Festo Distributing and Sorting System Report

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Summer project
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1 Introduction

1.1 Distributing station: Getting started with MP

The Distributing station separates workpieces. Up to eight workpieces are stored in the magazine tube of the stacking magazine. A double-acting cylinder pushes the workpieces out one at a time.
The Changer module grips the separated workpiece via a suction gripper. The swivel arm of the changer, which is driven by a rotary actuator, moves the workpiece to the transfer point of the downstream station.[2]

1.2 Special technology: Semi-rotary actuator

The Distributing station utilises various actuators, all of which are industrial components. The rotary actuator of the swivel arm can be set to various angles between 90°and 270°. The end positions are sensed by means of micro switches. A double-acting linear cylinder pushes workpieces out of the stacking magazine. The end positions are sensed using proximity sensors.

Figure 1: Distributing station

1.3 Sorting station

[3]The Sorting station sorts workpieces onto three slides. Workpieces placed on the start of the conveyor are detected by a diffuse sensor. Sensors upstream of the stopper detect the workpiece features (black, red, metal). Sorting gates actuated by short-stroke cylinders via a deflector allow sorting of workpieces onto the appropriate slides. A retro-reflective sensor monitors the level of the slides. [3]

1.4 Material detection

Inductive and optical sensors detect the colour and material of workpieces. Short-stroke cylinders stop workpieces on the conveyor and pass them on for sorting onto one of three slides.

- Sorting gates with short-stroke cylinder;
- Sensors;
- Guide rails;
- Conveyor motor.

Figure 2: Sorting station

2 Remote Control

2.1 Station 1 - Distributing Station

Table 1: Distributing Station

SENSOR	Comments	SWITCH	Comments
0	-	0	Push cylinder from tube
1	Pusher in position	1	Suck air in (collect cylinder)
2	Pusher in forward position	2	Release cylinder with air
3	Object vacuum to sucker	3	Move left to collect cylinder
4	Sucker in left position	4	Move right
5	Sucker in right position	5	Green Colour
6	Tube empty	6	Yellow Colour
7	Connection between stations	7	Red Colour

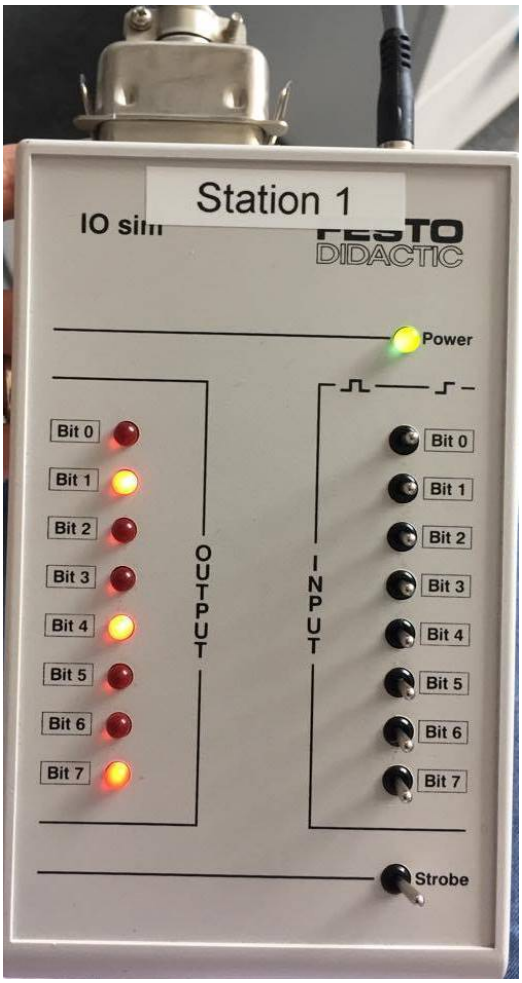


Figure 3: Distributing station - Remote control (Switch off)

2.2 Station 2 - Sorting Station

Table 2: Sorting Station

SENSOR	Comments	SWITCH	Comments
0	Object on path	0	Moving path
1	Metal cylinder	1	Close 1th gate (for pink)
2	Pink or Metal cylinder	2	Close 2d gate (for metal)
3	Cylinder reach destination	3	Block conveyor
4	1 gate open (pink)	4	Green colour
5	1 gate closed (pink)	5	Yellow colour
6	2 gate open (metal)	6	Red colour
7	2 gate closed (metal)	7	Check another station

