# Scopey: An Affordable Robotic Feeding Device For Those With Upper Body Mobility Restrictions

Instructables

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## Problem

Our client suffers from **Merosin-Deficient Muscular Dystrophy**, which weakens muscles and causes contractions (Dimachkie & Barohn, 2014), making mealtime and other activities difficult. Our goal was to create a robotic feeding device that allowed our user to eat **independently** and required **limited motor ability** to use effectively.

## Background

**Problem**

There are not many affordable and effective robotic devices for those with upper body mobility restrictions (Naotunna et al., 2015).

**Our Client**

Has Merosin-Deficient Congenital Muscular Dystrophy; a disease that causes muscle weakness and contractures that makes eating difficult (Dimachkie & Barohn, 2014).

**Solution/Goal**

Developing a robotic feeding device that will help make mealtime easier for the client, with minimal movements for control.

## Preliminary Designs

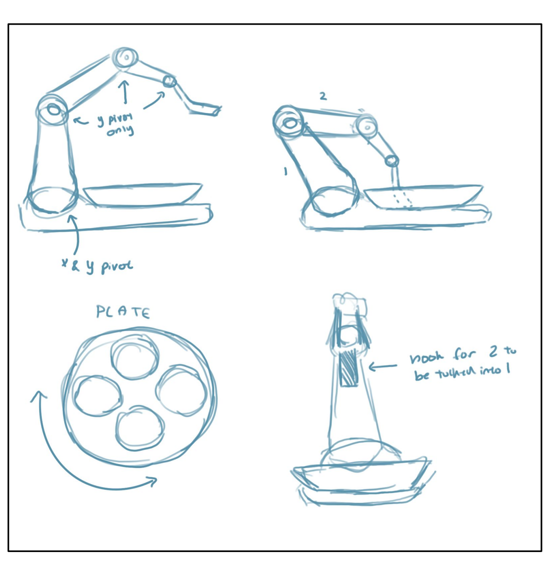


*Figure 1:* Linear motion design including rotating plate and 3 motors. This was inspired by Obi (MeetObi, n.d.).

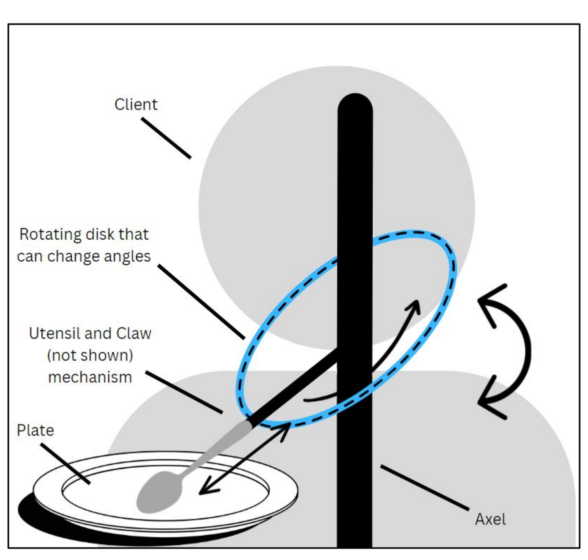



*Figure 2:* Rotating disk design with spoon attached.

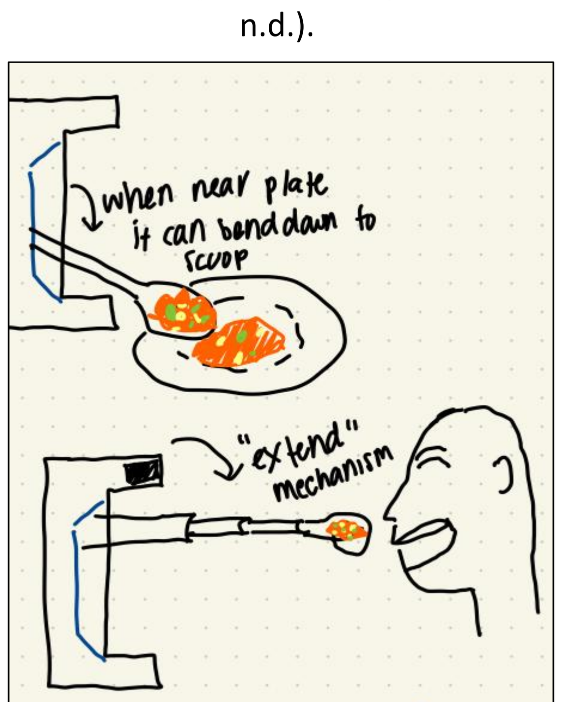



*Figure 3:* Telescoping design including an elevator with a telescoping arm and computer vision.

*Figure 4:* Final product for the BOT Appetit robotic device created last year (Mohanaskrishnan et al., 2022).

