University of Southern Denmark
Mærsk McKinney Møller Institute

3. Semester - Master in Advanced Robot Technology

PiR - Hydrovertic

Kode: RM-PR **Robotics Team 1** **Date: 21-12-2023**

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1 Assignments

1.1 Flow

1. Tray in
2. Detect tray
3. Move tray into fixture
4. push down into fixture
5. Take pot
6. Insert plant
7. Place pot with plant
8. When all is complete, remove tray and replace with a new one.

1.2 Todos

- Introduction (Ibrahim)
- Setup robot (Ibrahim and Kasper)
- Create fixture for tray (Tobias)
- create cupholder (Emil)
- setup camera (Steffen)
- make robot program (Adam)

Abstract

Keywords: Simulation, admittance control, Trajectory Control, Blend of Several Robot skills.

2 Problem Description

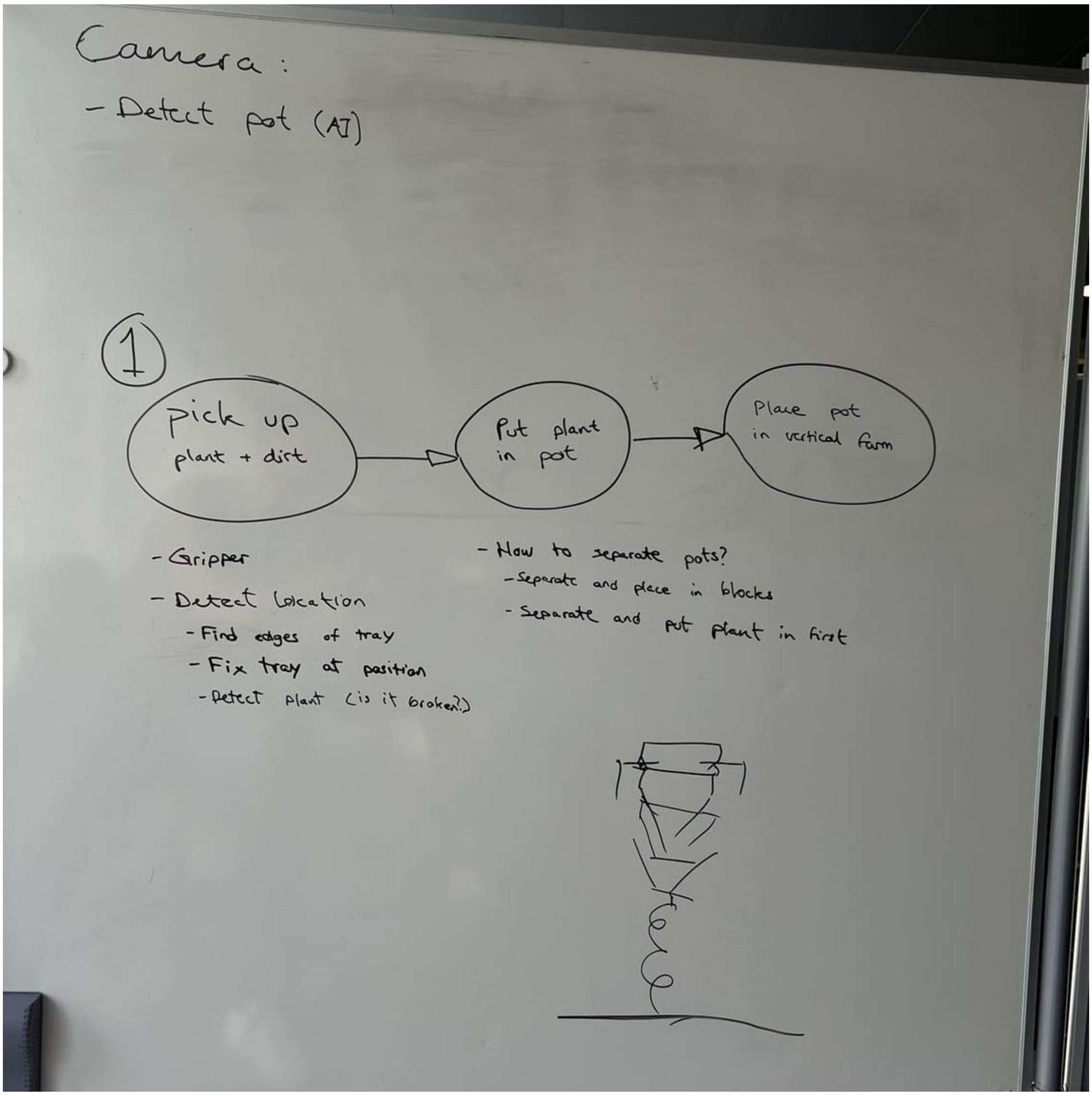

Figure 1: *brainstor*

Figure 2: *Problem from Hydrovertic*

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3 Introduction

Efficiency, cost-effectiveness, and sustainability are essential in the fast-paced agricultural industry. Meeting the increasing demand for fresh, locally-grown produce requires innovation, and commercial gardeners are always searching for new ways to achieve this. Hydrovertic system is a modular solution that automates the manual process of transplanting plants from a block into separate cups, developed by experienced gardeners.

Figure 3: *Problem from Hydrovertic*

Automating the tedious process, as seen in figure 3 of moving plants from modular blocks into tiny cups is the main goal of the HydroverticSystems project. This has always been a labor-intensive manual procedure that takes a lot of resources. This team has developed an automated idea to automate this process by using a robotic arm with a custom-designed gripper as a cutting-edge answer. The gripper has three main functions, transporting modular blocks around, picking a cup for the cupholder, and transposting a plant from the modular block to the cup. On top of that, a camera is used to detect the process of transporting the plant around and reporting any feedback about the overall process.

The advantages of Hydrovertic Systems are substantial. It boosts overall efficiency, accelerates production, and lowers labor expenses. Furthermore, it results in healthier and more fruitful crops by protecting every plant during the transplanting procedure. This introduction looks at the difficulties faced by commercial gardeners and the creative fix offered by Hydrovertic Systems.

In the following sections, the overall process, development of the required tools, the implementation of the solution, and evaluation of the solution are going to be discussed.

4 Problem Analysis

5 Implementation

5.1 Robot Program**

Hydrovertic Systems' advanced robot programming is a key factor that sets it apart in commercial gardening. The programming enables precise movement and coordination of the robotic arm, ensuring accurate and efficient transfer of plants from modular blocks to individual cups. A critical component of the system is the use of homography, which allows for the mapping of the table's coordinate system to the robot's coordinate system and vice versa.