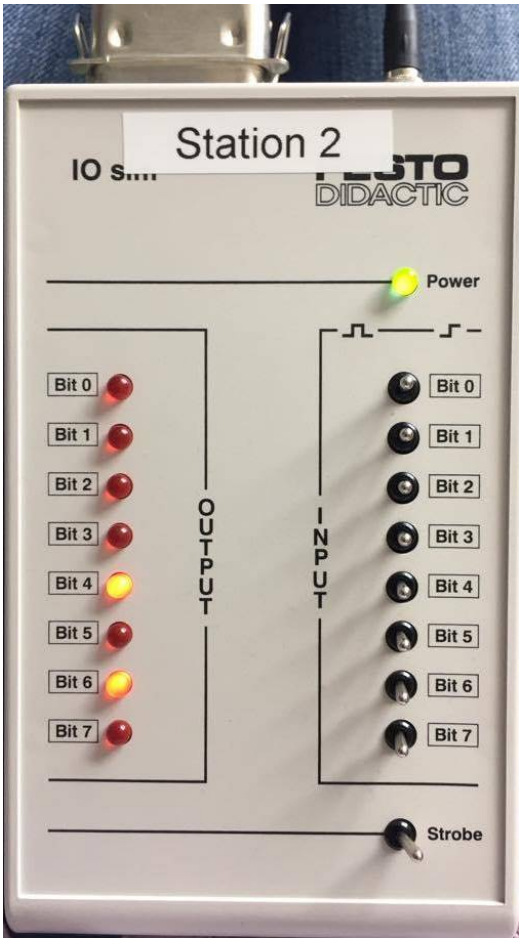


Figure 4: Sorting station - Remote control (Switch off)

3 Hardware

To set parameters for Festo sorting station I built external control module. To build control module circuit I used Arduino Uno board, 4 buttons, 10k resistors, potentiometer, 16x2 LCD, solderless breadboard prototype, PCB prototype breadboard and wires(*figure 5)*. Remote control module box is made from acrylic. At first I design it in Solidworks and later cut it in Laser cutting machine and glued.
One of each M-Duino's connected directly to station (distributing/sorting). Also sorting stations M-Duino (slave) is connected to external control module Arduino Uno (master). Initial parameters (desirable number of pink and metal cylinders) are set in external control module and transferred to sorting station through I2C connection *(figure 6)*.

