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A Novel approach to help Visually Impaired people

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Abstract – Visual impairment is characterized by the decrease in functional abilities of eyesight causing increase in dependencies. Recently many systems have been developed to help visually impaired people for making them self-dependable during their daily living activities. A walker design concept provides direction assistance to visually impaired people for their obstacle free movement. In this article, a new hardware design concept is proposed to help visually impaired people. The system is made possible by the use of different sensors mounted on walker at various positions. Infrared sensors and ultrasonic sensor detects obstacles in front of them and provides directional information about it to the microcontroller. In response system will trigger an audible notification via earphone to alert the visually impaired person if there is an obstacle. Accelerometer sensor alerts the visually impaired person about the possibility of fall due to stuck or potholes by the buzzer sound indication as well as by the audible notification.
Since many walkers available in the market are heavy in weight and requires training to use, proposed smart walker provides reliability in carrying it with easy to handle phenomenon.
Keywords- Visual impaired (VI), self-dependable, walker, navigational assistance, sensors.

I. INTRODUCTION

Several reports had said that in modern world more number of people are suffering from visual impairment and it is increasing day by day. Visually impairment makes person dependable on others. Referring to this, assistance is required by humans or technological mediations to address the needs of visually impaired persons in terms of mobility. The consequences of this assistance measured in terms of improvement in the daily living of visually impaired people. The objective of this article is to make visually impaired people self-dependent in unknown environment. To fulfill the requirements of visually impaired people, walker is designed with the use of different sensors as shown in "Figure 1". Sensors analyze environmental data near to the front of the walker and provide steering information to the visually impaired person. This information is conveyed to visually impaired people by the use of audible notifications via earphones for obstacle free movement. The sensors, infrared sensor and ultrasonic sensor are used to detect the obstacles. Infrared obstacle detection sensors are mounted on walker at some height from ground to detect lower height obstacles such as steps. Ultrasonic sensor is mounted on the servo motor and motor is fixed at the center of the chassis of the walker to detect obstacle at higher height [1]. The servo motor covers semicircle region. Ultrasonic sensor with motor also covers semicircle region same like motor around the walker. Another sensor that is Accelerometer sensor is used to detect the ongoing potential fall due to potholes or shallow surface. It uses the phenomenon of continuously comparing the change in the angle with respect to the default value. If the change in the value occurs then there is possibility of fall of the walker. All the sensors are providing their data to the controller. Controller converts this information into audible messages and provides to visually impaired person via earphones.

Fig.1 Walker design

The objective of this research is to develop a smart technological mediation to help visually impaired person to gain self-reliance for improving the mobility in daily living environment.

Although there are various designs of the walkers present in the world, this smart walker introduces new easy to handle hardware guidance that support visually impaired person in any complex environment.

II. RELATED WORK

According to the need of the visually impaired people many products had developed to assist them for hassle free movement in the environment. Such as Walking Aid [2], the walker developed is suitable for stability and good balance purpose. It comes with 4 legs design and is more beneficiaries in weight. It could handle more weight of person. The revised version of walking aid is provided with an electric motor [3] to move further in environment. Since motor creating vibrations on walker, the walker gets unstable. Due to this, this design is not successful. Wearable Obstacle Avoidance Electronic Travel Aids for Blind: A Survey [4] provides a comparative survey among obstacle avoidance systems as an effort to inform the researcher community and its users about the capability of these systems and about the progress in technology which provides assistance for visually impaired people. A Smart Tactile for Visually Impaired people [5] provides a new, inexpensive and simple system, which consists of two main elements: batons, and tagged paths to make traveling alone possible. The proposed system also available for IOS and Android mobile devices, and it consists of two software applications, “InGuide” and “OutGuide”, for indoor and outdoor environments respectively. Both of these applications use voice command, interpreter algorithms to guide tactile users. A Navigation Aid for Blind People with Walking Disabilities [6] which provides a concept of walker that supports assistance as well as enables blind persons to avoid obstacles. This system detects both positive and negative obstacles such as curbs, staircases and potholes in the ground and transmits obstacle proximity information through haptic feedback to the person.

