Visually Assistive Hat: A Wearable Device for the Visually Impaired

Sociotechnical Factors Contributing to the Inequalities in Visual Impairments Across Genders

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

Visual impairments, blindness, and visual degradation are an extremely serious and prevalent issue globally. Over 1.02 million people are legally blind in the United States alone, with an additional 3.22 million people suffering from visual impairments as of 2015. These values are projected to double by 2050 (Varma et al., 2016). Blindness and low vision is estimated to affect over 3.89 million people over the age of 45 in the United States alone, as of 2017 (Chan et al., 2018). As the eldery population increases due to growing average life spans, the issue will only become more prevalent in time. Globally, over 50 million people are affected by blindness, and of those 64.5 percent are women (Abou-Gareeb et al., 2001; Courtright & Bassett, 2003). Another important factor to consider, which will be discussed further throughout this paper, is that this issue is especially harmful for women. Inability to access to healthcare and lack of child care make it difficult or impossible for many women to seek care for their decreasing eyesight at all stages of life (Courtright & Lewallen, 2009). Up to 20% of women forego care because of issues in finding alternative people to care for their child while they go to appointments (Gaur et al., 2020).

The specific research that will be done in the STS topic portion of this prospectus aims to explore why inequalities exist between men and women when it comes to eyecare, as well as what sociotechnical factors contribute to this disparity. As stated previously, more than half of all blind persons globally are women, even after accounting for other factors such as the average increased lifespans that women have over men. In order to assist those with visual impairments or blindness, the technical portion of this project focuses on the creation of a visually assistive hat that provides tactile and auditory feedback to users about upcoming obstructions. This device

would provide users an inconspicuous, hands-free way to navigate through their surroundings without fear of physical harm.

Technical Topic

Vision loss or impairment is considered a major disability which hinders the impacted population's ability to carry out daily life tasks, most notably tasks involving ambulation (Committee on Public Health Approaches to Reduce Vision Impairment and Promote Eye Health et al., 2016). Current devices for users, like the standard folding guide stick, don't allow users to sense if there are approaching obstructions or the full use of both of their hands. This can be dangerous, particularly while crossing streets or while traveling alone. This project's goal is to address this issue through assisting the visually impaired with obstacle avoidance and wayfinding This will be accomplished through the creation of a lightweight device, embedded into a hat, which the user can place on their head. This device will provide the user with a clear awareness of their surroundings by monitoring obstructions from the user's front, sides, and behind.

This will be done by embedding sensors, both LiDAR sensors and ultrasonic sensors, into the hat and connecting them to a central low power microcontroller board to process current surroundings. The device will gather real-time information regarding a user's surroundings from all sides, as well as any incline changes. There will be five vibration motors total, one motor located next to each of the five sensors, and two speakers located on the temples of the hat. Upon startup, a special tone from the two speakers will indicate successful initialization and calibration of the incline setting, in order to allow functionality for users of varying heights. After startup, information will be provided by the sensors to the microcontroller (MCU), and the vibration

motors will be programmed to buzz whenever their respective sensor detects an object. The motors will increase the vibration frequency as the object gets closer to the individual to show approaching objects. Additionally, the two small speakers mounted to the side of the cap will be connected to the MCU to provide auditory feedback in a similar manner as the motors for users who may prefer to have auditory feedback. Lastly, the sensor located on the brim of the hat pointing downward gives feedback to the user through both vibrations and auditory tones from the speakers about incline changes. The auditory feedback for this sensor will be different from that of the other surrounding sensors so that the user can distinguish between an object approaching and a change in incline.

There will be toggle buttons to allow the user to adjust the feedback settings for a number of different conditions. The default condition will be that both the speakers and motors are active, while another will be to have only the speakers active, and a third will be for when only the motors are active. There will be an additional option to set the hat into indoor mode or outdoor mode. The default will setting will be outdoor mode, causing the device to sense obstructions from a much farther distance than in indoor mode. Additionally, there will be a way for the user to adjust the volume of the speakers as well as reset the device if necessary.