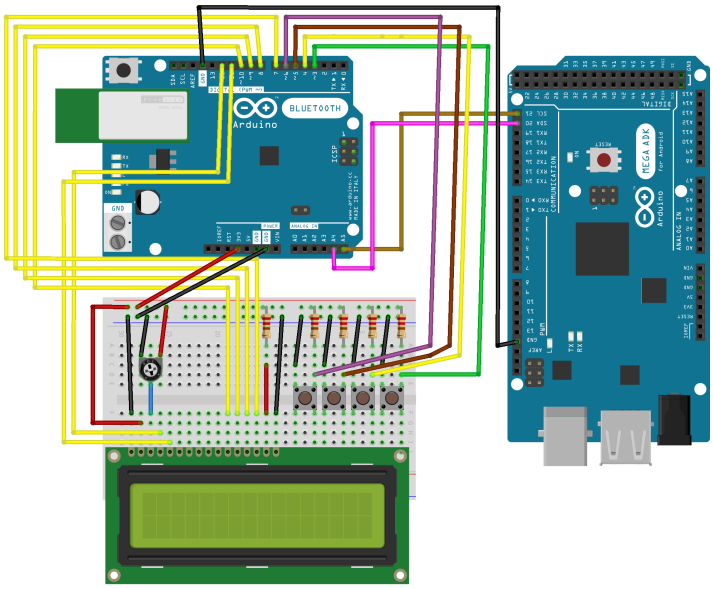


Figure 5: External control module circuit

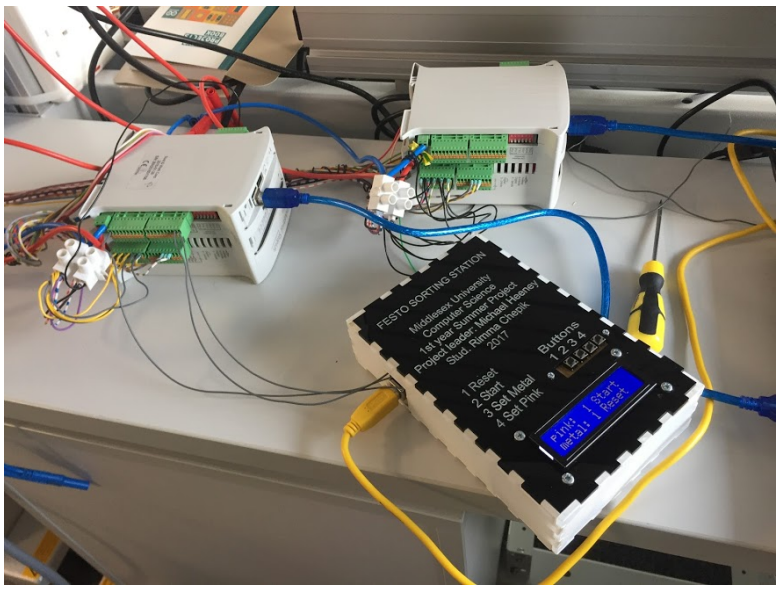


Figure 6: Control module

3.1 Master Writer/Slave Receiver

M-Duino and Arduino Uno boards are programmed to communicate with one another in a Master Writer/Slave Receiver configuration via the I2C synchronous serial protocol [1] *(figure 6)*. Several functions of Arduino's Wire Library are used to accomplish this. Arduino Uno, the Master, is programmed to send 3 bits (3 buttons: pink, metal and start) of data to uniquely addressed Slave once initial parameters are set and start button is pressed. Once that message is received, sorting station starts sorting and sorting progress can then be viewed in the Slave board's serial monitor window opened on the USB connected computer running the Arduino Software (IDE). LiquidCrystal library is used to communicate 16x2 LCD on Arduino Uno bus.

3.2 Hardware

- Arduino Uno Board;
- 2xM-Duino Boards;
- 4 buttons;
- 10k resistors;
- 16x2 LCD;
- Potentiometer;
- Solderless breadboard prototype;
- PCB prototype breadboard;
- hook-up wires;
- acrylic case.

3.3 External control module circuit

Arduino Uno (master) pin 5 is connected to M-Duino (slave) SCL pin and pin 4 to M-Duino SDA pin. Both boards share a common ground. Buttons and 16x2 LCD are connected as shown in *(figure 5)* In order to enable serial communication, the slave Arduino must be connected to computer via USB.

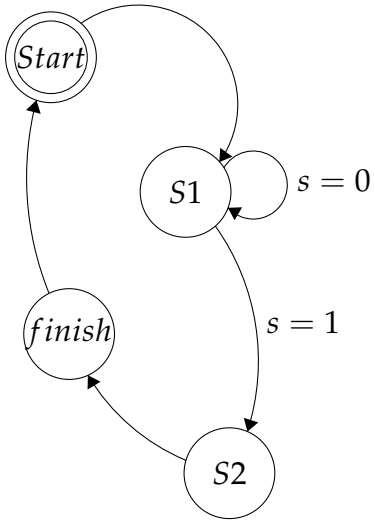
4 Software

- Arduino IDE (Arduino control programs);
- Arduino Code https://github.com/RimmaChepik/FestoDistributionAndSortingProject
- Solidworks 2015 (design external control module box);
- 2D design (Laser Cutting Machine);
- TexStudio (report);
- Umlet (activity diagrams);
- Frizting (design schematics).

5 Sorting process

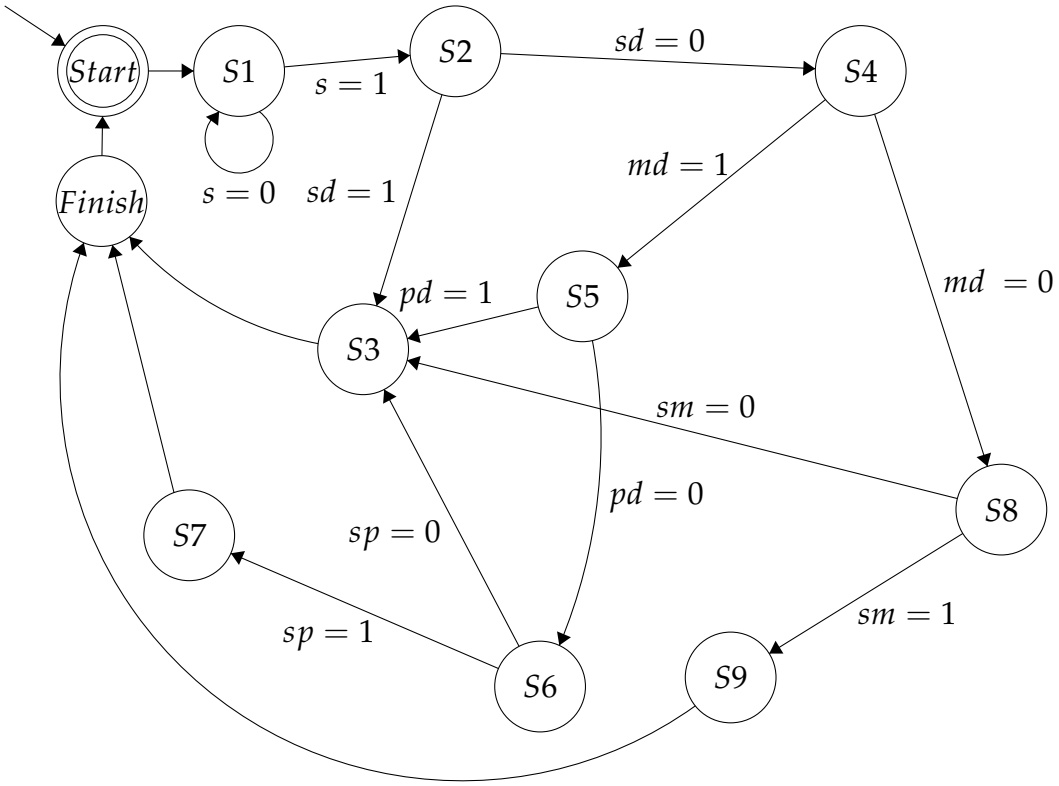
Cylinder sorting can be done manually by manipulating switches on distribution/sorting stations remote controls or automatically by using 2 M-Duinos and Arduino Uno boards which is much faster and more efficient way.