## Process/Methods

1. SKETCH DESIGNS
2. PROTOTYPE WITH CARDBOARD
3. CAD AND 3D PRINT
4. ASSEMBLE ROBOT
5. CONNECT WITH SOFTWARE
6. TEST ROBOT

## Final Design

**Key Features:**

- Telescoping arm with a **continuous rigging** design (*How Are Telescoping Arms Rigged?*, 2020)
- Spoon has two pieces that splits and close to scoop up food to **limit spillage**
- Controlled using buttons – also has an **emergency stop button**

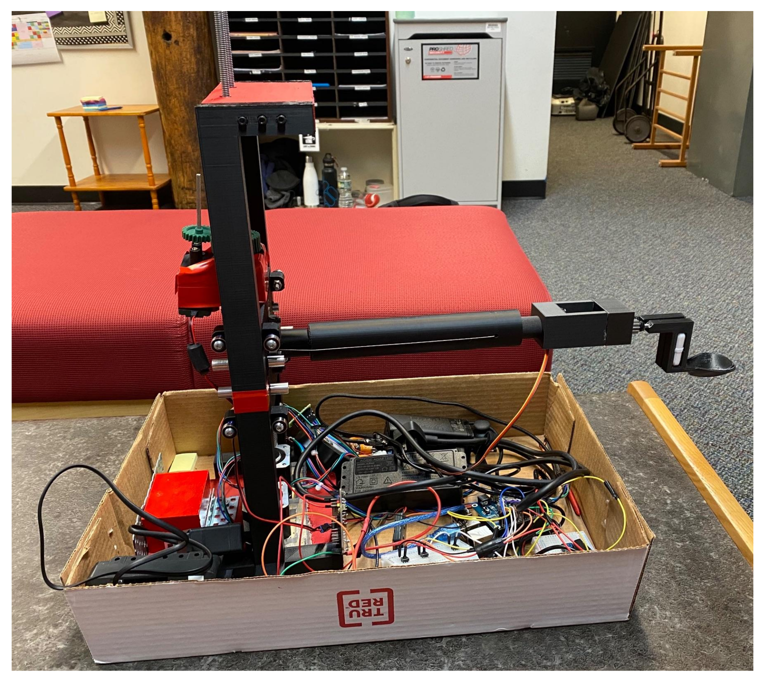


*Figure 5:* Picture showing final prototype.

## Requirements

| Criteria | Level | Type | Final Prototype |
|---|---|---|---|
| The emergency stop button is functional | 1 | Functional | Pass |
| All control buttons can be used with little movement | 1 | Functional | Pass |
| Device can be controlled using one hand | 1 | Functional | Pass |
| Device can stop if made contact with an object or human | 1 | Functional | Fail |
| Device has gentle movement and will spill little to no food and liquids | 1 | Functional | Pass |
| Device does not have motors that can injure the user | 1 | Physical | Pass |
| Device is made of food-safe material | 1 | Physical | Pass |
| Device is made of materials that are not a common allergen | 1 | Physical | Pass |
| Device is constructed using less than $350 of materials | 1 | Cost | Pass |

## Design Studies

### Design Study # 1: Ultrasonic Sensor Testing

This experiment was to determine if an ultrasonic sensor would be useful to determine the distance from the user's face and the telescoping arm. This was for potential use with machine learning for adaptive positioning. The sensor was held directly above the arm, and was extended towards an iPad that acted like a user's face (Figure 6). The sensor measured the distance and time while we ran code from Arduino IDE (Figure 7). This study showed us that the ultrasonic sensor was not optimal to be used for our final prototype due to the large fluctuations in measured distance.

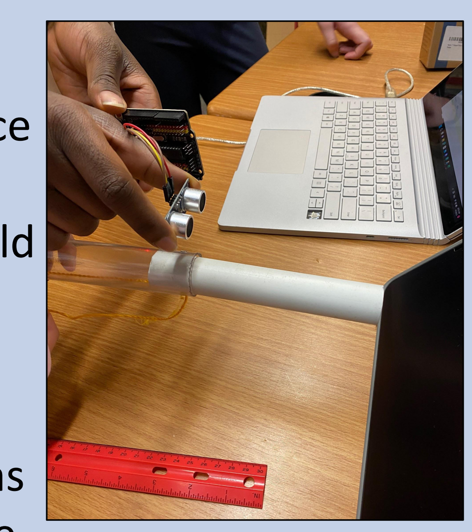


*Figure 6:* Set up of experiment.

