Cover Page

MCT 331 (Design of Mechatronic Systems (1))

Report
(Full project integration)

Name: team 10

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Group: 2

Section: 1

Table of Contents & figures:

Table of figures

1. Introduction:

In this project we are focusing on doing a fully automated production line for products that the user choose. The production line is divided into 5 main stations, Feeding, assembly, sorting, disassembly, and handling. Every station is fully automated, no need for any human interaction in the production line unless the user want to turn on/off the system or specific station.

The integration of the project has been done as CAD model by taking the 5 stations, and arrange them in the desired way as the feeding will start and feed the parts to the assembly station, which works to install the product as one part, then it goes to the sorting station which determine where to put the product depending on its weight and store it for 30 sec. After that, the part goes to the last station, which is the disassembly, it mainly disassemble the product to its main parts and finally deliver it to the feeding mechanism.

After the CAD, we had to make the simulation of the integrated project, this was done using MATLAB and the contact library which was the heart of the simulation. finally, we have implemented the project on real life with all necessary tools (electronics, drivers, valves...etc.)

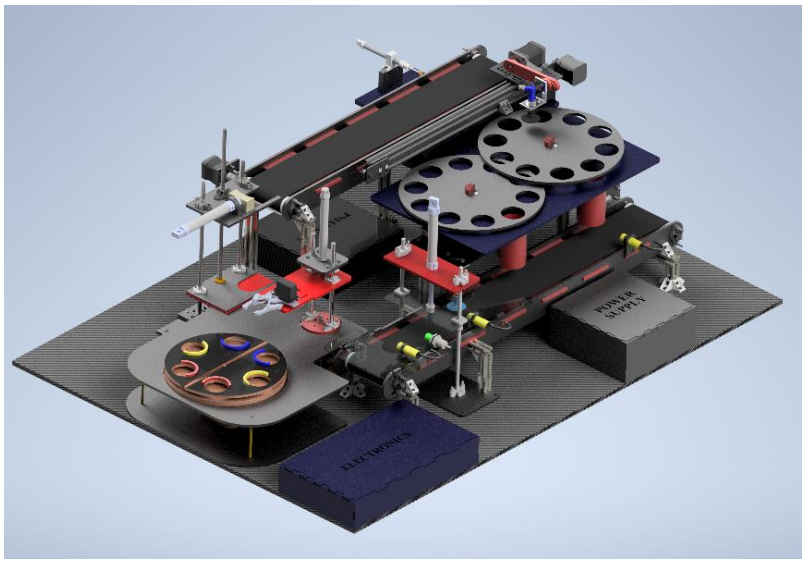


Figure 1: whole project

2. Design & Planning

The integration process was very important, also there were some design considerations that must be done in order to make a functional project with high efficiency and reliability. Firstly, we put all the stations together in one inventor file.

The 5 stations will be:

1. Feeding station

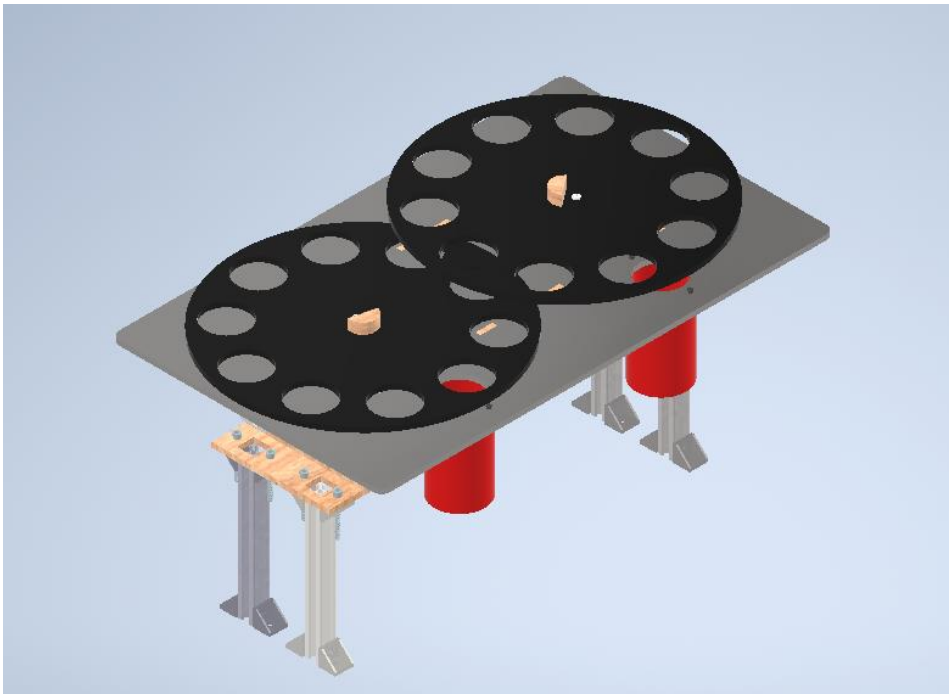


Figure 2 feeding station

Feeding subsystem is the subsystem tasked with the storing of un-assembled parts and adding them to system when needed, it also receives parts from disassembly to complete loop of project.

Parts received from disassembly are placed in slots labeled 1. Parts are stored on periphery of rotating plate one plate carries one half of product while the other part is carried by the other plate, (parts stored in areas in rectangles shown).

2. Assembly station

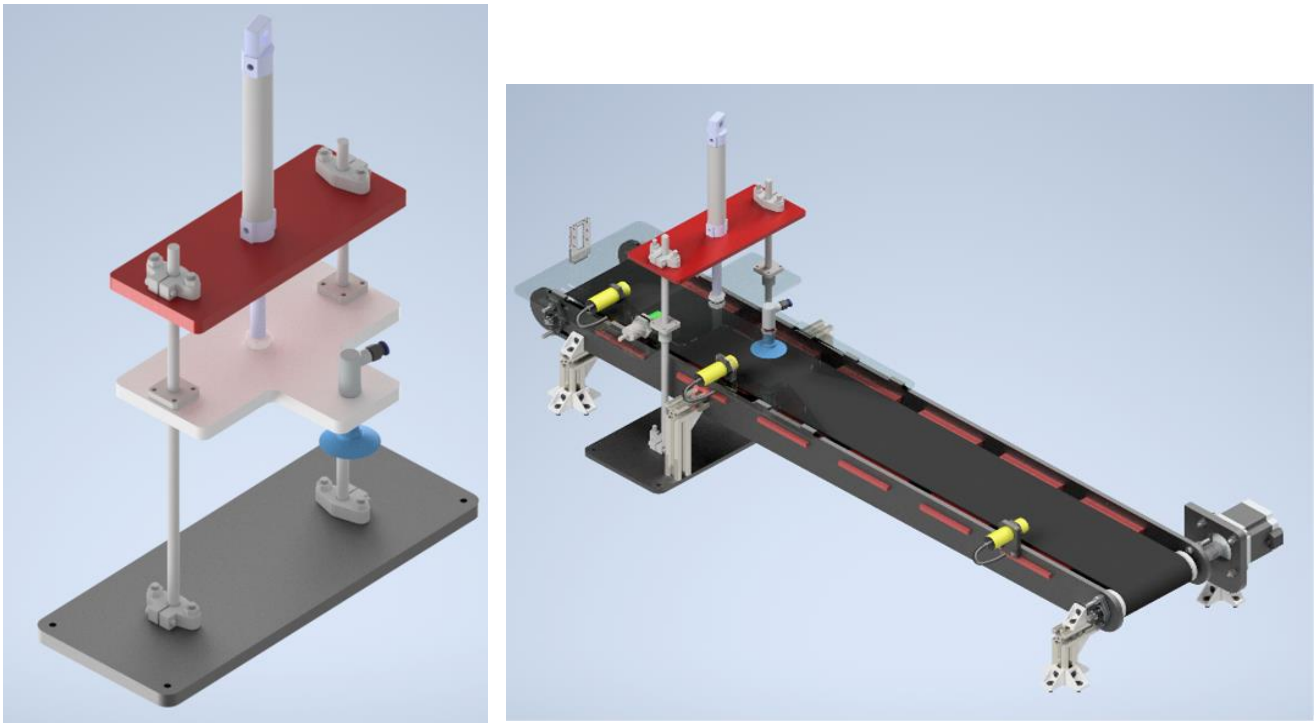


Figure 3 assembly station

The assembly station objective is to assembly the parts which is received by the belt from the feeding station, and the mechanism will be done using mainly suction cup and pneumatic cylinder as a motor, as shown in the figure above.

The pneumatic cylinder goes up and down with the help of 2 rods which guide the motion and 2 linear bearing. It is attached to the fixed table to hold it, the rod in pneumatic cylinder connected to the sliding table which have the suction cup in it, so the suction cup goes up and down at end.

3. Sorting and storing station

Figure 4 sorting and storage station

This subsystem Responsibility is to detect the assembled product on the assembly line, and successfully grab it and move it to the storing area according to its type. The storage time is 2 minutes but for the simulation we stored it for 10 seconds to save rendering time. After the product is stored, it was then moved to the handling elevator to reach the disassembly line.

For such system at least 4 degrees of freedom was required. And to limit the degrees of freedom for a single moving part we designed the storing area to have its own degree of freedom. So rather than the object going to its storing area. The storing position will be set to the product using a splatted indexer as the storing area. Each side of the splatted indexer holds a different type of product.

