TEAM 6

INDUSTRIAL AUTOMATION

Production line Simulation project

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
MECHATRONICS ENGINEERING DEPARTMENT
CREDIT HOURS PROGRAM

MCT313 / MCT312 (UG2018)

Submitted to:

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Abstract

This project explores the design and simulation of a comprehensive production line using the FACTORY I/O platform, aiming to replicate the complexities and operational challenges of real-world industrial processes. By integrating Siemens TIA Portal software and Ladder Logic programming, the project establishes a sophisticated control system for managing the production line's machinery and processes. A key component of the project is the development of a Human-Machine Interface (HMI) module, which facilitates real-time visualization and interaction with the production system. The simulation provides a detailed environment to test and optimize control strategies, enhance understanding of industrial automation, and demonstrate the practical application of theoretical concepts. The project bridges the gap between conceptual design and practical implementation, offering valuable insights into process control and system integration.

Introduction

This project focuses on the design and simulation of a fully functional production line utilizing the FACTORY I/O platform. The primary goal is to replicate the complexities inherent in real-world industrial processes, offering a detailed and interactive virtual environment. The simulation is intricately controlled through Siemens TIA Portal software, which employs Ladder Logic to ensure precise integration of various functions. This approach allows for the creation of a sophisticated control system that manages the production line components efficiently. In addition to the simulation and control programming, the project also encompasses the development of a Human-Machine Interface (HMI) module. This HMI module is designed to visualize and interact with the production line's various states and operations, providing real-time data and user controls. Overall, this project aims to enhance understanding of industrial automation by addressing process flow, machine interactions, and system response, thus bridging the gap between theoretical knowledge and practical application in industrial environments.

Project Objective

1. Design a fully functioning production line on a simulation platform (ex. FACTORYI/O) to mimic the considerations coupled with real industrial processes.
2. Use Siemens TIA portal software (Ladder Language) to control the simulated production line and fully incorporate the studied functions in the designprocess of such applications.
3. Design a suitable HMI module to visualize the various states of the simulated production line.

Link Drive

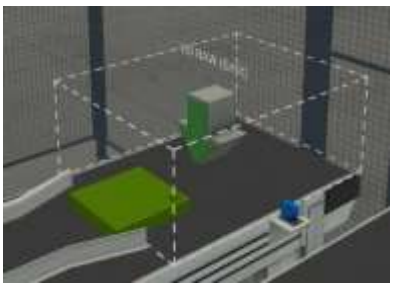
https://drive.google.com/drive/folders/1gAMbnEP_94nnxUhPzSD45a0aWZHLq7J1

Production Line Components:

In this production line we used some of components which are:

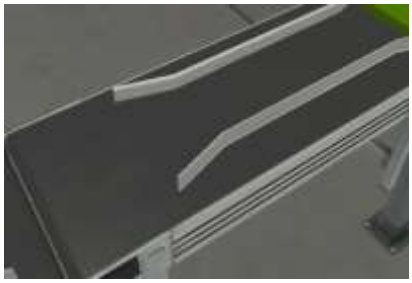
- Emitter

The emitter in the production line plays a pivotal role in the initial stage of the manufacturing process. It is the device responsible for dispensing the raw materials—specifically, the blue and green components—that are essential for producing the lids and bases.



- Conveyer

The conveyor system in the production line is integral to the efficient transportation and handling of raw materials and components, The conveyor system is essential for maintaining the continuity and efficiency of the production line. It ensures that raw materials, components, and finished products are transported smoothly between different stages of the manufacturing process.



