Interactive Learning Facility for PLCs, and Simulations Using Factory IO

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I. Introduction

To improve efficiency, productivity, and worker safety, industries are implementing automation facilities into their processes to take advantage of the rapid development of technologies [1]. Programmable Logic Controllers (PLCs) are one of the major parts of automatic systems in the industry [2]. Learning PLCs and their functions is one major component in learning industrial automation, and hence laboratories pay much attention to instruct students about PLCs and their functions.

On the other hand, there is much research being done on intelligent learning platforms such as ALESK, and BYJU's learning, where they implement student knowledge assessment methods and adaptive teaching methods [3].

This is one part of an ongoing project working on developing an intelligent learning platform for students to learn PLCs, its decentralized connections and simulations using factory IO. With an attempt to identify the hardware components needed to build a 'Palletizer', this work tries,

- to develop a simulation in Factory IO for students to learn about PLCs, ladder programming and input/output devices,
- to develop a web platform for students to refer to lab materials, data sheets and tutorials.

As outcomes of this work, a simulation and the ladder logic program of a palletizer was built, and the components needed to build a physical palletizer and their specifications were identified. Moreover, a web interface was designed for students to learn about the lab practical.

II. Literature Review

Using different methods to teach PLCs and Industrial Automation to students is a widely researched topic. Authors of [4] have developed a learning media for programmable Logic Controllers for a sorting machine application and have done a feasibility study to conclude that their PLC learning media is suitable to be used in PLC practicum course. Authors of [5] discuss the advantages/disadvantages of using physical, virtual, or remote/online platforms for laboratory experiments.

In 2019, authors of [6] tried using Factory IO as a virtual engineering laboratory environment to introduce students of PLCs. The student responses of that implementation suggest that Factory IO was a useful, and enjoyable software to be used in virtual laboratory environments. The authors of [7] have also developed a virtual simulation system with different examples and tools to practice and learn PLCs. Moreover, an interactive learning facility was developed to teach profibus communication in PLC-based automated systems by authors of [1]. Their results show that the use of web applications to supply guided materials has been beneficial for students.

However, there stays the opportunity of improving the learning experience of PLCs through web platforms. This work tries to build an interactive learning platform to teach students simulations using Factory IO through a web platform and tries to improve the learning experience of the web platform.

III. Methodology

In achieving the goals, design of the simulation of a given scenario (Palletizer) and development of web application were done simultaneously.

A. Simulation using Factory IO

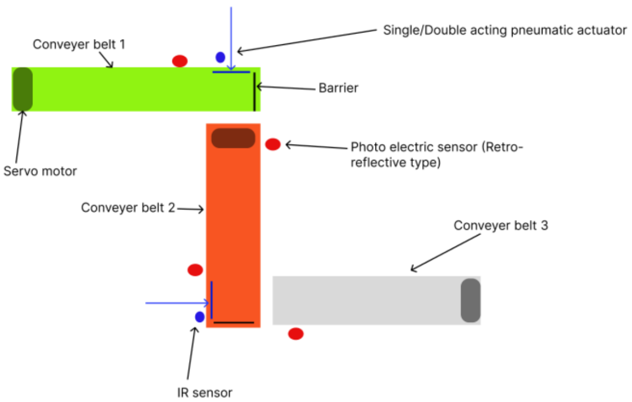

Fig 1: Top view of the 'Palletizer' with components identified

The scenario developed was the ‘Palletizer’ system, shown in Figure 1. The system collects packages from conveyor belt 1 and 2 making four packages at the end of conveyor belt 3, ready for packing. The simulation for the scenario is built in Factory IO and the ladder logic was developed using TIA portal (V17) and S7 PLCSIM (V17). The RLL was developed on TIA portal and connected with the simulation of Factory IO through S7 PLCSIM.

B. *Web platform*

The web application is built with Firebase, firebase as a web application development platform that offers services such as cloud functions, real-time database, authentication, and hosting. Moreover, Firebase hosting is utilized to host the applications and use google cloud functions to integrate machine learning algorithms in future developments. Figure 2 shows the overall system architecture of the web interface.

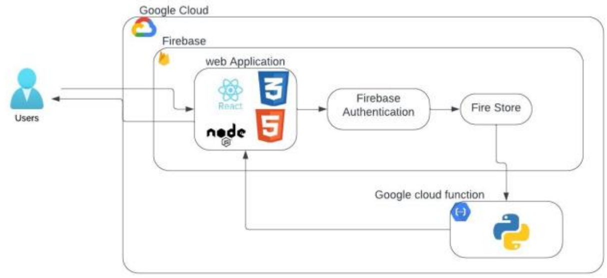

Fig 2: Architecture of the web interface

The main goals of web application are to:

1) guide students in simulating the given scenario in factory IO,
2) help students finding the technical details of S7 1200 PLC and different sensors and actuators,
3) guide students building ladder program for the given scenario in TIA portal,
4) present a Q&A for students to evaluate themselves.

Aligning with the design flow which has been defined according to the UX-based workflow, the designing of web interface is adhered to following steps; requirement gathering, interface design, prototyping.

IV. RESULTS AND DISCUSSION

Hardware components needed for the lab setup were identified using the results of the simulation. Figure 3 shows an instant of the simulation of the given scenario in operation. Table 1 shows the hardware specifications of those components. Moreover, this simulation of the ‘Palletizer’ is added to the web page, as a reference simulation for students to learn.

Fig 3: Simulation of 'Palletizer' in Factory IO

TABLE I. SPECIFICATIONS OF HARDWARE COMPONENTS

Component	Specification
DC geared Motors (3)	*10-15 W output power 12 V*
Pneumatic actuators (2)	*Single acting, Reciprocating, stroke-8-12cm*
Photoelectric Sensors (4)	*Diffuse type*

The procedure for simulating the scenario and ladder program is linked to the web application.

The homepage of the web interface is shown in Figure 4. To achieve earlier goals, three sections; ‘tutorial’, ‘datasheets’ and ‘lab practical’ are included to the web interface. As future work, UX (User experience) assessment based on user testing must be followed as the last step of design flow.

Fig 4: User interface of the web interface

V. CONCLUSION

As conclusion this work simulates a ‘Palletizer’ scenario on Factory IO and identify the hardware components needed for a physical laboratory set up. Moreover, develops a web platform for students to learn about the laboratory practical and evaluate themselves.

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