GNG2101

Design Project User and Product Manual

Guide2GO

Submitted by

GNG2101-A01, Team 1

Kierra Caminiti 300105421

Erika Johnson 300108468

Nathan Meraw 300112438

Dominic Salas 300169706

Qassim Alkassir 8883657

05/12/2021

University of Ottawa

Table of Contents

List of Figures

List of Tables

1 Introduction

This User and Product Manual (UPM) provides the information necessary for people that are visually impaired to effectively use the Guide2Go cane and for prototype documentation. Some assumptions that have been made during our work is that the next person to develop the cane will have all the necessary resources to do so. This document is intended to be used to understand as well as recreate the Guide2Go cane from start to finish.

The UPM is split into six main sections; the first providing an overview of the cane's importance and functionality, the second providing a walkthrough of how to get started, the third describing how to use the product, the fourth mentioning ways to get support if an issue is encountered, and the last detailing how the final product was built. A conclusion is included to provide a summary of the context of this document, as well as discuss how the cane can be improved for future development.

Note that this manual includes personal information which shall only be used if a problem with product development is encountered, or an inquiry is made.

2 Overview

Throughout the COVID-19 pandemic, the importance of keeping our distance from others has significantly increased. Luckily, the vast majority of the population is able to see whether those around are masked and socially distanced. However, members of the blind, or visually impaired, community are living through this pandemic without said “ability to see”. Not only do they not know when to distance but finding an unfamiliar guide to help them navigate a new location is very unsafe.

The user, therefore, requires a product with handles on either end, allowing an unfamiliar sighted individual to guide them, while remaining six feet apart. The cane should be able to be used across terrains of various width and steepness, without drawing attention to the individuals or the final location. The user requires a simple, easy-to-use product, so that it can be used without having to see it. Finally, a simple navigation system would greatly increase the efficiency of the product, so the guide can clearly communicate directions with the user.

The Guide2GO is a solution to the above problem, allowing a visually impaired user to be guided by anyone, while respecting COVID-19 guidelines. The product displays never-before-seen features on a white cane, including a simple haptic feedback navigational system, eliminating the need for any complicated Bluetooth connections, a dual-purposed end, allowing for both single and dual use, and the ability to lock the cane at various lengths, for increased comfort and versatility. The Guide2GO also considers societal and health & safety conditions by allowing for a distance of 6.2ft between users, a useful feature for mitigating the spread of viruses during current and future pandemics. The Guide2GO is a step forward in making the world more accessible for

those with physical disabilities, by allowing for a safe, easy way to get around unfamiliar destinations.

Figure 1: The Guide2GO in its collapsed state, measuring 1.5ft.

Figure 2: The Guide2GO in its fully extended state, measuring 6.2ft.

As seen above, the cane includes a spring pin locking mechanism, allowing for various lengths. It also features a navigational system, which can be powered on and off, where the sighted guide can take advantage of buttons, sending vibrational signals to the blind user, alerting them of an upcoming left or right turn. A microcontroller connected to a 9V battery is used to power the vibrational motor. Additionally, the non-permanent handle of the cane may be removed, using the same spring mechanism, to be replaced by a marshmallow end, included with the cane. Finally, the cane features reflective tape for increased safety when walking at night.

3 Getting started

3.1 General Walkthrough

To use the Guide2GO, the user must first extend the cane to the appropriate length, using the spring pin locking mechanism. This is done by pulling the telescopic segments out of each other, one at a time, until the pin peeks through the hole in said segment.