4. Handling station

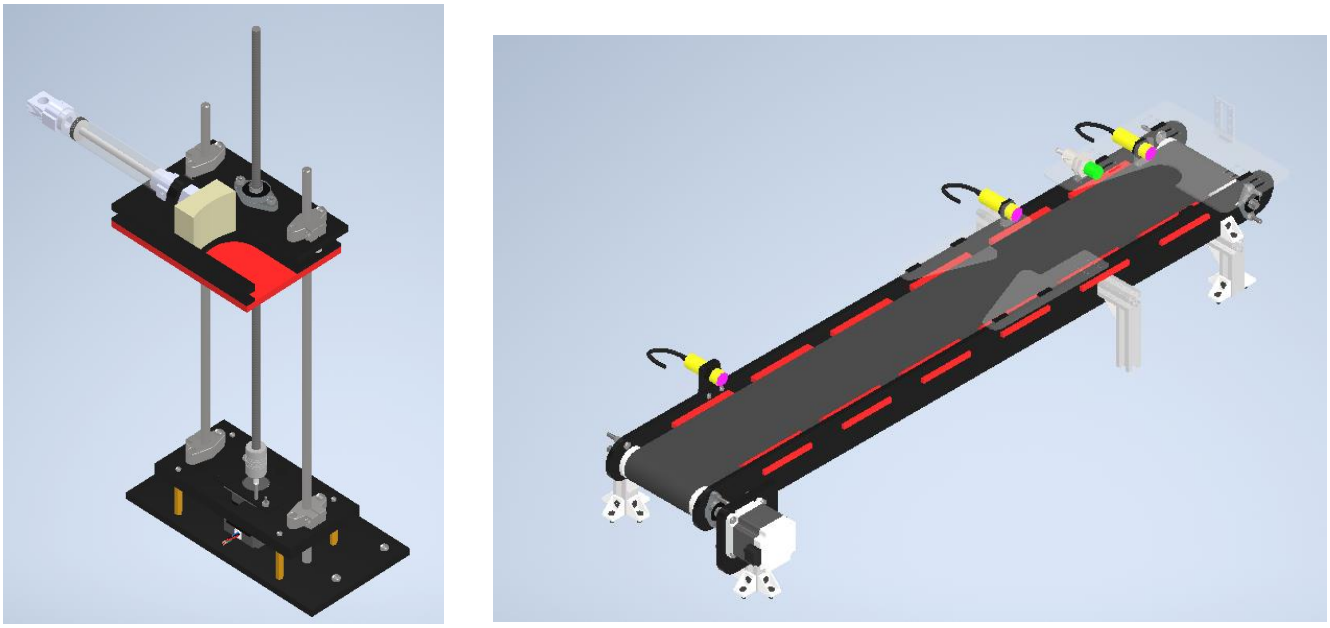


Figure 5 Handling station

This subsystem Responsibility is to connect all 4 stations together. The Handling subsystem consists of three parts. First part is the assembly line (lower conveyor), second part is the elevator, and the third part is the disassembly line (upper conveyor).

The main part in handling subsystem is the elevator which focuses on lifting the product for the storing station to the disassembly line.
The lower conveyor moves the product from feeding station to assembly station then to storing station and the upper conveyor moves the part from elevator to disassembly station then back to feeding station connection all 4 stations together.

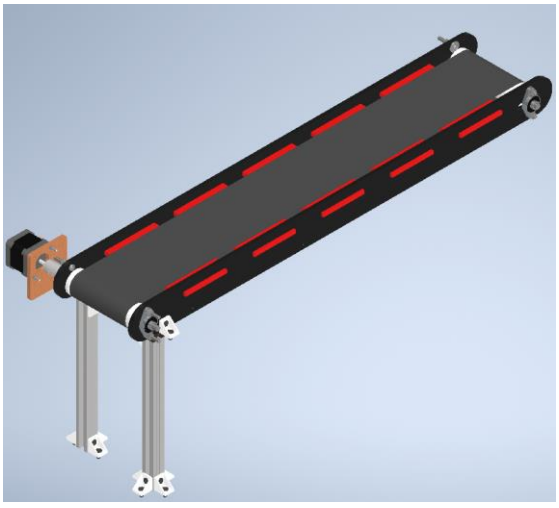


Figure 6 conveyor for disassembly

5. Disassembly station

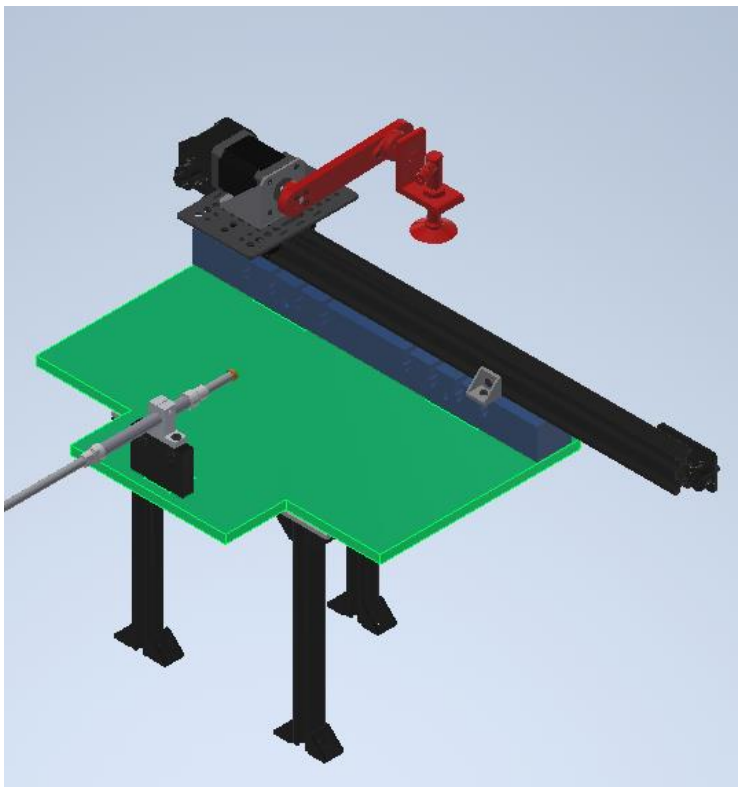


Figure 7 disassembly station

The disassembly station is responsible of dis assembling the product, transporting, and passing it to the feeding system.

The station consists of:

- 2 NEMA17 motors
- 1 suction cup
- V slot and gantry plate
- Pneumatic piston
- Acrylic arm

This system has 2 degrees of freedom provided by the v-rail and the arm.

Overall integrated system

This is the final model for our project, after editing some spaces, designing more complicated design to make our dimensions less than we expected, also we have added all manufacturing considerations into account and drivers and pneumatic boxes, at the end we will do a comparison between the model we designed and the real model we have done.

