Group number: Festo	1.27
Workstation name	Distributing and Handling station (DH)

	Student initials and name	ID number	Department
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Control Strategy and Model

The Festo workstation should be able to finish its task without manual intervention. Therefore a control strategy has been devised in order for the controller to respond to irregularities and continue normal operation. The controller detects the location of a product and its orientation using sensors. Using this information, the controller knows which step should be taken in order to complete the task of distributing the products from their location. The control strategy is used for implementing these steps and as a result, guaranteeing the successful completion of the proces.

The controller has a sequence that it follows to determine what position needs to be reached. The gripper moves along the rails in the x direction to the correct position. When the gripper is at the right position the arm moves down and when at the lowest point, grips the product when this is sensored. If there is no product sensed, the arm will stop and the reset button needs to be pushed, then new products can be added. When the product is grabbed the arm moves up and then back to the drop point to drop the product.

The products in the stacks inside the inventories are pushed into position for the gripper. The pusher retracts fully to drop the stack, one product in front of the pusher. The pusher extends to put the product in the right position. The process is repeated when the product is removed by the gripper or manually.

The vacuum arm moves to the product when this is placed by the arm, when in the right position, uses the vacuum pump. When the product is stuck, it moves to the other side to drop it for testing.

CIF model, reset, stop buttons and energy efficiency realization

The control decisions and logic are done as efficiently as possible and is such a way that the process is a success and can be categorized as follows.

The gripper arm should go and pick a grey and then a red product. All three pushers move their product in order for the gripper to pick them up. This is done so that a product is always ready to be picked up. This makes it easier for the operator in case of when an accident happens. The products can still be picked up manually by the operator.

1. The arm gripper will stay a short amount of time next to the gripper after having grabbed a product. This is done to ensure that the vacuum will not collide with the gripper arm. These timers are crucial, so no parts are getting damaged.
2. When the reset button is pressed, the gripper arm goes to its original position and the process can start from the start.
3. When the stop button is pressed, the gripper arm stops moving.
4. The key for auto-switch will let the operator handle the products manually. Products from the gripper will be placed in the product bins next to the pusher.

Another desired trait of the system is energy efficiency. The process needs to go as quickly as possible without the components interfering with each other in such a way that the no products are distributed or too slowly. The time lost can be crucial in a production process. Time efficient also means energy efficient. The main idea behind time efficiency is to achieve a higher throughput of the workstation. There are a few limiting factors that determine the speed of the distributing station. Namely the speed of the crane arm, the speed of the gripper, speed of the pushers, and the speed of the vacuum picking up a product. Because the speed of all these factors is set, the slowest one will determine the time efficiency of the system and will be depicted as the bottleneck. The vacuum arm only moves to pick up the product when there is a product present in the position to pick it up. The pushers automatically push the products in their slot in order to be picked up by the gripper. The gripper only operates when a product is in one of the three positions, ready to be picked up by the gripper. Afterwards the product is detected by the sensor and the pusher will be moving until pushed in the slot. The products will stay in their position until gripped. This will result in more energy efficiency as the next product will be of another colour, which means the gripper arm needs to move to another pusher. Having set the product already to be picked up, the gripper arm moves in a fluent motion. The

same can be said for the vacuum arm. This leads to less unnecessary movements and thus the system is more energy efficient.

Use cases

These 3 use cases could be implemented to show the performance of the workstation.

1. The workstation would start automatically with the start button. A red, grey, red product would be picked up in that order, after this the reset button will be used and the machines will go to their starting positions.

2. Another use case could be that after a time period a product manually removed, the arm gripper will stop immediately moving.

3. The last use case would be the integration of the stop button. The process will start and after 10 seconds the gripper arm, pushers and vacuum will stop moving and the process comes to an abrupt end. After a small time period the machine will be reseted.

Operator manual digital twin

To run the digital twin there will be assumed that the user is able to set up twin cat to the point where the initialization can begin.

1. Open the festo workstation simulation program
2. Now the green arrow in the twin cat program can be pressed to start the initialization in the festo workstation.
3. Wait for the initialization to finish before pressing any buttons.
4. Now the products can be spawned in, the amount or the place does not matter. Products can be spawned in with the
5. The green start button can be pressed to start the workstation. If there are products in the workstation the pushers, gripper arm and the vacuum will work with each other to move all the products to the next station.
6. If the user wants to reset the machine to the starting position the reset button can be pressed, all the machines will go to the position they started. If the gripper arm is gripping a product at that moment it will place this product in the place where the vacuum can pick it up.
7. When the reset is finished the start button can be pressed to start the machines up again.
8. If during the operation of the workstation the user wants to stop the machine then the stop button can be pressed at any moment and all the machines will stop.

9. When the machines are stopped the start button can be pressed to let the machine continue their operations or the reset button can be pressed to move the machines to their starting locations.
10. The key can be used to switch between auto or manual mode by right or left clicking. If the workstation is in auto mode (key vertical) the machine will behave as described, if the machine is in manual mode (key horizontal) the vacuum will stay in the starting position and the other machines will still operate. In this case the products that are placed in the position where the vacuum can pick them up should be removed manually.

Operator manual svg simulation:

Run the dh_ctrl_plant _tooldef 2 with f10 this will open the svg simulation.

1. In the svg simulation the products are already spawned so the user does not have to do this. The green start button can be pressed to start the workstation
2. while the machines are working the grey reset button can be pressed to bring the machines back to their starting position. They will finish the product they are holding and go to their original position.
3. When the reset is finished the start button can be pressed to start the machine up again
4. The red stop button can be pressed at any moment to stop all the machines in place.
5. When the machines are stopped the reset button can be pressed to bring the machines back to their original position. The start button can be used to let the machines continue their operations.