

Conference Paper

Development of Interactive PLC Learning Media Based on Virtual Learning

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Abstract

This research aims to develop interactive PLC learning media based on virtual learning. The interactive PLC learning media uses a 3D simulator design to simulate the application of PLC in the industry, so it looks like real and makes students more interested in learning PLC. This study uses experimental methods. The 3D simulation software is Factory I/O developed by Real Games. It enables us to build a conveyor virtual plant and to bring it into the classroom. The automatic controller used to control the virtual plant is the PLC Siemens S7-1200 with Tia Portal software. The PLC is connected to the computer server through an ethernet network via TCP/IP protocol. With the rapid development of current internet technology, PLC learning can be done in virtual learning. This PLC learning media can be run remotely through the internet with team viewer program so that PLC learning is not only done on campus but can be done anywhere. From the results of research that has been done, the user can create PLC programs remotely to control conveyor virtual plant on a computer server through an internet network without having to install the program on their computers.

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1. Introduction

The world of education today has shown very rapid progress along with the progress of science and technology. This development requires an effort to prepare students to participate in efforts to develop science and technology for the next generation. The ability to utilize technology in efforts to develop education certainly depends very much on the number and ability of experts in the field of education. Regarding the elements contained in learning to support the learning process, we need a teaching aid or learning media. The learning media has an important role in teaching and learning activities. The learning media can be used to channel messages from the sender to the recipient so it can be stimulated thoughts, feelings, attention, and interest in learning that leads to the learning process. The learning media can make an attractive learning atmosphere

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interesting. In [1], the use of multimedia-based learning media can also be used as innovative teaching and learning strategy in a problem-based learning environment.

Tools or media for independent learning in the era of technological advances are needed in the PLC learning process. This is needed to create a human quality that does not only depend on the verbal transfer of knowledge, whether carried out by schools or colleges or non-formal educational institutions at this time. In [2], PLC learning media by using adobe flash professionals can help improve creative thinking students. Programmable Logic Controller (PLC) is a digital electronic device that uses memory that can be programmed and reprogrammed as internal storage and provides instructions for carrying out specific functions such as logic, sequence, timing, counting, and arithmetic. The PLC is used for automation of industrial process [3]. PLC can control various kinds of automation processes such as automatic sorting conveyor belt [4], pressure control in multi-pump application [5], automation of tank level [6].

PLC courses try to as far as possible relate the subject matter to the actual reality that exists in industrial processes, using various examples of control in industrial process applications. Not all the controls on industrial process applications can be done in PLC laboratories because there are so many types of industrial process applications. All these applications cannot be practiced in PLC laboratories because of the limited availability of laboratory facilities, therefore a media that can provide an overview of the control of industrial process applications even if they are the only simulation. The system simulator can be used for vocational training to practice the programming of PLCs [7]. The development of internet technology is now very possible learning PLC in the laboratory can be done remotely. In [8], the remote laboratories were developed using LabVIEW. In [9], the implementation of a remote laboratory platform for robotics based on PLC is discussed. The remote laboratory enables students to set parameters and operate equipment from remote locations. therefore, this study aims to develop interactive PLC learning media with 3D simulation software based on e-learning or virtual learning.

2. Methods and Equipment

2.1. Methods

This study uses experimental methods, namely designing, making, and testing PLC learning media remotely through the internet network. The design of this interactive PLC learning media can be seen in Figure 1.

