Pathfinder V.1: A 'Seeing' Cane for Visually Impaired Patients

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1. ABSTRACT

The idea behind this project initiated from an attempt to facilitate a visually impaired acquaintance's navigation through the harsh urban environment with less dependant on the caregiver. The project is currently under development in conjunction with Thai Association of the Blind (TAB) with the hope to make this technology vastly available to visually impaired population. The technology is currently in its precocious state and will exist only as an alternative to conventional canes with no mean to completely replace the pre-existing inventions. However, the ultimate goal of this project is to elevate the living quality of visually impaired population and for people to live in harmony; an implementation that could create a tremendous impact.

2. PROJECT DESCRIPTION

Pathfinder V.1 is a potentially-more-efficient alternative to conventional white canes and other assistive devices that are declined to function with accuracy in urban environments where excessive amount of obstacles exist ubiquitously. This particular upgrade offers a more intuitive perception of the surroundings via high-definition camera and the pre-trained image processing technology that operates in conjunction with ultrasonic sensors to provide more accurate feedback receptions of the obstacle(s) as well as identify the object(s). The design of the cane is similar to that of the conventional white cane ,employing the collapsing mechanism as well as other physical properties. However, the tip of the cane is a modified roller tip to promote the stability of the camera by eliminating the swinging motion from the cane. The video input will be processed real-time via a single-board computer and then reports back to the user by the vibration (touch) of the handle and a pair of wireless bone-conduction headset (sound). Additionally, the image processing software could learn with pre-trained models to recognize stairs, inclination, uneven surfaces, and even slippery surfaces.

Keywords: visually impaired patients, white cane, object recognition, image processing, ultrasonic sensor, PIR sensor, artificial intelligence

Fig. 01: Pathfinder's Range of Detection

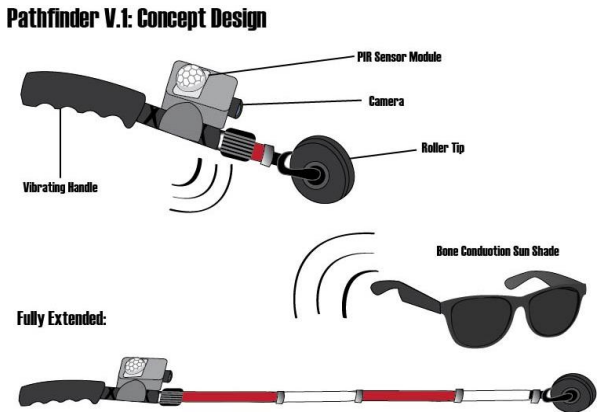

Fig. 02: Pathfinder - Concept Design

2.1 Process

The process behind the creation of this cane can be divided into two major parts: the body and the brain — the cane and the image processor. The materials that are used to construct the body of the cane is a combination of aluminium and 3D-printed PLA; a combination that allows a complex formation of the material by 3D printer as well as retaining the strength via the aluminium-augmented parts.The mechanical part of this cane is a straight derivation from the traditional folding cane with different collapsible segments to enhance the mobility and portability of it. The tip, however, must be modified in order to maintain the stability of the camera which is crucial to the data processing. Therefore, the tip is substituted with the roller tip to eliminate the swinging motion of the cane thus producing a more stable footage to the processor. Moreover,using the human centric design, the grip is shaped around natural stance of human palm to promote comfort while using the equipment. As for the electronics system, the input datas are received via a high-definition camera in front of the cane. The data then proceeds through a designated image recognition software via pre-trained models provided by Yolov.3 and Tensorflow. The software automatically detects every notable objects in a wide conical field in front of the cane user. However, the AI can not efficiently alert the user of the impending danger when there are abundance of irrelevant. Therefore, the occupancy modules is added to the system to 'confirm' the presence of the obstacle to avoid collision. There are two units in total: one at the front and one at an elevated angle to avert an head-level collision. The feedback is displayed through a vibration motor embedded in the handle and a pre-recorded audio alert via a pair of bone conduction sunshade. Additionally, the next step in the development is including a basic GPS navigation system to the cane to further assist the user with one-stop navigation system without additional devices.

2.3 Lessons Learned

This project is both challenging in the design process and the technology aspects behind it.As many would say that technology is essentially the intersection between human and science, this project evolved from the ideology by capturing society's pain points and form a solution based on human factors. This project involved face-to-face interviews with visually impaired patients along with their preferences of the equipment as well as the difficulties regarding the navigation in the urban areas of Bangkok. The process of forming a prototype based on the patients' demand was one of the biggest challenge in this project. From a personal standpoint, the hardest process of the whole project was the designing of the microcomputer/microcontroller and electronics system that have to be: 1. Small enough to fit in the handle portion of the cane, 2. Consume minimal amount of energy to prolong the operation time and to prevent them from overheating, and 3. Possess enough computing power to analyze the input data with minimal delay in the response time. Also, the reverse engineering process of the cane's collapsing mechanism and making the joints connect smoothly was just an arduous effort. Countless prototypes of different designs and material were made before the 'suitable' model was achieved .Not to mention the difficulties pertaining the image recognition software, for which a personal knowledge of the particular area is still scarce. However, using pre-trained models from ready-made softwares helped tremendously since a relatively minimal programming skill is actually required to operate the software.

3. BIOS

My name is Dee, Abhipol Vibhatasilpin. I'm 16 years of age and currently studying in grade 11 at Patumwan Demonstration School. From a young age, I have been particularly obsessed with science and technology but,more importantly, it potentials to solve problems inflicted upon this world — both natural-occurring and man-made. My area of interest is assistive robotics for which the potential of it is abundant as well as its vast application. My previous creations include: Music Advertisements via Light-Fidelity, Laser Powered Surveillance System, 'Sunblaster' - 100W Flashlight, and Portable Bluetooth Amplifier.