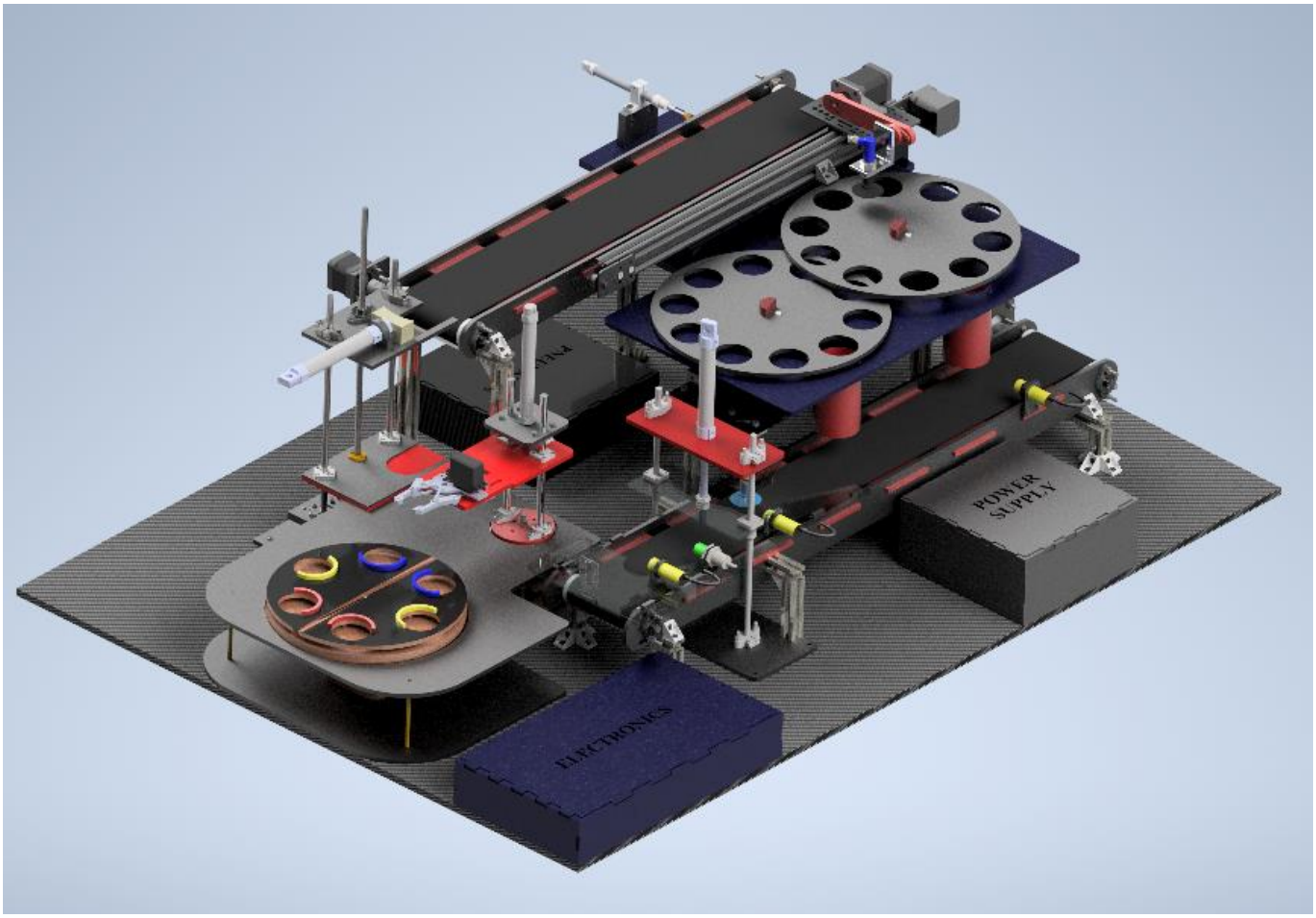


Figure 8 integration of all systems

3. Inventor (CAD)

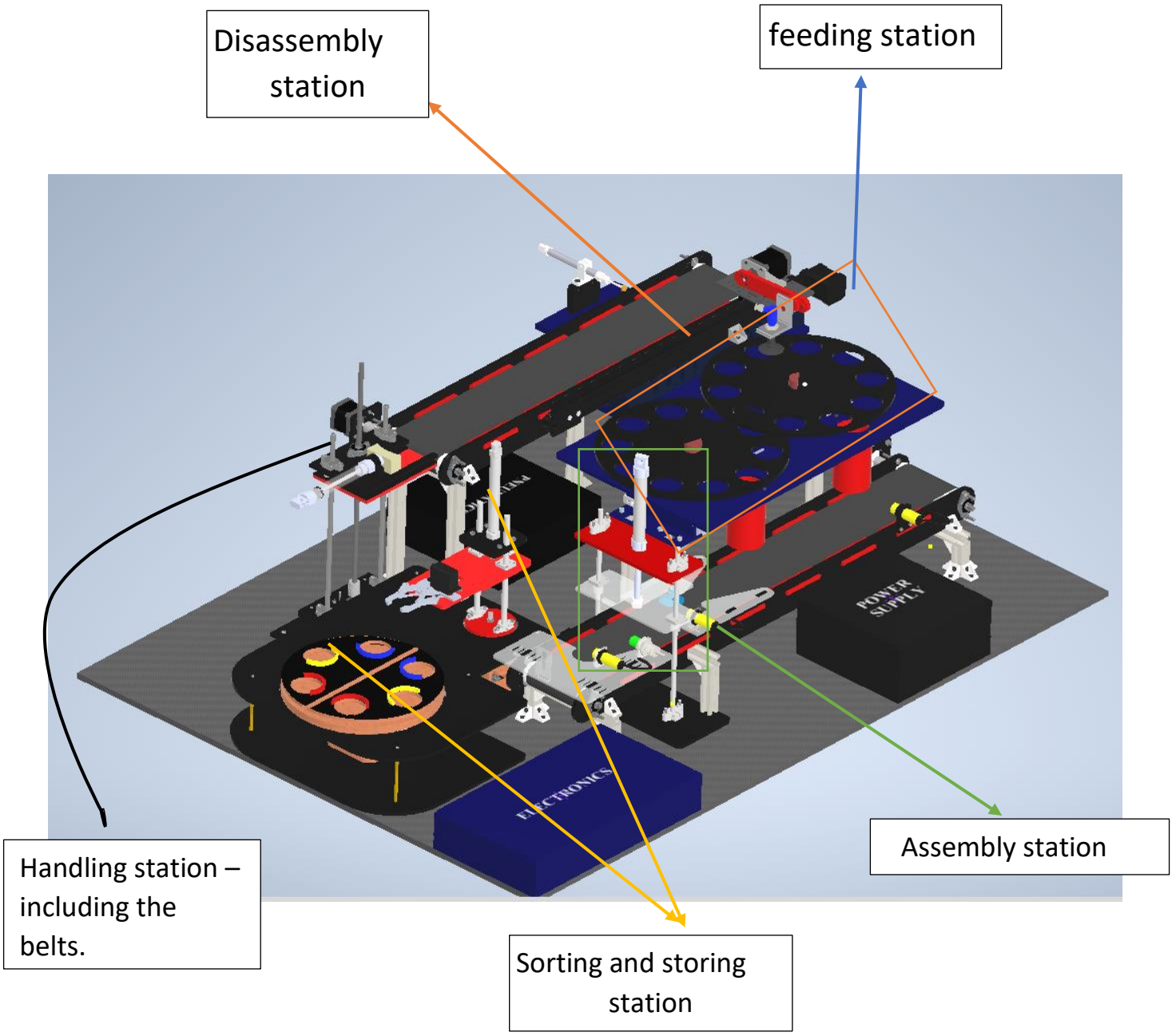


Figure 9 Inventor model integrated with all design and manufacturing considerations

4. MATLAB and Implementation

The implementation of all 4 subsystems in one MATLAB multilink file were provided by :

Dividing the whole project to five stations in MATLAB to provide better efficient, organizing system

