GNG 1103/2101

Design Project User and Product Manual

Modified Pick-up Stick

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1. Introduction

Helping Hands is the focus of pick-up sticks (grabber sticks) for people with physical disabilities. Helping Hands benefits users with arthrogryposis or similar disabilities with flexibility and comfort that outperforms any gripper sticks on the market. Conceptual designs and product assumptions were created for our product with prototypes and testing. Ideas from each conceptual design were drawn to have a general concept of our pick-up stick. Each prototype had its benefits and disadvantages when producing our product. Most of the benefits were taken into consideration to the final design of the pick-up stick. The testing department for Helping Hands met its target specifications.

The overview of this document structure provided a problem statement to expand and refine the information provided by the client based on the requirements. The user manual is organized by describing each subsystem of the Helping Hands and its functionality. A list of equipment was also determined to build the subsystem. Troubleshooting and support explained the problems and errors that occurred for the product.

2. Overview

Problem Statement: Paul Marriage requires an easy-to-use and useful gripper stick that makes picking things up off the floor easier for those who have physical disabilities, such as arthrogryposis. We will achieve this by designing a lightweight, mechanically assisted, and ergonomic gripper stick.

It is important to create our product, Help Hands, for our client, Paul Marriage, to support and improve people with a physical disability such as arthrogryposis. Using Helping Hands is more suitable and adjustable to control and aim for what needs to be picked. Comfort is ensured handling the pick-up stick while grabbing an object. The most important element of the pick-up stick is to be lightweight. Using plastic instead of metal provides the best possible choice for easy mobility. The motor is difficult to lift heavy objects with the actual stick that has no counterweight. By designing an arm support proves an effective counterbalance solution to the weight and length of the stick. This performs in the fundamental need of mechanical assistance. From the user's need, the safety of the Helping Hands also is ensured from any misplaced components.

Our product is mainly based on helping clients or users who have hand disability and clients who suffer from muscle or joint contracture weakness. Non-disabilities people are also able to use it. The product originated as a normal pick-up stick model. Our team modified and improved its design for effective use when grabbing objects. A normal pick-up stick model (or

grabber stick) is a beneficial tool to be able to lift small objects off of the floor. Individuals might find it difficult to apply enough force on the trigger to properly grasp an object. Helping Hands, however, can exceed its expectation by being able to pick various sizes of objects and the trigger is launched with the sets of buttons for easy grasp.

Figure 1: Final Prototype of Helping Hands

The final design has three main components: the arm brace, the hinge point, and the electronic operation. The user is responsible for the operation of each of these components.

The arm brace is a lightweight plastic material fastened to the base of the handle via a lockable ball joint passing through the brace and handle to the opposing side.

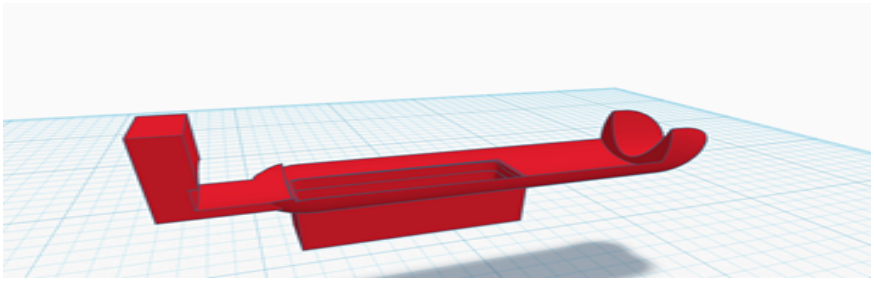

Figure 2: 3D Model of Arm Brace

Under the arm brace, our team implemented the electronic operation attached by heat-sealed plastic. Within the electronic operation, a motor is attached to the tension wire spool, the power supply, and the Arduino board controlling the power delivery to the motor via the control buttons of the grabber handle, all connected via conducting wires.