STS Topic

Globally, blindness affects over 50 million people, “two-thirds of whom are women, and ninety per cent of whom live in poorer countries” (Courtright & Bassett, 2003). There are many inequalities when discussing blindness and visual impairments, including socioeconomic class, gender, and geographical region (Ulldemolins et al., 2012). Among white persons, the leading cause was macular degeneration (54.4% of cases), whereas among black persons it was cataracts

and glaucoma (60%) (Congdon et al., 2004). Some authors tend to argue that because women live longer on average than men, this accounts for the discrepancy in their likelihood to develop eye problems. However, even when accounting for age, studies show that blindness is approximately "40% more common in women compared to men" (Courtright, 2009). One of the leading causes of blindness is cataracts, roughly 20 million people are blind from cataracts in the world, which is curable if given the appropriate treatment (Foster, 1999). The number of people who are blind from cataracts is also estimated by the World Health Organization to increase to 40 million in 2025 as the global population ages (Wang et al., 2017). Blindness caused by cataracts is entirely avoidable, given that people can obtain access to cataract surgery, and yet of those with cataracts the proportion who go blind ranges from 36% to 89% in some countries (Murthy et al., 2012). With this information, coupled with the fact that women are slightly more likely to develop cataracts, women should account for sixty to sixty-five percent of all cataract surgeries. Yet statistically, men are still more likely than women to undergo cataract surgery (Courtright & Lewallen, 2009).

Given all of this information, the question becomes: what sociotechnical factors lead to women being more likely to suffer from visual impairments, such as cataracts and blindness, than men? To answer this research question, the Wicked Problem framework will be used alongside literature review, documentary analysis, and ethical analysis. Starting with background information, context will be given regarding the socioeconomic disparities between men and women, primarily in developing countries where these issues are most prevalent. Specifically when looking for resources on to provide evidence for this question, the keywords will consist of phrases like "gender and vision loss", "cataracts and blindness", "women and visual impairments", as well as "vision loss statistics". This paper will utilize only official journals,

books, .gov, and .edu sources to ensure accurate information is provided. This will be accomplished primarily through the UVA Library research engine, as well as Google Scholar.

The Wicked Problem Framing technique developed by Seager will be used for gathering evidence on this inequality (Seager et al., 2012). Seager's methodology supports this research because the framework will allow for a closer look at the breakdown of problems surrounding women's lack of eyecare. The Wicked Problem framework will help to provide an in depth review of the inequalities between men and women, while still maintaining that such a complex issue can not have a simple solution. The research question can be defined as a wicked problem, because these problems are "large scale social challenges caught in casual webs of interlinking variables spanning national boundaries that complicate both their diagnosis and prognosis" (Reinecke & Ansari, 2016). Some authors, such as Nick Turnbull and Robert Hoppe, argue that this theory is flawed. Turnbull and Hoppe argue that the concept of wickedness fails to properly conceptualize policy problems. Instead, they argue for the re-conceptualization of wickedness as "problematicity", a measure of the political distance between analysts' view of a problem. Turnbull and Hoppe argue that addressing issues through the lens of problematicity is more practical and effective than using wickedness (Turnbull & Hoppe, 2019).

Through the use of literature reviews to look closely at all of the evidence, one can form a better understanding of why these inequalities in visual impairments occur, and how to address them. Evidence specifically about the various issues women face with blindness and visual impairments will be gathered; specifically evidence regarding problems such as risk factors, access to services, and life expectancy. This evidence will be used to analyze the inconsistencies in eyecare, and will account for the core of the argument in the STS research paper.

Conclusion

This paper aims to uncover and address the problems that the visually impaired face daily, especially women with visual impairments. As the number of individuals who face problems with eyecare is predicted to increase significantly over the next thirty years, it is important to uncover what improvements could be made. The technical portion of this design is a hat created to provide visually impaired individuals access to their surroundings in a hands-free way, in order to provide a safe way for them to navigate their surroundings. This will be accomplished through the use of distance sensors, vibration motors, and speakers around the perimeter of a hat. The research paper aims to fully understand what sociotechnical factors play into women being more likely to be affected by visual impairments than men. This portion of the research paper will be analyzed through the lens of the Wicked Problem framing methodology, in order to approach all of the issues that cause this discrepancy.

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