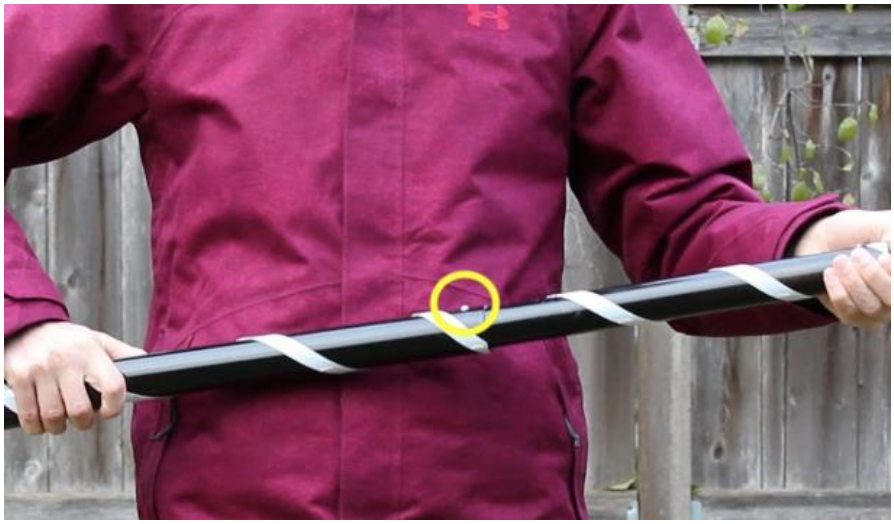

Figure 3: The spring pin peeking through the hole in the segment.

Note that the pin must line up with the hole in order to “peek out”. Next, the user can decide which interchangeable cane end they will be using, either the J-shaped handle or the marshmallow

cane end. Both ends are found in the portable bag included in the purchase of a Guide2GO. These ends are held in place through the same spring pin locking mechanism as explained above.

Figure 4: Both handle options locked in place, by spring pins.

The marshmallow tip allows for self-use, where the visually impaired person may use the cane as a typical white cane to feel the ground, and any potential obstacles, around them. When the J-shape handle is selected, the cane allows for use by two people: the guide and the visually impaired individual. In order to effectively communicate directions with the visually impaired person, a haptic feedback system is included. There exists two buttons on the permanent handle of the cane.

Figure 5: Buttons and electrical components on the permanent handle of the cane.

Once the switch on the battery pack, located on the purple compartment, is turned “ON”, one click of the yellow button sends two vibrational impulses to the user on the other end of the cane, signifying that the guide is turning right. A click of the white button sends a single vibration to the visually impaired individual, to notify them of a left turn.

When the users have arrived at their destination, the switch on the battery pack may be turned “OFF” to conserve energy. The cane simply collapses by pressing each spring pin and simultaneously pushing the telescopic components back into one another. The cane ends are stored in the bag provided.

3.2 Set-up Considerations

See section 3.1 for an overview of the equipment, configuration and use of the Guide2GO cane.

It should be considered that the input of the system is a 9V battery. Although the battery can be turned on and off to conserve energy, the battery can die eventually. It is easily replaced using the removeable door of the battery pack.

The output of the system is the vibrational motor. This will vibrate as long as the connections remain intact, and the battery has enough energy.

3.3 User Access Considerations

The cane is intended to be used by members of the blind community. It is, therefore, very easy to use without having to see the product. The cane does, however, require the ability to feel vibrational motors, in order to use it to its full ability. Finally, its main function is to help the user navigate an unfamiliar area, meaning they must be able to walk on their own.

3.4 Accessing the System

To access the Guide2Go cane, the user must first extend the cane to the desired length using the spring pin locking mechanism. Following that, if the intention of the user is to be guided by another person, The J-shaped handle needs to be installed on the other end of the cane and the switch on the battery pack needs to be switched to the “ON” setting. This will allow the guide to send vibrational instructions to the visually impaired person being guided as described in section 3.1.

However, if the cane is to be used solely by the visually impaired person, the battery pack can be switched to the “OFF” setting and the marshmallow tip can be fastened.

3.5 System Organization & Navigation

The cane features can be divided into 2 sections seen below:

2-person mode:

2-person mode refers to situation when the visually impaired person is being guided by another person. In this mode, the J-handle should be fastened to the other end of the stick and the cane should be extended to a minimum of 6 feet in length. The battery pack should also be switched “ON” to allow the guide to send vibrational instructions to the visually impaired person throughout the trip.

In this mode, the navigational system operates as follows:

- One click of the yellow button sends two vibrational impulses to the user on the other end of the cane, signifying that the guide is turning right.
- A click of the white button sends a single vibration to the visually impaired individual, to notify them of a left turn.