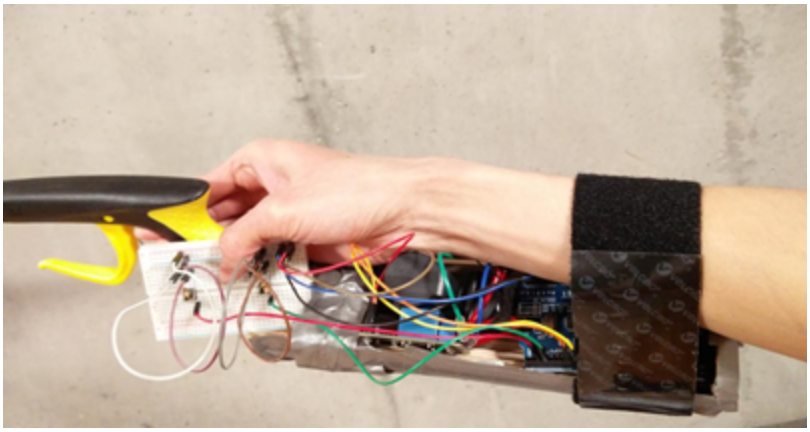

Figure 3: Prototype Position of the Electronic Operation

Toward the midsection at the pivot point, there is a hinge controlling the XY-axis movement, attached by screws through the shaft. On the top, half of the pivot point is a simple locking mechanism consisting of a rod passing through two loops (one on each side of the break) and towards the handle. There will be a lever controlling the movement of the rod along the x-axis. The lever will be fastened to the shaft by two hose clamps sealed with a thread lock and an adhesive. When the lever is pulled it exits the furthest loop and allows the shaft to pivot freely.

Figure 4: Hinge Point

Figure 5: Lever Release

2.1. Conventions

User Action - This indicates that the user is responsible for the indicated operation.

2.2. Cautions & Warnings

The cautions and warnings of the Helping Hands will be to check if there is any battery leakage. Overheating may affect the leakage of the system in the electronic housing. Avoid any liquid from the electronic operation. Without the electronics, the system will not be able to operate in its proper way.

3. Getting started

The following section will go over how the grabber can be set up for user operation. The grabber can be broken down into 3 components. The jaw, shaft and handle. To successfully use the grabber the user will need to insert their arm into the arm brace. Once they have comfortably secured the grabber they will then have easy access to the buttons. These buttons are used to control the jaws to open and close around the objects that they are trying to lift. They can then use the grabber and easily aim the grabber at the object, ensure the jaws are around it and then press the retract button. This will trigger the jaws to close and securely hold the object of their choice. Once the object has been picked up by the jaws, there is then a lever in the middle of the shaft that can be pulled on which will release the locking mechanism, this will allow the shaft to break and swing towards the user, therefore, allowing them to access the object that they lifted. Once the object is in reach of the user, the release button will extend the actuator and relieve pressure on the object.

3.1. Set-up Considerations

The product is an attachment that can be implemented to any pick-up stick found in the market, alternatively if the user would like they can purchase the stick and have it modified for their benefit. The user must ensure however that the stick that they choose to have modified has an existing tension wire that runs through the shaft. If the existing tension wire is not long enough, the user may be required to replace it with a longer tension wire. In addition, the user should take into consideration when purchasing a stick to modify that if there is not an existing tension wire the grabber will not be compatible.

If the stick that they choose to modify has the correct tension wire, then to install the product, they will also need the following tools to complete the installation process:

- Saw

- Screwdriver

- Drill

These tools will be needed to make a cut in the shaft to allow the stick to swing to the user once the item has been picked up. To do this you will also need to attach a hinge. To install the buttons, they will need to drill a hole in the handle to allow the buttons to be placed where comfortable for the user. In addition, they will need to attach the arm brace to the base of the handle where comfortable. All electronics will be pre-assembled so that they can be installed once the tension wire is attached to the linear actuator. Before finalizing the installation of the attachments, the saw will also be used to cut the shaft where desired so that the lever can be installed to bring the object closer for easy access for the user. After installation is complete, the user is required to install 4 AA batteries and a 9 V battery in the specified positions.