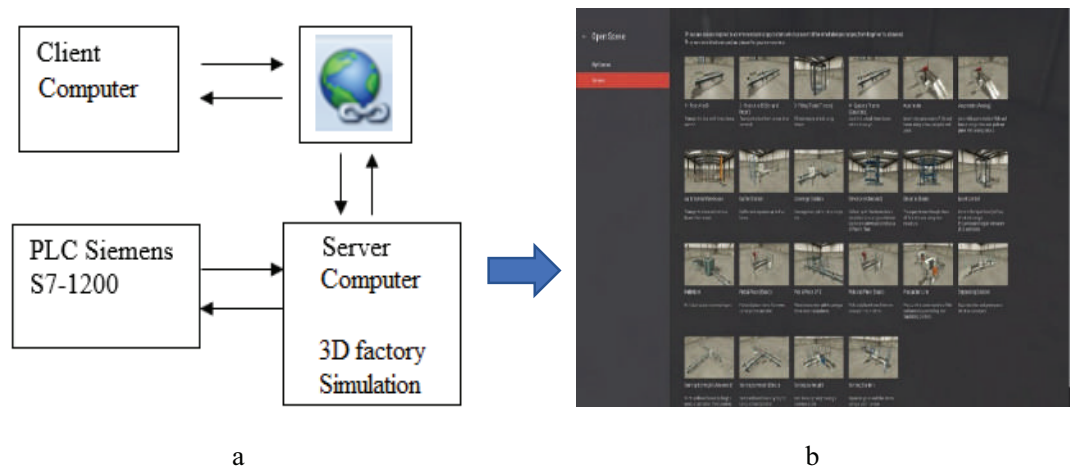


Figure 1: Block Diagram System (a), Scene Virtual Plant in Server Computer (b).

As shown in Figure 1a, the PLC Siemens S7-1200 is used to control the virtual plant on the computer server. The virtual plant uses factory I/O software, where the factory has many scenes inspired by typical industrial applications, ranging from beginner to advanced difficulty levels. Some factory I/O scenes can be seen in Figure 1b. The PLC is connected to the computer server through an ethernet network via TCP/IP protocol. The input and output devices that are present in each of these system simulations are connected to the PLC Siemens S7-1200 that has a specified address. By using a remote desktop system, users can access server computers remotely through the Internet network. The software used for remote desktop is a team viewer. If the user has successfully connected to the server computer, the user can create a PLC program to control the simulation of the selected system. Then the user can send the program to the PLC, try the system using a virtual button, and see the results through a simulation display.

2.2. Equipment

2.2.1. PLC

PLC (Programmable Logic Controller) is a controller that can be programmed and works digitally based on logic operation according to an algorithm programmed on it so it can control a process. For the PLC Siemens S7-1200 to communicate with the virtual plant contained in the factory I/O software, the PLC configuration must be full access and permit access on the connection mechanism must be a checklist. After that, download the hardware configuration to the PLC. The setting of the PLC configuration is shown in Figure 2.

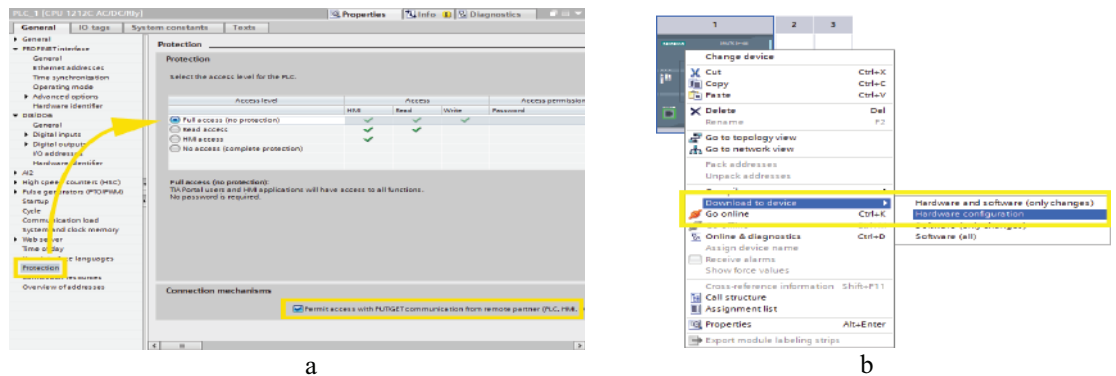


Figure 2: PLC, setting configuration protection (a), download hardware configuration (b)

