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The Smart Assistive Cane for the Visually Impaired

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ABSTRACT – Daily mobility of individuals with visual impairments present unique challenges. Glaucoma is the most commonly acquired optic neuropathy. It represents a public health challenge because it causes an irreversible blindness. Blind Canes are an essential mobility aid or device which assist people with all levels of visual impairment. Blind people use canes for navigating through places around them through the sounds and echoes they listen to. The support cane is used for support and for physical stability and the probing cane is used to locates obstacles in their path of travel. However, the existing white cane do not provide immersive feedback about the environment surrounding the blind. The problem with the existing models is that it can detect low objects, but it fails to detect objects above the knee height, Hence, The Smart Assistive Cane for Visual Impaired Individuals," is a novel solution that integrates cutting-edge technology to enhance the independence and safety of visually impaired individuals.

KEYWORDS: Glaucoma, White Cane, Ultrasonic Sensor, Assistive Device, Blind people.

1.0 INTRODUCTION

A group of progressive, irreversible optic neuropathies known as glaucoma can cause blindness and significant loss of visual field. Primary open-angle glaucoma and primary angle-closure glaucoma are the two most prevalent types of the disease[1], [2]. A large number of glaucoma sufferers have no symptoms and are unaware that they have the condition[3]. The white cane serves as a symbol of the blind members of society as well as a tool for gaining independence. These devices served as a means for the blind to detect obstacles in their route[4]. People who are visually impaired face numerous obstacles in their everyday lives, including reading, playing sports, interacting with others, pursuing an education, and, most importantly, moving elsewhere[5]. It has been discovered that walking speed and gait pattern are directly impacted by visual loss. For those who are visually impaired, navigating on their own without assistance is a significant challenge which can result in frustration, low self-esteem, decreased autonomy, and hazards to one's physical safety. While the white cane aids in users' orientation and mobility, its range is restricted, and it is unable to identify aerial obstacles like trash cans and tree branches[6]. This invariably results in accidents, endangering the users' safety. The visually challenged person requires assistive technologies to increase their mobility. A few blind technologies are currently in use, such as the Intelligent White Cane, an electronic device for visually impaired persons that can detect obstacles in the path and vibrate to alert users[7], and the Electronic Travel Aid (ETA), a device that gathers environmental data and transmits it to the user to allow independent movement [6].

2.0 METHODOLOGY

The methodology chapter focuses on the methods to produce a successful prototype. The chapter also covers the operational flow of the smart assistive cane for the visually impaired.

2.1 PROJECT DEVELOPMENT METHODS

The development of the smart assistive cane begins by analyzing the requirements of the blind person. A blind person named Mr Subramaniam was interviewed as part of the research process to understand the challenges faced by the visually impaired and gather feedback from them. The feedback received was based on the struggle they faced in navigating through new places and bumping into obstacles which they could not touch with the white cane, such as a branch of a tree, tables, and cars.

The Process follows with designing the feedback mechanism. The feedback mechanism consists of vibration motors in the cane handle to provide Vibration feedback to the user. The inputs from the HC-SR04 sensor are used to detect obstacles during navigation. Arduino Nano was integrated as the

microcontroller to process the input signals and send the required output signals. A rechargeable Battery powered all these components. The Process continues with designing the casing for the electronics. The design considers ergonomics with curved corners to avoid injuries to the user.

2.2 BLOCK DIAGRAM

The process begins as the user adjusts the angle of the sensor by pressing the button; by doing that, the angle of the sensor coverage changes. The reading obtained through the ultrasonic sensor feds into the microcontroller, and signals are sent to the vibration motors to provide feedback regarding the obstacles to the user.