III. SYSTEM

This system approach fulfills daily living activity requirements of visually impaired persons. The aim of system is to restore self-reliance in visually impaired people. Different sensors and electronic devices are placed on the walker at proper position so as to get accuracy in detecting obstacles or holes.

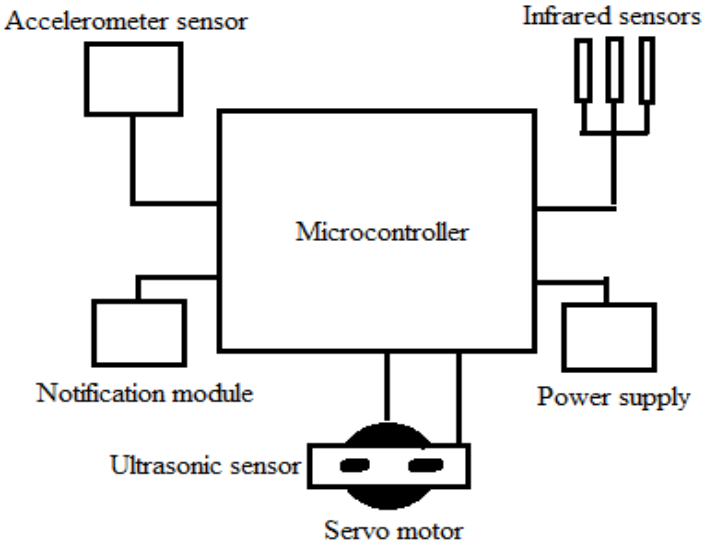

Fig.2 Block diagram for smart walker

The hardware block description of the smart walker is shown in "Figure 2".
The smart walker design integrates different sensors and modules onto one single system. Each module comes with different function such as

- Detection of obstacles (lower or higher)
- Potential fall detection
- Audio message alerts

A. Obstacle detection

Since the visually impaired person is at higher risk while move through the obstacles despite of his/her perception of the environment. At this point, obstacle detection is very important for injury free move of person. Lower height obstacles such as steps are also cause injury, are detected using infrared sensors. They are provided with continuously emission of infrared waves and reception of the same waves for detecting the obstacles. These sensors detect reflected waves from any type of obstacles which made them suitable for design of smart walker. This smart walker is furnished with three infrared sensors fixed on front side of the walker at proper distance above the ground, on rods of the walker as shown in "Fig.1" [1]. Lower height obstacles are notified to system by interruption on infrared sensor. This information about obstacle is provided to the visually impaired person via earphones.

Higher height obstacles are detected using an ultrasonic sensor. The ultrasonic sensor constantly triggers a signal, if the echo signal come then there is obstacle. The use of the ultrasonic sensor is well suited for stationary and moving objects. Ultrasonic sensor has a larger spectrum than the infrared sensors and wider area coverage. Despite of the relatively large region, left and right sides near the front of the walker are not included. To overcome this difficulty, the ultrasonic sensor is mounted on servo motor which has 180 degree rotation. This is shown in "Figure 3".

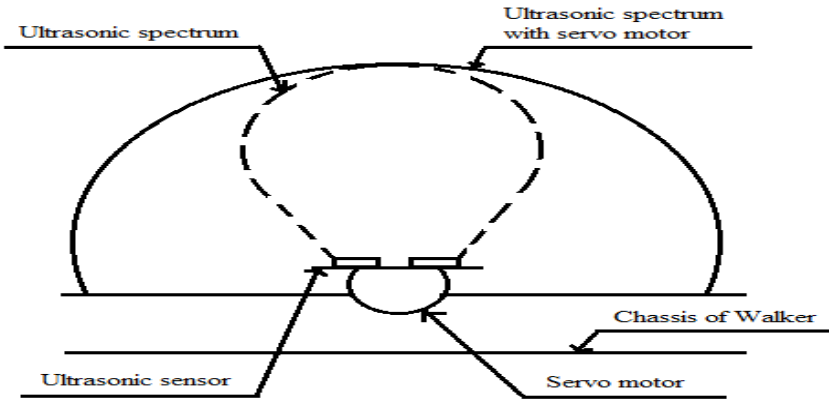

Fig.3 Ultrasonic sensor obstacle detection scheme

The motor provides a surface area of a semicircle. The motor shaft moves from right to left. If an obstacle is present the servo motor stops for a while and the visually impaired person is immediately notified about the position of the obstacle so that he can move safely by knowing it.

