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Smart Path Guidance Mobile Aid for Visually Disabled Persons

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Abstract

A traditional blind-navigation cane mostly used by a visually impaired person is not very appropriate mainly due to narrow search area. While a conventional cane warns of changes along the ground, it does not warn of other walking hazards and objects above a person's waist. There are many electronics based blind-navigation devices employ a voice guided GPS (global positioning system) and/or complex high-order processor. It is apparent that the costs of these devices are too high that a common visually impaired people cannot afford them. In addition, a kind of previous arts is difficult to handle due to the weight, volume and functions incubated with basic purpose. Therefore, these types of advanced navigation systems are difficult to be commercialized. The purpose of this research is to design and develop a smart path guidance system for the blind and visually impaired, particularly the mobile aid to carry by hand, contains a smart sensor logic system. An appropriate model has developed for the selected design with embedding fuzzy logic decision. A presented solution is also tested for various condition inputs to verify the system's behavior. Through several experiments, the sensors are calibrated to increase the accuracy of decision. The presented prototype enables the blind person to walk freely in an unfamiliar environment.

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1. Introduction

Designing a device to aid a blind person is not something new. Various technologies have been used to aid the blind and as technologies get more and more advanced, ideas come up to make some very interesting solutions to aid the blind. However, designing a solution that is able to serve its purpose yet is so expensive that the aid becomes a so called luxurious item would not be most applicable in most developing countries. According to the World Health Organization (WHO) [1], 285 million people are estimated to be visually impaired worldwide of which around 39 million people are blind. Also, WHO estimates that most young blind children would need, for personal development, visual rehabilitation interventions. However, it usually comes with huge medical bills and with 90% of the visually impaired persons in the world living in low income settings, visual rehabilitation is not the best option for all.

For full psychological development and better independence without these huge bills, visually impaired persons need some sort of guide to help with their activities. This guide may be in the form of a walking stick, a guide dog, or even a human personal assistant. Another person may not always be available and not always preferred for a blind person that is looking for independence. The choice between a walking stick and a guide dog is a personal one that involves careful consideration of travel factors, lifestyles and preference.

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Man’s best friend, the dog, may be specially trained to move around obstacles, stop at stairs or curbs and go through doorways. According to the Blind Foundation of New Zealand, to become a guide dog, puppies train for 2 years, walk thousands of steps and have to pass 55 tests [2]. Guide dogs are usually provided to blind people free of charge and costs are met through sponsorships, legacies and public donations. However, dogs may not be allowed in all places in public and like all living things they need constant care and this may be difficult to manage for a blind person. When compared to the cane, the guide dog can interact with the user and environment and prove more useful in certain locations but canes are usually preferred for reasons of price, allergies, and care [2].

The second and most preferred method is the cane or walking stick. Here, a white cane is used as a mobility tool enabling the user to move about safely and independently in most cases. It may also act as a symbol that the person carrying this white cane is blind or visually impaired. There are several types of canes and all have one feature in common – to find objects before the user hits them. However, this tool has flaws as well such as avoiding traffic, at times sensing depth and sometimes leave the user confused of its surrounding.

There is room for improvement on these canes to take them closer to faultlessness and precision. Installing electronic sensors and processing units will increase their accuracy and be able to guide the blind better and more effortlessly. From as early as 1962, ultrasonic has been experimented with in designing mobility aids for the blind [3]. It was unclear at that time how valuable this new development would be to the visually impaired because of the user’s psychological factors. It was concluded that a large number of blind people would have had to have undergone the trials and tests to have a clear indication on the viability of including ultrasonic into mobility aids for the blind. The late nineteen nineties gave way to research into the applications of robotics in the development of mobility aids for the elderly/frail blind [4]. Here, mobile robot technology enabled mobility aid supports the user walking behind it and allows it to avoid obstacles for a safe travel. Again, understanding the user’s needs was shown to be vital for an applicable design.

Interest grew into this area of research and soon a blind mobility aid modelled after progressing research reported in literature [2, 5, 6]. Mainly it has presented that new ICT enabled technology, a blind person could differentiate between several objects at the same time without virtual imagery. A mobility aid was evaluated based on psychophysical experiments. Convincingly enough, this technology still remains in the research phase and is yet to make it to production. It will most likely find its place with other higher end and more expensive designs – it does however solve the problem of differentiating between obstacles. Recently, a concept of path guidance robot was presented in [7] to control steering angle of the robot in simulation.

However sophisticated a concept is, one key factor still dictates the overall design – the user requirements. It is therefore apparent that a thorough study of the blind and visually impaired must be done to bring out the best design. Another factor greatly impacting the design is cost. As mentioned earlier, with a majority of the visually impaired persons in the world living in low income settings, the design has to be cheap enough to reach production/manufacture stage and possibly have a positive impact on the blind society.

In this work, a handy mobile device is developed for a visually impaired person. The portable electronic gadget is suitable to navigate by the user independently through signals such as vibrations, beeps and audio warnings. A prominent objective is to provide a mobility device, which is simple to handle and a low cost solution to replace a traditional navigation device. Another objective is to provide a smart cane to warn the user not only the detection of an object, but also the distance of object relative to the user and the distinguishing of the obstruction. The method includes the smart logical skills like human using fuzzy logic design and the micro-processor is programmed to deliver decision after information processing on traveling direction, pointing direction and previous decision results, and furthermore, delivers comfortable warnings.

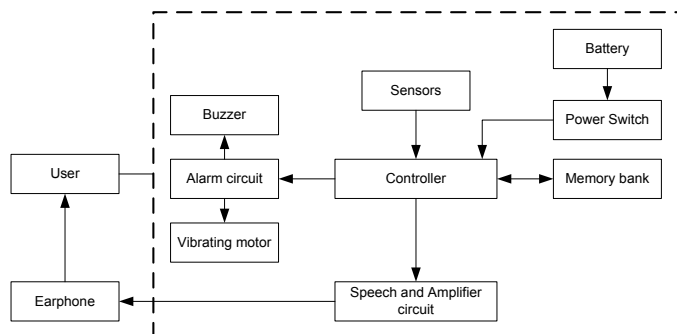


Fig. 1 Overall block diagram of the Smart Path Guidance Mobile

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