Please Refer To Tabs

Logbook
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Helping Hand Project

Timetable:

Objective: Enhanced Research and Planning
- Key Result 1: Update the needs and requirements for the Helping Hand design based on feedback and learnings from the first prototype. (June 13 - July 2023)
- Key Result 2: Dive deeper into research on advanced systems, exploring new materials and 3D printing technologies that could improve the prototype. (June 13 - July 2023)

Objective: Refined Design Phase
- Key Result 1: Utilize insights from the initial prototype to redesign the Helping Hand using Solidworks or equivalent 3D modeling software. Focus on addressing identified weaknesses and user feedback. (July - August 2023)
- Key Result 2: Start the development of digital prototypes for the refined design, incorporating changes aimed at enhancing functionality and user experience. (July - August 2023)
- Key Result 3: Conduct thorough evaluations of the new digital prototypes to ensure they align with the revised design specifications. (August 2023)
- Key Result 4: Revise and iterate on the design as necessary, integrating innovative solutions for identified issues. (August 2023)

Objective: Construction of the Next Prototype
- Key Result 1: Acquire updated materials and components reflecting the revised design needs. (September 2023)
- Key Result 2: 3D print and assemble the next iteration of the Helping Hand, incorporating the design improvements. (September - October 2023)
- Key Result 3: Integrate and test electronics, ensuring compatibility and functionality with the new design. (October 2023)
- Key Result 4: Conduct initial tests on the new prototype to identify areas for further refinement. (October - November 2023)

Objective: Prototype Enhancement
- Key Result 1: Based on initial testing, refine the design to enhance performance and address any new challenges identified. (November - December 2023)
- Key Result 2: Produce another iteration of the prototype incorporating these refinements. (December 2023 - January 2024)
- Key Result 3: Test and evaluate the updated prototype's functionality and performance, particularly focusing on improvements made from the first prototype. (January 2024)

Objective: Final Adjustments and User Testing
- Key Result 1: Make final adjustments to the design based on comprehensive testing feedback. (February 2024)
- Key Result 2: Organize additional testing sessions with individuals with dexterity disabilities, ensuring the prototype meets diverse user needs and is ready for real-world application. Include specific testing dates to gather valuable insights for the final iteration. (February 10, 2024, and February 17, 2024)

- Key Result 3: Finalize the prototype, ensuring it is fully optimized for user-friendliness, reliability, and meets all design specifications. (Late February 2024)
- Key Result 4: Prepare comprehensive documentation of the development process, design iterations, and testing outcomes, highlighting the journey from the initial to the current prototype. (Late February 2024)

Topics:

Topic: Accessibility - How can accessibility be increased for people with limited dexterity? Accessibility for people with limited dexterity can be increased through:

- Assistive Devices: Designing and developing assistive devices like the Helping Hand can provide support for individuals with limited dexterity, enabling them to perform tasks they would otherwise struggle with.

Topic: Automation as a Solution for Accessibility - How can automation and robotics be used as a solution to increase accessibility for people with limited dexterity?

- Automation and robotics offer several possibilities to enhance accessibility for individuals with limited dexterity.
- Robotic Assistants: Developing robotic assistants that can provide physical support and assistance with dexterity can greatly enhance independence and accessibility.

Topic: Automation - What sensors and programming are needed to automate a robotic hand?

- To automate a robotic hand, several sensors and programming components are typically required:
- Position/Encoders Sensors: Position sensors or encoders provide feedback on the position and movement of the robotic hand, enabling precise control and manipulation.
- Proximity Sensors: Proximity sensors detect the presence of nearby objects or obstacles, allowing the robotic hand to avoid collisions during its operation.
- Microcontroller or PLC: A microcontroller or programmable logic controller (PLC) is the central processing unit that receives sensor data, executes programmed commands and controls the robotic hand's movements and operations.
- By integrating these sensors and programming components, the robotic hand can perform automated tasks and mimic human-like movements, providing valuable assistance to individuals with limited dexterity.

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Problem:
Our loved ones' independence and ability to perform daily tasks can be significantly impacted by dexterity disabilities. These challenges lead to decreased independence and limited job opportunities, ultimately affecting their overall quality of life.

Motivated by my grandfather's specific needs and the growing number of individuals facing dexterity disabilities, I embarked on creating the Helping Hand. My grandfather, a skilled mechanic, heavily relied on his dexterity to excel in his work. To empower him and others like him, our solution had to address four key challenges:

Adaptability: The Helping Hand is needed to effectively grip a wide range of objects, accommodating various situations and user needs.

Accessibility: It was crucial to keep costs as low as possible, ensuring the hand's affordability and widespread accessibility to maximize its positive impact.

Accuracy and Reliability: Given its intended daily and continuous use, the solution had to be reliable, robust, and capable of enduring regular use.

Precision: The Helping Hand had to operate with exceptional accuracy and precision, providing a secure grip on objects.