2.2.2. Factory I/O

Factory I/O is a 3D factory simulation for learning automation technologies. Factory I/O developed by Real Games. Designed to be easy to use, it allows us to quickly build a virtual factory using a selection of common industrial parts. Factory I/O can be used as a platform for PLC training, but it can also be used with different types of controllers including Soft PC, microcontrollers, TCP/IP, and other technologies [10]. For the virtual plant in the factory I/O to communicate with the PLC Siemens S7-1200, it is necessary to set the IO driver and I/O configuration as shown in Figure 3. The PLC and the computer on which the factory I/O is having to be on the same network.

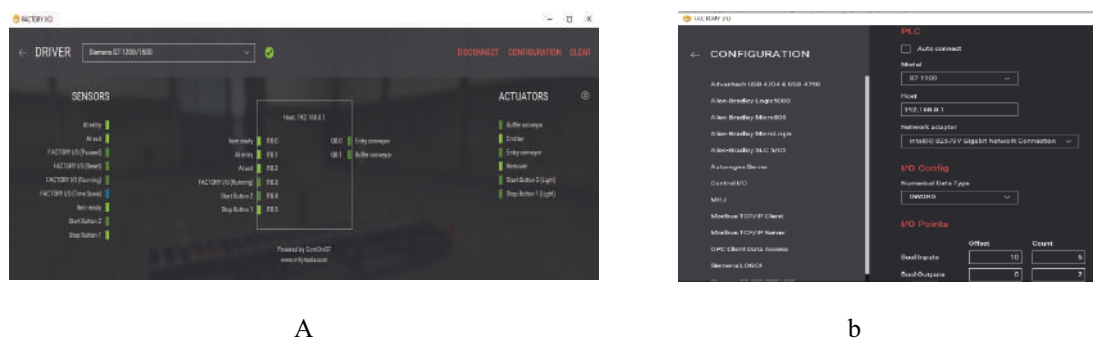


Figure 3: Factory I/O, setting IO Driver (a), configuration IO Driver (b).

One of the virtual plant scenes that PLC can control is the conveyor system as shown in Figure 4. This plant functions to carry objects using 2 pieces of the conveyor. The system work description is as follows: when the start button is pressed and there is an object, the output on the entry conveyor works so that the object will run above the entry conveyor. When the object is at the end of the entry conveyor, the buffer conveyor output works. When the object runs to the end of the buffer conveyor, the buffer conveyor will be OFF, and the entry conveyor will be OFF. If the stop button is

pressed, the system will be OFF. Addressing input and output PLC can be seen in Table 1.

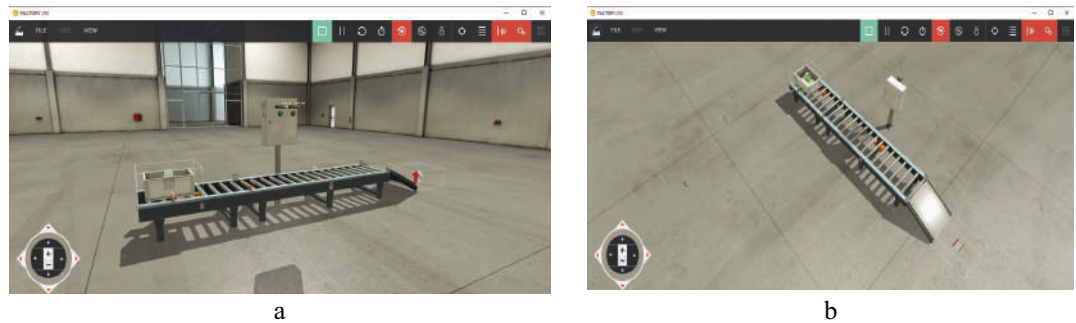


Figure 4: Conveyor Virtual Plant, side view (a), top view (b).