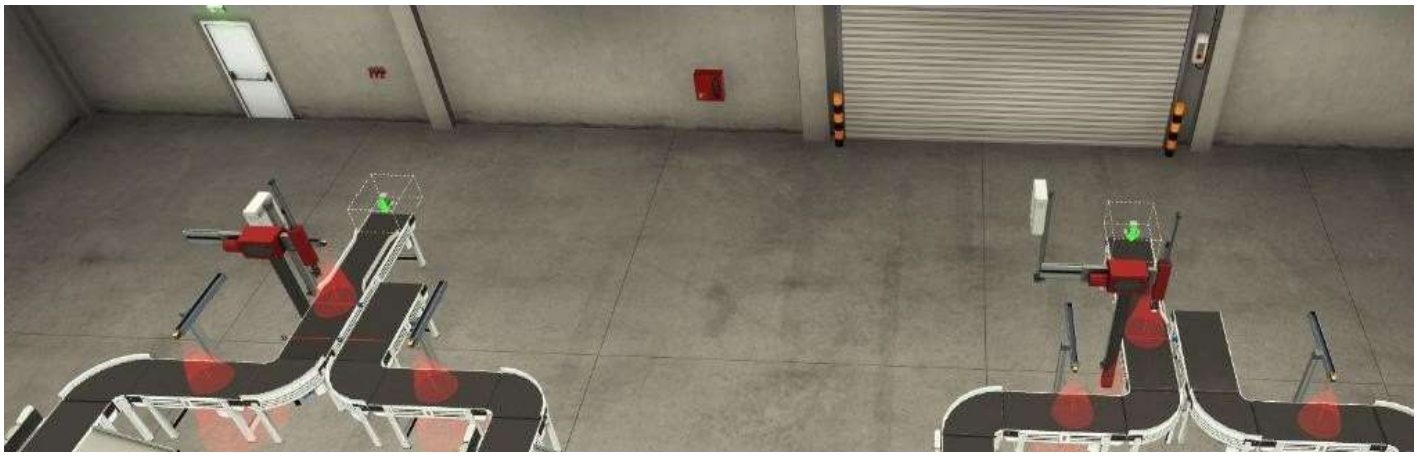
- Pick up & Place

The pick-and-place robot is a key component in the production line, responsible for the precise handling and assembly of parts. Its role in picking components from the conveyor, placing them accurately in assembly stations

Feeding and sorting:

It is the initial stage of our production line. When the start button is pressed, it triggers the operation of an emitter. This emitter is responsible for generating or releasing raw materials, which are identified by their blue and green colors. Once these raw materials are produced, they are deposited onto a conveyor belt.

The conveyor belt is a critical component in this stage as it serves the function of moving the raw materials from the point where they are emitted towards the end of the conveyor system. The movement of the conveyor ensures that the materials are transported efficiently and consistently along the production line, positioning them for the next phase of the manufacturing process or for further handling. This stage is essential because it sets the foundation for the subsequent steps in the production cycle, ensuring that the raw materials are delivered smoothly and accurately to their next destination.

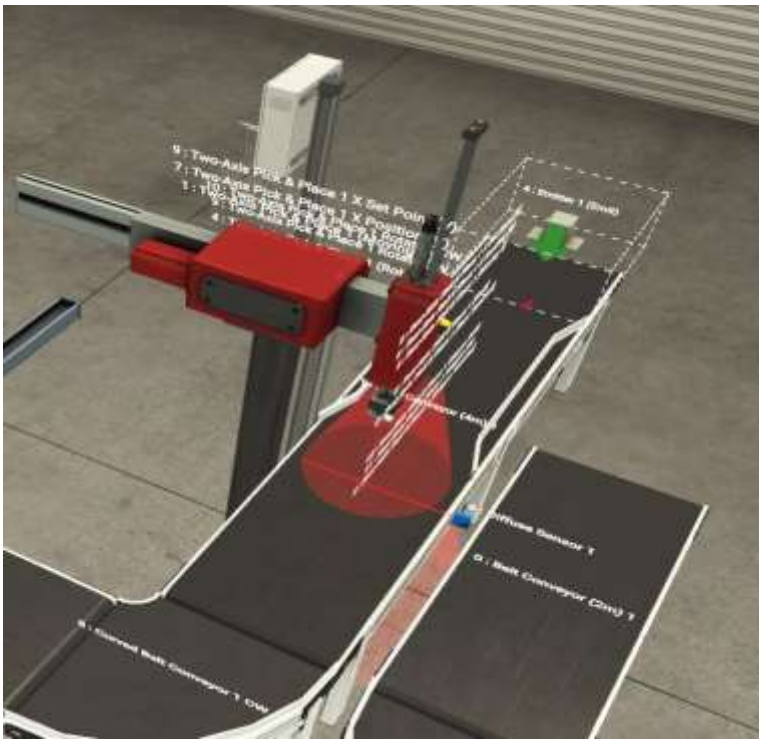


In the next stage of the production line, a pick-and-place robot is employed to sort the raw materials based on their color and other characteristics. This robot is equipped with advanced vision sensors that enable it to accurately identify and distinguish between the different parts, specifically by recognizing their colors—blue and green.

Once the vision sensor detects a part and identifies its color, the robot carefully picks up the part from the conveyor. The robot's programming allows it to make precise decisions based on the information provided by the vision sensor. After securely grasping the part, the robot then moves it to the appropriate conveyor designated for

further machining or processing.

Each conveyor is assigned to handle specific parts, so the robot ensures that the blue and green materials are placed on their respective conveyors. This sorting process is crucial, as it ensures that each type of material is directed to the correct machine station, where it will undergo the necessary processing steps.