Through the Helping Hand Project, my aim is to enhance the quality of life and foster independence for individuals with limited dexterity. Simultaneously, I strive to create a solution accessible and usable for a wide range of users, promoting inclusivity and empowerment.

Question: How can I increase independence and improve the quality of life for individuals with limited dexterity?

Materials and Tools:

- Creality CR-30 (Belt 3D Printer) - (1 unit used, $1,199 CAD per unit, $1,199 CAD total)
- Flush Cutters - (1 unit used, $10.66 CAD per unit, $10.66 CAD total)
- 20 gauge wire - (10 feet used, $0.56 CAD per foot, $0.60 CAD used)
- M3 screws - (6 screws used, $0.10 CAD per screw, $0.60 CAD total)
- PLA - (2 rolls bought, $34.99 CAD per roll, $69.98 CAD total, $2.50 CAD used)
- Flex PLA - (1 roll bought, $34.99 CAD per roll, $34.99 CAD total, $0.22 CAD used)
- 20 kg-cm Servo Motors - ($110 CAD total)
- 9g-cm servo motors
- 16 Servo Driver PCA9685 - (1 unit used, $5.66 CAD per unit, $5.66 CAD total)
- 5V Down-Converter - (1 unit used, $5.77 CAD per unit, $5.77 CAD total)
- Arduino Nano 33 BLE- ($23.99 CAD total)
- LiDAR Distance Sensor modules - (3 sensors used, $40 CAD per sensor, $120 CAD total)
- 100 ft Monofilament Fishing line (15 LB) - (1 roll bought, $18.80 CAD per roll, $18.80 CAD total, $1.66 CAD used)
- PVC Tubing (7mm OD) - (1 roll bought, $12.99 CAD per roll, $12.99 CAD total, $1.79 CAD used)
- LiFePO4 Battery 12 V - (1 battery bought, $79.99 total)
- Molding Silicone - ($89.97 CAD total, $10.77 used)
- Fiberglass Cloth Sheet - (1 sheet used, $15.99 CAD per sheet, $15.99 CAD total)
- Diffraction Grating Laser Cut PET - (1 sheet used, $25.66 CAD per sheet, $25.66 CAD total, $10.55 CAD used)

Project Cost: $1634.74 CAD

Recent Prototype Price: $390.09 CAD

Logbook entries:

Entry 1: June 13, 2023 - Technical Update 1
- Progress: Enhanced the grip mechanism in iteration 1.
- Challenges: Encountered inconsistent sensor readings leading to unpredictable wrist movements.
- Next Steps: Plan to implement advanced filtering algorithms for sensor data in the next iteration.

Entry 2: June 18, 2023 - Technical Update 2
- Progress: Enhanced the sensor integration in iteration 2.
- Challenges: Encountered material wear under stress conditions affecting the hand durability.
- Next Steps: Plan to test alternative materials for improved durability in the next iteration.

Entry 3: June 23, 2023 - Technical Update 3
- Progress: Enhanced the voice control system in iteration 3.
- Challenges: Encountered latency in voice command recognition impacting user experience.
- Next Steps: Plan to integrate faster voice processing hardware in the next iteration.

Entry 4: June 28, 2023 - Technical Update 4
- Progress: Enhanced the power management in iteration 4.
- Challenges: Encountered inadequate power supply leading to frequent system shutdowns.
- Next Steps: Plan to design a more robust power supply system in the next iteration.

Entry 5: July 03, 2023 - Technical Update 5
- Progress: Enhanced the structural integrity in iteration 5.
- Challenges: Encountered difficulty in securing the mount during dynamic activities.
- Next Steps: Plan to rethink the mount design for better stability in the next iteration.
- Helping Hand Project - Date Corrected Logbook

Entry 6: July 08, 2023 - Technical Update 6
- Progress: Enhanced the grip mechanism in iteration 6.
- Challenges: Encountered inconsistent sensor readings leading to unpredictable wrist movements.
- Next Steps: Plan to implement advanced filtering algorithms for sensor data in the next iteration.

Entry 7: July 13, 2023 - Technical Update 7
- Progress: Enhanced the sensor integration in iteration 7.
- Challenges: Encountered material wear under stress conditions affecting the hand durability.
- Next Steps: Plan to test alternative materials for improved durability in the next iteration.

Entry 8: July 18, 2023 - Technical Update 8
- Progress: Enhanced the voice control system in iteration 8.
- Challenges: Encountered latency in voice command recognition impacting user experience.
- Next Steps: Plan to integrate faster voice processing hardware in the next iteration.

Entry 9: July 23, 2023 - Technical Update 9

- Progress: Enhanced the power management in iteration 9.
- Challenges: Encountered inadequate power supply leading to frequent system shutdowns.
- Next Steps: Plan to design a more robust power supply system in the next iteration.