TABLE 1: Addressing Input-Output PLC for conveyor plant

No.	Name	Input Address	Information
1.	Sensor Item ready	%I 10.0	Serves to detect the incoming object
2.	Sensor At entry	%I 10.1	Serves to detect objects at the end of the conveyor entry
3.	Sensor At exit	%I 10.2	Serves to detect objects at the end of the buffer conveyor
4.	Start Button	%I 10.4	Serves to turn on the system
5.	Stop Button	%I 10.5	Serves to turn off the system
No.	Name	Output Address	Information
1.	Entry Conveyor	%Q 0.0	Serves to carry objects that enter the end of the entry conveyor
2.	Buffer Conveyor	%Q 0.1	Serves to carry objects from the end of the entry conveyor to the end of the buffer conveyor

2.2.3. Team Viewer

The Team Viewer is a type of software that allows users to share their desktops screen. It also allows the user for file transfer and distance presentation purposes but only between connected PC's via the internet. The client/student who wishes to use remote desktop need not have PLC software and factory I/O software installed in their PC as users can use the software installed in server PC. But they are supposed to have the membership in team viewer. The students, who need to connect, should know the login-ID and password of the server PC as shown in Figure 5. Then they can access server PC files, software, and program the PLC of the system.

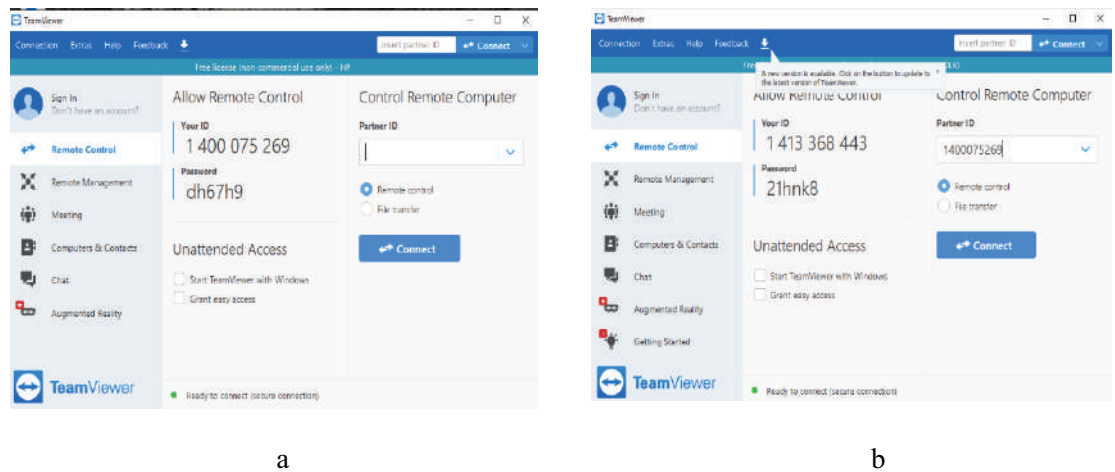


Figure 5: Team Viewer, the server computer (a), the client computer (b).

3. Results

Testing of interactive PLC learning media based on virtual learning can be done when the server computer and client computer are connected to the internet, the remote desktop programs that use the team viewer software on the server computer and client computer have been run, the condition of the server computer has been connected to the PLC Siemens S7-1200 through the ethernet network. In the client computer, the user must open the factory IO program and select a conveyor virtual plant. Then the user opens the Tia Portal program and makes a PLC Siemens program to control the virtual plant. After that the user transfer program to the PLC device. Next, the user runs a conveyor virtual plant in the factory IO program. When the PLC program is correct, the conveyor will work to bring the object. The results of these tests can be seen in Figure 6.