Homography, in this context, serves as the bridge between the table where the modular blocks are located and the robot's workspace. It allows for the translation of positions from one coordinate system to another. This is essential because the positions of the plants in the modular blocks are specified with respect to the table's coordinate system, while the robotic arm operates in its own coordinate system. Homography ensures seamless communication and coordination between the two.

In the process of moving plants from the modular blocks to the cups, the system needs to know the precise locations of the plants on the table. The homography mapping function takes the known positions of the plants on the table and translates them into coordinates that the robot arm can understand and act upon. This ensures that the robot arm accurately picks up plants from the modular blocks.

Conversely, when moving the robot arm to a specific position in the table's coordinate system, the system employs homography to convert these coordinates into robot-friendly coordinates. This step is important in the robot's movement towards the target position, guaranteeing that the plant is placed in the desired cup with precision and care with respect to the table coordinate.

The openCV homography function is used in this project to establish a mapping between the table and robot coordinates, and vice versa. This function requires four sets of points: the table coordinates and robot coordinates at those points.

In the HydroverticSystems project, seamless and efficient automation is achieved through the utilization of the URTDE library, a critical component that empowers the system to communicate with and control the robotic arm.

To accomplish the goal of moving the robotic arm to any specific (x, y, z) point, custom movement functions have been meticulously developed. These functions are the cornerstone of HydroverticSystems' ability to operate with precision.

In addition to custom movement functions, the HydroverticSystems project incorporates three predefined rotations designed to align perfectly with the gripper solution. These predefined rotations provide a standardized orientation for the robotic arm, ensuring that the gripper approaches the plants in the most efficient and effective manner. This standardization not only simplifies the programming but also guarantees the consistent and accurate handling of each plant.

Finally, Safety is of paramount importance in any automation system, and HydroverticSystems is no exception. To maintain the safety of both the robotic arm and the surrounding environment, the project defines safe workspaces within which the robot operates. These predefined workspaces ensure that the robot's movements are confined to well-defined areas, preventing any unwanted interference or collisions.

6 Experiments

7 Discussion

8 Conclusion

References

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9 Appendix