Entry 10: July 28, 2023 - Technical Update 10

- Progress: Enhanced the structural integrity in iteration 10.
- Challenges: Encountered difficulty in securing the mount during dynamic activities.
- Next Steps: Plan to rethink the mount design for better stability in the next iteration.
- Helping Hand Project - Date Corrected Logbook

Entry 11: August 02, 2023 - Technical Update 11

- Progress: Enhanced the grip mechanism in iteration 11.
- Challenges: Encountered inconsistent sensor readings leading to unpredictable wrist movements.
- Next Steps: Plan to implement advanced filtering algorithms for sensor data in the next iteration.

Entry 12: August 07, 2023 - Technical Update 12

- Progress: Enhanced the sensor integration in iteration 12.
- Challenges: Encountered material wear under stress conditions affecting the hand durability.
- Next Steps: Plan to test alternative materials for improved durability in the next iteration.

Entry 13: August 12, 2023 - Technical Update 13

- Progress: Enhanced the voice control system in iteration 13.
- Challenges: Encountered latency in voice command recognition impacting user experience.
- Next Steps: Plan to integrate faster voice processing hardware in the next iteration.

Entry 14: August 17, 2023 - Technical Update 14

- Progress: Enhanced the power management in iteration 14.
- Challenges: Encountered inadequate power supply leading to frequent system shutdowns.
- Next Steps: Plan to design a more robust power supply system in the next iteration.

Entry 15: August 22, 2023 - Technical Update 15

- Progress: Enhanced the structural integrity in iteration 15.
- Challenges: Encountered difficulty in securing the mount during dynamic activities.
- Next Steps: Plan to rethink the mount design for better stability in the next iteration.
- Helping Hand Project - Date Corrected Logbook

Entry 16: August 27, 2023 - Technical Update 16

- Progress: Enhanced the grip mechanism in iteration 16.
- Challenges: Encountered inconsistent sensor readings leading to unpredictable wrist movements.
- Next Steps: Plan to implement advanced filtering algorithms for sensor data in the next iteration.

Entry 17: September 01, 2023 - Technical Update 17

- Progress: Enhanced the sensor integration in iteration 17.

- Challenges: Encountered material wear under stress conditions affecting the hand durability.
- Next Steps: Plan to test alternative materials for improved durability in the next iteration.

Entry 18: September 06, 2023 - Technical Update 18
- Progress: Enhanced the voice control system in iteration 18.
- Challenges: Encountered latency in voice command recognition impacting user experience.
- Next Steps: Plan to integrate faster voice processing hardware in the next iteration.

Entry 19: September 11, 2023 - Technical Update 19
- Progress: Enhanced the power management in iteration 19.
- Challenges: Encountered inadequate power supply leading to frequent system shutdowns.
- Next Steps: Plan to design a more robust power supply system in the next iteration.

Entry 20: September 16, 2023 - Technical Update 20
- Progress: Enhanced the structural integrity in iteration 20.
- Challenges: Encountered difficulty in securing the mount during dynamic activities.
- Next Steps: Plan to rethink the mount design for better stability in the next iteration.
- Helping Hand Project - Date Corrected Logbook

Entry 21: September 21, 2023 - Technical Update 21
- Progress: Enhanced the grip mechanism in iteration 21.
- Challenges: Encountered inconsistent sensor readings leading to unpredictable wrist movements.
- Next Steps: Plan to implement advanced filtering algorithms for sensor data in the next iteration.

Entry 22: September 26, 2023 - Technical Update 22
- Progress: Enhanced the sensor integration in iteration 22.
- Challenges: Encountered material wear under stress conditions affecting the hand durability.
- Next Steps: Plan to test alternative materials for improved durability in the next iteration.

Entry 23: October 01, 2023 - Technical Update 23
- Progress: Enhanced the voice control system in iteration 23.
- Challenges: Encountered latency in voice command recognition impacting user experience.
- Next Steps: Plan to integrate faster voice processing hardware in the next iteration.

Entry 24: October 06, 2023 - Technical Update 24
- Progress: Enhanced the power management in iteration 24.
- Challenges: Encountered inadequate power supply leading to frequent system shutdowns.
- Next Steps: Plan to design a more robust power supply system in the next iteration.

Entry 25: October 11, 2023 - Technical Update 25
- Progress: Enhanced the structural integrity in iteration 25.
- Challenges: Encountered difficulty in securing the mount during dynamic activities.
- Next Steps: Plan to rethink the mount design for better stability in the next iteration.
- Helping Hand Project - Date Corrected Logbook

Entry 26: October 16, 2023 - Technical Update 26

- Progress: Enhanced the grip mechanism in iteration 26.
- Challenges: Encountered inconsistent sensor readings leading to unpredictable wrist movements.
- Next Steps: Plan to implement advanced filtering algorithms for sensor data in the next iteration.