SORTING AND STORING STATION

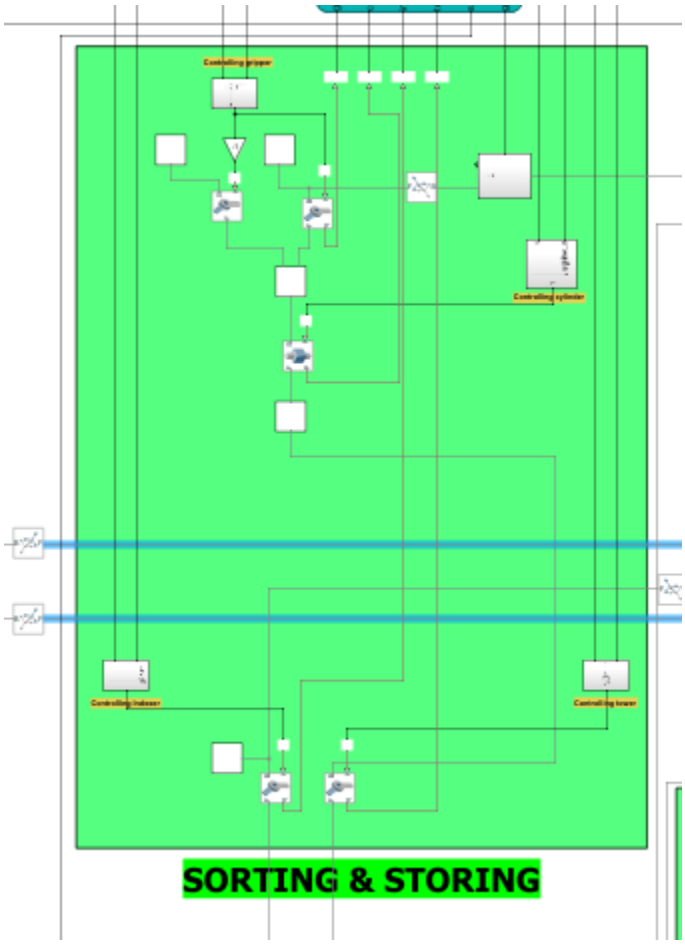


Figure 10 sorting and storage Simulink

FEEDING STATION

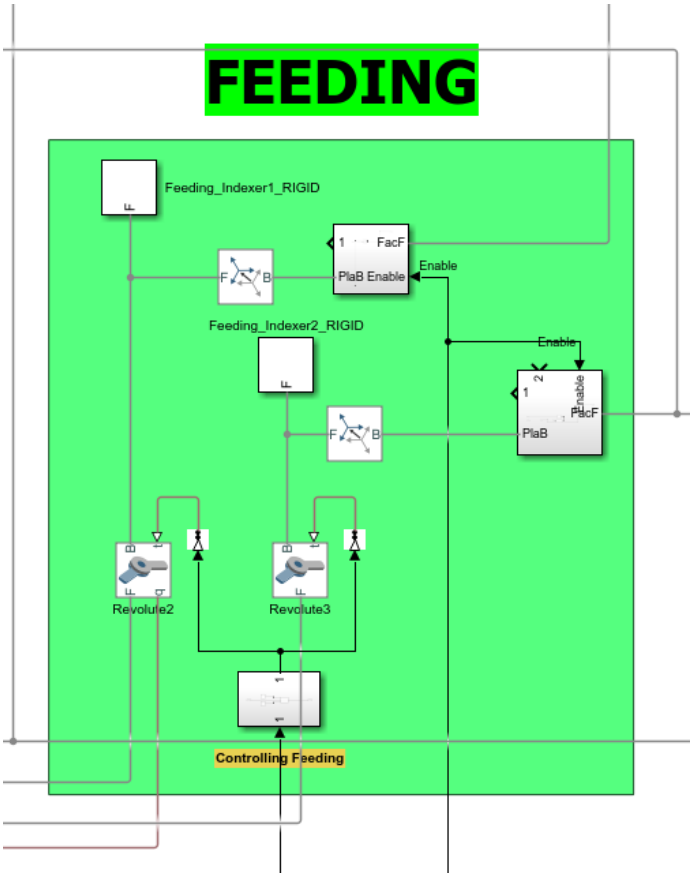


Figure 11 feeding Simulink

ASSEMBLY STATION

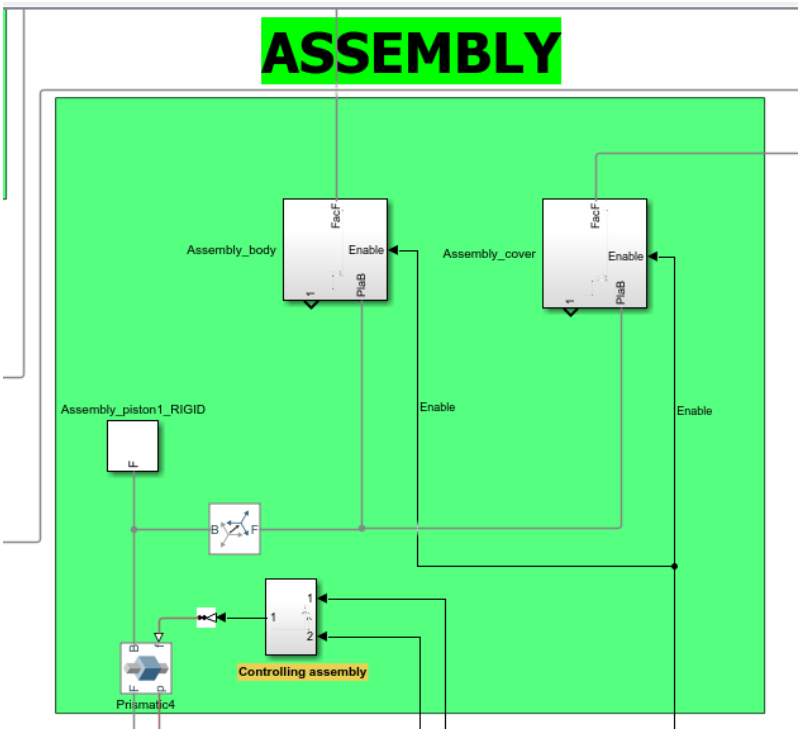


Figure 12 assembly Simulink

HANDLING STATION

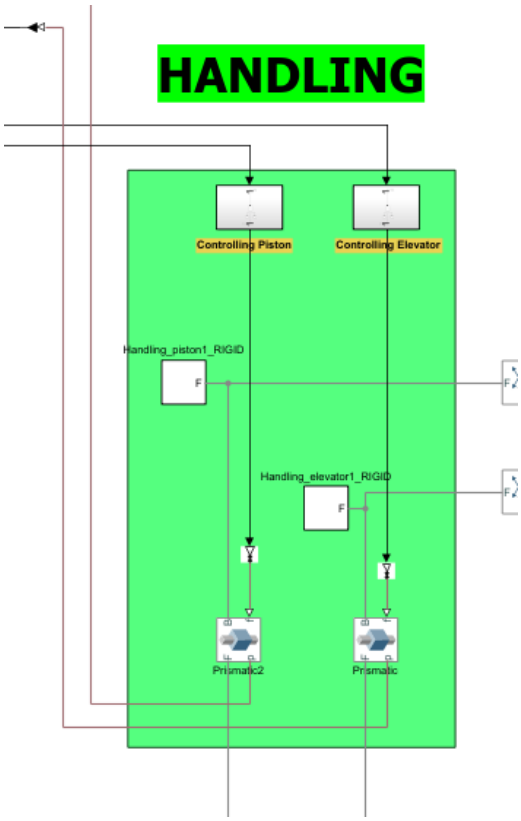


Figure 13 handling Simulink

DISSASSEMBLY STATION

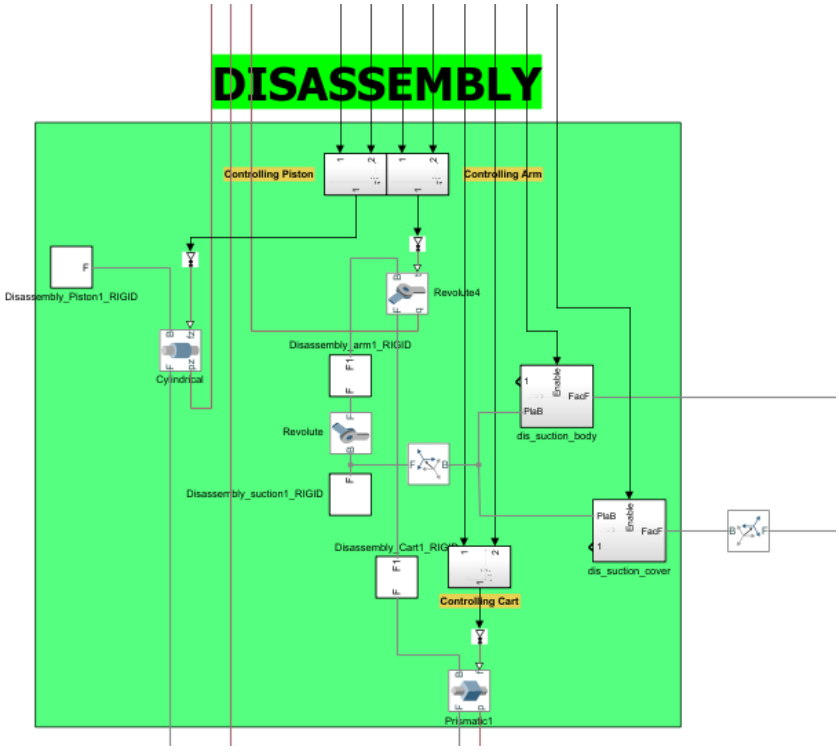


Figure 14 Disassembly Simulink

Implementing 3 major flow charts

Implemented to control the feeding and Assembly stations

