"Would the smart cane benefit me?": Perceptions of the Visually Impaired towards Smart Canes

Rezylle Milallos
rm7312@rit.edu
Rochester Institute of Technology
Rochester, NY, USA

Vinita Tibdewal
vt2173@rit.edu
Rochester Institute of Technology
Rochester, NY, USA

Yiwen Wang
yw7615@rit.edu
Rochester Institute of Technology
Rochester, NY, USA

Andre Udegbe
ao3353@rit.edu
Rochester Institute of Technology
Rochester, NY, USA

Tae Oh
thoics@rit.edu
Rochester Institute of Technology
Rochester, NY, USA

ABSTRACT

The white cane is used as one of the options for mobility by people who are blind or visually impaired (BVI) but it comes with limitations like the lack of overhead detection and recognition of safety hazards. Smart canes were designed to address some of the white cane's issues but the adoption of this technology has been minimal. We spoke with 16 BVI participants for an in-depth view on their smart cane experiences and needs. While the biggest concern was related to cost, we found that other factors like product consistency, durability, and the lack of awareness, trust, and confidence from the users all contribute to the low adoption rate of smart canes.

CCS CONCEPTS

• **Human-centered computing** → **Accessibility technologies**.

KEYWORDS

Accessibility, Individuals with Disabilities & Assistive Technologies, Ambient Devices/Internet of Things

ACM Reference Format:
Rezylle Milallos, Vinita Tibdewal, Yiwen Wang, Andre Udegbe, and Tae Oh. 2021. "Would the smart cane benefit me?": Perceptions of the Visually Impaired towards Smart Canes. In *The 23rd International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS '21), October 18–22, 2021, Virtual Event, USA.* ACM, New York, NY, USA, 3 pages. https://doi.org/10.1145/3441852.3476524

1 INTRODUCTION

In 2018, Cornell University's Disability Statistics estimated that over seven million people in the United States are blind or visually impaired (BVI) [4]. They utilize several mobility aids to ensure they are able to efficiently navigate in a safe manner and reduce the risk of bodily injury [14]. Around two percent of BVI individuals rely on the white cane for mobility [1] while another two percent work with guide dogs [5]. The rest utilize services from sighted guides, as well as any remaining usable vision, to assist them with day-to-day mobility and navigation. The options for independent mobility for BVI users are limited, which has caused issues related to safe travel and a negative impact on the overall quality of life [8].

While the white cane sometimes serves as a symbol for blindness [19], it comes with its own problems such as failure to detect low-hanging tree branches and drop-offs [11], unexpected safety hazards (e.g., open potholes, construction zones), and limited forward detection. This means that extra care has to be taken while using the white cane, leading to a reduced speed in movement [11] and consequently reducing self-confidence when navigating [14]. Smart canes take advantage of the white cane's cognitive model to provide timely detection and notification of upcoming obstacles [17]. Depending on the type of smart cane, it has additional features such as sensors for overhead and increased forward detection like the Ultracane (2010) which detects obstacles 2 to 4 meters away, both above chest and below knee-level [6], more informative thermal [15], haptic [16], or voice [7] feedback mechanisms, and smart capabilities like in-app voice navigation [7], personal calibrations, and a "find my cane" option [3].

Even with all of these additional capabilities, previous work has mentioned that smart canes have minimal impact on mobility [12] and are rarely adopted [11] by BVI users after all these years of technical evolution. Previous research has all been focused on the technical aspects of the smart cane (i.e., finding ways to provide more effective detection and feedback) and usability evaluations to compare new prototypes versus the traditional white cane. We believe that it is important to assess the viability of a product and how it will be used by people as part of their daily lives. Investigation on the implications of technology adoption is essential and continuous research must be performed to see if research prototypes actually work for the intended users [13]. This study aims to identify user's perceptions and attitudes towards the smart cane and any barriers preventing their use in order to uncover potential reasons of the low adoption rate of smart canes. We conducted 16 semi-structured interviews and analyzed the data resulting in three main points: *Lack of Features and Functionality*, *Usability and Durability*, and *Trust and Accessibility*. Due to their aesthetic similarity, reservations and concerns about the white cane may be carried over to the smart cane. The study found that it is important to build the end user's confidence in the product by allowing for more trial and

ASSETS '21, October 18–22, 2021, Virtual Event, USA

ACM ISBN 978-1-4503-8306-6/21/10.
https://doi.org/10.1145/3441852.3476524

training options as well as improving the smart cane's reliability and adding more novel features.