Self-mode:

Self-mode refers to the situation when the visually impaired person is using the cane by themselves. In this mode, the marshmallow tip should be fastened to the other end of the stick and the cane should be extended to the desired length. The battery pack can be switched “OFF” to conserve the battery.

3.6 Exiting the System

2-person mode:

Once the destination is reached, the battery pack can be switched to the “OFF” setting. The cane can then be collapsed, and the J-shaped handle can be removed and stored in the carrying pouch.

Self-mode:

Once the destination is reached, the cane be collapsed, and the marshmallow tip can be removed and stashed away in the carrying pouch.

4 Using the System

The following sub-sections provide detailed, step-by-step instructions on how to use the various functions or features of the Guide2Go cane.

4.1 2-person mode

In 2-person mode, the cane is set up in a way to allow 2 users (the guide and the visually impaired person) to use the cane (figure 6). In this mode, the guide has access to 2 buttons that allows them to send navigational instructions to the visually impaired person.

Figure 6. Guide2Go cane in 2-person mode

4.1.1 Navigational System

The navigational system on the Guide2Go cane consists of 3 main parts:

1. Battery pack
2. Navigational buttons
3. Vibrational motor

These 3 components work together to allow the guide to send directional instructions to the visually impaired person. The battery pack houses a 9V battery and has an “ON” and “OFF” switch to conserve battery when not in use. There are 2 navigational buttons. When the yellow button is clicked, two vibrational impulses are sent to the user on the other end of the cane, signifying that the guide is turning right. When the white button is clicked, a single vibration is sent to the visually impaired individual, to notify them of a left turn.

4.2 Self mode

In self-mode, the cane is set up to allow the visually impaired person to solely use the cane by utilizing the marshmallow tip (figure 7). This tip can replace the J-shaped handle that is used in 2-person mode. In this mode, the navigational system is not needed so the battery pack can be switched to the “OFF” setting.

Figure 6: Guide2Go cane in self mode

5 Troubleshooting & Support

5.1 Error Messages or Behaviors

A known issue with the Guide2GO cane is the pins failing to line up. To address this issue, please realign the pins located on the cane's shaft so that they fit in the other telescoping sections of the shaft.

For any other errors, please feel free to contact anybody on the Guide2GO staff using the contact info in section 5.2.

5.2 Support

To get emergency assistance and system support with the Guide2GO, here are the names and emails of the staff, feel free to contact at any time via email:

Name	Email
Dominic Salas	dsala011@uottawa.ca
Kierra Caminiti	kcami026@uottawa.ca
Erika Johnson	ejohn074@uottawa.ca
Nathan Meraw	nmera043@uottawa.ca
Qassim Alkassir	qalka062@uottawa.ca

6 Product Documentation

6.1 Mechanical System

With regards to the structure of the cane, it was ensured that the cane was of the best structural integrity, could collapse and extend with ease, and was lightweight. To select the proper material for the cane length segments, we looked into materials which were lightweight, rigid, and strong. Materials that were considered were: aluminum, carbon fiber and PVC pipe. Aluminum has a lower density than any other commercial metal, meaning that it was the most lightweight option out of the 3. However, it is also prone to fail during repetitive stress loading and is expensive since the pipes would have needed to be personally manufactured. Carbon fiber was the best material property-wise due to its dimensional stability, physical strength, toughness, and its lightweight properties. However, carbon fiber is extremely expensive to manufacture, costing between 7-15$ per pound of material [1]. In the end, PVC pipe was selected over all other options since it is the cheapest option of the three materials, has high hardness and is lightweight.