Figure 6: Each subsystem of the pick up stick attachment

Should the user be unable to complete these installations or want them to be completed for them, then they can request Helping Hands to have it built for them to their specifications.

3.2. User Access Considerations

This device is ideal for those users with physical motor restrictions but can be used by anyone who would like to use the device for ease. This device is usable for all, however, if the customer or user has physical motor restrictions, they may require assistance to install the attachment .

3.3. Accessing the System

To turn the system on, there are batteries that must be installed and an on/off switch located on the side of the handle.

3.4. System Organization & Navigation

To turn the system on once installed, there are batteries that must be installed and an on/off switch located on the side of the handle.

3.5. Exiting the System

Once the attachment is installed the user will need to access the on/off switch to operate the device.

4. Using the System

The Handi-pro Grabber has been designed with the concept of increasing the ease of living standards for those with mobility issues. The final design has three main components: the arm-brace, the hinge point, and the electronic operation. The user is responsible for the operation of each of these components. Before operating the user will adjust the arm brace to whichever placement is most comfortable to themselves, at which point they will pick up and aim the grabber

at what they will aim to pick up. To bend and lock the grabber the user will operate the manual handle on the top of the stick at the desired times for proper use, the lock should be disengaged at the fingers towards the ground to avoid swinging or dropping the object. Using the electronics controlled by the buttons the user will activate and deactivate the grabber fingers at the appropriate times, note that when the stick is bent and the linear actuator deactivated the fingers remain under tension so the object is not dropped.

The following subsections first provide a general step-by-step process, followed by more specific instructions on how to use the various functions or features of the Handi-Pro Grabber along with operation details in order to ensure safe and practical operation.

4.1. Handi-Pro Grabber

General Process Description

1. User action- Align forearm parallel with the arm brace
2. User action- Secure handle in the palm of the hand
3. User action- Place finger over control buttons
4. User action- Align grabber fingers around the desired object to be picked up
5. User action- Press button to engage linear actuator and close grabber fingers
6. User action- Lift stick above ground
7. User action- With freehand disengage locking handle
8. User action- Allow the hinge to bend freely
9. User action- Raise arm holding the stick to bring the object closer to user
10. User action- Press the button to release the linear actuator and release the object
11. User action- Lower arm to allow the stick to straighten
12. User action- Engage lock with a freehand

4.2. Specifications of General process Description

4.2.1. The arm brace is designed to allow the user extra support when operating the Handi-Pro Grabber. The user is able to adjust the alignment of the brace to whatever is most comfortable to them. It is important to ensure the arm brace does not get wet or broken as it houses the electronics.

4.2.2. The handle of the Handi-Pro Grabber is aligned with the arm brace, the user should be wary of adjusting the placement of the arm brace too much as this may misalign the handle and brace.

4.2.3. The two buttons affixed to the handle control the opening and closing of the grabber's fingers. They operate in the fashion that one button after being clicked once will engage the fingers until the other is pressed and disengages the fingers.

4.2.4. This step is self-defining.

4.2.5. This step is self-defining.

4.2.6. When raising the object off the ground it is suggested that the user points the stick towards the ground to avoid: a) dropping the object b) causing an uncontrolled swing when disengaging the lock c) bearing the maximum weight of the object and grabber.

4.2.7. Disengaging the locking mechanism will allow the hinge point to swing freely which is why it is important to align the stick perpendicular to the ground before releasing.

4.2.8. When allowing the hinge to bend the user should be aware that this puts extra tension on the tension wire and can make it difficult to release the object the user picked up. It will also cause excess wear on the wire and for this reason, the user should attempt to have the stick in the extended state when not using it.

