Guiding Cane

GNG 2101

USER MANUAL
Team B32

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Table 1 - Acronyms

Acronym	Definition
PLA	Polylactic Acid is a thermoplastic polymer used to make 3D prints.
B.O.M	Bill Of Materials is a list used to present the items used to create a product.
CAD	Computer Aided Design is the use of a computer software to aid the creation, analysis and modification of a design.

1 Introduction

This User and Product Manual (UPM) provides the information necessary for visually impaired users and guides to effectively use the guiding cane. This manual includes a description of the cane's functions, step by step procedure for its usage, troubleshooting and support and more information that will encourage an effective use of the guiding cane. This document also gives overall information about all prototypes.

The User Manual is arranged in different sections from the cane’s overview and support to more detailed information explaining the cane’s build up and tests validating its efficiency. All sections have been listed in the table of contents and clearer insight is given throughout this document.

2 Overview

Due to the ongoing Covid-19 pandemic, visually impaired individuals are not able to safely receive the navigation aid they could previously have due to social distancing regulations. Before the pandemic, individuals would be able to link arms with a navigator allowing them to travel safely in difficult to navigate spaces such as the grocery store, a shopping mall, or even outdoor trails. This created a need for a companion guiding cane which allows users to receive navigation aid while still maintaining the required 2 meter social distance.

During the initial meeting with our client, the team was able to understand that this cane was intended for use between a user and navigator. The team was able to empathize with the client and understand their needs and wants for this product. The need with the highest priority was that the can had to extend to a length of 2 meters. The entire purpose of the apparatus is to maintain social distance between two individuals, therefore it makes sense for this to be the number one priority. Other major needs of this cane is for it to fold down to a portable size, be lightweight and easy to carry around, as well as be very simple and fast to assemble.

The client requires an intuitive, compact, and portable guiding cane which allows visually impaired individuals to receive navigation aid from others that ensures the user is able to oblige by social distancing restrictions implemented due to COVID-19.

While benchmarking other canes similar to this one, the main components of the cane design became very apparent. These components included the weight, ease of use, portability, price, and novelty. Some competitor canes were exceptional in a few categories while not meeting the standard in others. This group's cane product is able to meet the standard in all categories and surpass the standard in others such as the weight, the ease of use, and the price.

Figure 1 - Final Product

This cane design includes features such as two telescoping tubes with comfortable handles at one end and a double hinged joint connecting them in the middle.The telescopic tubes allow for a very simple assembly while the double hinged joint allows for the cane to fold down to a compact and portable size. The handles provide a comfortable grip and also include a safety strap so that if the user were to accidentally drop the device, it would not be hard to retrieve seeing as it would be strapped to them at the wrist.

2.1 Cautions & Warnings

This apparatus extends to a length of 2 meters. A pole of this length may be difficult to manipulate on your own. The user should be cautious of other individuals in the vicinity while extending the cane to it's full length. If individuals in the vicinity are unaware of the cane and the user is not aware of the surrounding individuals, the canes' obtrusive length could accidentally contact an individual while being extended.

3 Getting started

The guiding cane has simple mechanical features. In order to extend the cane, it has to be extended at the hinge. After the cane has been unfolded it should be steady and at this form it is ready to be used. The cane has in-built tubes that allow users to operate the cane at desired lengths. Careful dimensioning for production has allowed the cane to follow the 2 meter social distancing rule enforced due to COVID-19.

The cane extended should be ready for use. There are two handles on either side of the cane for the visually impaired and the guide. The cane handle also has wrist supports for a better experience while using the cane. An additional feature of the cane is the hinge that also acts as an ergonomic handle that allows users carry the cane around when it is not in use.

3.1 User Access Considerations

This apparatus is specifically designed for members of the blind community and will uniquely be targeted towards them. No other groups of individuals require such a device, therefore no restriction should be placed on the system accessibility for any users. All of the components and applications of the cane are meant for ease of use.

4 Using the System

The first major feature of this product is the locking telescoping tubes. This ensures the user is able to operate the cane without it collapsing to its folded position. Due to the tight tolerance during manufacturing, there is very little play in between telescoping parts. Another important feature of the cane is the double hinge as it allows the cane to fold flat and additionally can be used as a handle.

5 Troubleshooting & Support

The following procedures should be followed in the case of the listed failures:

Button Missing in Assembly

During assembly if the button does not appear through the hole while locking the cane at a desired length, pull the smaller tube gently to its maximum length out of the bigger tube. Make sure not to forcefully pull on this tube to avoid potential damage. After pulling on the smaller tube carefully rotate the tube and the button should be located and lock the plane in place.

Loose Hinge

A loose hinge problem would most likely occur as a result of loose knobs at the hinge. In the case of this problem all that needs to be done is to hold down on the knobs until they are steady in place. If the problem continues to persist, contact us.