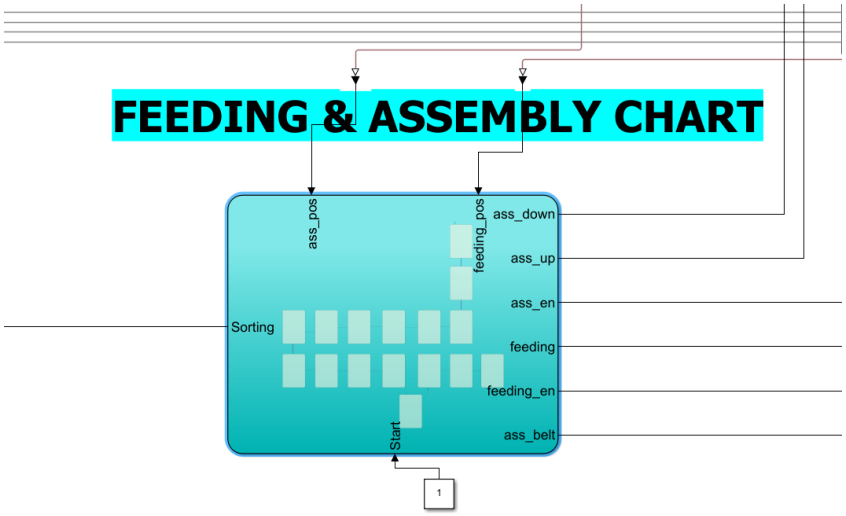


Figure 15 Flowchart of feeding and assembly stations

Implemented to control the Handling and Disassembly stations

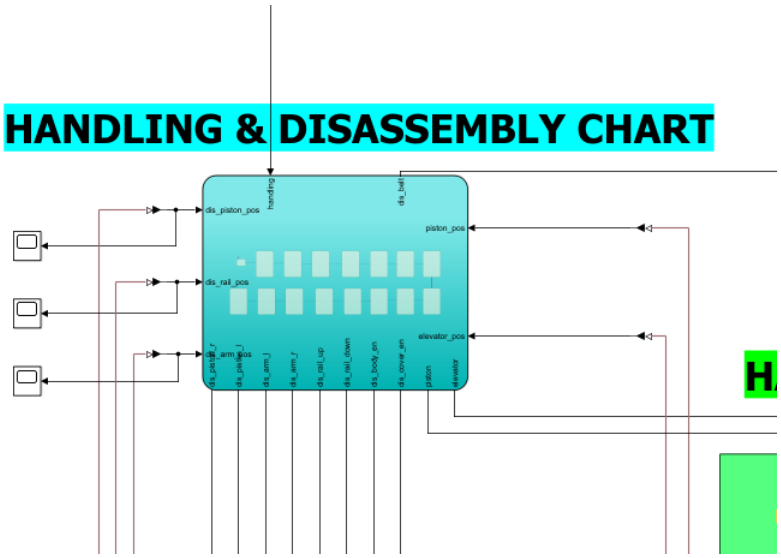


Figure 16 flowchart of handling and disassembly stations

Implanted to control the sorting and storing station

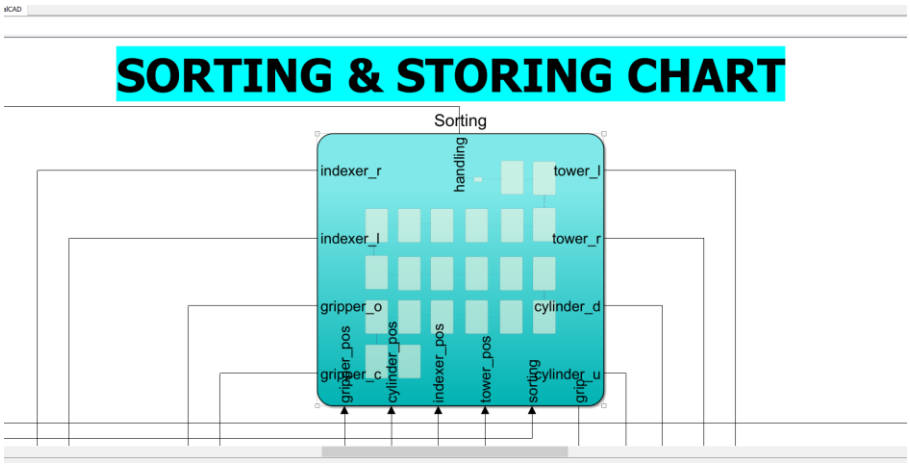


Figure 17 flowchart of sorting and storage flowchart

WHOLE MATLAB DESIGN

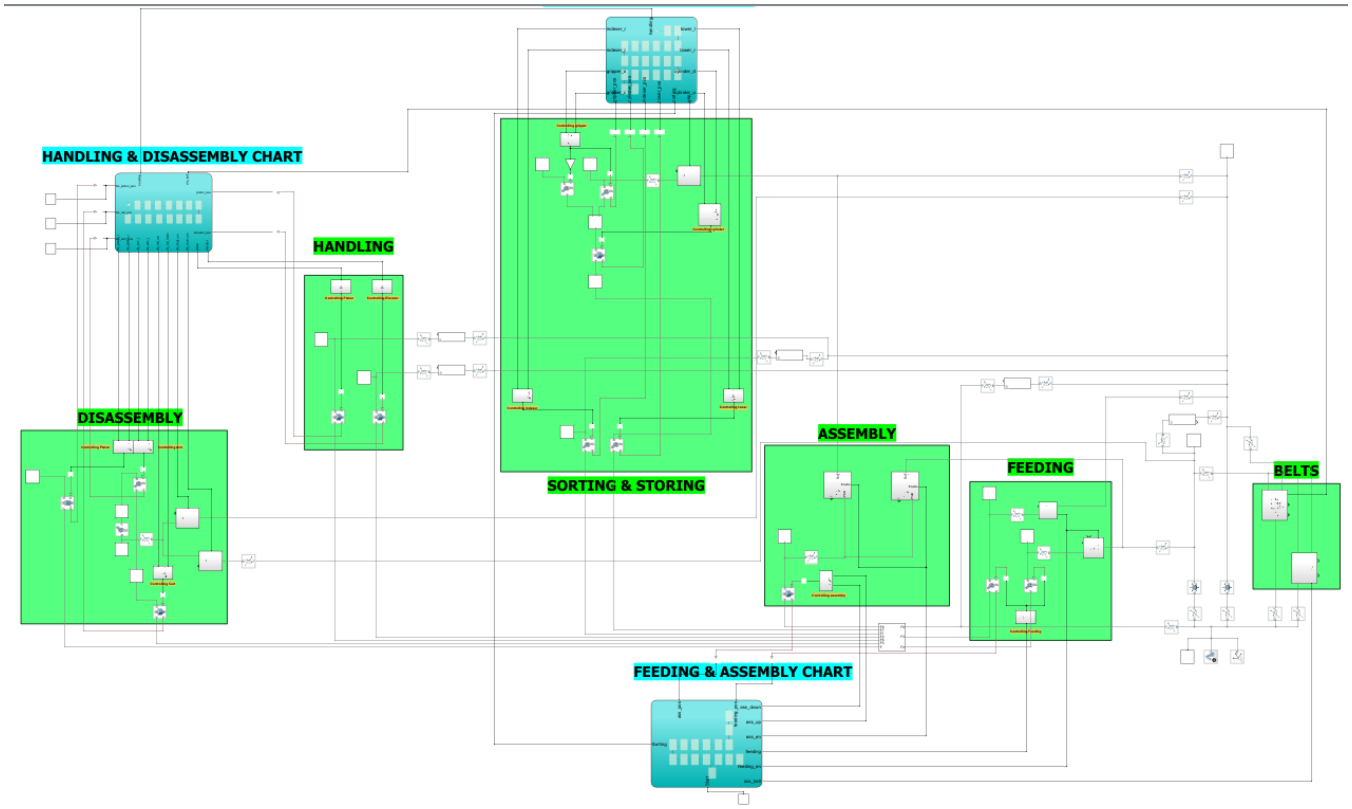
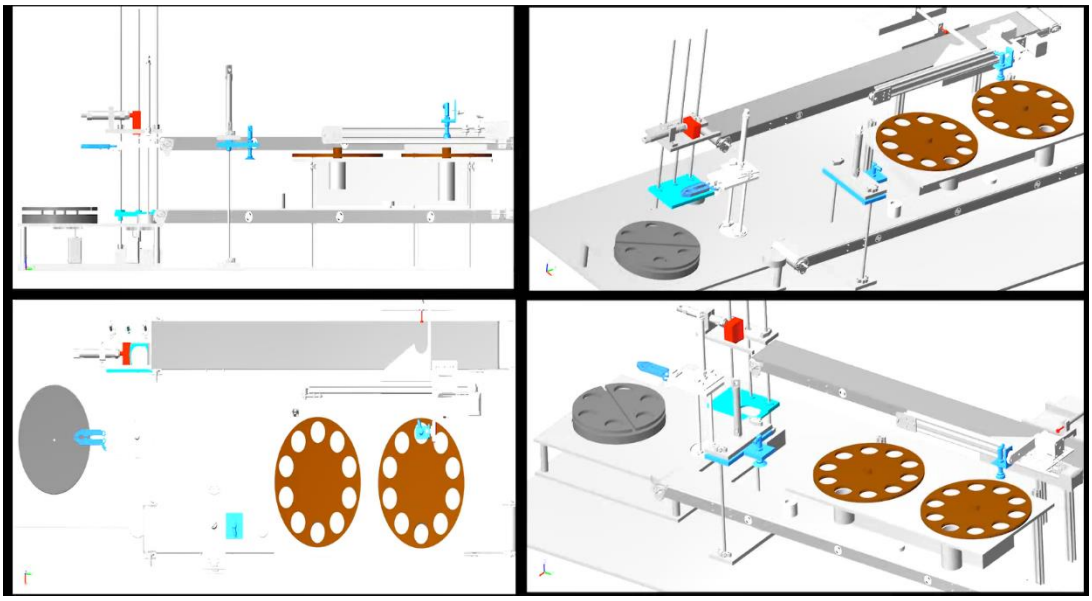