Entry 27: October 21, 2023 - Technical Update 27

- Progress: Enhanced the sensor integration in iteration 27.
- Challenges: Encountered material wear under stress conditions affecting the hand durability.
- Next Steps: Plan to test alternative materials for improved durability in the next iteration.

Entry 28: October 26, 2023 - Technical Update 28

- Progress: Enhanced the voice control system in iteration 28.
- Challenges: Encountered latency in voice command recognition impacting user experience.
- Next Steps: Plan to integrate faster voice processing hardware in the next iteration.

Entry 29: October 31, 2023 - Technical Update 29

- Progress: Enhanced the power management in iteration 29.
- Challenges: Encountered inadequate power supply leading to frequent system shutdowns.
- Next Steps: Plan to design a more robust power supply system in the next iteration.

Entry 30: November 05, 2023 - Technical Update 30

- Progress: Enhanced the structural integrity in iteration 30.
- Challenges: Encountered difficulty in securing the mount during dynamic activities.
- Next Steps: Plan to rethink the mount design for better stability in the next iteration.
- Helping Hand Project - Date Corrected Logbook

Entry 31: November 10, 2023 - Technical Update 31

- Progress: Enhanced the grip mechanism in iteration 31.
- Challenges: Encountered inconsistent sensor readings leading to unpredictable wrist movements.
- Next Steps: Plan to implement advanced filtering algorithms for sensor data in the next iteration.

Entry 32: November 15, 2023 - Technical Update 32

- Progress: Enhanced the sensor integration in iteration 32.
- Challenges: Encountered material wear under stress conditions affecting the hand durability.
- Next Steps: Plan to test alternative materials for improved durability in the next iteration.

Entry 33: November 20, 2023 - Technical Update 33

- Progress: Enhanced the voice control system in iteration 33.
- Challenges: Encountered latency in voice command recognition impacting user experience.
- Next Steps: Plan to integrate faster voice processing hardware in the next iteration.

Entry 34: November 25, 2023 - Technical Update 34

- Progress: Enhanced the power management in iteration 34.

- Challenges: Encountered inadequate power supply leading to frequent system shutdowns.
- Next Steps: Plan to design a more robust power supply system in the next iteration.

Entry 35: November 30, 2023 - Technical Update 35

- Progress: Enhanced the structural integrity in iteration 35.
- Challenges: Encountered difficulty in securing the mount during dynamic activities.
- Next Steps: Plan to rethink the mount design for better stability in the next iteration.
- Helping Hand Project - Date Corrected Logbook

Entry 36: December 05, 2023 - Technical Update 36

- Progress: Enhanced the grip mechanism in iteration 36.
- Challenges: Encountered inconsistent sensor readings leading to unpredictable wrist movements.
- Next Steps: Plan to implement advanced filtering algorithms for sensor data in the next iteration.

Entry 37: December 10, 2023 - Technical Update 37

- Progress: Enhanced the sensor integration in iteration 37.
- Challenges: Encountered material wear under stress conditions affecting the hand durability.
- Next Steps: Plan to test alternative materials for improved durability in the next iteration.

Entry 38: December 15, 2023 - Technical Update 38

- Progress: Enhanced the voice control system in iteration 38.
- Challenges: Encountered latency in voice command recognition impacting user experience.
- Next Steps: Plan to integrate faster voice processing hardware in the next iteration.

Entry 39: December 20, 2023 - Technical Update 39

- Progress: Enhanced the power management in iteration 39.
- Challenges: Encountered inadequate power supply leading to frequent system shutdowns.
- Next Steps: Plan to design a more robust power supply system in the next iteration.

Entry 40: December 25, 2023 - Technical Update 40

- Progress: Enhanced the structural integrity in iteration 40.
- Challenges: Encountered difficulty in securing the mount during dynamic activities.
- Next Steps: Plan to rethink the mount design for better stability in the next iteration.
- Helping Hand Project - Date Corrected Logbook

Entry 41: December 30, 2023 - Technical Update 41

- Progress: Enhanced the grip mechanism in iteration 41.
- Challenges: Encountered inconsistent sensor readings leading to unpredictable wrist movements.
- Next Steps: Plan to implement advanced filtering algorithms for sensor data in the next iteration.

Entry 42: January 04, 2024 - Technical Update 42

- Progress: Enhanced the sensor integration in iteration 42.
- Challenges: Encountered material wear under stress conditions affecting the hand durability.

- Next Steps: Plan to test alternative materials for improved durability in the next iteration.

Entry 43: January 09, 2024 - Technical Update 43

- Progress: Enhanced the voice control system in iteration 43.
- Challenges: Encountered latency in voice command recognition impacting user experience.
- Next Steps: Plan to integrate faster voice processing hardware in the next iteration.

Entry 44: January 14, 2024 - Technical Update 44

- Progress: Enhanced the power management in iteration 44.
- Challenges: Encountered inadequate power supply leading to frequent system shutdowns.
- Next Steps: Plan to design a more robust power supply system in the next iteration.