6.1.1 BOM (Bill of Materials)

Table 1: Bill of Materials for Mechanical System

Mechanical Parts					
Item	Description	Price (CAD)	Quantity	Total	Reference
1	0.5 in. X 15 ft. White Reflective Tape	7.34	1	7.34	Link
2	3 PCS Foam Hose 0.98 inches x 0.35 inches for Grip	13.68	1	13.68	Link
3	Filament for 3D Printing	0.00	1	0.00	Provided by Makerspace Resources
4	PVC Piping of Different Diameters (total 6 ft. in length)	27.11	1	27.11	Link
5	6x Spring Pins	19.39	1	19.39	Link
Total				67.52	

6.1.2 Equipment list

- 3D printer with 8mm filament
- Drill press
- 3/8” drill bit
- Scissors
- Hot glue
- Horizontal bandsaw
- Deburring Tool
- Caliper
- Measuring Tapes
- File

6.1.3 Instructions

1. First we started with selecting the PVC pipes to use for our cane. The team had to ensure that we found five pipes that fit inside one another. This led to us selecting pipes of diameter 2’’, 1.50”, 1.25”, 1.00”, and 0.50”. The team was able to obtain the first four pipes since these are commonly purchased PVC pipes. But we were unable to obtain the final 0.50” pipe due to its small size. Our solution of this was to 3D print the 0.50” diameter tube at the makerspace. The pipes can be seen below fitting in one another on a CAD model.

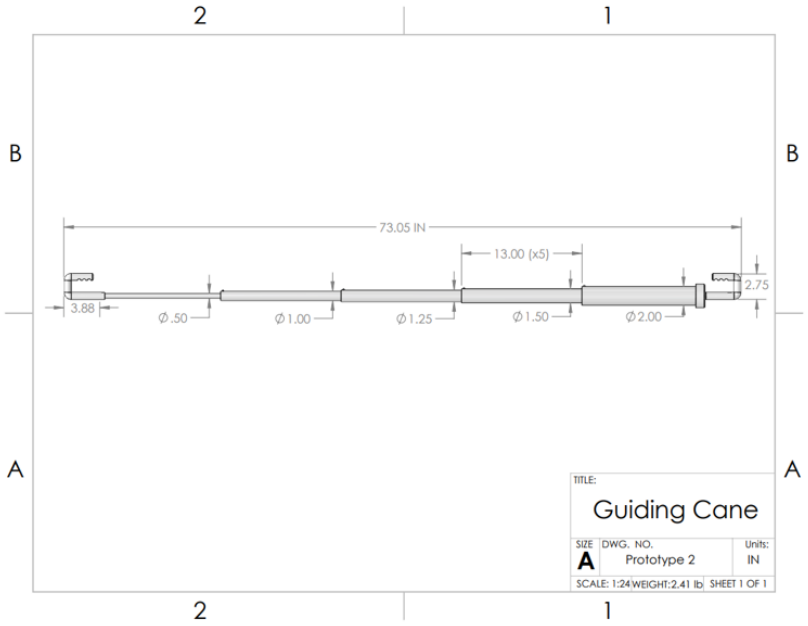

Figure 7: CAD Model of Cane Displaying PVC Segments

2. The next task involved cutting the pipes down to the desired length and drilling the holes for the spring push pins. The pipes were cut down to 14” using a horizontal bandsaw. Then two holes were drilled on each end of the cane 0.75” from each end on a drill press. The drill bit size used was 3/8”.

3. The pipes were then filed down on each end to remove sharp edges from cutting. The holes were also deburred using a deburring tool to remove excess material around the hole.

4. The spring pins were then installed in each pipe segment (1 per segment). The spring pin was simply slid inside the pipe until it matched up with the hole. The image below was obtained from the internet but display how we installed the spring pin into our pipes.

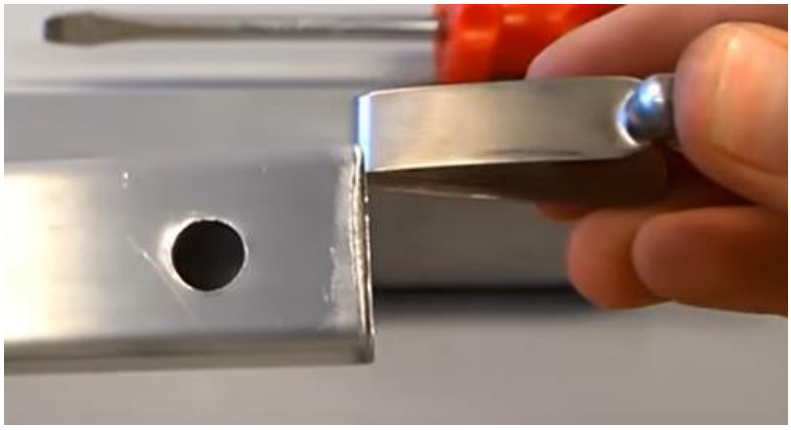

Figure 8: Demonstration of the Push Pin being Inserted into a Pipe Segment [2]

5. Once the spring pins were installed it was time to assemble the cane. The four PVC segments are shown assembled into one another as seen below.

