

1DH Distribution Handling Controller

Final Assignment Report

Course: 4TC00

Group Number: 114

Kirill Naval (1855921)

Valentin Nikushor (1847120)

Daniel Tyukov (1819283)

Date: November 10, 2024

Control Strategy Functionality

The controller for the 1DH Distribution Handling system is designed to manage the efficient distribution of products from three distinct stacks. The primary functionalities include:

- **Alternating Product Selection:** The controller alternates between stacks 2 and 3, which contain identical products (e.g., jars), and stack 1, which contains different products (e.g., lids). This ensures a synchronized delivery of complementary products.
- **Automated Positioning:** Utilizing the auto position of the key, the rotating transfer cylinder places products in the Testing Station only when it is ready. In manual mode, the Handling Station operates independently of the Testing Station's readiness.
- **Handling of Key Switching:** If the key is turned during a product transfer, the controller allows the current transfer cycle to complete before applying the new key setting.
- **Error Handling:** In cases where a product is unexpectedly removed from the gripper, the controller retrieves a new product from the same stack set to maintain the correct delivery order.
- **High Throughput and Energy Efficiency:** The controller optimizes actuator usage by activating only necessary components, thereby reducing energy consumption while maintaining high operational throughput.
- **Safety Measures:** Ensures safe operation for both equipment and operators by managing actuator states and sensor inputs.

Assumptions and Parameter Estimates

Several assumptions were made to facilitate the development of the control model:

- **Sensor Reliability:** It is assumed that all sensors provide accurate and timely feedback without delay or noise.
- **Actuator Response Time:** Actuators respond instantly to control signals without lag.
- **Maximum Buffer Size:** Each product stack can hold up to 5 products, as defined by `MAX_BUFFER_SIZE`.
- **Product Movement Speed:** The velocities for pushers and crane movements are based on typical operational speeds observed in similar systems and are set to ensure synchronization.
- **Energy Consumption:** Actuators are considered to consume energy only when active, aligning with the energy-efficient control strategy.

These estimates were derived from the Festo hardware manual and observations from the digital twin simulations. The assumptions are reasonable given the controlled environment and the nature of the simulation.

Use Cases

The simulation model supports the following automated use cases:

1. **Alternating Product Delivery:** Products are spawned on pushers 1 and 2, and the controller alternates between delivering products from these stacks and stack 3. This ensures a consistent supply of both jars and lids to the Testing Station.
2. **Simultaneous Multi-Stack Operation:** Products are spawned across all three pushers with stacks 2 and 3 containing identical products (cans) and stack 1 containing different products (lids). The controller follows the sequence 1-3-2-3 to maintain the correct pairing of jars and lids.

3. **Error Recovery on Product Loss:** If a product disappears from the gripper during transfer, the controller initiates a retrieval process from the same stack set to maintain the correct order of product delivery.

These use cases are fully operational within the SVG simulation, demonstrating the controller's ability to handle normal operations and unexpected events effectively.

Operator Instructions

Simulation Modes

Manual Mode:

- **Stack Management:** Each stack has three buttons:
 - **Add Single Product:** Adds one product to the respective stack.
 - **Fill Stack:** Fills the stack to its maximum capacity.
 - **Empty Stack:** Removes all products from the stack.

Automatic Mode:

- **Starting the System:** Press the **Start** button on the Distributing Station interface panel to initiate automatic operations.
- **Stopping the System:** Press the **Stop** button to halt operations at any time.
- **Switching Modes:** Use the **Auto/Manual** key to toggle between automatic and manual positioning of the transfer cylinder.

Digital Twin / Festo Workstation Instructions

Operating in Real-Time Control:

- **Initialization:** Ensure all product stacks are appropriately filled using the simulation buttons before starting.
- **Start-Up Sequence:** Press the **Start** button on the Distributing Station interface panel. Observe the LEDs indicating actuator states and sensor statuses.
- **Monitoring Operations:** The LEDs on the interface panel provide real-time feedback on the system's status:
 - **Green LED:** Indicates active actuators.
 - **Red LED:** Indicates inactive or error states.
- **Handling Errors:** If a product is lost during transfer, the system will automatically attempt to retrieve a new product from the same stack set. Monitor the LEDs and system logs for feedback.
- **Shutting Down:** Press the **Stop** button to safely halt all operations. Ensure all actuators return to their default states.

Specific Controls and Indicators

- **Start Button (green dstart button):** Initiates the control sequence.
- **Stop Button (red dstop button):** Halts all operations immediately.
- **Auto Switch (s_dautoswitch):** Toggles between automatic and manual positioning modes.
- **LED Indicators:**
 - **a_dstartled:** Green indicates the start button is active.
 - **a_dstopbutton:** Maroon indicates the stop button is active.
 - **a_gripperclose:** Indicates the state of the gripper (closed/open).
 - Additional LEDs provide real-time status of pushers, transfer lever, and other actuators.