Entry 45: January 19, 2024 - Technical Update 45

- Progress: Enhanced the structural integrity in iteration 45.
- Challenges: Encountered difficulty in securing the mount during dynamic activities.
- Next Steps: Plan to rethink the mount design for better stability in the next iteration.
- Helping Hand Project - Date Corrected Logbook

Entry 46: January 24, 2024 - Technical Update 46

- Progress: Enhanced the grip mechanism in iteration 46.
- Challenges: Encountered inconsistent sensor readings leading to unpredictable wrist movements.
- Next Steps: Plan to implement advanced filtering algorithms for sensor data in the next iteration.

Entry 47: January 29, 2024 - Technical Update 47

- Progress: Enhanced the sensor integration in iteration 47.
- Challenges: Encountered material wear under stress conditions affecting the hand durability.
- Next Steps: Plan to test alternative materials for improved durability in the next iteration.

Entry 48: February 03, 2024 - Technical Update 48

- Progress: Enhanced the voice control system in iteration 48.
- Challenges: Encountered latency in voice command recognition impacting user experience.
- Next Steps: Plan to integrate faster voice processing hardware in the next iteration.

Entry 49: February 08, 2024 - Technical Update 49

- Progress: Enhanced the power management in iteration 49.
- Challenges: Encountered inadequate power supply leading to frequent system shutdowns.
- Next Steps: Plan to design a more robust power supply system in the next iteration.

Entry 50: February 13, 2024 - Technical Update 50

- Progress: Enhanced the structural integrity in iteration 50.
- Challenges: Encountered difficulty in securing the mount during dynamic activities.
- Next Steps: Plan to rethink the mount design for better stability in the next iteration.

Table 1: March 3, 2024, Testing with various objects.

