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Factory I/O As Simulation Software For Teaching The Subject Of Programmable Logic Controllers At UFPSO

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Abstract:

One of the learning strategies is active learning that requires students to be able to learn independently. For this to be realized, learning must be integrated with simulation software to enrich the teaching and learning processes.

This influence is very important especially in the fields of Industrial process control and this is where the concept of Industry 4.0 appears. Consequently, the term Industry 4.0 implies changes in all areas of society. Education is an area affected in two ways, in terms of the need to update the educational curriculum to meet the demands of students, the market and society and, like any other area, to adapt the workforce and infrastructures to the new challenges.

In this sense, this article presents the incorporation of Factory I/O software, Tia portal software and Plc SIM software, to develop a problem given in the subject of Programmable Logic Controllers at UFPSO. With the active learning strategy based on problem solving supported by simulation software.

Keywords: Factory I/O software; Tia Portal; active learning; simulation software.

1. Introduction

Technological progress and its rapid evolution have had a positive impact on the industrial sector and on the different productive/service sectors. One of the service sectors that has benefited the most has been the Education sector. In this sector, the implementation of current and emerging technologies

combined with innovative pedagogical procedures and best practices is known as Education 4.0 (Miranda et al. 2021).

Education 4.0 tends to combine information available in the real and virtual world(Mourtzis et al. 2019). And it is the integration of sophisticated technologies into traditional learning to promote intelligent thinking in the classroom (Samiha et al. 2021).

The term Education 4.0, as defined by the World Economic Forum (WEF), refers to the need to increase the skills and knowledge of the new generations working in the Industry 4.0 era. Undoubtedly, since 2020, defining this concept clearly and supporting specific actions to address global social problems in countries and meet the United Nations agenda for the 17 Sustainable Development Goals (SDGs) for 2030 has been urgent . figure 1 shows Impact of research in education 4.0. Based on the Sustainable Development Goals (Garay-Rondero et al. 2021).

Figure 1. Research impact on education 4.0. Based on the sustainable development goals.

Fuente: (Garay-Rondero et al. 2021)

We are in the digital age, where globalization and the rapid evolution of technologies such as ICT, IoT, AI and robotics are bringing significant changes to society and industry. The rapid evolution of is bringing dramatic changes to society. There is an urgent need to establish a balance between information and ICT development and pedagogical skills (Tavares and Azevedo 2021).

As an important characteristic for universities that train engineers and specialists, it is essential that they have the ability to solve real problems, as indicated in the criteria of the Accreditation Board for Engineering and Technology (ABET).(A. Osman, A. A. Yahya 2018).

The new generation of engineers and specialists must be prepared with automation skills. They must be able to create and control the "smart factory" of the future. The virtual learning environment is one

of the best options for providing experiments to students without the risk of injury or damage to equipment. This approach is widely applied in higher education to deliver interactive instruction (Elbestawi et al. 2018).

In engineering education, simulation programs have been increasingly adopted to provide effective teaching methods. Several projects have been carried out to apply computer simulation in teaching, such as Factory I/O,(Chen et al. 2017)

This research proposes the use of educational software for training in PLC Tia Portal, Plc sim, for the development of the Industrial problem, then Factory software is used to perform the simulation.

Factory IO works the basic concepts and tools to be used in different contexts, in our case it will be applied in the subject of programmable logic controllers of the specialization program in Industrial Automation at the Universidad Francisco de Paula Santander Ocaña to contribute to the development of experimental skills in students enrolled in the course.

2. Materials and Methods

2.1 Factory I/O

This software allows you to create and simulate 3D models of factories, processes, conveyor belts and tank control, among others. It is an interactive program, which allows to design plants with a high visual quality with a high degree of realism. In addition, it allows the connection with external equipment such as PLC's, microcontrollers, FPGA, as well as the connection with TIA Portal. The user can realize his KOP code for the simulated plant and subsequently check its operation. Figure 2 shows a simulation scenario.