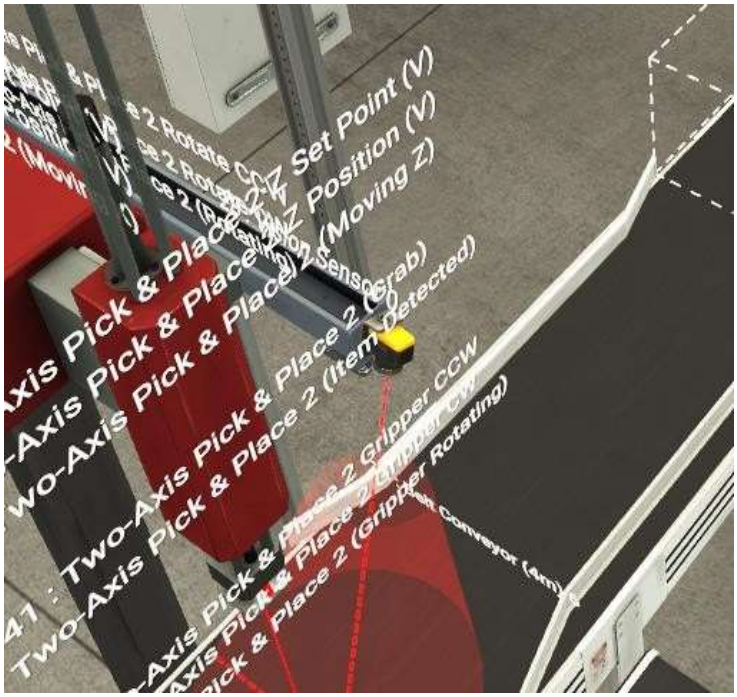
In this advanced stage of the production line, the system is designed to operate with the assistance of two vision sensors strategically placed on two separate production lines. These vision sensors play a crucial role in identifying and analyzing the specific parts that pass through each line. The sensors are highly sophisticated, capable of detecting various attributes of the parts, such as size, shape, orientation, and, most importantly, color.

As parts move along the production lines, the vision sensors continuously scan and collect data on each piece. This data is instantly processed, allowing the system to determine the precise characteristics of the parts in real-time. The information gathered by these sensors is then relayed to the pick-and-place robot.

The robot, equipped with the capability to interpret the data from the vision sensors, identifies the specific part it needs to handle. Based on the input from both vision

sensors, the robot decides which part to pick up and which production line it belongs to. Once the robot has identified the correct part, it carefully picks it up using its specialized gripping mechanism. The robot's programming ensures that it handles each part with the appropriate care, avoiding any potential damage or mishandling. After securing the part, the robot then places it onto the correct production line, ensuring that each part is routed to its designated processing area.

Following the feeding station in the production line, there is an excess raw material removal station designed to manage and optimize the flow of materials. This station is

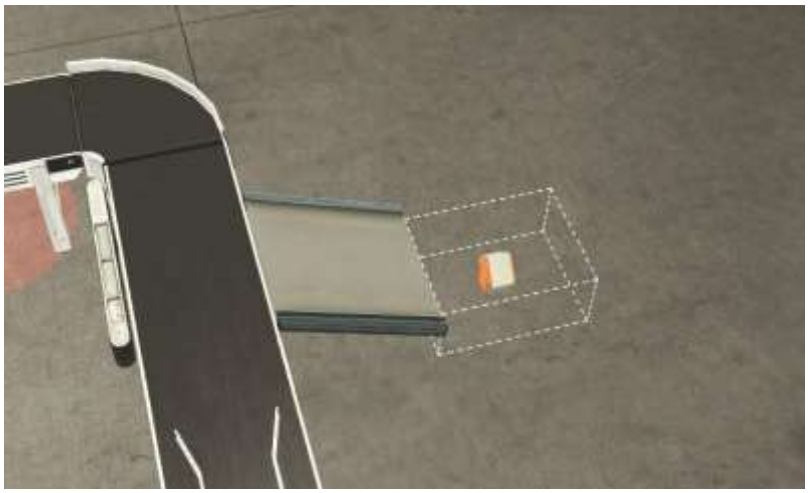


activated after a predetermined number of blue and green raw materials have passed through the initial stages of the line. The system continuously monitors the count of each type of raw material, ensuring that the production process remains balanced and efficient.

Once the specific threshold of raw materials is reached, the excess raw material removal station automatically engages. This station is equipped with a hydraulic arm, a powerful and precise tool that is specifically designed to remove any surplus raw materials that may accumulate on the conveyor.

The hydraulic arm is programmed to operate with a high degree of accuracy. It carefully identifies the excess materials, distinguishing between the blue and green raw materials

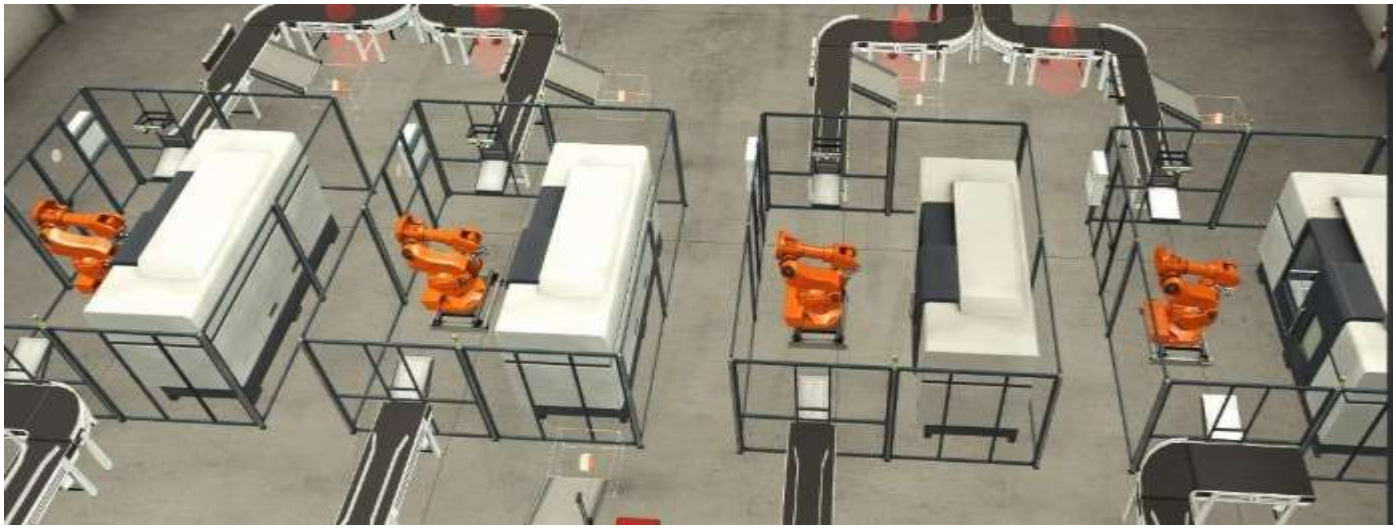
based on the established criteria. The arm then extends and selectively removes the excess pieces from the conveyor, ensuring that only the necessary amount of raw material continues along the production line.