4.2.9. When the user is lifting their arm to bend the stick is when the tension wire is under maximum tension, they should be mindful of the amount of time the tension wire is under tension and if the object they have picked up is fragile.

4.2.10. When pressing the button to release the tension wire the wire will remain under tension to not drop the object and the user will be able to remove the object from the grabber's fingers.

4.2.11. The user will have to bring the two halves of the stick in line with each other in order to re-engage the locking mechanism.

4.2.12. To re-engage the lock the user will push the locking handle away from themselves to mate the locking rod with the female connector on the lower half.

5. Troubleshooting & Support

5.1. Error Messages or Behaviors

When the stick is in the maximum bent position the tension wire is under its maximum tension. This will put excess stress on the points of attachment, to avoid failure or breakage limit the time that the stick is in this state. In the same position the wire scrapes along with the exposed aluminum at the hinge point, maintain this area with lubricant or replace the wire if fraying occurs. The ball joint is designed to move for comfort but this also creates the scenario where it may move during use, to solve this the user can modify the stick to stay permanently in the position they find the most comfortable.

5.2. Special Considerations

When picking up a fragile object the user should consider that the fingers may have too much closing force and could crush the object.

5.3. Maintenance

The only regular maintenance aspect of the grabber will be checking and changing the batteries, it will be easily accessible with a screwdriver through the electronics housing on the base of the arm brace.

5.4. Support

Tetra Society of North America - 604-688-6464

6. Product Documentation

6.1. Shaft Hinge System

6.1.1. BOM (Bill of Materials)

Table 1: Bill of materials used to make the hinge system

Item Description	Quantity	Unit Price	Amount
Pickup Stick	1	$19.99	$19.99
Hinge	1	$1.80	$1.80
Lever Plunger	1	$3.78	$11.34
Steel Rod (Previously Owned)	1	$0.00	$0.00
Total (After Tax)			$37.43

6.1.2. Equipment list

To build the hinge system, the following equipment was used:

1. Saw

2. Drill
3. Screwdriver

6.1.3. Instructions

To complete the installation of the shaft hinge system an incision was made at the midpoint of the shaft to allow it to break into half to swing towards the user. This method was used because gravity would assist in bringing it towards the user allowing the user to exert minimal energy while operating the stick. In addition, it simplifies the method used to bring the object closer to the user while exerting minimal strain on the user.

The steel rod was used as a means to save money in the budget as we were approaching our maximum allowance. However, it would be ideal to use aluminum to reduce the weight of the attachment . An additional benefit of using gravity to bring the object closer is that when the shaft is broken and drops, the tension wire is pulled slightly increasing the grip on the object, thus ensuring the object will not fall while being brought towards the user.

6.2. Electronics System

6.2.1. BOM (Bill of Materials)

Table 2: Bill of Materials used to make the electronics system

Item Description	Quantity	Unit Price	Amount
Pickup Stick	1	$19.99	$19.99
Buttons	2	$0.10	$10.99
Resistors	2	$0.29	$7.35
Arduino	1	$8.99	$8.99
Battery Pack	1	$9.98	$9.98

Actuator	1	$8.90	$8.90
PVC Pipe (previously Owned)	1	$0.00	$0.00
Total (After Tax)			$74.78

6.2.2. Equipment list

To build the hinge system, the following equipment was used:

1. Saw
2. Drill
3. Screwdriver
4. Soldering Iron
5. Solder

6.2.3. Instructions

To get a nice curvature that will match the shape of a forearm, a PVC pipe was cut to be used for the pickup stick. This PVC pipe brace was then fitted to the bottom of the handle using screws.

The tension wire was switched to run through the bottom of the handle allowing it to be attached to the actuator. For the electronics system, the following schematic was implemented to build the electronics.