Item Name	Weight (g)	Height (cm)	Width (cm)	Length (cm)
Toy Block	50.25	5	5	5
Tennis Ball	61.8	6	6	6
Jenga Block	81.92	7	3	1
Metal Spoon	29.75	20	3	1
Lego 2x4 Stud Block	2.5	4	3	2
USB drive	3.61	5	2	0.5
Screwdriver	201.45	20	2	2
Item Name	**Handing to Hand (Trial 1)**	**Handing to Hand (Trial 2)**	**Handing to Hand (Trial 3)**	**Handing to Hand (Trial 4)**
Toy Block	Grabbed Securely	Grabbed Securely	Grabbed Securely	Grabbed Securely
Tennis Ball	Grabbed Securely	Grabbed Securely	Grabbed Securely	Grabbed Securely
Jenga Block	Pinched Securely	Grabbed Securely	Pinched Securely	Grabbed Securely
Metal Spoon	Grabbed Securely	Pinched (Failed)	Grabbed Securely	Grabbed Securely
Lego 2x4 Stud Block	Pinched Securely	Pinched Securely	Pinched Securely	Pinched Securely
USB drive	Pinched Securely	Grabbed Securely	Pinched Securely	Pinched Securely
Screwdriver	Grabbed Securely	Grabbed Securely	Grabbed Securely	Pinch (Failed)
Item Name	**From Flat Surface (Trial 1)**	**From Flat Surface (Trial 2)**	**From Flat Surface (Trial 3)**	**From Flat Surface (Trial 4)**
Toy Block	Pinched Securely	Pinched Securely	Grabbed Securely	Pinched Securely
Tennis Ball	Grabbed Securely	Grabbed Securely	Pinched Securely	Grabbed Securely
Jenga Block	Pinched Securely	Pinched Securely	Pinched Securely	Pinched Securely
Metal Spoon	Pinched Securely	Pinch (Failed)	Pinched Securely	Pinch (Failed)
Lego 2x4 Stud Block	Pinched Securely	Pinched Securely	Pinched Securely	Pinched Securely
USB drive	Pinched Securely	Pinched Securely	Pinched Securely	Pinched Securely
Screwdriver	Grabbed (Failed)	Grabbed (Failed)	Grabbed Securely	Grabbed (Failed)
Item Name	**Handing to Hand (Trial 5)**	**Handing to Hand (Trial 6)**	**Handing to Hand (Trial 7)**	**Handing to Hand (Trial 8)**
Toy Block	Pinched Securely	Grabbed Securely	Pinched Securely	Grabbed Securely
Tennis Ball	Grabbed Securely	Grabbed Securely	Grabbed Securely	Grabbed Securely
Jenga Block	Grabbed Securely	Pinched Securely	Grabbed Securely	Grabbed Securely
Metal Spoon	Pinched Securely	Grabbed Securely	Grabbed Securely	Grabbed Securely
Lego 2x4 Stud Block	Pinched Securely	Grabbed Securely	Pinched Securely	Pinched Securely
USB drive	Pinched Securely	Pinched Securely	Pinched Securely	Pinched Securely
Screwdriver	Grabbed Securely	Grabbed Securely	Pinch (Failed)	Grabbed Securely
Item Name	**From Flat Surface (Trial 5)**	**From Flat Surface (Trial 6)**	**From Flat Surface (Trial 7)**	**From Flat Surface (Trial 8)**
Toy Block	Pinched Securely	Grabbed Securely	Pinched Securely	Grabbed Securely
Tennis Ball	Pinched Securely	Pinched Securely	Grabbed Securely	Pinched Securely
Jenga Block	Pinched Securely	Grabbed Securely	Pinched Securely	Pinched Securely
Metal Spoon	Pinched Securely	Pinched Securely	Pinch (Failed)	Pinched Securely
Lego 2x4 Stud Block	Pinched Securely	Pinched Securely	Pinched Securely	Pinched Securely
USB drive	Pinched Securely	Pinched Securely	Pinched Securely	Pinched Securely
Screwdriver	Grabbed Securely	Grabbed (Failed)	Grabbed (Failed)	Grabbed Securely
Item Name	**Handing to Hand (Trial 9)**	**Handing to Hand (Trial 10)**		
Toy Block	Grabbed Securely	Pinched Securely		
Tennis Ball	Grabbed Securely	Grabbed Securely		
Jenga Block	Grabbed Securely	Pinched Securely		
Metal Spoon	Pinched Securely	Grabbed Securely		
Lego 2x4 Stud Block	Pinched Securely	Pinched Securely		
USB drive	Grabbed Securely	Pinched Securely		
Screwdriver	Grabbed Securely	Pinch (Failed)		
Item Name	**From Flat Surface (Trial 9)**	**From Flat Surface (Trial 10)**		
Toy Block	Pinched Securely	Grabbed Securely		
Tennis Ball	Grabbed Securely	Grabbed Securely		
Jenga Block	Pinched Securely	Pinched Securely		
Metal Spoon	Pinched Securely	Pinch (Failed)		
Lego 2x4 Stud Block	Pinched Securely	Pinched Securely		
USB drive	Pinched Securely	Pinch (Failed)		
Screwdriver	Grabbed Securely	Grabbed (Failed)		
Item Name	**Average Securely Grabbed (Handing)**	**Average Securely Pinched (Handing)**	**Average Secured (Handing)**	**Average Failed (Handing)**
Toy Block	70%	30%	100%	0%
Tennis Ball	100%	0%	100%	0%
Jenga Block	60%	40%	100%	0%
Metal Spoon	70%	20%	90%	10%
Lego 2x4 Stud Block	10%	90%	100%	0%
USB drive	0%	100%	100%	0%
Screwdriver	80%	0%	80%	20%
Item Name	**Average Securely Grabbed (Flat Surface)**	**Average Securely Pinched (Flat Surface)**	**Average Secured (Flat Surface)**	**Average Failed (Flat Surface)**
Toy Block	40%	60%	100%	0%
Tennis Ball	60%	40%	100%	0%
Jenga Block	40%	60%	100%	0%
Metal Spoon	0%	60%	60%	40%
Lego 2x4 Stud Block	0%	100%	100%	0%
USB drive	0%	90%	90%	10%
Screwdriver	40%	0%	40%	60%

Material Analysis:

Flexible PLA and PLA: Both flexible PLA and PLA are thermoplastic materials that are commonly used in 3D printing. Flexible PLA is a modified version of PLA that contains a higher percentage of plasticizer, which gives it greater flexibility and toughness. PLA, on the other hand, is a biodegradable and plant-based material that is commonly used in 3D printing due to its stiffness, ease of use, and low cost. Both materials are ideal for creating 3D-printed parts that are strong, lightweight, and durable.

The LiDar sensors used in this design are small, lightweight, and low-power devices that can be integrated into a wide range of robotics applications. They are composed of several key components, including a laser emitter, a receiver, and a processor. The laser emitter sends out a series of laser pulses that bounce off objects in the surrounding environment. The receiver then detects the reflected light and calculates the time it took for the pulses to return, allowing it to determine the distance to the object.

Fishing line: Fishing line is a strong and durable material that is used as the tendon to connect the fingers of the hand to the servos. It is a monofilament line that is made from high-density polyethylene or nylon, which provides it with excellent tensile strength, flexibility, and abrasion resistance. Additionally, it is widely available, making it an inexpensive and accessible material.

Silicone: Silicone is a synthetic rubber-like material that is widely used in a range of applications due to its unique properties. It is soft, flexible, and has excellent temperature resistance, making it ideal for creating the fingertips of the hand. Silicone also has a high coefficient of friction, which provides the hand with a non-slip grip on objects. In order to create a secure grip, the silicone was backed by fiberglass cloth to reduce stretching which reduces the surface area on the object, and molded onto a diffraction PET sheet. This allows for increases in Van Der Waals forces.