Figure 18 full integrated system flowchart

SIMULATION AND RENDERING



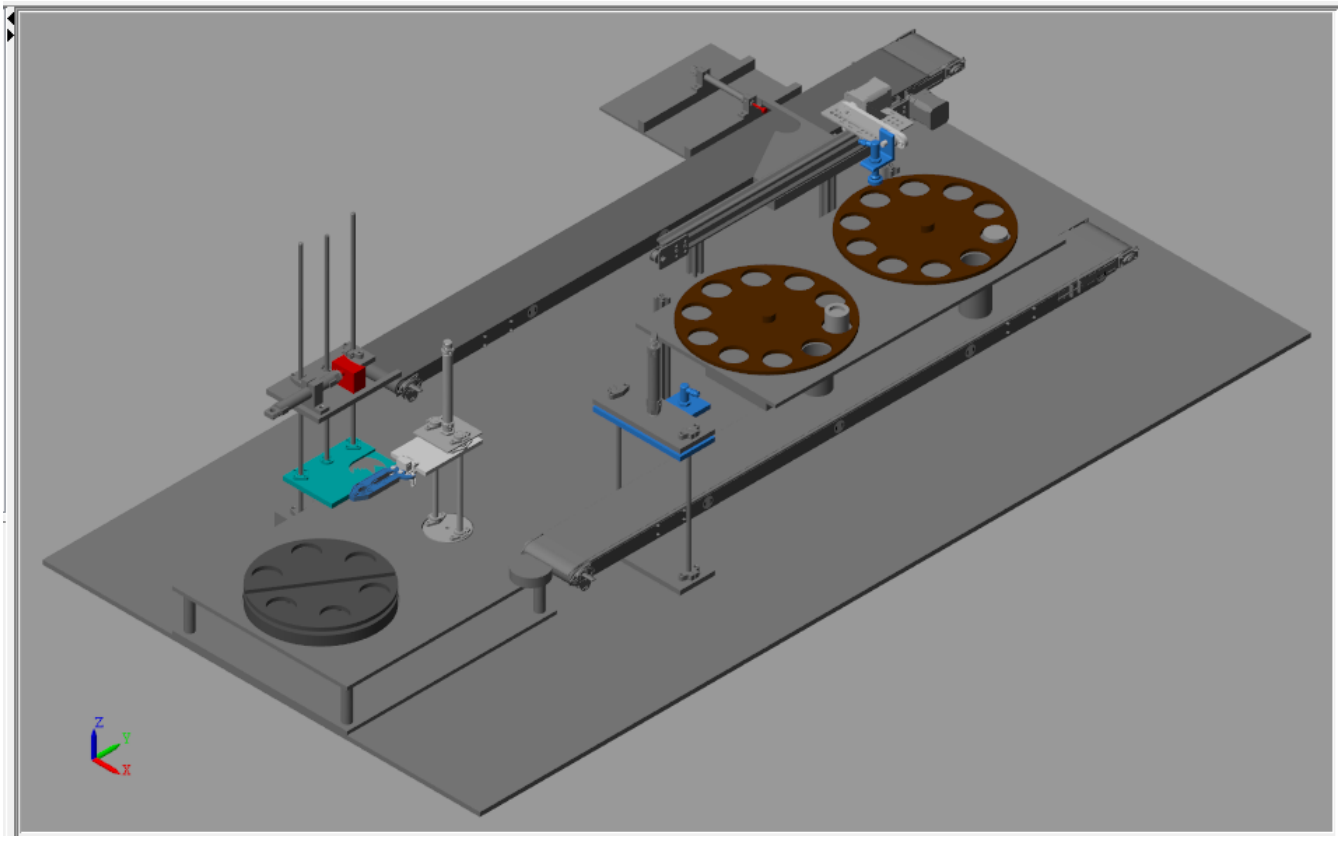


Figure 19 MATLAB simulation

5. Real model implementation

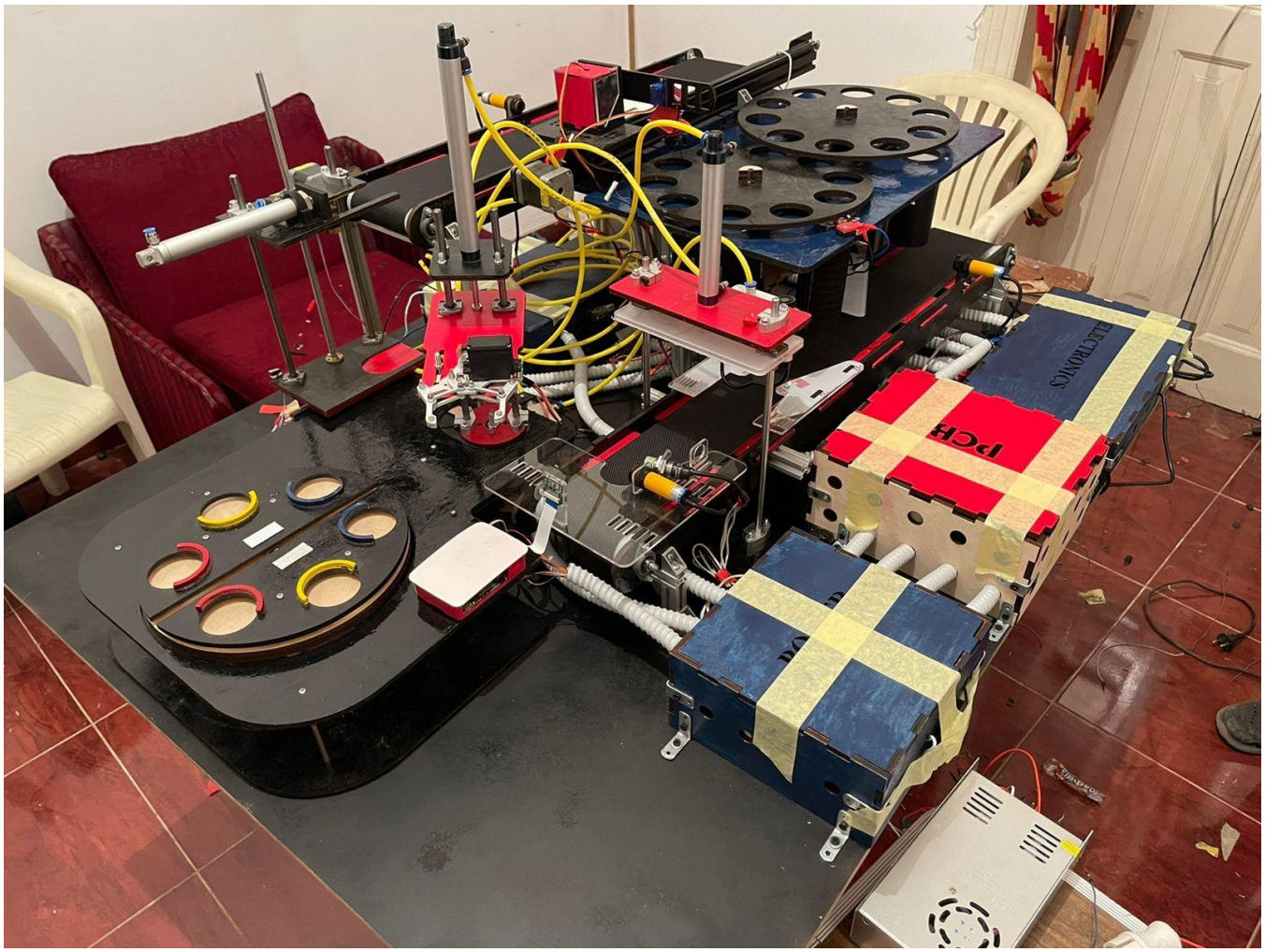


Figure 20 Isometric view of the physical integrated system

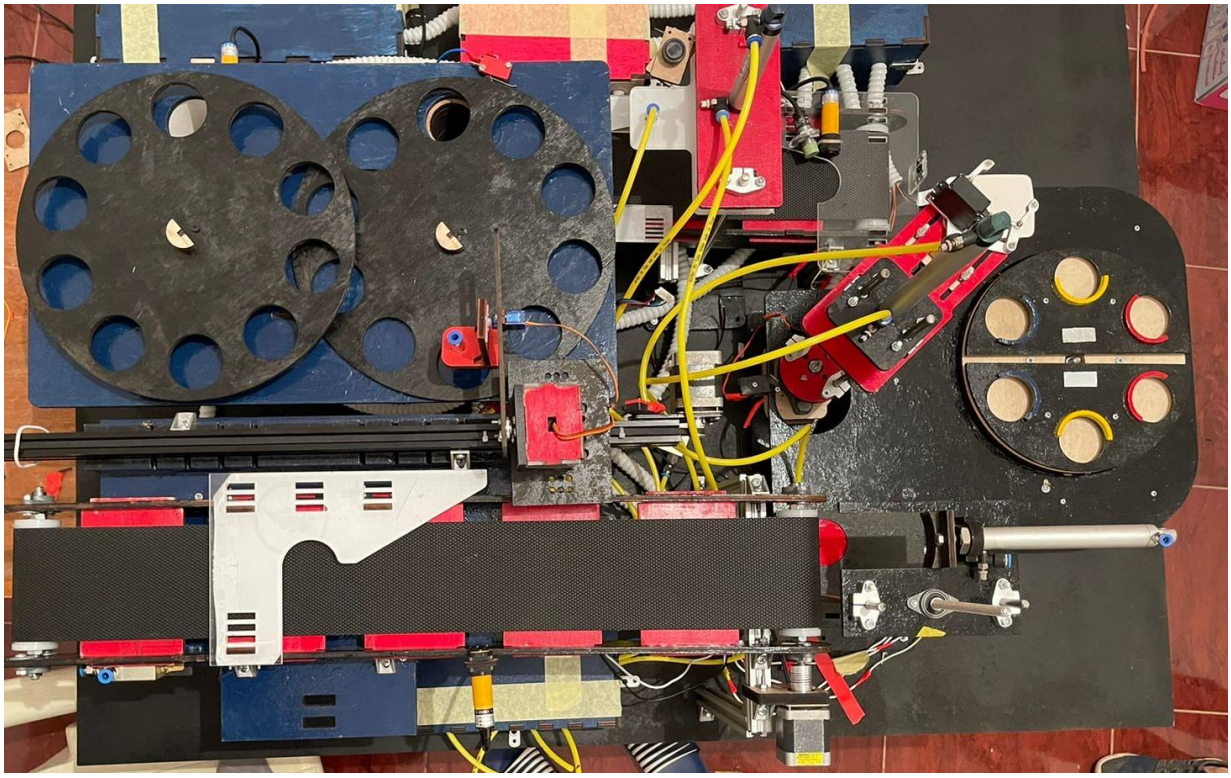


Figure 22 Top view of the integrated system

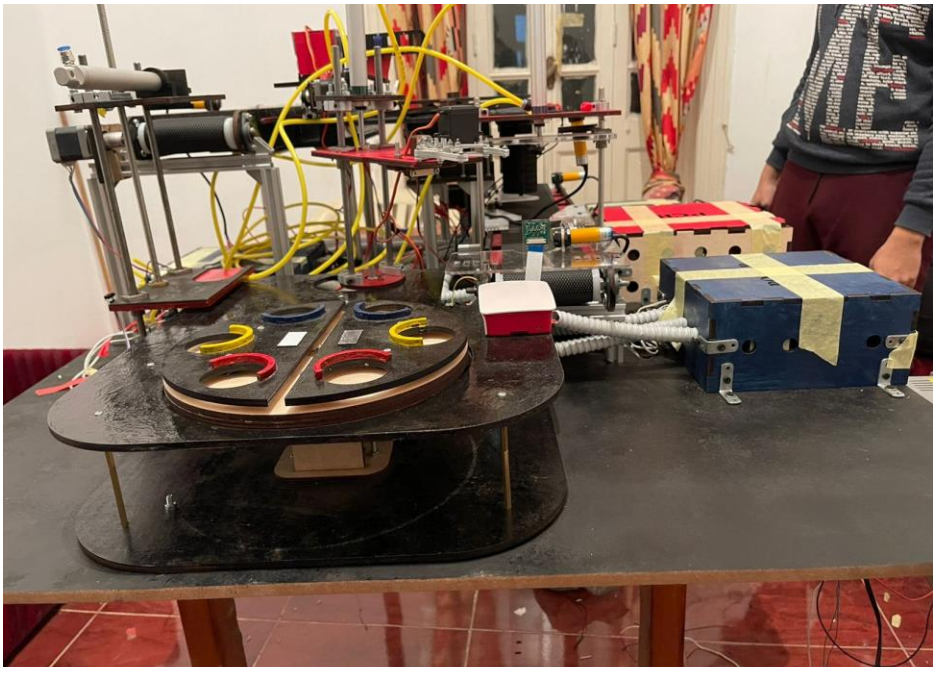


Figure 21 Elevation view of the integrated system

6. PCB circuit

For the whole project we have designed two PCB circuits, one for the drivers, motors, and sensors, second one for the relays and pneumatic valves