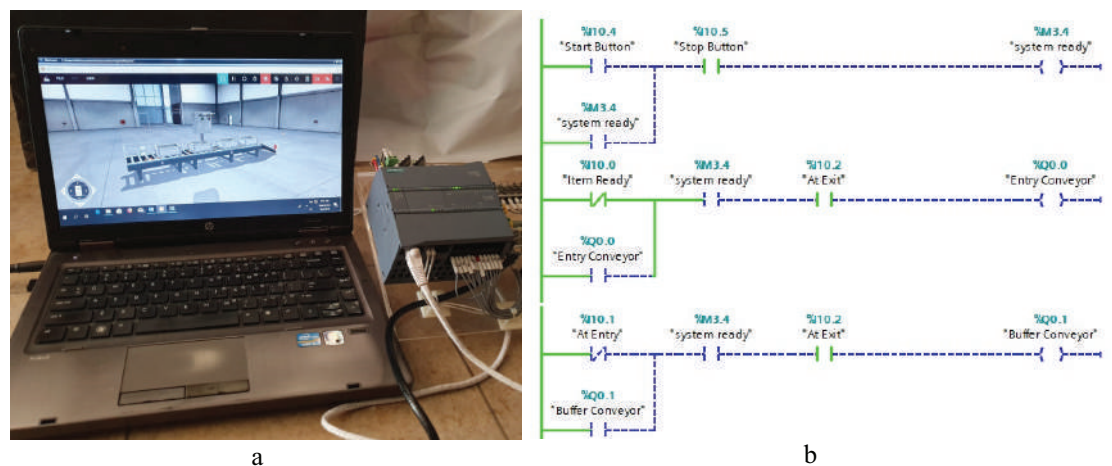


Figure 6: PLC and computer server (a), Program of PLC Siemens S7-1200 (b).

Subsequent tests were carried out to see the response time delay from the simulation results on client computers with the speed of the existing internet network. The results of internet network speed can be seen in Figure 7. While the results of delay display on client computers based on internet network conditions can be seen in Table 2.

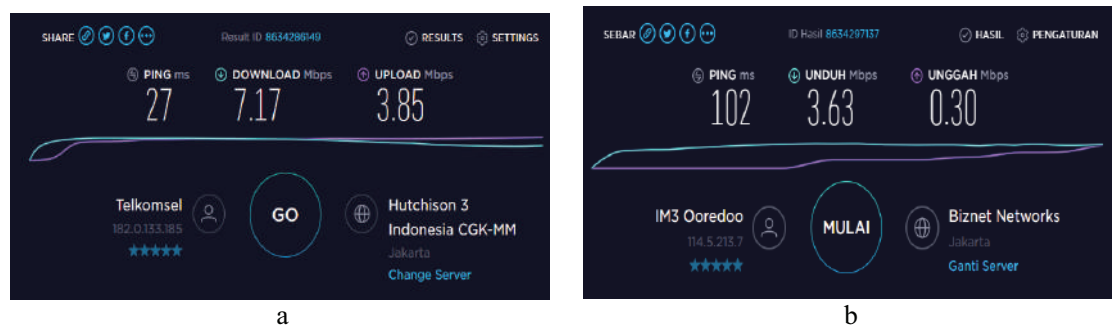


Figure 7: Internet Network Speed, the server computer (a), the client computer (b).

TABLE 2: Results of delay display on client computers based on the internet network

Virtual Plant	Server Computer		Client Computer		
	Download speed (Mbps)	upload speed (Mbps)	download speed (Mbps)	Upload speed (Mbps)	Time of delay (second)
Conveyor	7.17	3.85	3.63	0.30	0.15

4. Conclusion

The interactive learning media with factory I/O software can be used to simulate the use of PLC in the industry. With 3D graphics simulation contained in the factory I/O can make students more interested in learning PLC because the virtual plant looks real. The level of difficulty in PLC programming can also be selected from several scenes in the factory I/O software. The PLC learning media can be done with a remote desktop system through a team viewer software that is connected to the internet network.

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Conflict of Interest

The authors have no conflict of interest to declare.

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