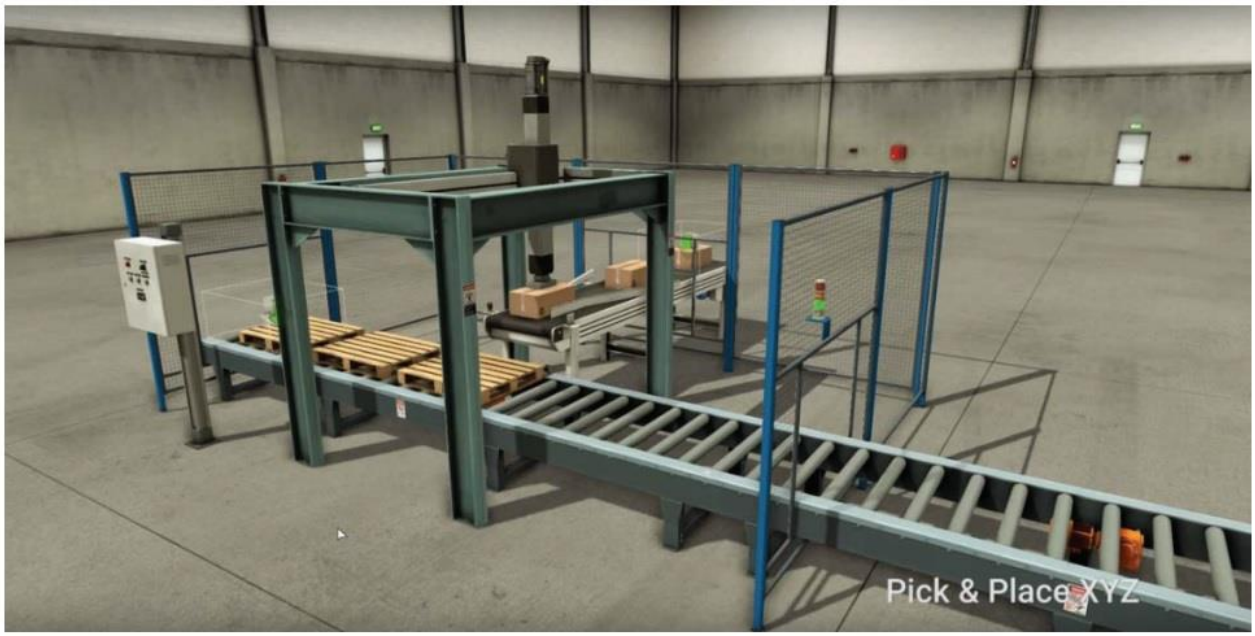

Figure 2. Factory I/O simulation system

Fuente:(Philippot et al. 2017)

2.2 TIA portal y PLCSim

The TIA Portal is the current SIEMENS software that integrates all the programming and simulation programs for SIEMENS PLCs. It has three types of programming language:

- KOP: Contact language, it is a graphical language and probably the most widespread.
- FUB: It is a graphical language that uses Boolean algebra tables to represent logic.
- SCL: A text-based control language, this is the most complex programming language and most similar to computer programming (Htet Htet Aung | Thu Zar Thein 2019).

Simatic PLCSIM is a computer software that generates virtual controllers to simulate S7- 1200 and 1500 PLCs. With this software a virtual controller can be created, and thus a large number of simulation functions can be used. In addition, virtual controllers can also be tested and validated in the context of a plant/machine. Figure 3 shows the PLCSIM application that allows us to simulate the operation of a physical PLC, just by starting the runtime, we can check the operation of any automation system in order to verify the real operation of the installation and avoid many programming errors that commonly occur.