5.1 Finite state machine - Distributing station



S1 - Sensor checks if cylinder is in tube
s=0 (cylinder is detected),
s=1 (cylinder is not detected)
S2 - Moves cylinder to sorting station

5.2 Finite state machine - Sorting Station



S1 - sensor checks if cylinder is on belt.
Sensor input: s , where s = 1 (cylinder is detected), s = 0 (cylinder is not detected).

S2 - Arduino program checks if sorting is done
where sd = 1 (sorting is done), sd = 0 (sorting is not done)

S3 - sends cylinder to last slide

S4 - Arduino program checks if metal cylinders sorting is done
md = 1 (metal cylinders sorting is done), md = 1 (metal cylinders sorting is not done)

S5 - Arduino program checks if pink cylinders sorting is done
pd = 1 (pink cylinders sorting is done), pd = 0 (pink cylinders sorting is not done)

S6 - Colour sensor checks if it is pink cylinder
sp = 1 (pink cylinder is detected), sp = 0 (pink cylinder is not detected)

S7 - sends cylinder to pink cylinder's slide (first slide)

S8 - metal sensor checks if it is metal cylinder
sm = 1 (metal cylinder is detected), sm = 0 (metal sensor is not detected)

S9 - sends cylinder to metal cylinder's slide (second slide)

5.3 Distributing station flow:

- Distributing program is uploaded to Distributing station's M-Duino.

- If sensor detects cylinder in stacking magazine, the swivel arm of the changer, which is driven by a rotary actuator, moves the workpiece to the transfer point of the downstream station[2].

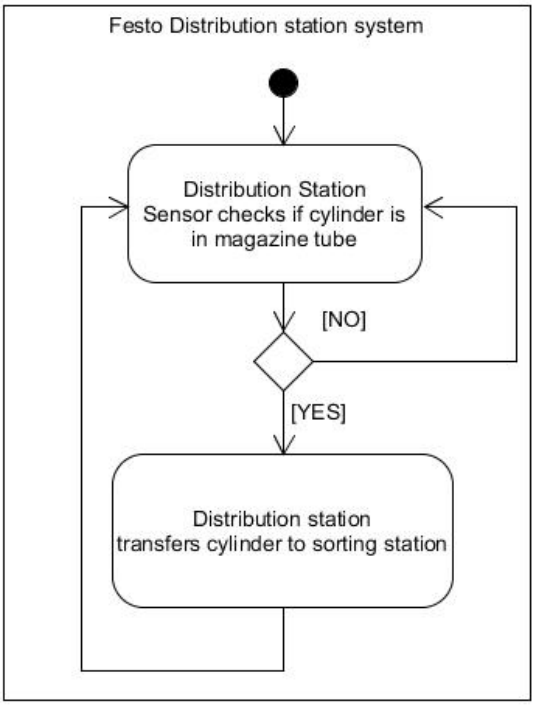


Figure 7: Flowchart of distribution station analysis logic

5.4 Sorting station flow:

- Sorting program is uploaded to sorting station's M-Duino (slave).

- 3 bytes are received from Arduino Uno (master).

- Depending on received information sorting process is started.