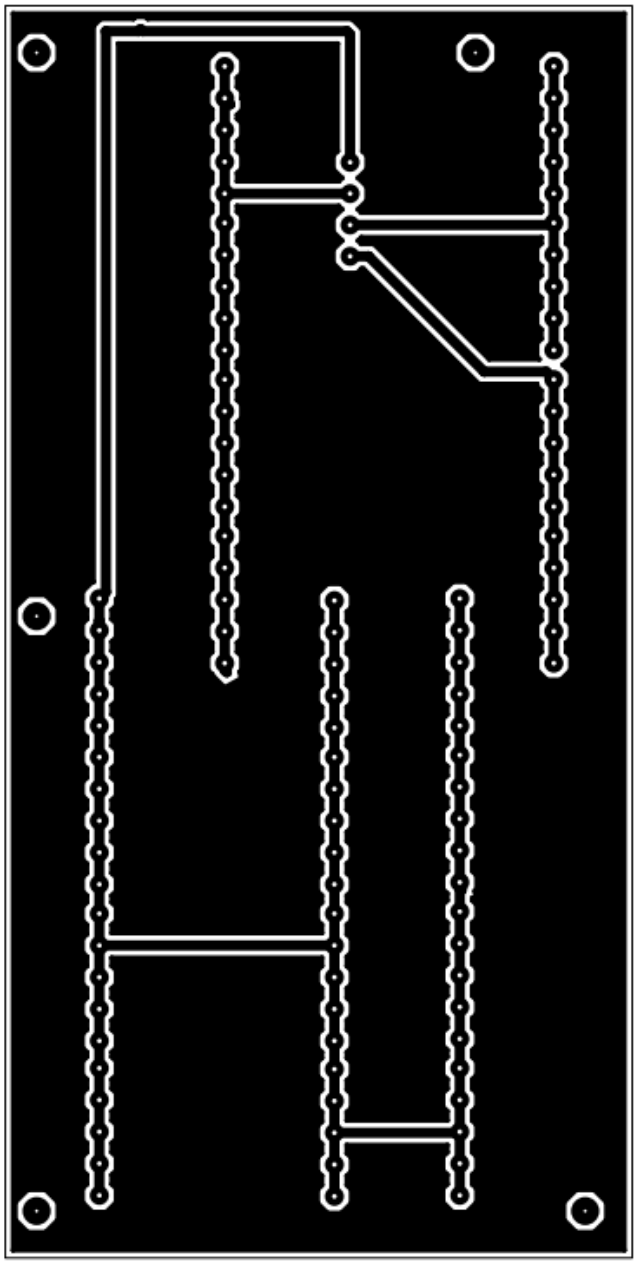


Figure 23 motors. drivers, and sensors PCB

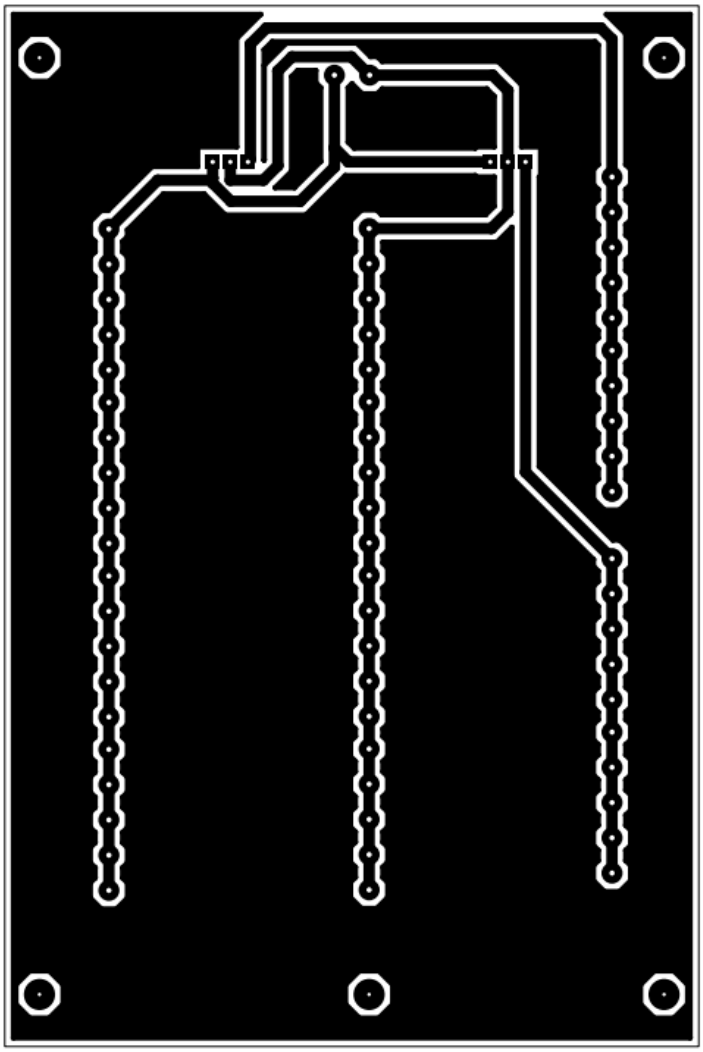


Figure 24 Valves and relays PCB

7. PCB box

In order to organize the project, we have made several boxes to gather the wires, drivers, and PCB circuit, this design helped us to communicate between Arduinos, know the designation of wires, and its comfortable to the eyes to see it in that way, rather than custom wires every ware.