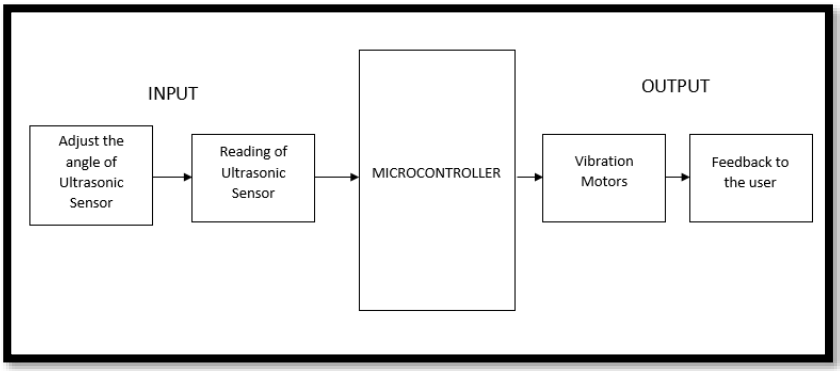

Figure 1. Block Diagram

3.0 RESULTS & ANALYSIS

The proposed design comprises an angle-adjustable obstacle-detecting sensor, vibration feedback motors, an on-off switch, a foldable mechanism, and an ergonomics casing. The proposed design addresses the navigation problems that Visually Impaired persons face in new environments. In those circumstances, the device will be turned on to navigate through with the help of the electronic system. In a familiar environment, people who are blind can turn off the system and use the proposed design as a normal blind cane. This approach can save battery consumption and avoid unnecessary energy usage.

Figure 2. Blind stick model

Figure 3. Rear View

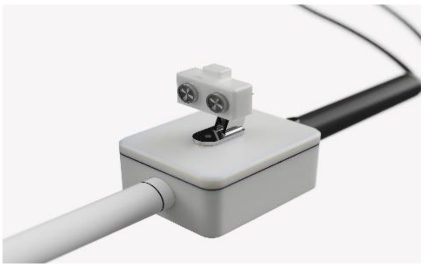

Figure 4. Front View

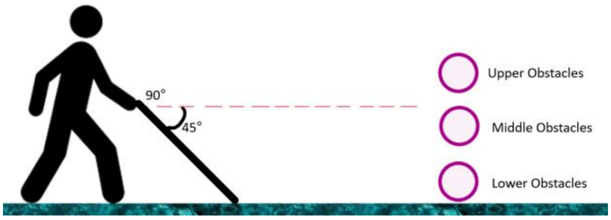

Figure 5. Sensor detection Range

Table 1. Distance recorded for sensor at the upper, middle and bottom position

Angle of sensor	Obstacle Position	Distance (cm)
90°	Upper Obstacles	197
		199
		200
	Middle Obstacles	212
		216
		213
	Lower Obstacles	225
		222
		223
45°	Upper Obstacles	230
		222
		224
	Middle Obstacles	221
		214
		221
	Lower Obstacles	209
		210
		208

Then range of sensor detection is divided into two categories which is 90° and 45°. Each of these two categories is tested with 3 obstacle position namely, upper obstacles, medium obstacles and lower obstacles. At the angle of 90°, the upper obstacles are detected much earlier compared to the medium and lower obstacles. Hence, this is proven that, the aimed upper obstacles are detected much more easily by the sensor facing with the angle of 90°. On the other hand, at the angle of 45°, the lower obstacles are detected much earlier compared to the medium and upper obstacles. The aimed lower obstacles are much easily detected by the sensor facing at the angle 45°. Medium obstacles are also detected efficiently with the maximum range of 10cm from upper and lower obstacles. Hence, both 90° and 45° range of sensor are capable to detect the middle obstacles.

4.0 CONCLUSION

Glaucoma, a prevalent cause of blindness, continues to challenge the medical community, highlighting the necessity for innovative solutions. Traditional white canes, despite their invaluable role, are limited in their ability to address the multifaceted challenges faced by visually impaired individuals. Their primary focus on ground-level obstacle detection neglects the equally vital need to detect head-level obstacles, hanging hazards, and changes in elevation[8]. By integrating ultrasonic sensors with various range of detection angle and an Arduino Nano, it offers real-time obstacle detection in different range of obstacles positions and give tactile feedback through vibrations to alert the users[9]. A different form of vibration will be produced to indicate the different level of obstacles. This technology, designed to supplement the traditional white cane, holds the promise of revolutionizing mobility and enhancing the independence of individuals with visual impairments[10]. The Smart Assistive Cane serves as a beacon of hope, addressing the limitations of traditional blind sticks and propelling individuals with visual impairments toward safer and more confident navigation in a dynamic world. This innovation exemplifies the positive impact that technology can have on the quality of life for those who face unique challenges in their quest for mobility and independence. With continued advancements in assistive technology, the future holds the potential for even greater inclusivity and accessibility for individuals with visual impairments.

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