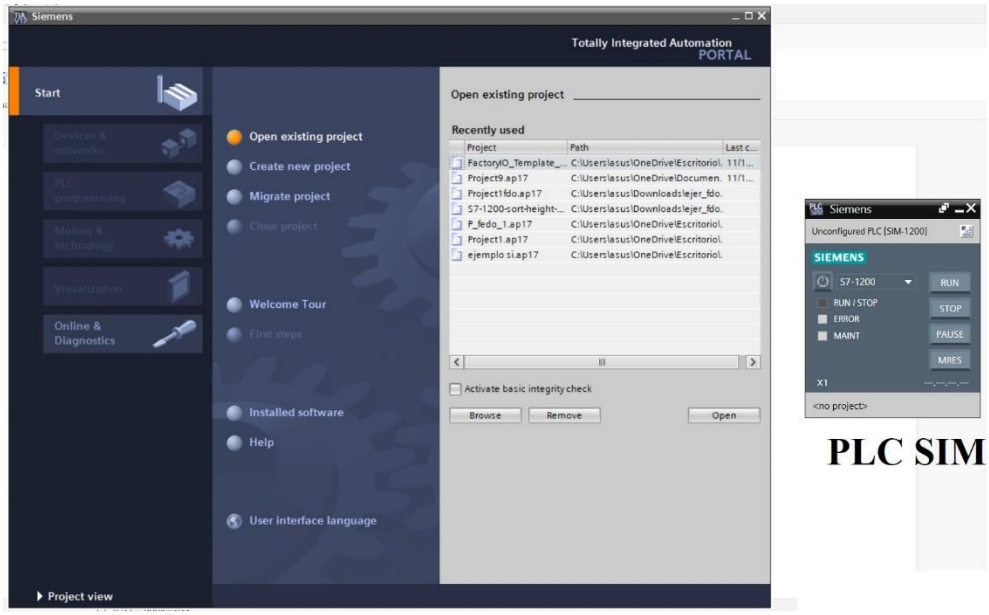

Figure 3. Tia Portal y PLCSim

2.3. Problem-based methodology

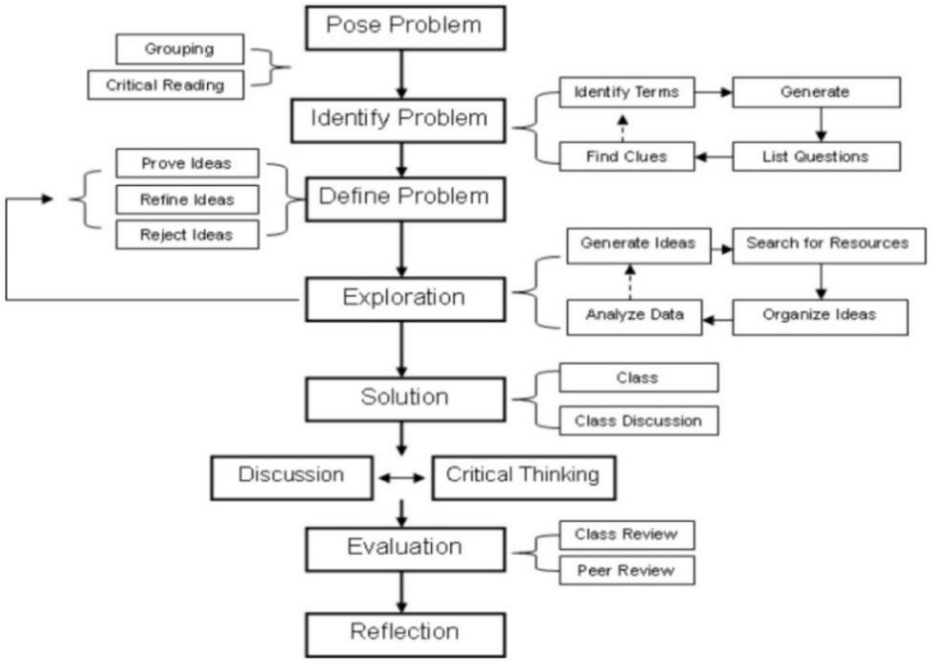

Figure 4. PBL procedure

Fuente: (Shih 2008)

Problem-based learning (PBL) is a learning model based on a constructivist framework and emphasizes situated learning practice and collaborative learning (Arango et al. 2020).

Unlike traditional education, PBL is a student-centered pedagogy where teachers provide only the necessary support. Students are required to create self-directed learning, actively explore rich learning resources, experience real-life problems, and seek solutions through careful research (Gonzalez 2019).

3. Results and discusión

In the case of the subject of programmable logic controllers of the program of specialization in Industrial Automation of the Universidad Francisco de Paula Santander Ocaña, where there are 11 students, with professions of Electronic, mechanical, electromechanical and mechatronic engineers.

The main idea of the course is to familiarize the students of the program with the concepts of automation with a focus on PLC programming and integration with higher level systems. Automation requirements, even at the PLC level, continue to increase in complexity, making it necessary for a thorough knowledge of PLC programming techniques. In addition, industry is seeking to automate production processes not only at the lower level of the automation pyramid, but also at the middle and upper levels, which increasingly requires integration of automation equipment with manufacturing execution systems and even with enterprise resource planning systems.