2 METHODS

16 participants (blind: 13, low vision: 2—P6 and P12, severe low vision: 1—P9) were recruited through various channels (e.g., Twitter, Reddit, organizations for the blind) for a semi-structured interview. Participants ranged between 22-80 years old with an average cane experience of 27.81 years. All of them used white canes and most took advantage of other mobility devices such as guide dogs, smartphone apps, and other smart devices in conjunction with the cane. The interviews were conducted via Zoom, where participants were asked questions related, but not limited to, their experience in using assistive devices, thoughts about smart canes, and other opportunities to increase awareness. The interviewer asked how the participants came across smart canes and their thoughts on the usage of smart canes at public places.

3 FINDINGS

While the majority of participants were interested about the smart cane technology, the results show that more novel features and detailed information about smart canes are needed for greater awareness. Consecutively, options for trial and training should be made available to increase confidence and trust from BVI community.

3.1 Lack of Features and Functionality

Participants noted different scenarios in which the obstacle detection of smart canes (i.e., for overhead detection and for typical objects like doors) could aid them in their activities such as hiking or when walking at a faster speed because of earlier detection of obstacles. However, some expected more unique features from the smart canes. They mentioned that they would like to see a built-in GPS feature in the smart cane to lessen the number of devices they would have to carry, especially when commuting. According to the participants, the system should share nearest addresses or points of interest, street names, and/or allow for indoor navigation. In addition to this, some participants wanted an object identification feature and not just obstacle detection.

Because of this, a few participants directly mentioned that they had no plans on getting a smart cane because the product was not worth it for the cost and that *"it brings nothing new to the table [P1]"*. While they thought it was a good idea, smart canes had capabilities that they had already found a solution for (e.g., AIRA, sighted guides, guide dogs, other mobility devices). As P2 said, *"What kind of information would it give me that I can't get otherwise like through AI or through a phone?"*

3.2 Usability and Durability

Participants were also worried that too much additional weight can cause hand and wrist strains; the length of the cane should also be adjustable based on the user's height. As most of the participants used multiple mobility options at the same time, they noted that it should be easy enough to hold the cane in one hand and another tool (e.g. smartphones) in the other hand. They also expected the smart cane to work consistently in all environments (e.g., places with a lot of noise, construction sites). In relation to this, several participants were worried about the smart cane's usability in terms of its battery life—*[P8] "Is that going to last me for 10, 11, 12 hours a day?"*—especially if they had to recharge it multiple times a day in order to fully make use of the product: *P12] "I can't think of anything that would stop me other than that you have to constantly charge it"*.

Several participants were worried about the durability of the smart canes and wished they were made of high-quality materials that can withstand daily wear and tear as well as other factors like the weather. P2 was curious how the smart cane will perform *"with a little bit of rain, heat, and all the elements."* Because of it's high cost, they expected the product to last a long time but are turned off because white cane tips only have a life span of a few weeks to a few months, depending on use [2]. As such, participants were concerned that they may need to replace the smart canes as often as they need to replace the white cane or its parts. P10 stated the importance of durability because the smart cane *"can get damaged by a lot of different things: a car could run over it or it could get caught in an elevator."*

3.3 Trust and Accessibility

Two main barriers for adoption of smart canes were trust and access to the product. Because of all the different kinds of smart canes both on the market and in the prototype stage, people have varied understanding and expectations on the consistency of the smart canes. Those who have previously participated in short usability evaluations may have some bias on the effectiveness of the smart canes as well. Any disappointment may carry over and go against future, more robust products.

