# Automated Well Plate Transfer

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## Introduction

The biological assays performed by the researchers at the Marcus Center for Cell Characterization and Manufacturing (MC3M) are labor and time intensive, often requiring researchers several hours of time per week in order to perform them. While many devices exist which can analyze samples automatically, transferring samples from incubation or between devices is not a problem which has been widely solved. Enabling the automatic movement of well plates between devices will enable end to end automated procedures which will vastly reduce the labor required to complete experiments, allowing researchers more time to focus on the science of the projects at hand.

## Problem

While medical researchers are refining and making the growth process more robust, one environmental variables are hard to control and expensive. Even temperature, humidity, and other constant variables are dealt with, it is hard to completely mitigate the unforeseen impacts that scientists have on the stem cells every time they are analyzed. Each inspection is another chance for the stem cells to be disturbed and fail. We wanted to create a system that could automatically, inside a carefully controlled environment, perform the tasks of the scientist while requiring no contact with the outside world.

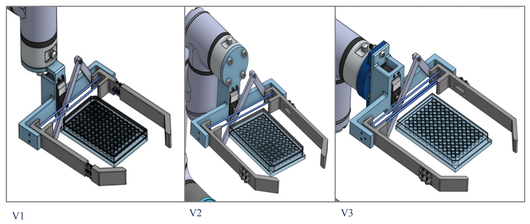
## Engineering Design

To solve this problem, we decided to use a robot that could manipulate the stem cell well plates automatically, carefully picking up, moving, and putting the sensitive cultures down in new locations for tests to be performed. We used the Universal robot, which is accurate and small enough for the task.

## Hardware Team

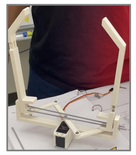
### Goals

- Design and fabricate end effector
- Test and revise prototypes
- Adaptable for different size well plates
- Easily sanitized and maintainable
- Gentle yet secure grip on well plate
- Reliable and repeatable well plate location




### Version 1

- Mounted at 90 degrees to aid in assembly and freedom of robot movement
- Taper to assist in sample location

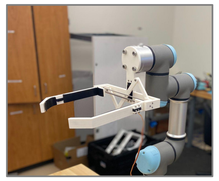


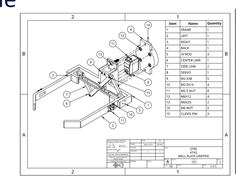
### Version 2

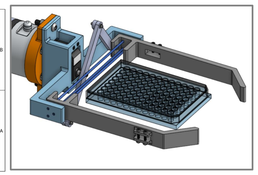
- Adjusted mounting angle
- Redimensioned frame to fit limit switches and rods
- Third rail for stability
- Rubber for increased grip and sanitization

### Final Version

- Two piece mounting system
- Structurally stable
- Compact
- Sterile





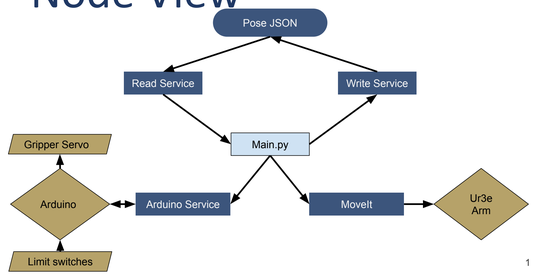


## Software Team

### Goals

- Connect to robotic arm
- Wait for signal to move
- Move robot precisely and with necessary constraints
- Verify correct movement
- Be able to open and close a gripper precisely and receive feedback
- Be adaptable between different well plate setups

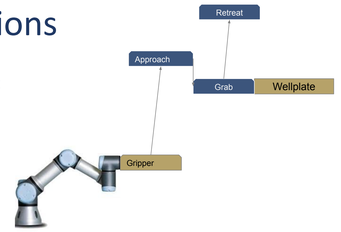
### Node View



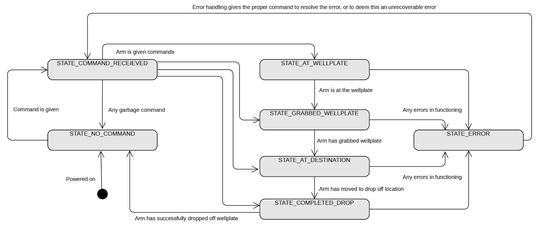

- This node view shows all of the different parts of the program which controls the robot

### Approach and Retreat Positions

- These are the basic states of the robot when grabbing the well plate




### Finite State Machine




- This finite state machine diagram describes the different states that the robot can be in and what inputs trigger which actions

## Results

Gripper precisely aligns with the well plate and moves it to the given position. The arms lift the well plate without tilting and spilling the samples. The program moves the robot arm to correct angle, so human interaction is not needed for movement.

## Conclusion

Our results show that we are able to reduce the need for time-intensive human input transferring samples to incubation areas and between automatic testing equipment areas. However, while our work is important to the overall complete automation of stem cell creation, there is still much work to be done. For instance, the robot can be made to manipulate the well plate lid, or have different edd-effectors that can perform tests on the individual well plate wells.

## Acknowledgements

We want to first thank our mentors that had guided us through this difficult project - Mr. Walker Byrnes, Mrs. Shelley Carter, and Mr. Avi Balakirsky. Next, we would like to thank the GTRI team that has provided us with this incredible opportunity - Dr. Erick Maxwell, Mrs. Therese Boston, Dr. Leigh McCook, and Dr. Jim Hudgens. Finally, we would like to thank all the GTRI employees and tour guides that provided us with critical knowledge and amazing insights into Georgia Tech.