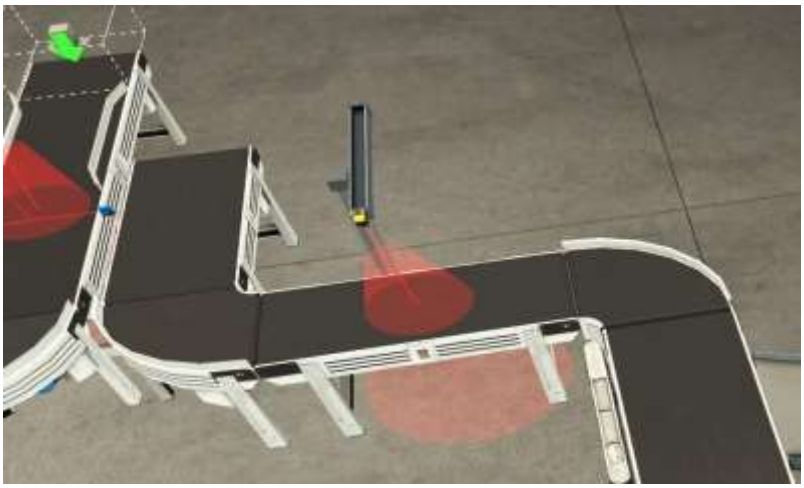


Machining:

In the production line, the machining station plays a vital role in the manufacturing process by transforming raw materials into finished components, specifically lids and bases. This station is designed to operate with a high level of precision and efficiency, ensuring that each raw material is expertly crafted into its designated form.

At the heart of this station are articulated robots, which are advanced robotic systems capable of performing complex tasks with multiple degrees of freedom. These robots are strategically positioned to handle the incoming raw materials as they arrive at the entry bay of the machining station. The entry bay serves as the point where raw materials are delivered and prepared for processing.

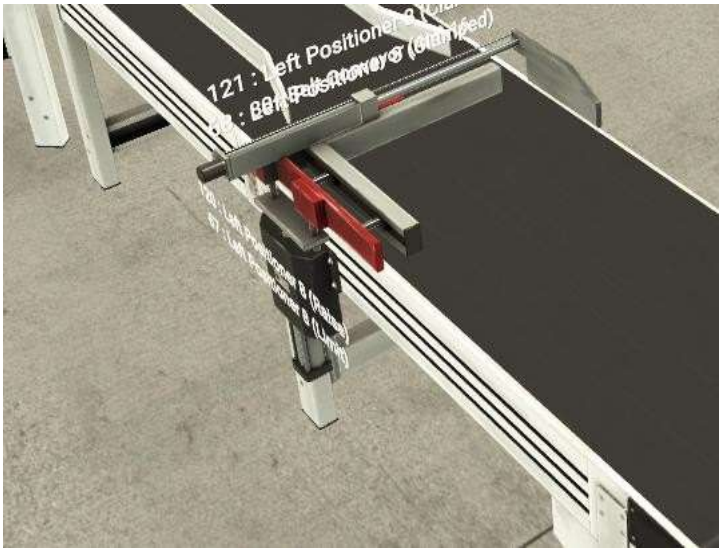




Jamming

In the assembly phase of the production line, ensuring a smooth and uninterrupted flow of components is crucial to maintaining efficiency and preventing disruptions. To achieve this, an automated blocking mechanism is implemented. This sophisticated device is designed to control the movement of parts as they approach the assembly station, specifically preventing multiple components from entering the assembly phase simultaneously, which could lead to jamming or other operational issues.

The automated block operates with precision timing and is synchronized with the pace of the production line. As parts arrive at the assembly station, the block strategically intervenes to manage their entry. It is programmed to allow only one part to pass through at a time, effectively spacing out the components and ensuring that the assembly process can proceed without interruption or overlap.