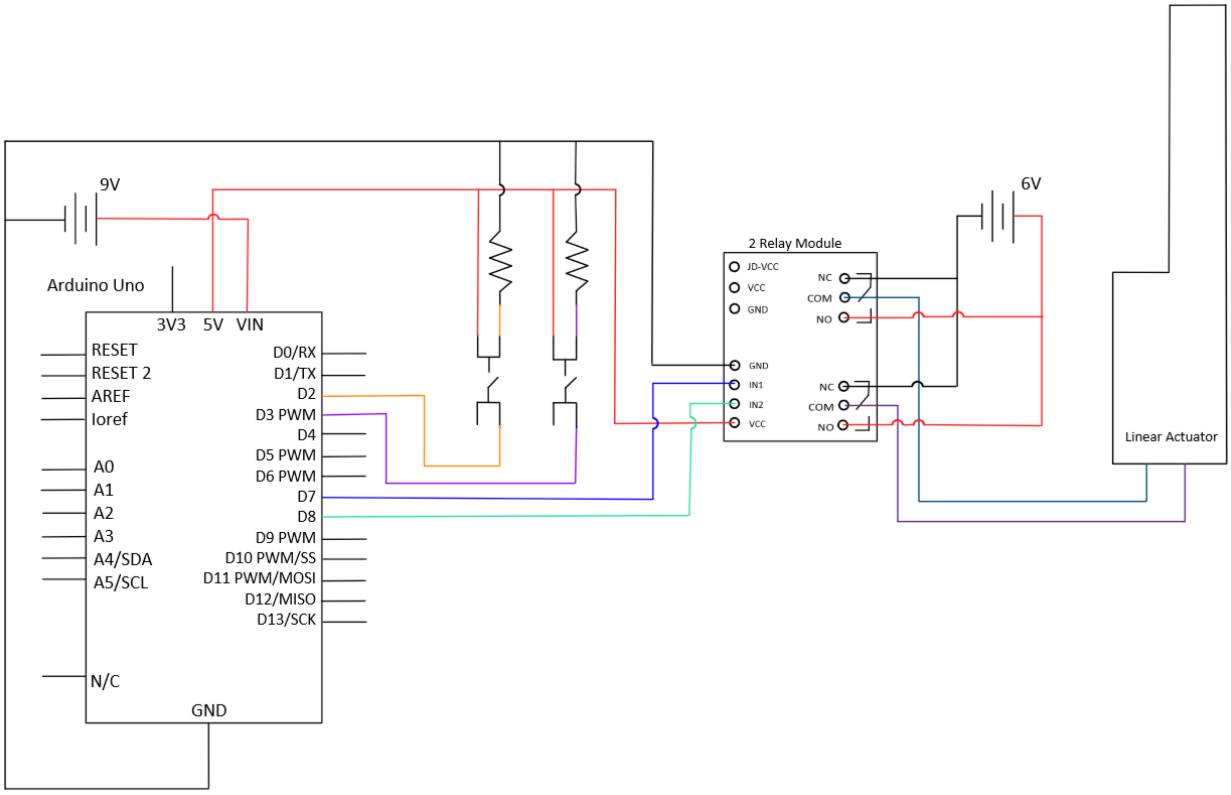

Figure 7: Schematic drawing of the electronics used

The buttons used were installed on the side of the handle to be accessed by the fingertips, however, due to time constraints we were unable to design an adjustment system that would allow the button system to be moved to several positions throughout the handle. Once the PVC pipe was placed and the electronics were soldered, they were attached to the bottom of the PVC pipe.

6.3. Testing & Validation

To complete the testing, it was done in phases prior to it being tested as a whole device.

6.3.1. Shaft Hinge System

To test the shaft hinge system once installed, the system was tested via a trial-and-error method. If the system did not perform as intended small adjustments were made to the system such as adjusting the position of the hinge, shortening the length of the steel rod, and adjusting the position of the lever.

