Deliverable G. Prototype II and Customer Feedback

Group 1

GNG 1103 – Engineering Design

Faculty of Engineering – University of Ottawa

March 13, 2022.

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Client Feedback

Our pitch presentation (client meeting 3) took place on March 8th. We started our presentation with our solution to the inverse kinematics, then proceeded to go over our user interface, then our CA prototype, and lastly, we concluded our pitch by talking about our proof of concept for the safety component. We visually noticed Theo seemed impressed with our user interface. As Ty was going over the UI; the facial expressions that Theo was making seemed very positive, as he was smiling and nodding his head. After our presentations finished, no questions or feedback was given to the group. Even after he took a moment to think if he had anything to ask or comment on, he still had nothing for. We are taking this as approval from the client to move forward with our designs and plans. Theo did give general feedback to the whole class, which was that he appreciated the focus on the inverse kinematics and user interface. Therefore, we will continue to put our focus toward those two aspects in the next 2 prototypes and testing.

Prototype 2 Testing

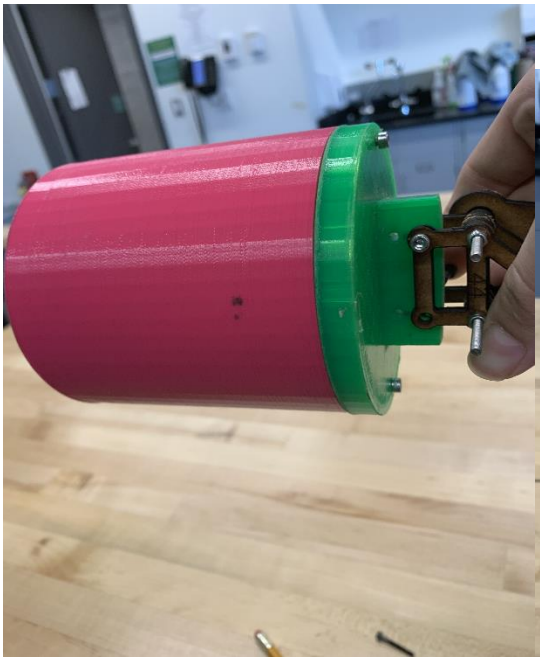
Test 1: Inverse Kinematics Efficiency

Test 2, 3: Camera End-effector prototype: Ergonomics, weight, assembly and connection to arm.

Table 1. Prototype 2 Tests

Test ID	Test Objective	Description of Prototype used and of Basic test method	Description of Results to be Recorded and how these results will be used	Estimated Test duration and planned start date
1	Inverse Kinematic Operation	The arm and Arduino Code. Will be tested by inputting various location values and analyzing if the arm moves there.	The results will be recorded manually to find the boundaries of the arm's reach.	March 12th, 1 day
2	End effector connection	Testing if various size screws are strong enough	Results were tabulated, and the best connection	March 12th, 1 day

		to hold the end effectors weight onto the arm	will be used within the final product.	
3	End effector assembly	Testing the best way to attach the lid and arm connector to the camera holder.	Results were tabulated, and the best connection will be used within the end effector	March 12th, 1 day