5.1 Error Messages or Behaviors

Broken Tube

Broken pieces should be carefully handled to avoid possible injuries. If a crack is noted on any of the tubes then it should be replaced. Immediate maintenance could be used like the use of adhesive or tape but this would be temporary.

Faulty Hinge

Faulty hinges should rarely occur because of the material used to construct the hinge. However in the case of a possible faulty hinge lubricants could be used to reduce friction about the hinge to ease movements. New knobs could also be requested if the knobs could have worn out due to usage overtime.

Faulty Handle

Handles could easily be replaced if any problem with the handle occurs. There are also a number of handles available to suit the user's preference.

5.2 Special Considerations

Visually impaired users would have to seek help from other people when the cane is faulty. This is because it may be hard to follow the troubleshooting instructions.

5.3 Maintenance

The user is recommended to keep the hinge joint and crevices clean in order to maintain the cane's ability to fold properly. The cane should also be handled with care as it is made from PLA filament which is relatively less durable than the other possible materials. If carbon fiber and aluminum is used instead, it is recommended that the hinge be routinely oiled to assure smooth folding.

5.4 Support

For any issues related to the cane itself you can contact any of our group members via email.

- Olivia Carnegie → ocarn019@uottawa.ca
- Murad Ismail → misma072@uottawa.ca
- Timilehin Tella → otell056@uottawa.ca
- Nathaniel Veluppillai → nvelu072@uottawa.ca
- Harry Xu → hxu136@uottawa.ca

6 Product Documentation

The most important aspect of the final prototype was tolerancing as producing a functional and usable product was valued above all else. This quickly ruled out most conventional manufacturing processes as they were too complex to achieve the necessary tube dimensioning required. Thus led to the choice of 3D printing the final prototype as it was the only practical means of manufacturing our cane. Due to the fact that the printers at the University were quite small, the initial plan was to try and find an external 3D print manufacturer and try and get it printed there. Another aspect the team wanted to improve upon was the quality of the print itself, as external manufacturers were able to print more precise and larger pieces while utilizing stronger materials. However, after sending the *.STL* files to some of the companies, it was discovered that the cost to print the cane exceeded the initial budget. This meant the only option was to print the cane at school. In order for this to successfully happen, the telescoping tubes of the cane had to be split in two and printed separately to ensure they fit in the printer. There were still however a few issues with 3D printing the parts: namely failed prints. Due to some issues with printing, numerous parts had to be reprinted. After the parts were successfully printed, the next step involved in manufacturing was gluing the assembly. The cane was then assembled and tested.

6.1 <Subsystem 1 of prototype>

6.1.1 BOM (Bill of Materials)

Table 2 - B.O.M. for final prototype

Materials	Amount Needed	Cost ($)	Link to Material
PLA filament	763.82 g	0.00	Makerspace
Grip tape / Handle	1.0 m	4.50	link
Cyanoacrylate glue	20 g	8.99	link

Table 3 - B.O.M. for market product

Materials	Amount Needed	Cost ($)	Link to Material
Carbon Fiber Tubing	2.0	22.00	link
Grip tape / Handle	1.0 m	4.50	link
Aluminum	84.0 g	12.00	link

6.1.2 Equipment list

- 3D printer
- Makerspace workshop session
    - Pliers
    - Scissors
- Aluminum machining

6.1.3 Instructions

The guiding cane was designed to be easily assembled by any individual including a visually impared individual. Below will consist of a step by step process on how to operate this guiding cane as well as images to follow along with.

Instructions:

Figure 2 - Collapsed Cane

- Step 1: Extend and Pull out tubes from both sides. Refer to Figure 3

Figure 3 - Extended Guiding Cane

- Step 2: Fold Out the guiding cane to full length. Refer to Figure 4

Figure 4 - Unfolded Guiding Cane

- Step 3: Grab grip with strap or without and hold on. Refer to Figure 5

Figure 5 - Collapsed Cane

6.2 Testing & Validation

In order to understand the strong and weak points of this prototype it was necessary to undergo certain prototyping tests to build the final prototype. There were in total three different prototype testings which will be discussed in detail below.

Prototype 1:

Prototype one testing consisted of multiple structural integrity tests which was meant to test the material in order to see if it is suitable to the clients' needs. This prototype was 3D printed with PLA material. The first test was a drop test from a 4 storey building. The idea for this test was to drop it from that height(62ft) a number of times until it broke. The prototype survived the first drop and had little to no scratches on it. The next test was a slam test and that was to test how the material will do under a scenario where the cane gets whipped to the ground. During the test it was observed how shock absorbent the PLA material is because of how it bounced off the cement. The prototype survived the slam test which was expected based on the drop test. During the second drop test, the prototype accumulated a small fracture which can be seen in Figure X. Based on these tests we were able to determine that PLA may be cheaper than aluminum; but it wouldn't be as strong as it.

