시각 장애인을 위한 스마트 지팡이에 관한 연구

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A Research on Smart Stick for the Blind

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Abstract

Unfortunately, the number of blind people increases every 5 seconds in our world. An extensive research was made on improving the conventional walking cane and developing a microcontroller based walking stick for the blind with sensors and a feedback in form of vibration. Two different kinds of sensors are used to detect obstacles, ultrasonic and infrared distance sensors. The signal from an ultrasonic sensor is fed to a microcontroller. With the help of the supporting software, the Pulse Width Modulation (PWM) principle is extensively used to form three zones and run the corresponding vibration motor at different spends according to how far the detected object is located. The other infrared distance sensors are connected to amplifiers and after that to their corresponding vibration motors through motor drivers. The vibration motors are to be located around the user's arm to notify the blind of the obstacles in the intended walking way. It can be very reliable and sufficient device guiding the blind other than the conventional walking cane which has many drawbacks which will be explained and discussed.

1. Introduction

Designing devices to be used by others is always much tougher than designing a device to be used by the designer himself to ensure the success of the device. An extensive research about the users, their requirements, their preferable shape and functions of the device are required. Here in this case, the users are the blind people and this makes the situation even more sensitive than it ever could be because their lives would depend on this device and its reliability. Furthermore, all the previous researches and the currently used mobility aids regarding our issue must be studies carefully.

2. Causes of Blindness

There are many causes may result in a serious visual impairment and these causes are categorized into different types; such as injuries, diseases, genetic defects and poisoning. Diseases and malnutrition contribute the biggest factors to blindness. World Health Organization (WHO) published in 2002 that the most common causes of blindness around the world are [10]:

- Cataracts (47.9%): That is defined as a clouding in the lens and that will result in impedance of the light passage going through the eye.
- Glaucoma (12.3%): It's the second leading cause of blindness and it's a group of similar diseases. It generally blocks the drain fluid in the eye.
- Age-related macular degeneration "AMD" (8.7%): it affects people who are 50 years old and above.
- Corneal opacity (5.1%): It consists of a wide variety of eye diseases result in scarring of the cornea.
- Diabetic retinopathy (4.8%): it's caused by vascular changes in the retinal circulation.

3. Literature Review

This huge significant number of these people who are visually impaired in this world inspired others who care about their community and its well-fair to come up with useful invents and equipments to help them facing their daily life with less problems and danger. These equipments or mobility aids are usually used when the medical science fails to solve the visual impairment occurred. The main purpose of these developed equipments is to ensure a safer daily life with less danger faced.

Nowadays, variety of useful tools or aids meant to be used by the blind people helping them to practice their daily regular activities. Their designs are meant to help them in mobility and communication. Below is an illustrative demonstration of those tools and their assistance in mobility and communication. However, blind people usually don't need to use any mobility aid when they are using familiar paths or familiar area like moving around in the house, because after some time going through the same paths every day, an imaginary image will eventually be created throughout the days in the blind's mind allows him/her to

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move around much safer. On the other hand, the moment the person walks out of the familiar indoor area or walks out of the house, it might be dangerous to walk on the road even though if the blind person memorize the path because it's impossible to predict the moving objects on those paths.

To overcome the dangerous accidents that may occur for the blind person walking on the sidewalks of the road, the walking cane is widely used and it's the most tool used for guidance by the blind people. The mobility cane is usually made of Aluminum, graphite-reinforced plastic or other fiber-reinforced plastic sometimes. It comes with a big variety of tips depends on what the user prefers. Furthermore, the visually impaired people mostly use white canes with red tips and it has become the international symbol of blindness.

As the desired ways of use vary, different types of walking canes have been developed depending on the user age, compatibility of the walking cane to the user and other various aspects. Long cane, "kiddie" cane, identification cane and support cane were developed to satisfy the different ways of use by the blind people. it's also known as Hoover□s cane, after Dr. Richard Hoover. Despite all the useful things about the white cane, it has a great drawback which is a swinging motion is required by the user in order to discover the obstacles and that's inconvenient for the walkers beside the blind user of the white cane.

Guide dogs are also known sometimes as the assistance dogs. These guide dogs are actually well trained to lead the user walking through the path. Additionally, they are professionally trained to help the blind navigating around and indicating the user when there's a step up or down ahead. Usually, the guide dog is taken as a pet by the visually impaired person and in that way they both take care of each other. They are very practical and helpful to the blind people for avoiding obstacles, cars on the road and holes and much safer than using a white cane. On the other hand, guide dogs are impossible to be understood the complicated directions, besides the fact that dogs can't understand and respond to the street signs. More drawbacks rise when it comes to using the guide dogs by the blind people such as need to be taken care of and they have high daily expenses like shelter and feeding expenses which some may not afford financially besides it's actually expensive to buy a well professionally trained guide dog. They need to be cleaned also. It's a high possibility that the guide dog guides the blind person to a wrong direction unless he/she memorize it. In addition, the guide dog may go through narrow paths where a grown man impossible to go through or even in the case of the presence of a hanging object which cause the blind person to be hit in the face.

4. Device Operation

The cane designed in this project is actually an electronic version of the normal traditional walking cane which is used widely by the blind. This cane is designed to alert or warn the blind walker of any obstacles or holes ahead by vibration without touching them at all.