We divide the training into four sessions (4 hours per session). In the first session, we help the students to get familiar with Tia portal and PLCSim by practicing the ladder language in these two softwares, In the second session the students learn about the sequential workflow approach in PLC programming

and how to use Factory I/O Software to simulate Industrial processes, in the third one an Industrial problem is placed to the student and using the problem based learning methodology described in section 2. 3 the student is asked to solve it using the TIA portal software, PLCSim and Factory I/0 software to perform the simulation, in the fourth section the student delivers the solution of the problem simulated in the software described above and the evaluation of what has been learned is done.

3.1 First sesión

In this first session, we guide the students step by step to build and run a program in TIA Portal using the Ladder language. This system has a conveyor belt to get boxes and on the belt there is a box counting sensor when 5 boxes pass, the conveyor belt must stop, it must have a start button, and an emergency stop. in figure 5 you can see the TIA Portal programming screen. Figure 6 shows the PLCSim in simulation environment to check the operation of the exercise without having a physical PLC connected.

3.2 Second section

In this second session, we guide the students step-by-step to build and run the counting boxes scenario, as shown in Figure 7. At first, we introduce about Factory I/O, and the connection with PLCSim. Next, we teach them how to use these tools. In this session, your goal is to build a simple counting process in Factory I/O and develop a program in TIA Portal to run this process.