3.3.1 Accessibility. One resounding concern expressed by all participants involved the costs associated with the purchase of a smart cane (i.e., they were worried about the financial implications of owning a smart cane). Participants mentioned that there is a limited supply of funds for assistive devices considering both state or federal financial relief programs and any kind of health insurance—BVI users need to prove why they need the item before being considered for any financial help. P15 spoke about the lack of support: *"They're just gonna say, 'Oh, you have a regular cane. Why do you need a smart cane?'"* In addition to this, most participants who were interested in smart canes did not have any clear idea where to purchase or try one. P1 expressed their disappointment on the lack of information on the product website, saying that *"it's not detailed enough for me or not that informative either."*

3.3.2 Trusting New Products. With its high upfront cost, participants expressed strong feelings regarding the opportunity to test the smart cane for a longer period of time (e.g., a whole week or a whole month) before committing to buying it. A few participants had experience using a smart cane through a previous evaluation session or a smart cane demonstration at some conference, but were only given a chance to interact with the smart cane for a short period of time. P3 participated in a demonstration that *"only lasted like 10 minutes. And what I would prefer is being able to use a smart cane for like a week or longer so that I could really become familiar with it and how it worked."* This experience was congruent with the evaluation of previous research where participants were trained with

the cane for no longer than 10 minutes [9, 15]. Smart cane access in public places (e.g., public libraries, museums, airports, and BVI-related conferences and organizations) or through loaner programs were suggested for better familiarity. A lot of participants further mentioned that training is essential for new technologies and was expected in the form of manuals or modules, webinars, online assistants, or actual training with O&M specialists—individually or in groups.

Most participants shared that O&M instructors influence their choice of navigation because of their expertise in the field. Continuing education and training for the instructors themselves may increase use of and confidence in the smart cane. It should also be noted that according to the participants, O&M instructors encouraged their students to develop navigation techniques and obstacle detection skills without depending on technology because technology always has a chance for failure P2 further explains that a good number of O&M instructors *"probably endorse it (smart cane) but then also say that, we shouldn't be preventing people from having those fundamental [navigation] skills."* In addition to this, participants also mention that they will be more trusting of the product if it is recommended by their friends.

4 DISCUSSION AND FUTURE WORK

Most participants were comfortable with their primary mobility method and were taught not to rely on technologies and instead enhance their skills for reliable orientation and mobility. This attitude is emphasized as BVI users noted smart canes do not have significant new features compared to the combination of various mobility options that they use now (i.e., guide dog + white cane + smartphone apps). Electronic mobility aids must provide novel information to BVI users that directly contribute to their decision making when navigating; redundant information is unnecessary and can cause a heavier cognitive load than needed [10]. Some suggested features include obstacle identification, notification of street signs and addresses, OCR reader, and indoor navigation to help them better navigate their environments. Future developments should also design more ergonomic smart canes that fit well into different scenarios (i.e., body constraints of users like arm length and muscle strength). Adapting the design and components to fit people of various skill levels would make the adoption rate easier as it would require less initial training [18].

As it is right now, users are still unsure of the smart cane's consistency, feasibility, and reliability compared to other mobility aids and navigation options. Considering the potential battery constraints brought by the mobile devices and durability issues from the wear and tear of everyday use, users felt uncertain about whether the value of smart cane is worth the cost. To help increase trust in new technologies for the BVI community, the role of O&M specialists should be considered given their professional experience, credibility, and influence. Future research should look into allowing O&M instructors and potential end users longer access to trials or training involving smart canes. There is no doubt that people are interested in new technologies. However, it is up to companies, BVI organizations, specialists, and researchers like us to increase awareness about smart canes and other groundbreaking assistive devices such that it can be applied to the users' daily lives.

REFERENCES

[1] [n.d.]. 10 fascinating facts about the white cane. https://www.perkins.org/stories/10-fascinating-facts-about-the-white-cane. (Accessed on 03/26/2021).

[2] [n.d.]. 6. Care and Feeding of the Long White Cane. https://nfb.org//sites/default/files/images/nfb/publications/fr/fr15/issue1/f150121.html

[3] [n.d.]. BAWA Cane. https://www.bawa.tech. (Accessed on 03/26/2021).

