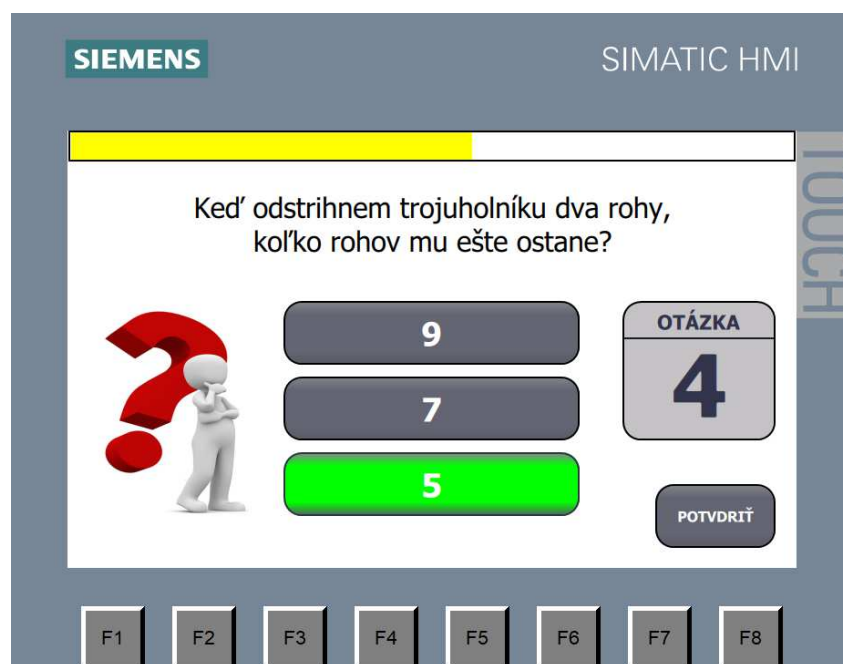


Fig. 9. HMI panel with ongoing game

The final design of the proposed system is shown on the following figure where the control parts are included in the main device and the automated magazine is also showed as the addition to it. As an addition to the proposed system a signaling industrial beacon is added to indicate the actual status of magazine.

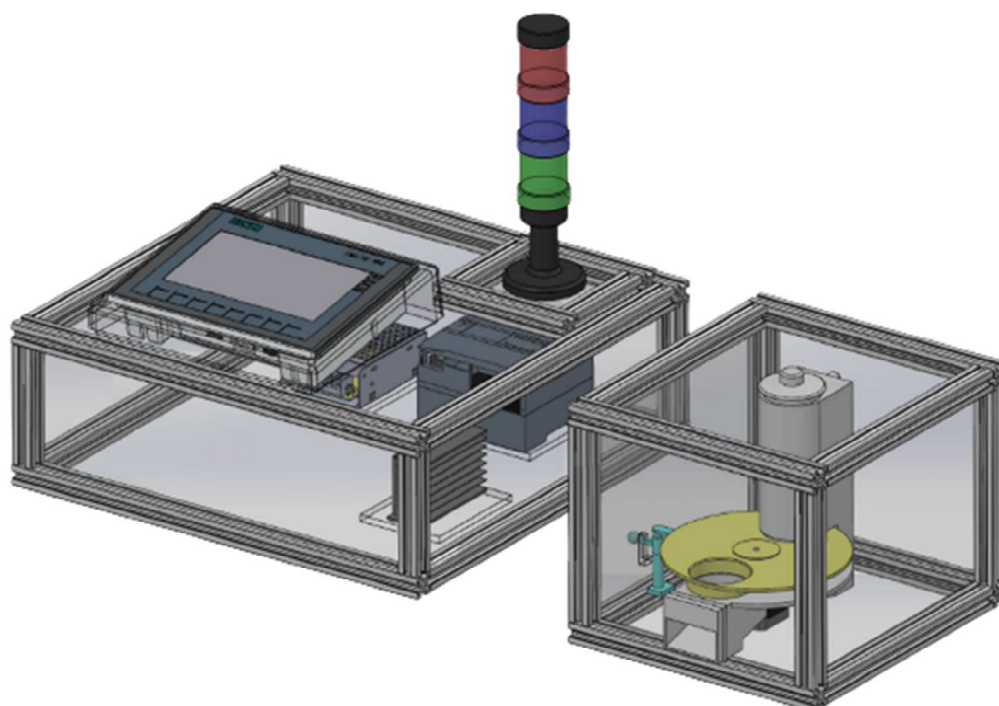


Fig. 10. Interactive automatic device for presentation purposes

**Conclusions.** The article described a proposal of automated device for presentation purpose for the Department of Automation a Human Machine Interactions. The proposal is based on the curriculum of the study program. The goal was to create such a system that can be transported to various location while allows to introduce the content of the field of automation in an



interactive way. During proposal 3 variants were created and evaluated, which, with their functionality, would adequately present the content of the department's education. The chosen variant works as a interactive quiz system, which rewards the user if a sufficient number of questions are answered correctly. The interactive machine also offers the possibility of expanding it with other functionalities. The device can be supplemented with a program of a new game or another magazine, which would be used to issue another prize in kind when winning. The interactive automat also offers the possibility of expanding the signaling of current device states.

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*Роберт Ракай*

## ПРОПОЗИЦІЯ АВТОМАТИЗОВАНОЇ СИСТЕМИ ДЛЯ ПРЕЗЕНТАЦІЙНИХ ЦІЛЕЙ

*Автоматизація - це багатопрофільна галузь, яка вимагає спеціалізованого вивчення. Кафедра автоматизації та взаємодії машин і машин факультету машинобудування Технічного університету Кошице забезпечує таку освіту. З метою кращого уявлення про навчальну програму для громадськості доцільно створити презентацію, яка б цікаво представляла практичний зміст навчання.*

*Важливим аспектом викладання в галузі промислової автоматизації є додавання нових знань студентам на практичній основі. Домінуючою рисою сьогодні є оцифровка та використання промислових комунікацій. Використовуються контрольно-обчислювальні технології, регулюючі елементи, пневматичні та гідравлічні рушії або різні датчики. Управління промисловим обладнанням найчастіше забезпечує промисловий комп'ютер.*

*Головною метою цієї роботи є розробка моделі, яка буде слугувати цілями презентації, такими як День відкритих дверей тощо. Запропонована система повинна документувати спрямованість та зміст професійно-технічної освіти.*

Запропоновано модель автоматизованої системи, що складається з пристроїв, які в даний час використовуються в галузі промислової автоматизації людино-машиинних взаємодій. Метою було створити систему, яку можна транспортувати в різні місця і одночасно здійснювати інтерактивну презентацію змісту навчання в галузі автоматизації. З точки зору технічного рішення, система має необхідні габаритні розміри для транспортування, оптимального розташування та безпечної експлуатації. Не менш важливим фактором є врахування вимоги спроектувати такий пристрій, який під час презентації залучить і надихне аудиторію на подальше вивчення. Були створені 3 варіанти системи, які за своєю функціональністю адекватно відображають зміст освіти кафедри. Вибраний з трьох варіантів працює як інтерактивна система оцінювання, яка заохочує користувача, якщо він правильно відповів на достатню кількість питань. Існує можливість розширення сигналізації про поточні стани автоматизованої системи.

У статті представлено результати науково-методичного дослідження.

**Ключові слова:** автоматизована модель; пропозиція; представлення; plc; огляд.

Рис.: 10. Табл.: 1. Бібл.: 10.

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