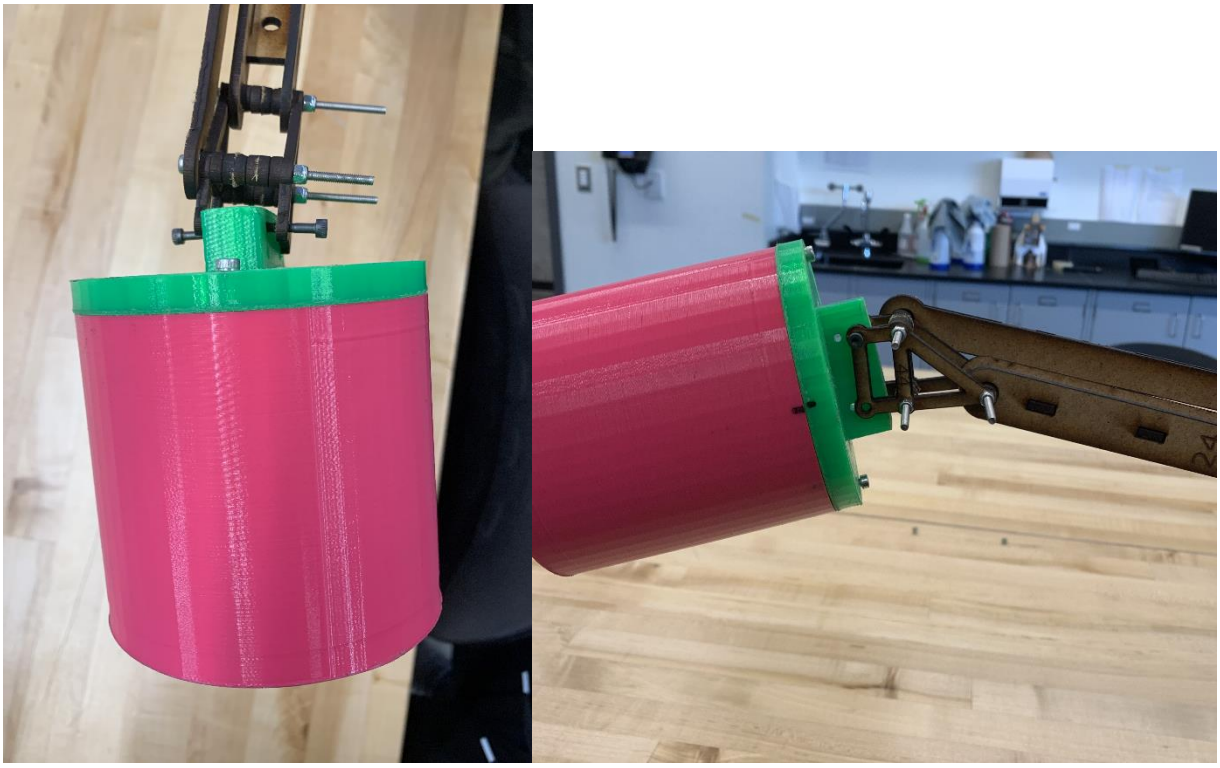


Figure 1-4. Camera End-Effector prototype 2

Observations/Results from testing on March 12, 2022.

- Weight of end effector without the Arduino, driver and ultrasound sensor: 200 g
- The weight is light enough to be supported by the arm, we know this because we attached our end-effector to the arm, and it was able to support it.
    - Note the motors were not even on when we tested this, this is good because when the motors are on the arm will be able to support even more weight due to extra force supplied by the motor.
- When we tested the connection, we noticed that the portion that gets secured to the arm was too long length wise, as a result the screw-holes that we had in our CAD design did not align with the holes on the arm. In order continue to test the concept of our connection design we had to improvise. First, we had tried to shave/file down the part to

make it fit, however, we could not file it down enough because it was consuming too much time given the time we were allotted in the Makerlab on this date. After 3 failed attempts to shave it down and connect, we went for another approach that was successful. We decided to drill 2 new holes a few millimeters back from the original printed holes (using a drill press) to make the connection fit into the robot arm slot. This was successful, as we were able to get it to be secured to the arm. We noticed that there is a slight down tilt to the end-effector when attached, this is because the screws were not screwed very tight and we were not able to rectify this issue at the time due to time constraints in Pankaj's schedule and our inability to have unmonitored access to the robot arm.

    - One of big take away from testing the connection our prototype end-effector to the arm is that we must shorten the length of the of the part of lid that connects to the arm by 1.5mm, the size and spacing between the original holes was perfect.

- During this testing day, we came intending to also test our inverse kinematics coding with the provided arm, but as you already know, none of the groups were able to be that because the was an issue with the arm itself. However, we were still very productive as we also tested the connection of the 2 parts of the end-effector which is the Lid (green part) and housing/container (pink part). Our threading worked and we able to find screws that fit perfectly. As a result, the two parts can be attached and detached easily, which was a goal of ours.
- We also tested the dimensions of our hardware housing. All the hardware components that need to be in the housing fit perfectly inside it. The only adjustments we must make

to this part is shortening the space between the two holes created for the ultrasound sensor on the front of the housing, as well as making these holes slightly larger.

- Due to the arm being inoperable, we decided to test the UI. To test this, the group members who were not involved in the creation of the UI attempted to maneuver and operate it in its intended purpose. We found that the UI is very intuitive and simple, but the code that is used needs to be annotated so that anyone who operates the UI can edit it however they may need to, depending on the operator's needs.
- The results of the UI test will be seen in the UI as the code will be annotated with comments so that a 3rd party can look over it and understand what the variables mean and how they are used to run the UI to give the desired outputs.

Prototype 3 Test Plan

The next objective is to test our inverse kinematics coding with the arm since we could not do it this week because of the arm technical difficulties. We will also retest the connection to the arm with the previously mentioned adjustments we made based on this week's testing.

Table 2. Prototype 3 Testing

Test ID	Test Objective	Description of prototype used and of basic test method	Description of results to be recorded	Planned start date
1	Test accuracy of inverse-kinematic solution	The method used to test this will be to input values in our code and test the ability of the code to move the end effector to the desired location.	For this we will record the results of expected location vs actual location of end effector. We can calculate a percentage of accuracy of the IK solution based on deviation from	We will start these tests this week when Pankaj is available, assuming that the robot arm will be available to us and functional this week.

			expected end-effector location.	
2	Test speed of inverse-kinematic solution	To test this, we will record the amount of time required for our code to operate from the time it is started to the time the end-effector reaches the desired location in space.	The results recorded will be the speed of execution for each individual test trial. From this we can deduce an average time that our IK solver takes.	Again, these tests will begin when the arm, and Pankaj are available.
3	End-effector hardware	To test this, we must further develop the end-effector prototype by wiring the camera, lights, and depth sensor into the end effector.	Functionality of Wiring of camera, lights, and depth sensor to Arduino chip (yes or no result, yes=functional, no=non-functional)	The construction will begin this coming Tuesday, March 15 and we will test the functionality of our wiring then. This will be completed by Thursday.
4	End-effector: UI-interaction	We can test the ability of information from the pictures taken and depth recorded to be transferred to the user interface.	Ability of User interface to import images from the Arduino cam.	The ability of UI to import images from the Arduino cam may be tested on a date that must be ultimately specified after the connection of hardware components is functional. Ideally, it will begin on Friday March 18.