[4] [n.d.]. Disability Statistics. https://www.disabilitystatistics.org/reports/acs.cfm?statistic=1. (Accessed on 03/26/2021).

[5] [n.d.]. Guiding Eyes FAQ. https://www.guidingeyes.org/about/faqs/. (Accessed on 03/26/2021).

[6] [n.d.]. UltraCane. https://www.ultracane.com/ultracane. (Accessed on 03/26/2021).

[7] [n.d.]. WeWALK Smart Cane For Visually Impaired and Blind People. https://wewalk.io/en/. (Accessed on 03/26/2021).

[8] Summer Asad, Brittany Mooney, Ishfaq Ahmad, Manfred Huber, and Addison Clark. 2020. Object detection and sensory feedback techniques in building smart cane for the visually impaired: an overview. In *Proceedings of the 13th ACM International Conference on Pervasive Technologies Related to Assistive Environments*. 1–7.

[9] Galit Buchs, Noa Simon, Shachar Maidenbaum, and Amir Amedi. 2017. Waist-up protection for blind individuals using the EyeCane as a primary and secondary mobility aid. *Restorative neurology and neuroscience* 35, 2 (2017), 225–235.

[10] Emerson Foulke. 1970. The perceptual basis for mobility. *DOCUMENT RESUME ED* 84, 738 (1970), 93.

[11] Sung Yeon Kim and Kwangsu Cho. 2013. Usability and design guidelines of smart canes for users with visual impairments. *international Journal of Design* 7, 1 (2013).

[12] Árni Kristjánsson, Alin Moldoveanu, Ómar I Jóhannesson, Oana Balan, Simone Spagnol, Vigdís Vala Valgeirsdóttir, and Rúnar Unnthorsson. 2016. Designing sensory-substitution devices: Principles, pitfalls and potential 1. *Restorative neurology and neuroscience* 34, 5 (2016), 769–787.

[13] Joseph Lindley, Paul Coulton, and Miriam Sturdee. 2017. Implications for Adoption. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (Denver, Colorado, USA) *(CHI '17)*. Association for Computing Machinery, New York, NY, USA, 265–277. https://doi.org/10.1145/3025453.3025742

[14] Roberto Manduchi and Sri Kurniawan. 2010. Watch your head, mind your step: mobility-related accidents experienced by people with visual impairment. *Dept. Comp. Eng., Univ. California, Santa Cruz, Tech. Rep* (2010).

[15] Arshad Nasser, Kai-Ning Keng, and Kening Zhu. 2020. ThermalCane: Exploring Thermotactile Directional Cues on Cane-Grip for Non-Visual Navigation. In *The 22nd International ACM SIGACCESS Conference on Computers and Accessibility* (Virtual Event, Greece) *(ASSETS '20)*. Association for Computing Machinery, New York, NY, USA, Article 20, 12 pages. https://doi.org/10.1145/3373625.3417004

[16] Jagannadh Pariti and Tae Oh. 2020. Understanding the Hand and Wrist Strains Caused by Smart Cane Handles with Haptic Notification. In *The 22nd International ACM SIGACCESS Conference on Computers and Accessibility* (Virtual Event, Greece) *(ASSETS '20)*. Association for Computing Machinery, New York, NY, USA, Article 86, 4 pages. https://doi.org/10.1145/3373625.3418028

[17] Uta R Roentgen, Gert Jan Gelderblom, Mathijs Soede, and Luc P De Witte. 2008. Inventory of electronic mobility aids for persons with visual impairments: A literature review. *Journal of Visual Impairment & Blindness* 102, 11 (2008), 702–724.

[18] Jayant Sakhardande, Pratik Pattanayak, and Mita Bhowmick. 2012. Smart cane assisted mobility for the visually impaired. *International Journal of Electrical and Computer Engineering* 6, 10 (2012), 1262–1265.

[19] Philip Strong. 2009. The history of the white cane.