Figure 6 - Prototype 1

Prototype 2:

Prototype 2 went into further detail on how the guiding cane would work and the tests and CAD models revolved around the functionality of the prototype. This prototype was constructed in solidworks which can be seen in Figure X and underwent simulations on how the cane would extend and retract. These simulations were a success and would thereafter be 3D printed and tested in practicality. The prototype was designed so that the pieces extend in a telescopic way with a button at the end to prevent the pieces from extending too far. The 3D printed prototype however was unsuccessful because the printed buttons were printed inaccurately which can be seen in Figure X. This taught us to use a more accurate printer because of how precise the small CAD model pieces are.

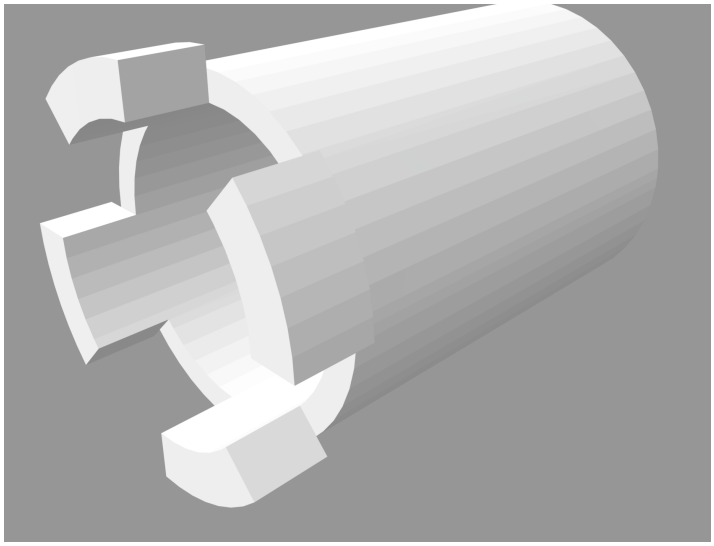

Figure 7 - Prototype 2, Locking Mechanism

Figure 8 - Prototype 2, Telescoping Tubes

Prototype 3:

Prototype 3 consisted of how the final prototype would look and work. This prototype was created with solidworks and thereafter 3D printed and assembled. This prototype was built with a hinge so that the cane will fold and thereafter extendable on both sides with a telescopic function which can be seen in Figure X and Figure X. The cane was 3D printed with PLA material in a better and bigger printer which was able to print the necessary size prints to reach the 2 meter

length that the client specified. This was a successful prototype because it was able to extend and fold to the necessary storable length.

Figure 9 - Single Pivot Hinge

Figure 10 - Half-size telescoping tubes

7 Conclusions and Recommendations for Future Work

This project has been a journey where we encountered many bumps but thrived to successfully create a functioning guiding cane. Some of the problems we encountered were team productivity where we found that the team gets most of the work completed when on a team call together. The design of the prototype was constructed with PLA material which isn't an ideal material for this guiding cane and aluminum or carbon fiber would've been more ideal. This wasn't possible because of how expensive the metal and carbon fibre is and isn't ideal for this budget. For a larger scale production it would be feasible but for this prototype this 3D print suffices. If this project were to be continued; it would be suggested to attempt to build this model with an aluminum body or carbon fibre if possible because then it would be ready to be sold. If there was more time to work on this project it would have been intriguing to add the arduino that was abandoned due to time and budget. This would be ideal because there would be more features that could be added that would help the client more. Overall this project was completed successfully and the team dynamics were good and we would be enthusiastic to work on another project together.

8 APPENDIX: DESING FILES

Table 4 - Relevant Documents

Document Name	Document Purpose	Document Location and/or URL	Issuance Date
Deliverable B	Needs, Problem Statement, Metrics, Benchmarking and Target Specifications	MakerRepo link	Sept 23, 2021
Deliverable C	Conceptual Design, Project Plan, and Feasibility Study	MakerRepo link	Sept 30, 2021
Deliverable D	Detailed Design, Prototype 1, BOM, Peer Feedback and Team Dynamics	MakerRepo link	October 7, 2021
Deliverable F	Prototype 2	MakerRepo link	November 11, 2021
Deliverable G	Business Model and Economics Report	MakerRepo link	November 18, 2021

Table 5 - Printed Parts

Document Name	Part Purpose	Document Location and/or URL	Number of parts required
Connection Part	To connect the tubes to the hinge	MakerRepo link	2
Part 2	Bolt connecting hinge components	MakerRepo link	2
Part 3	Bolt connecting hinge components	MakerRepo link	2
Part 15	Locking buttons	MakerRepo link	4
Part 16	Locking buttons	MakerRepo link	4
Part 8	Middle hinge piece	MakerRepo link	1
Handle	Base handle (smallest tube)	MakerRepo link	2
Main	Middle (medium tube)	MakerRepo link	2
End	Tube attached to the connection parts (Largest tube)	MakerRepo link	2