Figure 9: Four PVC Pipe Segments Assembled with Spring Pins

6. The fifth cane segment was then 3D printed and installed as well, as seen below.

Figure 10: 4 PVC Pipes Installed with 1 3D printed Segment

7. Next the navigation compartment was 3D printed, as seen below.

Figure 11: 3D Printed Navigation Compartment

8. The end handles were then 3D printed and installed on the cane. The green handle was hot glued onto the first pipe segment, while the pink handle was installed with a spring pin as this is the removal end, as seen below.

Figure 12: Installed 3D Printed Handles

9. The white cane tip was also then 3D printed and installed with a spring pin to attach to the removal end as well when desired, pictured below.

Figure 13: 3D Printed Marshmallow Tip

10. The cane was then spray painted using black spray paint.

11. The canes handles were then covered in foam and hot glued on.

12. Lastly, the compartment box was hot glued on, and the cane was wrapped in reflective tape, with the final product seen below.

Figure 14: Final Mechanically Assembled Cane

6.2 Software, Navigational System

6.2.1 BOM (Bill of Materials)

Table 2: Bill of Materials of Navigational System

Mechanical Parts					
Item	Description	Price (CAD)	Quantity	Total	Reference
1	Mini Flat Vibration Motor	2.50	1	2.50	Link
2	9v Battery Holder for Arduino	9.98	1	9.98	Link
3	10kΩ Resistor	0.01	2	0.02	Link
4	2x8 cm Protoboard	0.50	1	0.50	Link
5	2x Rechargable 9v Batteries and Charger	0.00	1	0.00	Kierra
6	Arduino UNO / Arduino Supplies (breadboard, wires, etc.)	0.00	1	0.00	Provided by Kierra
7	Transistor (BC547C)	0.50	1	0.50	Link
8	3 x 10Ω Resistors	0.01	3	0.03	Link
9	1kΩ Resistor	0.01	1	0.01	Link
10	5 ft. Insulated Wire (Black, 22awg)	2.50	3.5	8.75	Link
11	4x6 cm Protoboard	0.50	1	0.50	Link
12	2 x 12x12mm Tactile Buttons	0.20	2	0.40	Link
Total				23.19	

6.2.2 Equipment list

- 1 Arduino Uno R3
- 1 Vibration Motor
- 1 NPN Transistor (BJT)

- 1 33Ω Resistor
- 1 1kΩ Resistor
- 2 10kΩ Resistor
- 2 Push Buttons

Instructions

To replicate the building of the Guide2GO Navigation System, the repository can be found on GitHub (https://github.com/dominic-salas/GuidingCane). Additionally, a simulation of the circuit inside of the Guide2GO cane was created on TinkerCAD, and a screenshot of that circuit can be found below.