To start using this device, at first, the blind user has to switch it on by the switch attached in the main board. The blind user might want to check the device in a simple move by blocking the wave's way of any sensor attached to the stick and feel the vibration feedback. A bright LED on the board will switch on and it's useful as an indication sign for others.

After that, the device is to be switched on and working properly as tested. The blind user then is supposed to hold the stick and start walking in the intended direction and use it as a walking assistant. The user will be alerted by four vibration motors in the presence of any obstacles in front, at the sides besides holes using three IR sensors and an Ultrasonic sensor. The diagram below shows a block diagram of the electronic design and the operation of the stick.

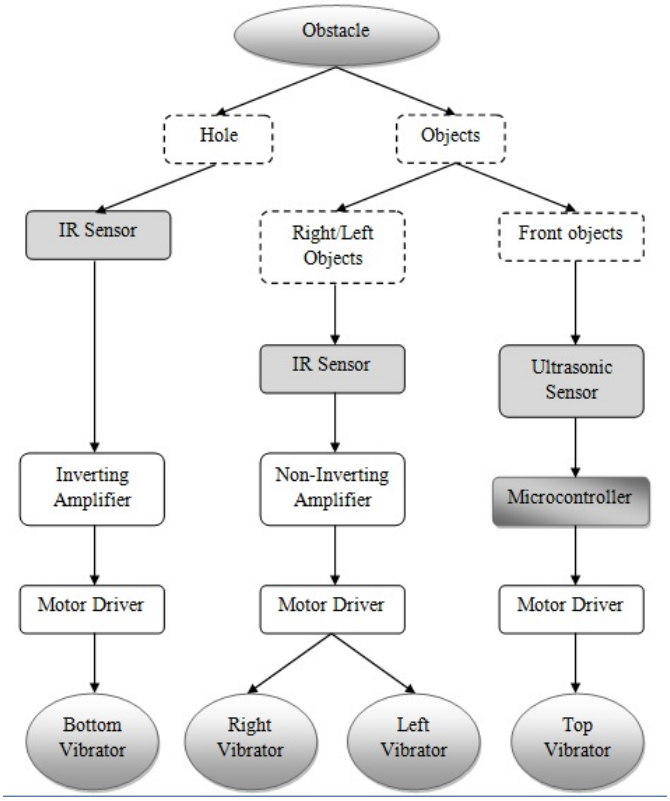

Figure 1: Device operation block diagram

5. Conclusion

The idea of this project was taken under consideration as the number of the visually impaired people increases literally every 5 seconds. Therefore, they definitely in need of practical walking aids to help them through in life. Two main walking aids are commonly used by them which are the conventional walking cane and the guide dog. Each of these has its own drawbacks. The conventional walking cane is very limited in range and a swing motion is needed in order to detect obstacles. Additionally, the recently blind persons are required to go through a rehabilitation course as it□s not that easy to learn the techniques of using it skilfully to avoid any obstacles on their way walking. The guide dog is not that convenient as well. Aside from be so expensive, the dog is height and flexibility allows itself to take paths which a person can never take. The electronic walking cane has been developed to overcome all these limitations of the traditionally used walking aids. In this project, sensors, ultrasonic and infrared distance sensors, were employed to detect obstacles to be used by the blind. Holes were well

considered and detected as well by one of the infrared distance sensors. Their ranges are adjustable by variable resistors which means the maximum detection ranges of the sensors can be used ,which are 80cm for the infrared distance sensors placed at the sides and over 6m for the ultrasonic sensors which is placed in front to detect the front objects, but it□s not recommended. The signals of the sensors will go through a microcontroller, operational amplifiers and motor drivers to give a feedback to the user in the form of a vibration. The vibration motors are placed on the user□s arm. They were preferred over alarm buzzers for several reasons discussed earlier. Furthermore, the strength of the vibration signal given to the user is becoming stronger as the user gets closer to the object that has been detected by the ultrasonic sensor.

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References

[1] Australian Institution of Health and welfare, A Guide to Australian Health Data, http://www.aihw.gov.au/publicationss/phe/agtaehd/agtaehd-c01.pdf .

[2] International Council of Ophthalmology, Visual standard aspects and ranges of vision loss, April 2002, http://www.icoph.org/pdf/visualstandardsreport.pdf .

[3] B. Ding, H. Yuan, L. Jiang, X. Zang (2007), “The Research on Blind Navigation System Based on RFID”, International Conference on Wireless Communications, Networking and Mobile Computing, pp.2058-2061.

[4] R. Velázquez, E. Pissaloux and P. Le Polotec, Laboratoire de Robotique de Paris, CNRS FRE 2507, “Towards a local spatial representation system for mobility assistances of the blind”, http://forte.fh-hagenberg.at/Project-Homepages/Blindenhund/conferences/granada/papers/VELAQUEZ/Velazquez.htm .

[5] Christian Blind Mission, FACTS about Worldwide Blindness, http://www.cbmuk.org.uk/pdf/Blindness_Factsheet.pdf .

[6] ABC-tech researches, The Human Eye, http://abcteach.com/free/r/rc_body_senses_eye_upperelem.pdf .