Final Report - Group 17

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ME-320 : Product development and engineering design

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Summary of the Approach

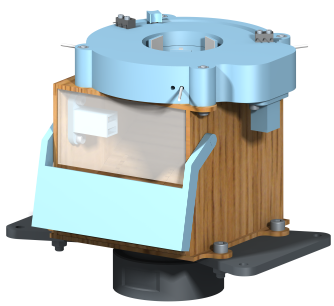

Figure 1: 3D version of the gripper

Our final decision was the IRIS mechanism clamp that could efficiently and quickly harvest as many intact ripe raspberries as possible. The concept behind the mechanism -mainly used for photographic lenses- makes full use of 3 points of contact with the fruit, providing a steady yet soft clamping.
The robot arm positions the gripper beneath a raspberry, centering it with a 1 cm clearance. When activated, the gripper's three sliders close simultaneously, securing the berry without damage, thanks to a pressure pad. Conductive tape on the sliders then measures the berry's resistance to assess ripeness, with a threshold of 500kΩ separating unripe and ripe fruit. If an unripe berry is detected then the sliders open automatically whereas if we have a ripe one it is harvested with a downward movement of the robotic arm detaching it from its stems and dropping it into a custom-made basket. A button-controlled mechanism later empties the basket into a communal container when a sufficient amount of raspberries has been gathered.

Sensors and Functional Features

1. **Pressure Pad:** Attached to one slider, this sensor is calibrated to 900 units of pressure, determined through trial and error. It prevents over-clamping while ensuring sufficient force to detach the berry.
2. **Limit Switches:** Three limit switches safeguard the mechanism:
   - Two switches monitor the sliders, stopping the motor when fully open or fully closed without a raspberry.
   - One switch controls the basket door, stopping the motor when the door is fully closed.
3. **Conductive Tape:** Positioned on two sliders, this tape measures resistance for ripeness detection, enabling efficient sorting of berries.

Materials and manufacturing To maintain cost-efficiency and sustainability, we selected recyclable materials and simple manufacturing techniques:

- **3D Printing with PETG:** Used for the sliders, the gripper base, and the basket door, PETG ensures durability and stability.
- **Laser-Cut MDF:** Chosen for the custom-made basket, MDF provides structural integrity and is eco-friendly.

Sustainability & Scalability

The gripper we designed is highly sustainable, as it can be manufactured using recyclable materials. Additionally, it is easy to dismantle and reassemble, allowing for simple replacement of any broken components, which can be readily reproduced using 3D printing.

What would we change for mass production:

- Currently used **PETG can be replaced by the more eco-friendly PLA** which is made out of sugarcane since the operating temperatures won't be that high to affect the functionality of PLA.
- We could **optimize the geometry to use less filament** thus making it more cost-efficient.
- We could **redesign some parts so that they can be laser cut** which is less expensive than 3D printing (for mass production).

Reflection on the design

Harvesting went as planned. We collected 7 ripe berries and correctly identified 14 berries as ripe or unripe. The ripeness identification process went exceptionally well since it was accurate and fast. What we would change for future use would be the motor rotation speed, as it was not as fast as we hoped, and the mounting point on the robot, which would ultimately change our personalized basket's style.

Literature/Patent Search

The design is original; therefore, we could not find many registered patents resembling our gripper. The following patents implement the IRIS mechanism for gripping purposes or in general.

- **US 10710247** is a very similar concept of a gripper using the IRIS mechanism; however, the design and functionality are different.
- **JP 2005249812A** is a registered patent for camera lenses that use an IRIS mechanism with a similar design to ours.
- **JP 7525922B2** is again a gripper implementing the IRIS mechanism like ours.

Final Gantt Chart

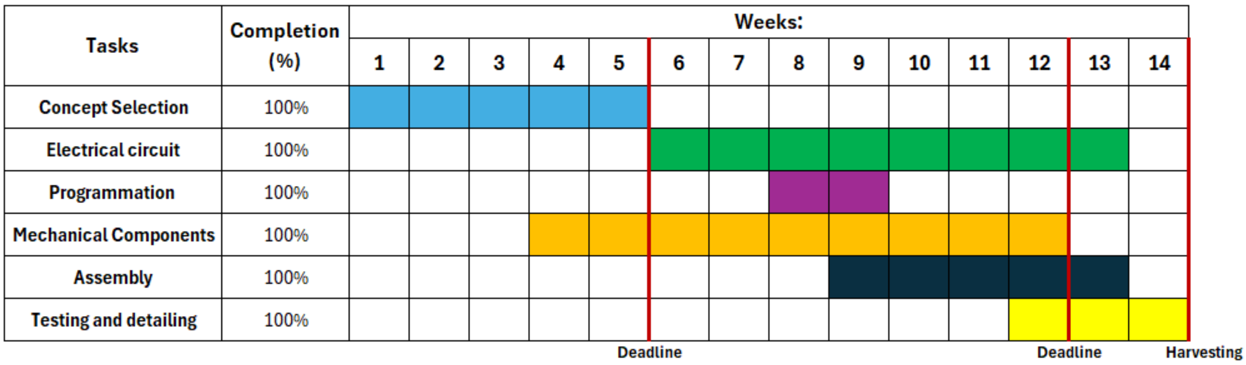

Figure 2: Final Gantt Chart

Compared to our initial plan, we have spent more time on electrical circuits, mechanical components and the assembly of the two. This was because we had new ideas on improving and optimizing the design as we started to assemble the gripper. This increase in workload was compensated by a programmation part that took less time than anticipated.