Assembly:

This part is being used to assemble Lids on Bases or pick and place items from one place to another by using pick up and place robot and use clamping to ensure that the there's no residual movement of parts while assembling and if we reached the required number of assembled products of both colors, it would turn off all of production.
This part of the production line is meticulously designed to ensure that lids are accurately assembled onto bases, with the added flexibility of moving items as needed. The use of a clamping mechanism guarantees the stability and quality of the assembly

HMI:

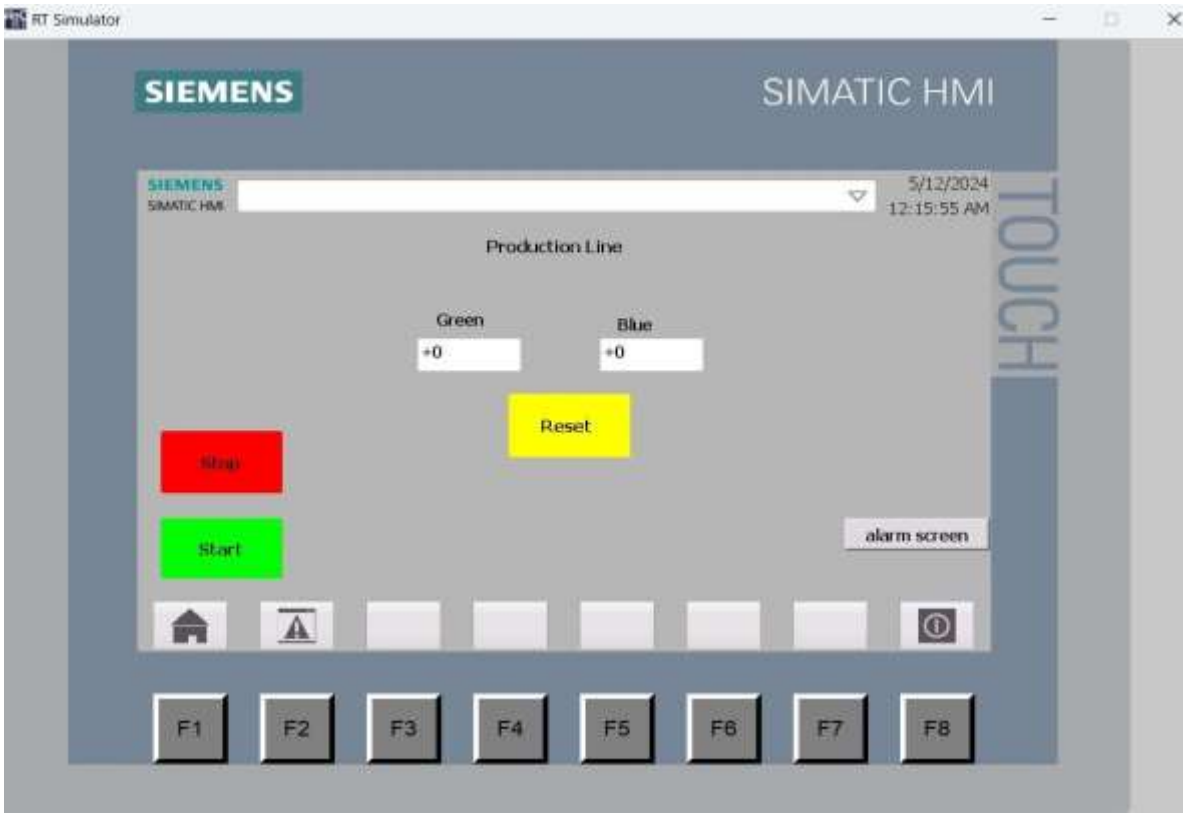
In our Human-Machine Interface (HMI), we have designed a user-friendly control panel that plays a crucial role in the operation and monitoring of the production line. This HMI includes several essential features, such as stop, start, and reset buttons, as well as two counters for tracking the production of blue and green products. Here's a detailed breakdown of these components and their functionalities:

Key Features of the HMI

1. Control Buttons:
    - Start Button
    - Stop Button
    - Reset Button
2. Counters:
    - Blue Product Counter
    - Green Product Counter
3. Warning Messages

    The HMI is equipped with a warning system that alerts operators when something goes wrong during the production process.
4. User Interface Design

    The buttons and counters are clearly labeled, and the warning messages are prominently displayed to ensure they are easily noticed.