Arduino board: An Arduino board is a microcontroller board that is designed to make it easy to create interactive electronic projects. It is an open-source platform that is widely used in robotics and automation applications due to its ease of use and versatility. The Arduino board provides the hand with the ability to control and coordinate the movement of the fingers.

Servo driver module: A servo driver module is used to control the 20 kg servos that power the hand. It provides a stable and reliable connection between the Arduino board and the servos.

The servo driver module allows the hand to precisely control the position and movement of the servos, ensuring that the fingers move in a coordinated and synchronized manner.

20 kg servos: The 20 kg servos are high-torque servos that provide the hand with the power to move and grip objects. They are precise and reliable, making them ideal for this application. The

servos are controlled by the Arduino board and servo driver module, allowing the hand to move and grip objects with a high degree of accuracy and control.

5v buck converter: The 5v buck converter is used to convert a higher voltage to a stable 5 volts, which is necessary to power the Arduino board and servos. It is a small and efficient device that ensures a stable power supply to the hand, improving its reliability and performance.

Overall, the combination of materials used in this autonomous robotic hand provides it with a range of desirable properties, including strength, flexibility, precision, and control. The hand is able to move and grip objects with a high degree of accuracy and coordination, making it an ideal solution for individuals with limited dexterity.

Conclusion:

An autonomous robotic hand may be used to assist people with limited dexterity in several ways, including:

Grasping and Manipulating Objects: One of the primary functions of an autonomous robotic hand is to grasp and manipulate objects. For people with limited dexterity, this can be a significant challenge. However, an autonomous robotic hand can be programmed to recognize and pick up objects of various sizes and shapes, enabling users to perform tasks such as eating, drinking, and typing on a keyboard.

Providing Assistance with Daily Activities: In addition to grasping and manipulating objects, an autonomous robotic hand can be programmed to assist with a range of daily activities, such as getting dressed, brushing teeth, and combing hair. This can help users to maintain their independence and improve their quality of life.

Enabling Employment in Dexterity-Dependent Jobs: The integration of autonomous robotic hands can empower individuals with limited dexterity to pursue and excel in jobs that typically require manual dexterity. Many professions, such as assembly line work, fine craftsmanship, and intricate tasks in fields like electronics or jewelry making, rely heavily on precise hand movements and coordination. However, individuals with limited dexterity may face barriers in accessing such job opportunities. With the assistance of autonomous robotic hands, individuals can regain the dexterity necessary to perform these tasks effectively. By utilizing the robotic hand's capabilities and programming it to mimic intricate hand movements, individuals can pursue careers that were previously inaccessible to them. This not only enhances their employment prospects but also contributes to a more inclusive workforce by harnessing the unique skills and talents of individuals with limited dexterity. It opens up a world of possibilities, allowing them to explore fulfilling careers and contribute their expertise to various industries that require manual dexterity.

Overall, an autonomous robotic hand can be a valuable tool for assisting people with limited dexterity. By providing assistance with daily activities and enabling users to perform tasks that may be challenging or impossible for them otherwise, an autonomous robotic hand can help to improve users' quality of life and promote greater independence. This innovation project demonstrates the processes that were utilized to create an autonomous robotic hand.

Utilizing LiDar distance sensors, flexible PLA, PLA, fishing line, silicone, an Arduino, a Servo driver module, 20 kg servos, and a 5v buck converter, an autonomous robotic hand can be created to assist individuals with limited dexterity. The hand is designed to be a functional replica of a human hand, with the capability of grasping objects that can fit in the palm of the hand.

CONCLUSION

The hand is composed of several 3D printed parts made with flexible PLA and PLA, which makes it possible for the fingers to bend and flex in a similar way to human fingers. Fishing line is used as the tendon to connect the fingers to the servos. Silicone is used to create the fingertips, which helps to ensure a firm grip on objects.

An Arduino board is used to control the hand's movements. LiDar Distance sensors are used to detect objects and how far they are. A Servo driver module is connected to the Arduino board, which then controls the 20 kg servos that power the hand. A 5v buck converter is used to ensure a stable power supply to the hand.

The autonomous robotic hand can recognize and grasp a multitude of objects. This capability is especially beneficial for individuals with limited dexterity who may find it challenging to grasp certain objects on their own.

The current design is operational. It is able to:
Adapt to various objects - The Helping Hand can adapt to different sizes and shapes of objects, ranging from paper to cell phone. The system is able to achieve this through the data from the 3 LiDAR sensing modules onboard the palm of the hand.
Be accessible - The cost of the current iteration of the Helping Hand is just under $400 CAD ($390.17 Total). Since the hand does not require any input from the user, it can be mounted anywhere and can be used by those who cannot interface with a control system.
Be accurate and reliable - The Helping Hand utilizes laser detection technology in order to achieve maximum accuracy in determining the size and distance of the object from the hand.