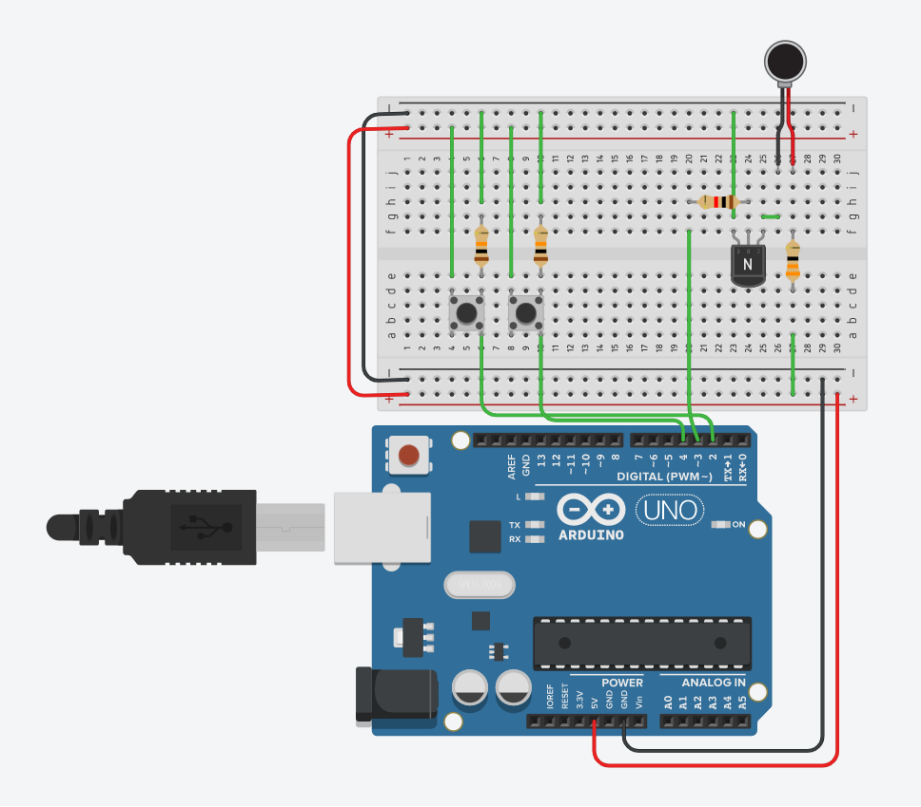

Figure 15: Circuit of the Guide2GO Navigation System

6.3 Testing & Validation

6.3.1 Testing of the Mechanical System

The following table demonstrates the testing of the final prototype against the product target specifications and client needs. As is seen, the final product passed all tests and is therefore a valid solution to our client's problem.

Table 3: Summary Table of the Final Product's Testing

Prototype	Assumption Tested	Testing Method	Expected	Actual
Mechanical Components	Cane can extend and collapse	Use CAD to collapse telescopic segments into each other and extend them again.	Telescopic segments fit into one another. (Value: N/A)	Telescopic segments fit into one another. (Value: N/A)
		Measure length of segments.	Segments are between 10 – 15 cm.	15inch
		Use CAD to determine whether the pins fit into the slots (to lock).	Spring pin mechanism allows length to be locked. (Value: N/A)	Spring pins fit into slots to lock (Value: N/A)
	Cane handle is removable	Use CAD to determine whether the pins fit into the slots (to release).	Spring pin mechanism allows handle to be locked and removed from product. (Value: N/A)	Spring pins fit into slots to lock (Value: N/A)
	Cane handle is portable	Measure length of the handle	Between 10 – 15 cm length and width.	9.9 cm x 6.9 cm

	Extended length is acceptable	Measure length of the extended cane	At least 6ft	6.01 ft
	Collapsed length is acceptable	Measure length of the collapsed cane	Max 1.5 ft	1.5ft
	Product's weight is acceptable	Measure weight of the product with all components, using the correct materials	Between 3-5 lbs	2.41 lbs without additional equipment (estimated to be up to 3.5 lbs with all components)
	Product components all fit	Ensure there is space for all components, while remaining aesthetically pleasing.	All required components fit comfortably on product (Value: N/A)	All required components fit comfortably on product (Value: N/A)
Physical Apparatus	Length of Cane Segments are small enough to be stored	Measure each length of pipe	< 15inch	14inch
	The cane is rigid	Hold the pipe horizontally to see whether the pins can resist the force of gravity	Spring pin locking mechanism is strong enough to withstand gravity	Spring pin locking mechanism is strong enough to withstand gravity
	The segment diameters fit perfectly into one another	Slip the pipes into one another to see whether they fit	Segments fit into each other, and there is no space between diameters	Segments fit into each other, and there is no space between diameters

6.3.3 Testing of Software, Navigational System

To test the Navigational System code of the Guide2GO cane, the "Verify" tool in the Arduino 1.8.16 software automatically compiles the code and finds any errors in syntax that would prevent the code from running of behaving properly. After compiling, the software shows "Done compiling." in the dialog box in the button, meaning that the code is ready to run.