RT Simulator
SIEMENS
SIMATIC HMI
SIEMENS
SIMATIC HMI
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TOUCH
Production Line
Green
+0
Blue
+0
Reset
Stop
Start
alarm screen
F1
F2
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F5
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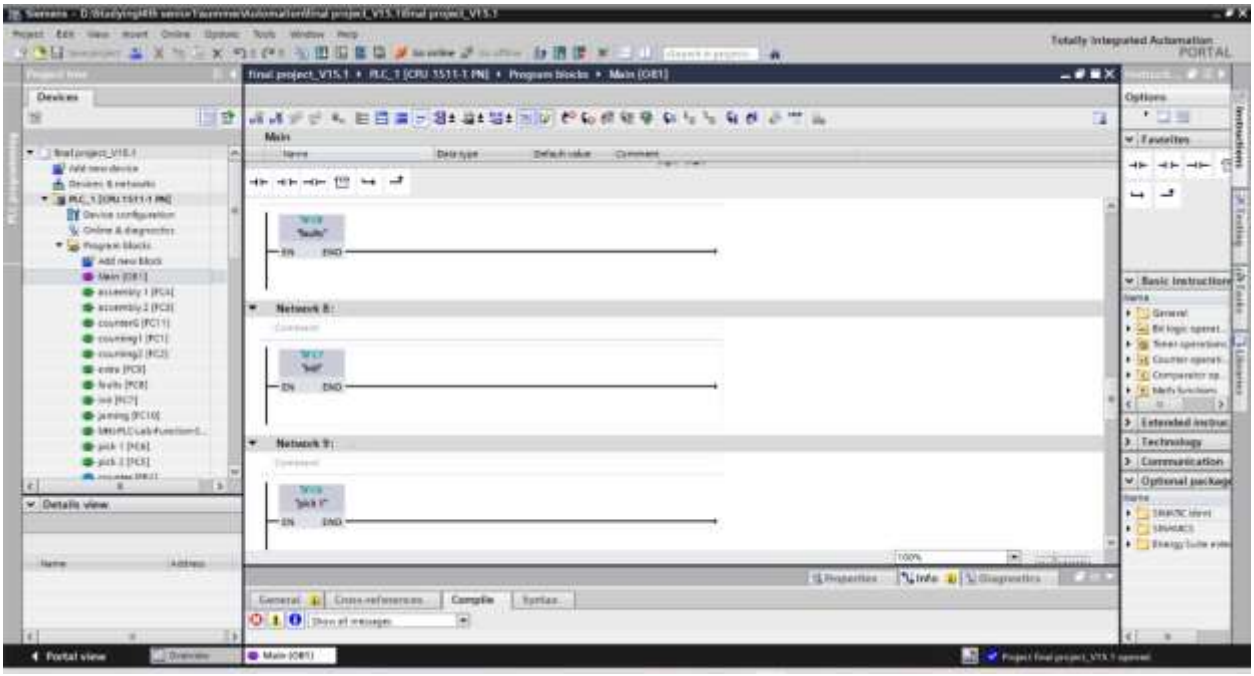
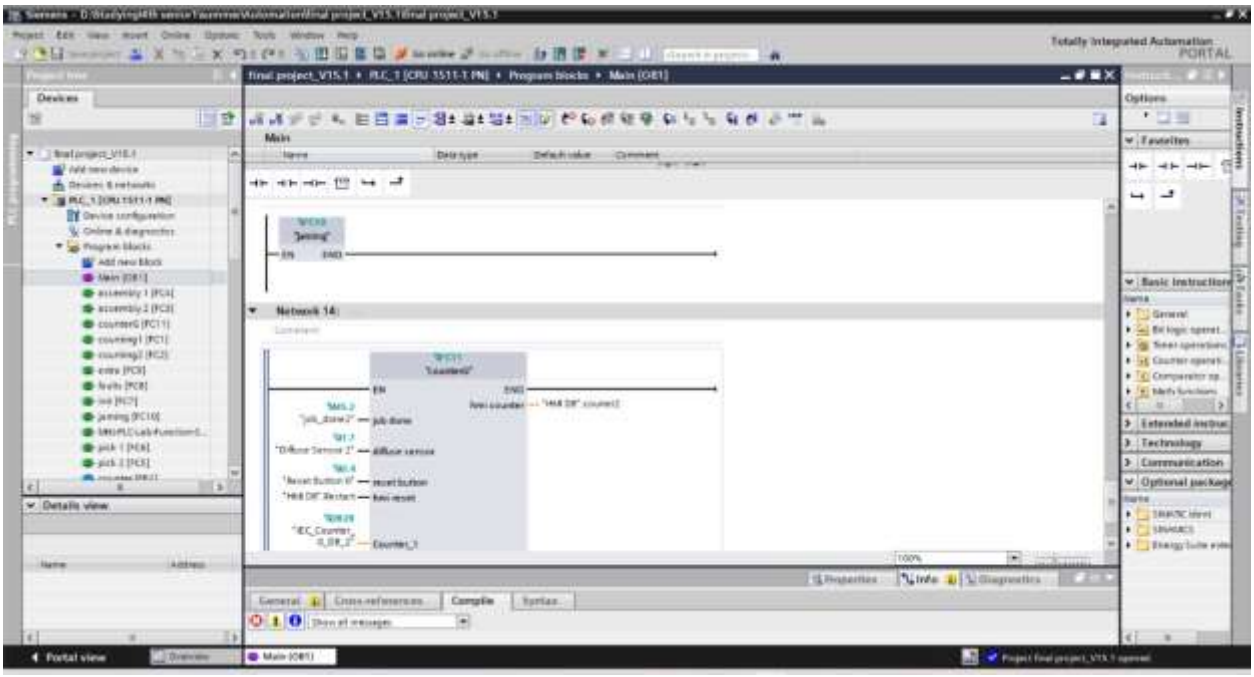
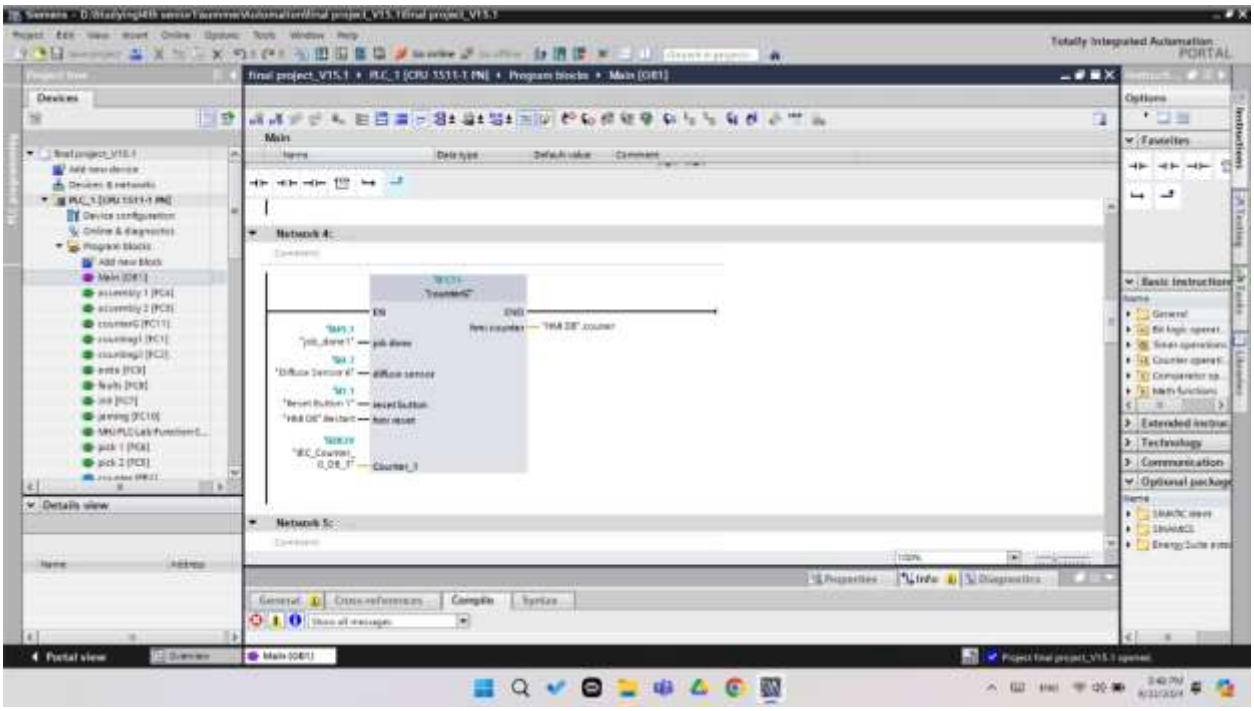
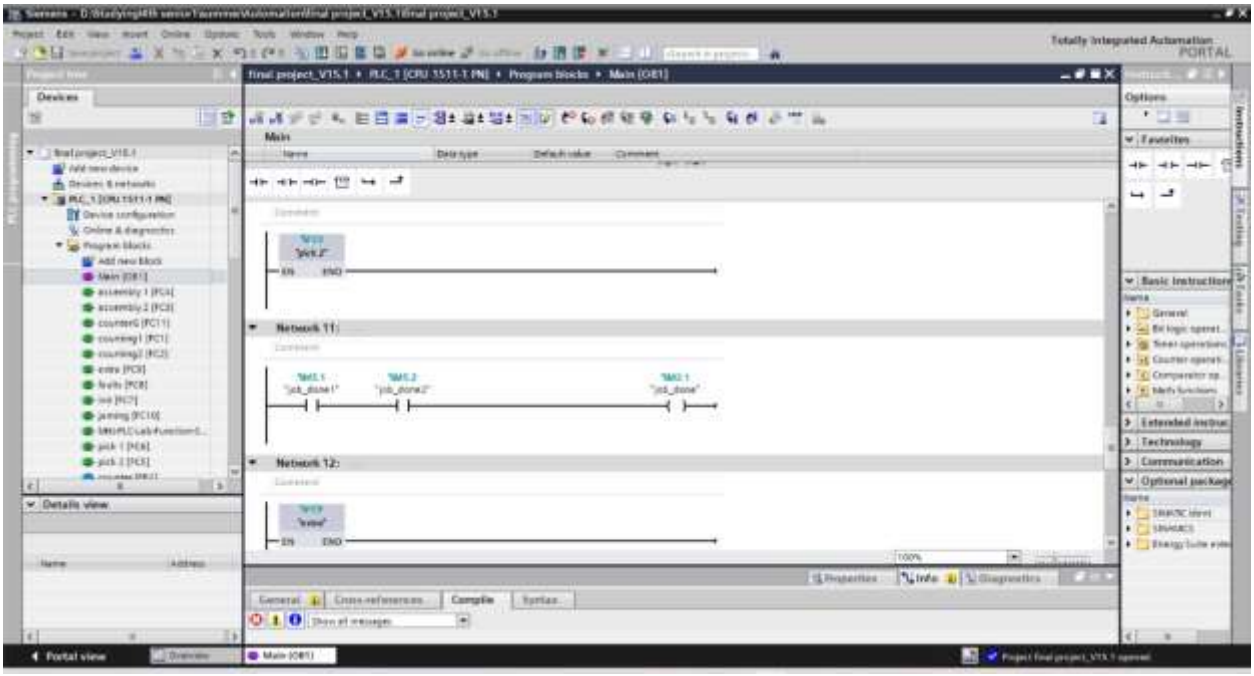
TIA Portal