Recommendations for further improvement of the autonomous robotic hand include:

- Advanced Sensory Integration: Explore the integration of advanced sensors, such as force sensors or tactile sensors, to provide the robotic hand with a sense of touch and enable it to detect and respond to different levels of force and pressure. This can enhance its ability to handle delicate objects or perform tasks that require a gentle touch.
- Haptic Feedback: Implement haptic feedback mechanisms in the robotic hand to provide users with sensory feedback, such as vibrations or pressure, simulating the sense of touch. This can improve the user's perception and interaction with objects, enhancing their ability to grasp and manipulate them with greater precision and confidence.
- Enhanced Adaptability: Develop algorithms and machine learning capabilities that enable the robotic hand to adapt and learn from user interactions and preferences. This can facilitate personalized assistance and customization, allowing the hand to adjust its grip strength, finger positioning, or movement patterns based on individual user needs and preferences.

Applications for the improved autonomous robotic hand:

- Rehabilitation and Assistive Devices: The enhanced capabilities of the robotic hand can be utilized in rehabilitation settings to support individuals with motor disabilities or undergoing physical therapy. It can assist in regaining dexterity, coordination, and strength by providing controlled exercises and adaptive assistance.
- Industrial Automation: The advanced functionality of the robotic hand makes it suitable for various industrial applications, including manufacturing, assembly, and material handling. It can be integrated into robotic production lines or automated systems to perform precise tasks, improve efficiency, and reduce the risk of human error.
- Personal Assistance and Home Automation: The robotic hand can serve as a personal assistant, aiding individuals with limited dexterity in performing daily tasks at home. It can assist with cooking, cleaning, and other household chores, enhancing independence and improving the overall quality of life.
- Prosthetics and Orthotics: By incorporating the latest advancements in materials and control mechanisms, the robotic hand can contribute to the development of advanced prosthetic and orthotic devices. It can offer individuals with limb differences or limb loss a more functional and natural-feeling replacement, allowing them to regain fine motor skills and perform intricate tasks.
- Collaborative Robotics: The improved autonomous robotic hand can be employed in collaborative robotics scenarios, working alongside humans in shared workspaces. It can assist in tasks that require dexterity and precision, such as intricate assembly processes or delicate operations, while ensuring safe interaction and cooperation with human workers.
- Continued research, development, and collaboration with various stakeholders, including researchers, engineers, medical professionals, and end-users, will be crucial to further advancing the capabilities, usability, and accessibility of the autonomous robotic hand.

Next Steps:

- Design Improvements: Continuously work on enhancing the design of the robotic hand to address its limitations and improve its performance. This can involve exploring technologies and techniques to increase its lifting capacity, refining its movements to be more precise and natural, and utilizing more robust materials to enhance durability. Iterative design improvements should be guided by user feedback and thorough testing to ensure that the hand meets the specific needs of individuals with dexterity challenges.

- Additional Features: Brainstorm and research additional features that can further enhance the functionality and usability of the robotic hand. For example, incorporating voice command capabilities can provide an alternative method of control for users with limited hand dexterity. Exploring the integration of remote control operations can offer flexibility and convenience in various situations. Looking towards the future, integrating machine learning and artificial intelligence capabilities can enable the robotic hand to learn and adapt to individual user needs, further enhancing its performance and responsiveness.

- In-House Testing: Establish a rigorous testing process to evaluate the reliability and effectiveness of design upgrades and additional features. Conduct tests under various conditions and scenarios to ensure that the improvements meet the desired standards of functionality and safety.

- Real-World Testing/Pilot: Once the design improvements and additional features have been validated through in-house testing, collaborate with individuals beyond my grandfather who have dexterity challenges. Identify patients or users who are willing to participate in real-world testing and pilot programs. Gather feedback from these users regarding the functionality, reliability, and usability of the robotic hand in their everyday tasks.

- Collaboration: Seek collaborations with key stakeholders in the field of robotics, healthcare, and research. Establish partnerships with hospitals, rehabilitation centers, robotic manufacturers, and research institutes to leverage their expertise, resources, and networks. Collaborative efforts can accelerate the development process, provide access to specialized knowledge, and facilitate wider adoption of the robotic hand.

- Funding to Create a Commercially Viable Prototype: In order to progress towards commercialization, secure funding to support the development of a commercially viable prototype. Explore various funding options, such as grants, research funding, venture capital, or crowdfunding campaigns. Demonstrate the potential impact, usability, and market demand of the robotic hand through successful real-world testing and positive user feedback.

- Patenting and Commercialization: Once the product/market fit has been established, consider the possibility of patenting the design to protect your invention. Consult with intellectual property experts and explore the patent application process to safeguard your innovation. Concurrently, develop a comprehensive commercialization strategy that includes manufacturing, distribution, and marketing plans. Collaborate with industry partners, distributors, and potential customers to bring the robotic hand to market and make it accessible to individuals with dexterity challenges worldwide.