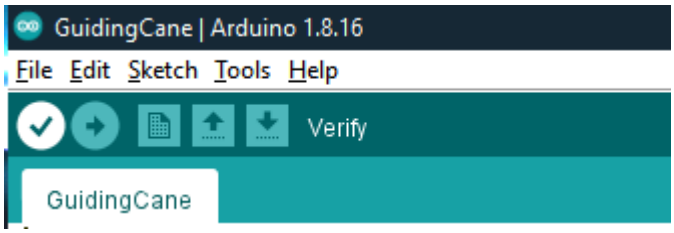

Figure 16: Screenshot of the Verify function in Arduino 1.8.16

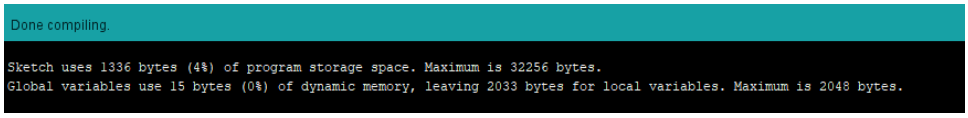

Figure 17: Screenshot of the Verify function in Arduino 1.8.16

7 Conclusions and Recommendations for Future Work

In conclusion, this UPM provided an overview of the cane's functionality, summarized how it can be used and detailed what steps should be considered if the cane is to be reproduced. Through multiple brainstorming sessions, client meetings, and rapid iterative prototype, all steps taken within our deliverables led to the development of a great final product and solution to our client's problem.

Some of the most important lessons learned throughout this project include, first, that it is important to stay in constant communication throughout the term. Although tasks can be done

separately, communication is required so that everyone can have cohesive timelines when preparing for upcoming deadlines. This reduces the risk of surprises arising. In terms of team dynamics, we learned it is essential to be very open and honest with the whole group. This way, our group can collaborate on finding solutions to problems which have been communicated and a last-minute fix can be addressed. One of the most important lessons that has been learned is that much of the current world is not built for those with physical disabilities. We should have more consideration for anyone who lives with an impairment or disability.

The most productive avenue for future work on this cane is the navigational system. Though the system works as intended, the wires are not stored in one place and more features can be added, including obstacle recognition, GPS input, etc. The focus of the next prototype should also be improving the product execution. The product can be finetuned so that it is more aesthetically pleasing.

If we had a few more months to work on this project, we would like to increase the structural rigidity of the cane's collapsible segments. We would do this by either 3D printing the segments using carbon fiber filament or getting the segments custom made by a carbon fiber manufacturer. Secondly, we would like to improve the navigation system by increasing the size of the wires to prevent them from breaking. We would also want the navigation system to be sleeker. Lastly, we would invest in carbon fiber manufactured handles with a comfier foam to go over top.

8 Bibliography

[1] “Carbon fiber cost: Factors that influence the most,” *SMI Composites*, 10-Nov-2020. [Online]. Available: https://smicomposites.com/carbon-fiber-cost-factors-that-influence-the-most/#:~:text=Carbon%20Fiber%20Cost%3A%20Factors%20That%20Influence%20The%20Most,can%20cost%20as%20little%20as%20%247%20per%20pound. [Accessed: 03-Dec-2021].

[2] YouTube. (2014). *Installing Locking Button in Telescoping Tube*. *YouTube*. Retrieved November 4, 2021, from https://www.youtube.com/watch?v=y3V6o3eca0g.

APPENDICES

9 APPENDIX I: Design Files

All project documentation is on makerepo: https://makerepo.com/kierracaminiti/1028.guide2go

Table 4: Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
Deliverable B	https://makerepo.com/kierracaminiti/1028.guide2go	Sept 23
Deliverable C	https://makerepo.com/kierracaminiti/1028.guide2go	Sept 30
Deliverable D	https://makerepo.com/kierracaminiti/1028.guide2go	Oct 7
Deliverable F	https://makerepo.com/kierracaminiti/1028.guide2go	Nov 4