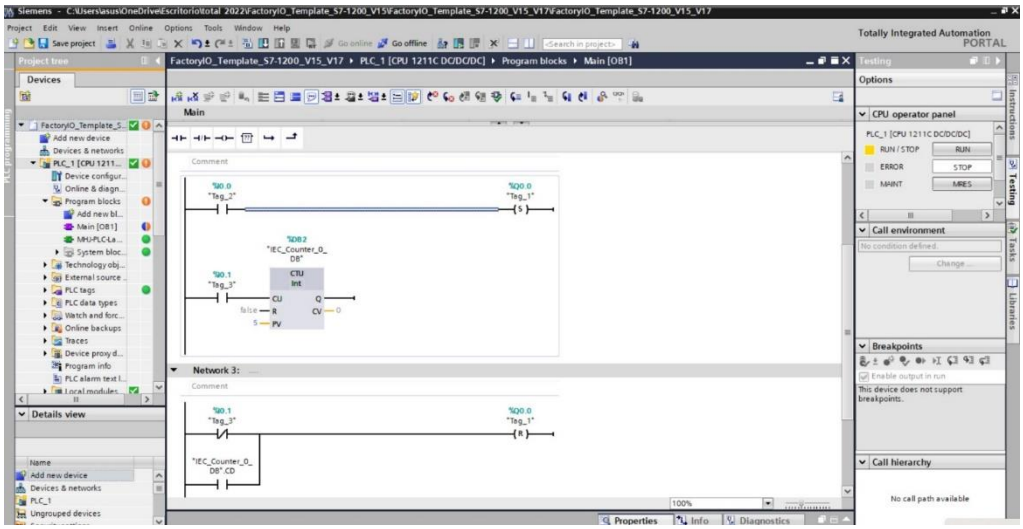

Figure 5. TIA Portal programming screen

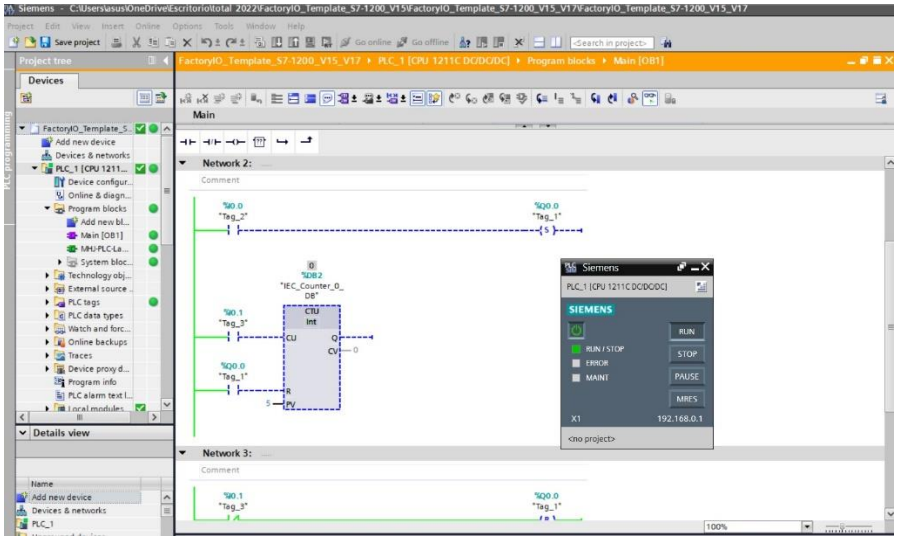

Figure 6. TIA Portal and PLCSim Simulation

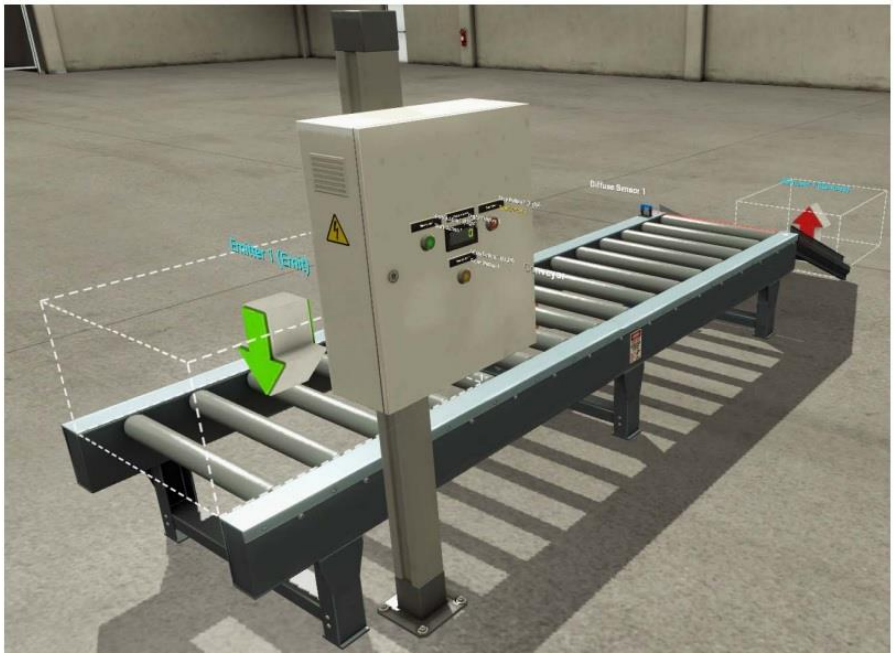

Figure 7. Scenario in Factory I/O

3.3 Section 3 and 4

In section 3 the following problem was posed to the student of the Industrial Automation specialization program:

Analyze a tank with level sensor, water is supplied by a pump, During operation, the pump is directly controlled by the level sensor, when the operation switch is on and the level sensor is off, the pump is on. The operation of the pump motor is subject to the following conditions:

- When the operation switch is on and the level sensor is off for 1 minute the pump motor is turned on.
- When the level sensor is on for 2 minutes, or the operating switch is off, turn off the pump motor.

In this section the student, using the problem-solving methodology, identifies the problem posed, explores and then proposes a solution that is presented and explained in section 4. Figure 8 shows one of the solutions proposed and realized with TIA Portal, PLCSim and Factory I/0 software.

Figure 8. Solution to the Problem

Conclusions

The industrial sector is undergoing a major transformation in the framework of Industry 4.0 due to increased digitization steps to gain operational efficiency and competitiveness in the market. This new professional environment requires greater collaboration between personnel with different fields of expertise. Consequently, this transformation in the industry requires initiatives to respond to the professional demands of higher education universities. In this sense, it is required to promote multidisciplinary knowledge in academic contexts to strengthen the teaching-learning process towards Education 4.0.

In the presented paper, a teaching factory architecture with a strong emphasis on the educational part is proposed. More specifically, the proposed framework aims to become the link between the real-life industrial environment and the classroom through the use of ICT technologies so that students can experience and learn what a working environment is like in reality, with all the deadlines and the pressure of everyday problems.

PLC program validation can be performed by real-time simulation between S7-PLCSim and Factory I/0 based virtual models. The PLC programming device uses the TIA Portal to program the Siemens PLC module. Virtual process models with various types of plant models can be developed based on a visual study to validate PLC programs in real time.

It is concluded that, in order to ensure that the virtual simulation performed by other users will show similar results to those shown, it is necessary to use a results similar to those shown, it is necessary

to use a simulation guide using virtual systems for PLC virtual systems simulation guide for PLC learning is necessary.

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