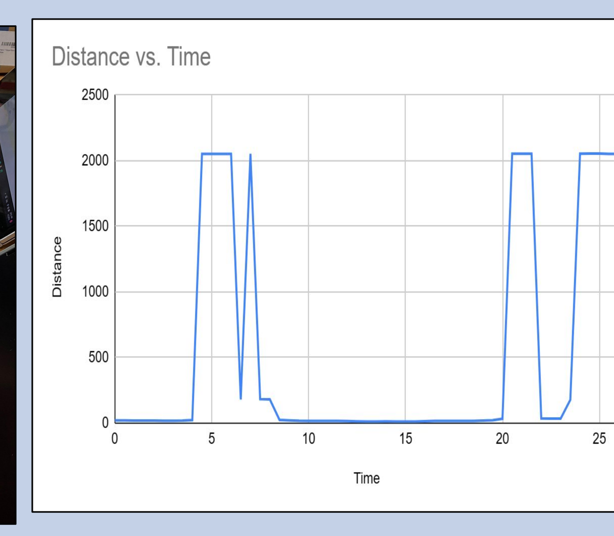



*Figure 7:* Distance vs time graph showing the readings that the ultrasonic sensor collected.

### Design Study # 2: Weight/Mass Test Of Telescoping Arm

This experiment was used to determine the durability of the telescoping arm to withstand varying masses and the maximum weight that the arm could hold without bending. We tied various masses to the arm (Figure 8) and visually determine whether the telescoping arm could withstand, bend, or break (Table 1). We determined that our arm would be able to pick up most food.

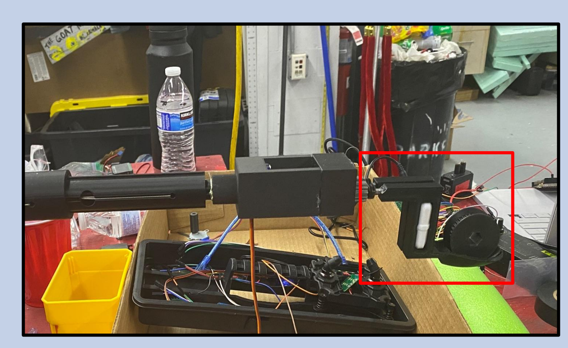


*Figure 8:* Set up of experiment, masses are placed on spoon.

| Mass Used | Results |
|---|---|
| 2 grams | Passed |
| 5 grams | Passed |
| 100 grams | Slightly Bends |
| 200 grams | Failed (Bends) |

*Table 1:* Results of experiment, showing whether each of the mass used passed (green), did not pass or fail (yellow), or failed (red).

### Design Study # 3: Extension of Assembled Robot

This experiment tested whether our fully assembled robot could extend its arm and scoop. We ran code on a laptop and pressed one of the buttons that allow for the extension of the arm. After extension of the arm, its length, total height of platform, and time taken to extend were measured (Table 2). We compared this version, which utilized a vex motor and a larger tube (Figure 9), to our first prototype, which used a smaller tube and stepper motor.

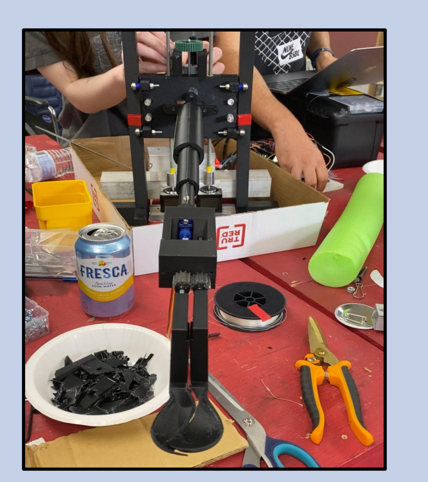
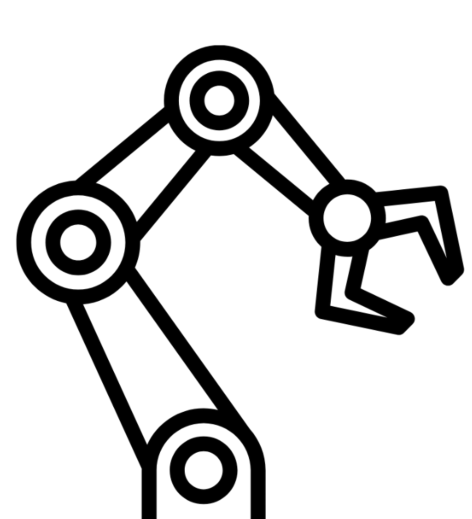


*Figure 9:* Set up of experiment, motor was being replaced.

| | Stepper Motor & Old Tube | Vex Motor & New Tube |
|---|---|---|
| Time (sec) | >20 | 9.51 |
| Length (in) | 5.1 | 7.5 |
| Height (in) | 4.3 | 4.3 |

*Table 2:* Data collected from study. Measurements included time for arm extension, how far the arm extended, and the height of the platform for stepper versus vex motor.

## Conclusion & Future Works



Some future works include:

- Allowing for **more capabilities** of the arm.
  - Creating a utensil that is able to pick up a **wide range of foods**, including **liquids** and **semi-solids**.
- **Machine learning** – using a camera to detect the user's face to automatically reposition
- **Reprinting** some of the parts for more stability.

Overall, we have designed and created a robotic feeding device that will assist people with **upper body mobility restrictions** during their meals. This device will help **promote independence** and **enhance** the user's **mealtime experience**.