B. Fall detection

Despite of the obstacles detection provided by the sensors, there is still a risk of getting fall of the visually impaired person. The walker legs may come across an unstable ground or potholes leading to potential fall. Lower obstacle sensors that are infrared sensor are not worthy during this situation. To overcome this difficulty, a MEMS accelerometer sensor is mounted at front side on top edge of walker [1]. Before the conversion routine is taking place, the accelerometer must be calibrated to set default value. A common reference value is selected to start the reading of acceleration data. Accelerometer sensor measures acceleration by measuring change in capacitance C1 and C2. It has a mass attached to a spring which is confined to move along one direction and fixed outer plates. So when acceleration in the particular direction will be applied the mass will move and the capacitance between the plates and the mass will change. This change in capacitance will be measured, processed and it will correspond to a particular acceleration value. Change in the acceleration value is processed and compared to threshold value. If change in value occurs then there is possibility of fall. Notification module conveys audible indication about fall alert via earphones to visually impaired person.

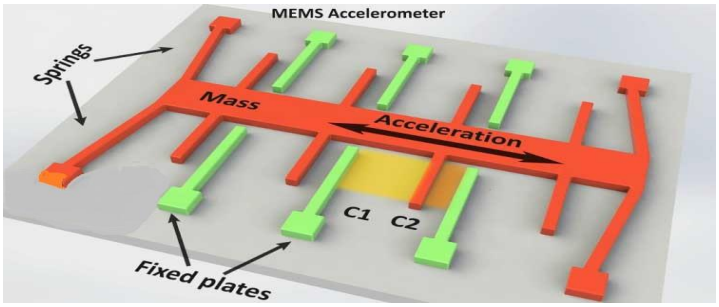

Fig.4 Fall Detection Phenomenon

C. Alerts and notification

The visual impaired person is get notified about obstacles as well as potential fall using audible messages. Controller processes all the data coming from specific sensors, and sends information to the notification module. Notification module alerts about these particular messages via earphones to visually impaired person. These messages are audible signals suitable for human ears. It converts

data coming from controller into audio which makes it compatible with any type of controllers. Proper attention is kept at the repetition of messages. Messages notify about the orientation of the obstacle as well as fall alert. These Messages are

- Lower height obstacle present
- Higher height obstacle present - at front or (on the left or right)
- Fall alert

IV. IMPLEMENTATION ANDEVALUATION

All the modules are tested independently for their characteristics. The program is downloaded into the controller. These modules are then assembled on the walker at various positions as per block diagram. The walker is made ready for testing purpose. To check the reliability of the walker for visually impaired person, we used a qualitative approach. Four visually impaired people are selected for testing of walker. After the test, we asked visually impaired people to give grade about the performance of the walker. The results of averages of persons experience are summarized below.

Obstacle detection phenomenon

Object	Quantity	Success Ratio
Person	25	100
Cupboard	10	100
Chair	20	95
Wall	10	100
Stairs	10	90
Bottle	10	90

Fall detection phenomenon

Condition	Quantity	Success Ratio
Potholes	15	100
Stuck	10	100
Threshold(barrier)	10	100

V. CONCLUSION

The walker is well suitable for providing mobility and safety to fulfill the requirements of an assisted living system for visually impaired people. The walker provides its reliability and effectiveness for giving more accurate guidance, easy to handle with real time operations to fulfill the requirements of an assisted living system for visually impaired people.

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