- Once sorting is done any extra cylinder on belt will be transferred to the last slide.

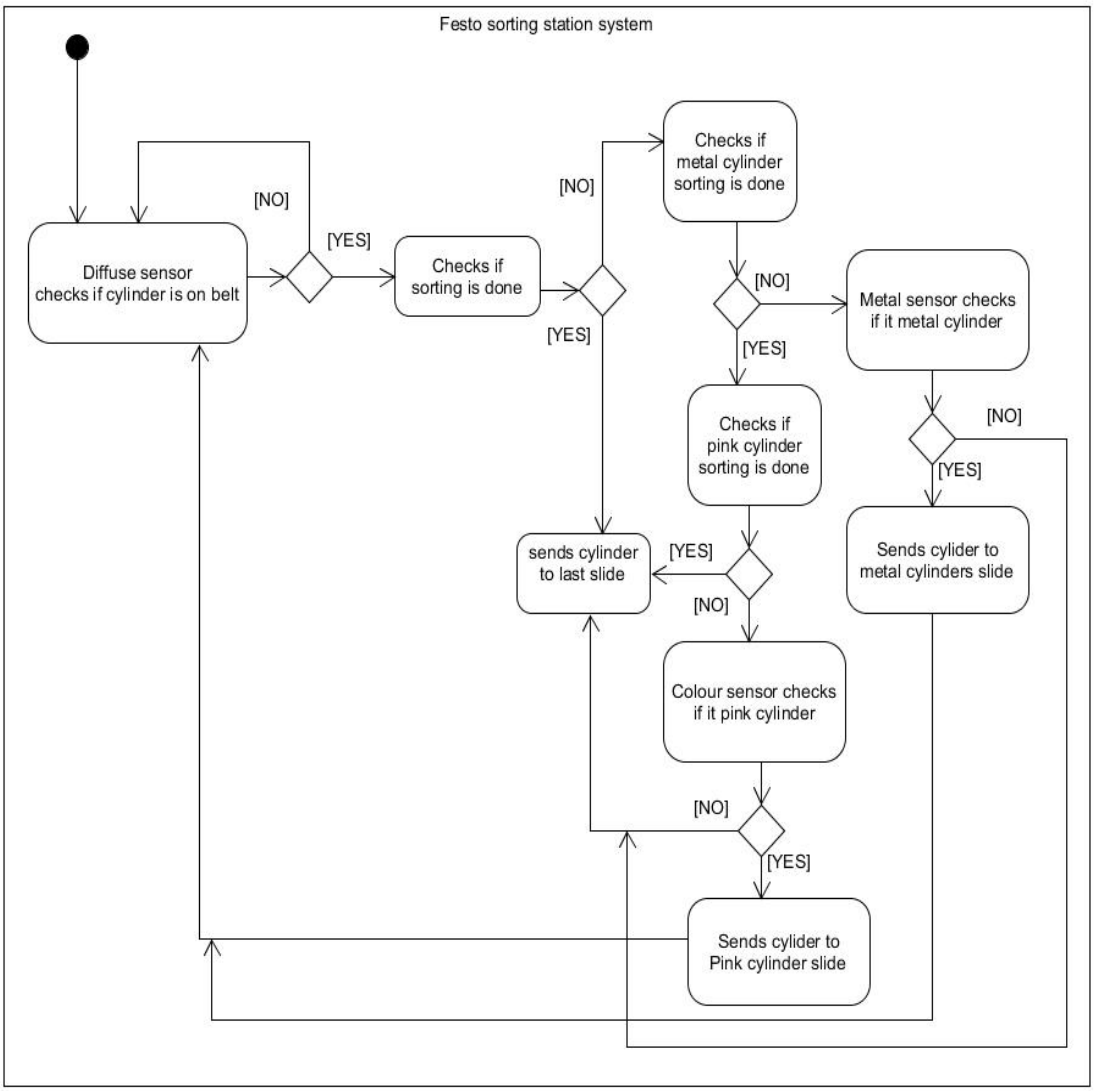


Figure 8: Flowchart of sorting station analysis logic

6 References

[1]https://www.arduino.cc/en/Tutorial/MasterWriter

[2]http://www.festo-didactic.com/int-en/learning-systems/mps-the-modular-production-system/stations/distributing-station-getting-started-with-mps.htm?fbid=aW50LmVuLjU1Ny4xNy4x

[3] http://www.festo-didactic.com/int-en/learning-systems/mps-the-modular-production-system/stations/sorting-station-finally.htm?fbid=aW50LmVuLjU1Ny4xNy4xOC42MDYuMzk0OA