Totally Integrated Automation
PORTAL
final project_V15.1 ▸ PLC_1 [CPU 1511-1 PN] ▸ Program blocks ▸ Main [OB1]
Main
Network 4:
Network 5:
Portal view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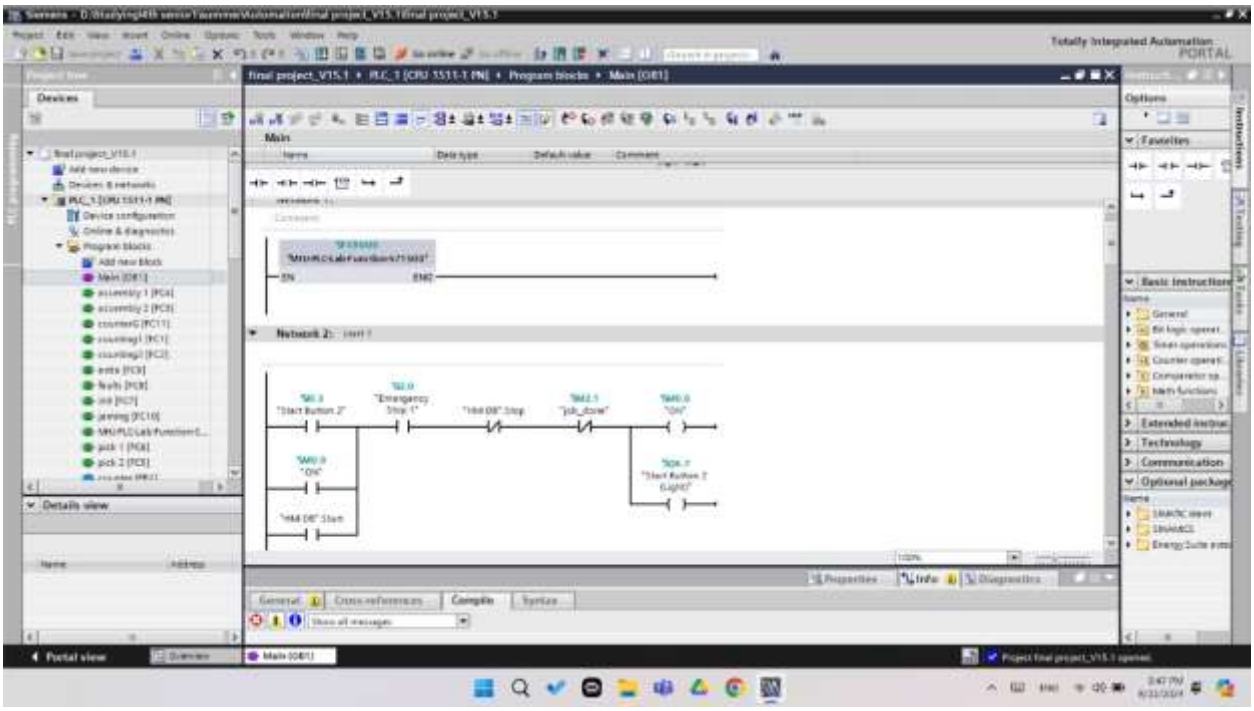
Network 11:
Network 12:
Portal view


Totally Integrated Automation
PORTAL
final project_V15.1 ▸ PLC_1 [CPU 1511-1 PN] ▸ Program blocks ▸ Main [OB1]
Devices
Main
Network 2:
Options
Favorites
Basic instructions
Extended instruc...
Technology
Communication
Optional package
Details view
Portal view
Overview
Main [OB1]

Conclusion

The project successfully demonstrates the capabilities of the FACTORY I/O platform in simulating a realistic production line, while effectively integrating Siemens TIA Portal for control system management. The use of Ladder Logic programming has enabled precise control of the production processes, ensuring smooth and efficient operation within the simulated environment. The development of the HMI module has enhanced user interaction by providing a clear and intuitive interface for monitoring and controlling the production line. Through this simulation, the project has provided significant insights into the complexities of industrial automation, process flow, and system integration. It has bridged theoretical knowledge with practical application, showcasing the effectiveness of virtual simulation tools in understanding and optimizing real-world industrial processes.

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