6.3.2. Electronics System

To test the electronics system, all electronics were wired together via Breadboard. To test to see if the wiring was correct, a digital multimeter was used to check the continuity of the connections. Once the relay connections were confirmed, a code was implemented to test for the actuator control via the button components. After the initial test errors were found in the code and not the electronics. The code was adjusted to ensure the proper functionality of the actuator.

6.3.3. Modified Pick Up Stick

To test the device as a whole, the electronics system was attached to the tension wire prior to the brace to ensure that the actuator pulls the tension wire correctly. This was done to ensure that prior to the device being assembled as a whole all the electronic components were working correctly as desired. This was also used to approximate the desired length of the tension wire to ensure that the electronics were installed in a comfortable position on the brace.

Once it was ensured that the electronic system was functional and installed, various objects were used of different sizes and weights to be picked up by the grabber. examples of the objects used include a medicine bottle and a water bottle.

7. Conclusions and Recommendations for Future Work

Helping Hands has been successful at creating a project that both meets the client's requirements and emphasizes with the user's needs. Helping Hands have created a product that is easy and intuitive to operate for many people that suffer from disabilities.

Functionality wise, the device operates as intended, however, due to time constraints many features originally planned could not be implemented. This includes designing interchangeable claws and a more user-friendly operating lever. Furthermore, should more time and resources be made available, the fit and finish of the product can also be vastly improved. As the circuit is the most fragile and pressure-bearing part of the device, the possibility of the device failing due to electronic connectivity issues cannot be dismissed; should the design be improved, the materials used to house the electronics and seal off minuscule gaps would be changed. As a result, the product will be able to stand up against abuse and continues to be a reliable attachment.

More things to consider if more time can be allotted, the electronics inside will be sealed off, and the device can be water-resistant, therefore, the device can be used outdoors and in rainy conditions. Additionally, given more time an improvement that can be made to allow the electronics to be more compact is to solder all components onto a printed circuit board and to use an Arduino Nano instead of an Uno. By doing so, it will allow the compartment for the electronics to be smaller by having a more compact circuit. As mentioned above, the fit and finish of the device can be improved to make the device more reliable, though this process requires rigorous testing through trial and error which is prohibitively time-consuming.

8. Bibliography

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Johnson, J. (2020, June 10). *What are relays and why are they so important for applications?* https://amperite.com/blog/relays/#:~:text=Relays%20are%20electric%20switches%20that,form%20or%20break%20existing%20circuits.

9. APPENDIX I: Design Files

Table 3. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
MakerRepo - Helping Hands	https://makerepo.com/Arman/827.helping-hand-	15/03/2021
Deliverable B	https://docs.google.com/document/d/1rgkIPQ6aF2v3KZP9CpA7VZA-qgSFrtkUmbcyT79oMQE/edit	18/01/2021
Deliverable C	https://docs.google.com/document/d/1cL_TdDLGrQ0-7biE_sjEel1kCUkvcdTPkcDdOCAMgUg/edit	25/01/2021
Deliverable D	https://docs.google.com/document/d/1TRFOlpe7SysXSQ0BUpM3MWhzeGK1Hdgv3dLajNIR8IU/edit	04/02/2021
Deliverable F	https://docs.google.com/document/d/1q9AAv2N3QqrJwlmaFI4BLPkFtonyEuK8f6mhfoZA4tY/edit	08/02/2021
Deliverable G	Business Model - https://docs.google.com/document/d/1f4-9ZDbVxCaSM-hkw7c8lbpARW5O76jj3hN06WPs9A8/edit Economics Report - https://docs.google.com/document/d/10ZwDwuTA0Ycr1seQGJxA54l86jRNSrs5ia3_I3hQi8Y/edit	18/03/2021
Wrike Snapshot	https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=LoT1tOmqk4v0IyBL7kUOptqb2ub1IgWI%7CIE2DGNBUG44DMLSTGE3A	11/04/2021