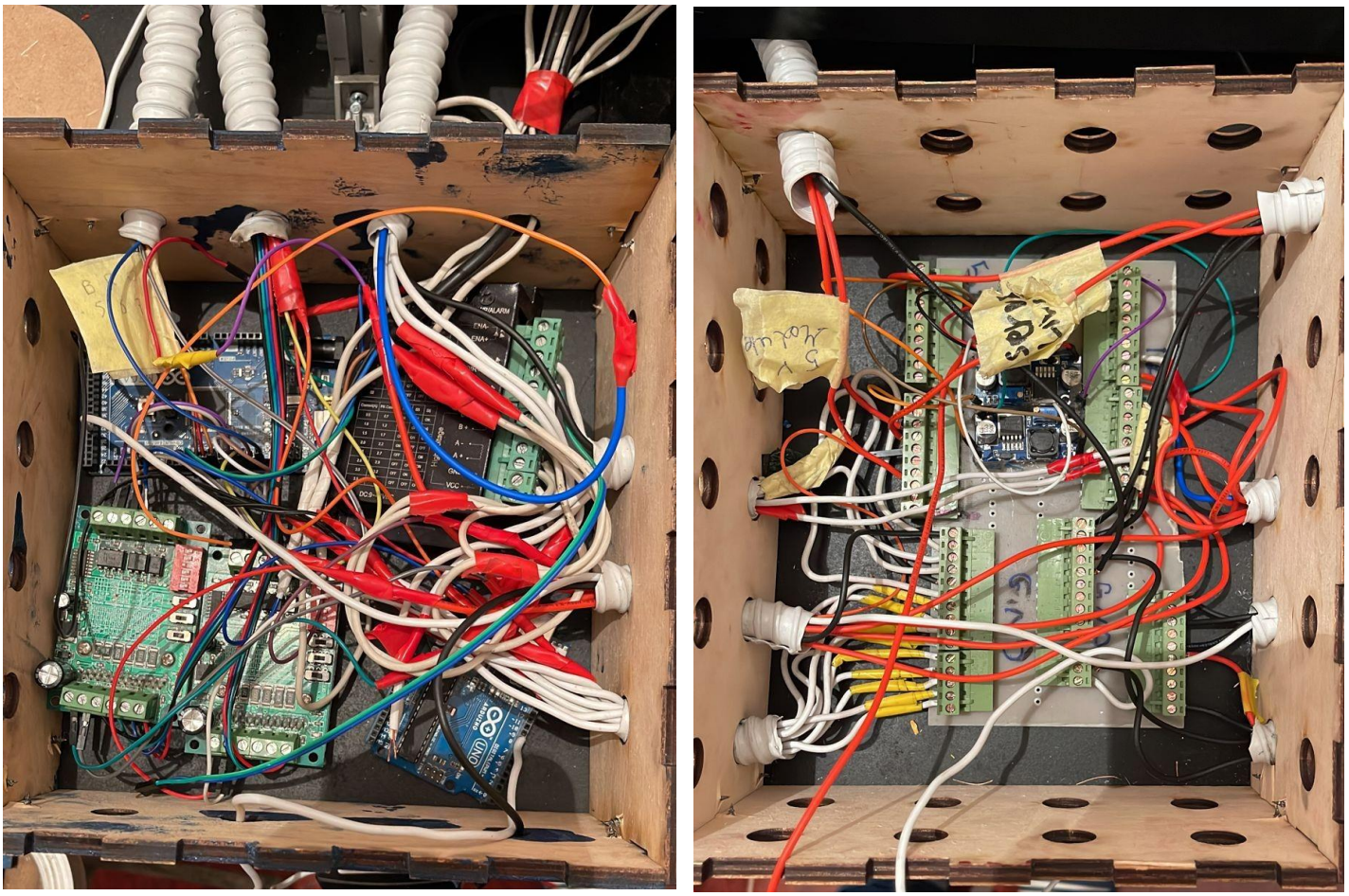


Figure 25 PCB and drivers boxes

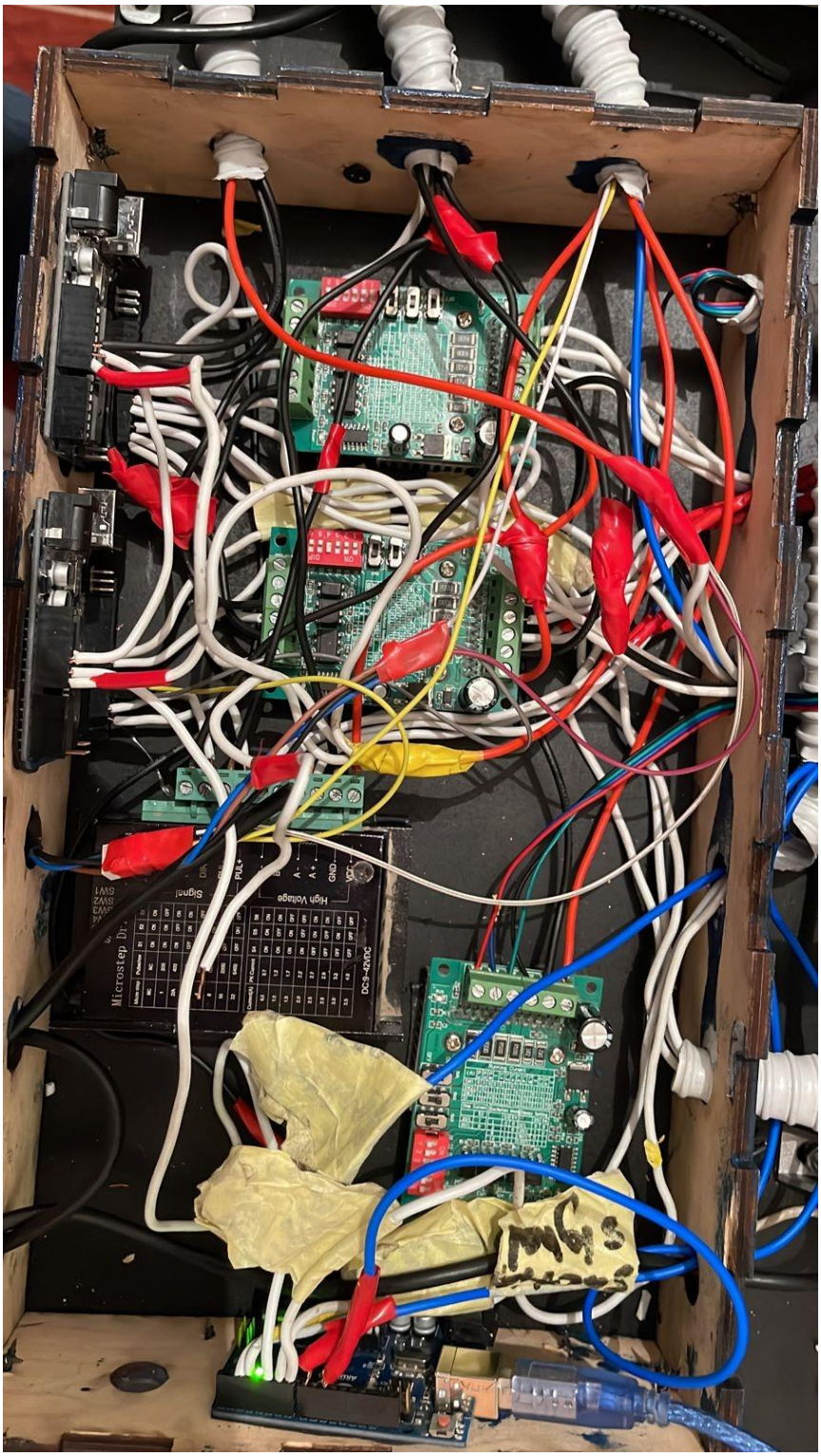


Figure 26 Arduinos and drivers box

8. Comparison between inventor & physical model

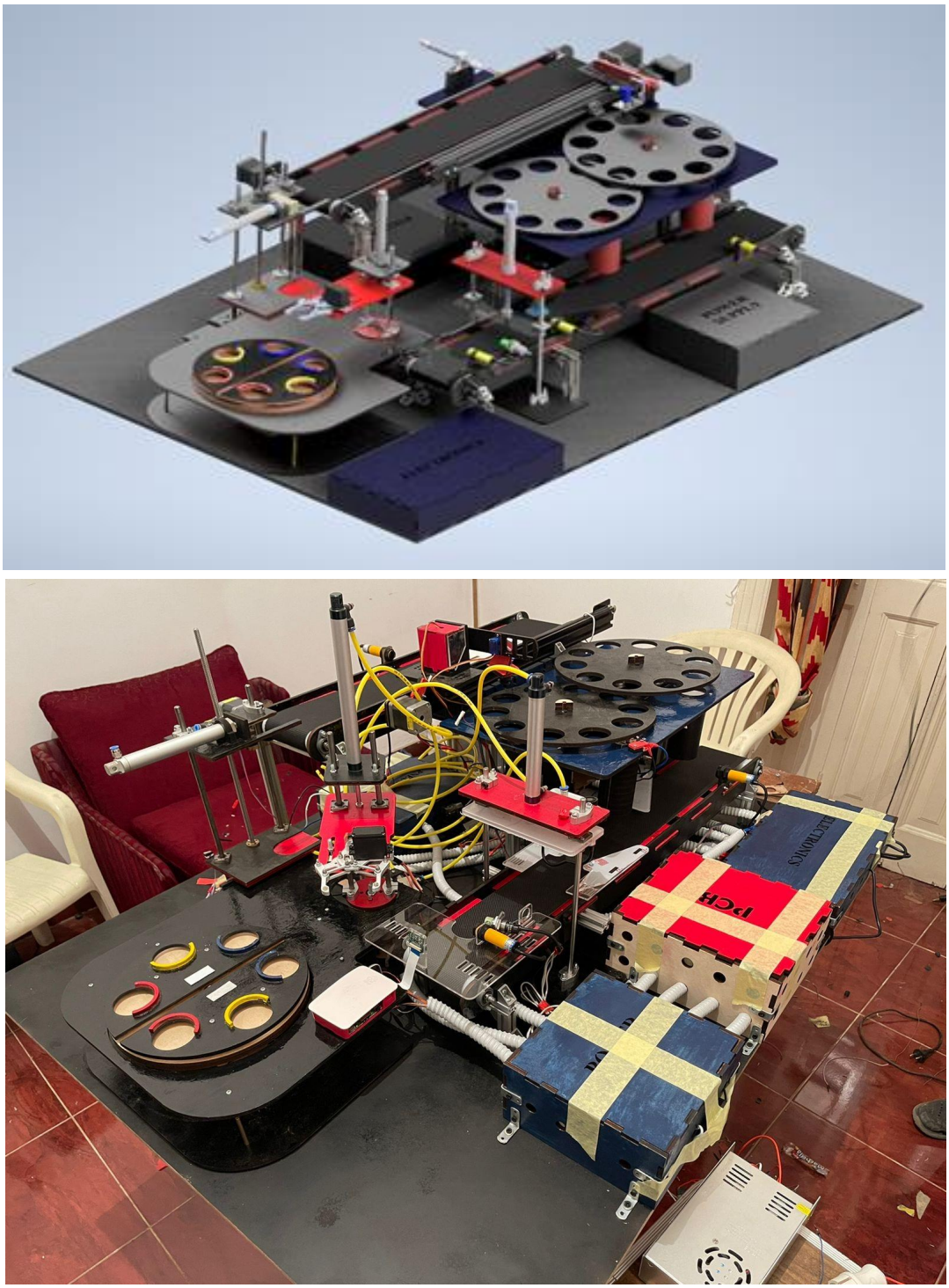


Figure 27 Comparison

9. Conclusion

The design of our project we took a great care to design it with a precise, neat, stable consideration while also maintaining a high degree of performance and smoothening the assembly.

In simulating the system, we made sure to make a complete cad, MATLAB design with all consideration taken care. We managed to export it to MATLAB and make a full simulation showing the full loop of the project and showing the working of each sub system. Also, we have managed to implement all the stations while taking all design considerations into account, we have implemented full integrated production line like the one we have designed on inventor with the same dimensions and all considerations. We tried to design the system to be functional, fast, reliable, and fully automated. Finally, we have done our best to make such a project, we have invested our time to make this project work in order to gain experience, knowledge, and patience. This project took long time of preparations, designing, mechanical implementation, integration between systems, and electrical components wiring and coding. As a result, we hope you enjoy the project, thanks.

Links

Links for the drive MATLAB files:

https://drive.google.com/file/d/1kvXBJaGvtwkVziaI_vwVBq7oY5nGND11/view?usp=sharing

MATLAB working video of integration:

https://drive.google.com/file/d/1T1485rbemU_uV8iE6q8tKz7_7_EZT7Yq/view?usp=sharing

Inventor files for all stations and Integration:

https://drive.google.com/drive/folders/15ZrVXAsuo83w8cjc84_bn6pUQt00nwBw?usp=sharing

links for working stations:

https://drive.google.com/drive/folders/1gfmOJBO050DP0d0uHqaJglNTzCbdD_J4?usp=sharing