International Journal of Control and Automation
Vol. 13, No. 2, (2020), pp. 512 – 519

Voice Assisted Smart Vision Stick for Visually Impaired

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Abstract

This paper focus on smart waking aid to help visually challenged people and it to identify the obstacles in order to provide assistance to reach their destination. The use of multiple walking aid for scribes which supports to move around indoor and outdoor locations even they are travel in public transport but none of them provide run-time voice assisting device. In this paper, a smart Electronic Traveling Aid (ETA) is proposed. An ultrasonic sensor is utilized to echo sound waves and detect objects. It can detect an obstacle within a 5 to 35 cm range of distance. The proposed system provides complete guidance and protection to scribes under various circumstances. Playback voice module which has 8 channels with eight different voices can be feed into the module, all the audio can be recorded up to 60 seconds..

Keywords: *Smart walking stick, Electronic Traveling Aid (ETA), Ultrasonic sensor, Playback voice module.*

1. Introduction

Worldwide scribes are facing many psychological and social challenges in their day to day life. One of the issues is related to their transportation. They are suffering with obstacle in their path. Many researchers focusing to develop the module or aid stick for supportive the scribes and it should be cost effective. Hence, this work aims to provide the cost effective solution to the scribes.

1.1. Literature review

Aritra Ray and Hena Ray (2019) reported that they is no worthy prototype production for visual impaired. The authors developed the MEMS sensor based and low weight walking aid for the scribes benefit. Namita Agarwal et al. (2015) proposed a safe and secure electronic guiding stick for scribes. The navigation system provides the information to the scribes through their headset for both indoor and outdoor conditions. Agrawal and Gupta (2018) developed a user friendly and vibration based smart aid stick for visual impair. The authors concentrated on low cost and mass production system for low economic people point of view.Arora and Gaikwad (2017) provided the theoretical model for smart electronic aid to the scribes. The theoretical model utilized the IR and ultrasonic sensor for hurdle detection and the GPS module for the voice assistance to the desired location and emergency conditions. Divya et al. (2019) described the ultrasonic based walking aid for scribes using Arduino micro-controller. In this work, the GSM module provides the alert message. The alert signal is generated by the Buzzer sound to the scribes. The purpose of GPS module is to give the location to the guardian, when the scribes in emergency or threat. The authors reported that the cost of the system is Rs.

ISSN: 2005-4297 IJCA

2,500 and the battery back of 12 hours.Liang-Bi Chen et al. (2019) presented the paper on wearable smart glass smart walking aid for scribes. In this work, deep learning tool used to intelligent reorganization of front image or any signals. Mohammed Noman et al. presented a smart glass model incorporating with smart phone for scribes. The special features of this work to recognize the English and Arabic language for face reorganization and in-door navigation. The authors reported that their model cost ranges from 245 USD to 1900 USD.A project reported by Mohammadi et al. (2013) explained the detailed design and implementation of a Self-Energized Smart Vision Stick for Visually Impaired People. The device consists of three main systems which are detection and alert, emergency, and renewable power generation. The detection and alert system are composed of an ultrasonic sensor that detects surrounding obstacles and sends a signal to a microcontroller for processing. The distance of potential obstacles is calculated and feedback is given to the user accordingly in order to avoid the potential obstacle.

1.2. Existing solutions

The literature review shown that the most common existing methods are walking aid with different microcontrollers incorporating GPS etc. These techniques are depending on hitting objects to identify their locations. The drawbacks of these techniques are it does not identify approaching objects such as bicycles.

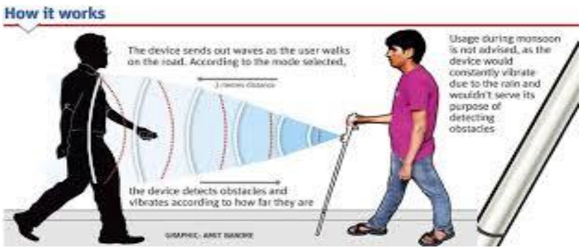

Fig. 1. Basic ultrasonic stick

1.3. Proposed solution

Sustaining the positive aspects of the white cane and guide dogs, this project focuses on designing the “voice assisted smart stick” using current technologies. The voice assisted Smart V Stick is a smart tool capable of enhancing the lives of visually-impaired people that can lead to an increase in their daily independence, privacy, and safe surrounding objects with the vision stick and alert the user accordingly. It incorporates an emergency system which is able to provide efficient ways to rescue the user in dangerous situations. As the project name implies, the system is voice assisted using playback module which has 8 channels using NRF the frequency range is get increased, using the help of aurdino the transmitter and receivers has been made to travel independent in the public transport. In this midterm report, the names “Voice assisted smart stick”, smart stick, and vision stick are used interchangeably to represent both the project and the prototype.

1.4. RFID enabled robotic guide dog

In this project was carried out by a group of undergraduate students in Central Michigan University, USA. They have designed and built a prototype of a smart cane that can guide visually-impaired people to avoid obstacles using ultrasonic sensors and RFID technology. However, RFID tags need to be installed along streets and signals before the cane can identify and notify the user accordingly of the surrounding environment. In addition, the smart cane is equipped with a heavy bag that carries both the power supply and system circuitry. The user has the option of using gloves that would vibrate to alert the user in addition to vocal feedback.

1.5. Advantages of proposed system

- ✓ The smart stick doesn't only help to walk independently; he can able to travel in the public transport without any help.
- ✓ Around 8 different bus routes can be feed into the smart stick using playback module
- ✓ All routes can be insisted to the person using voice via speakers
- ✓ It will insist clearly if more than one bus comes to the bus stop.

2. System design

In this section, the alternative designs for the voice assisted Smart Vision Stick are presented and compared to the chosen stick design. This allows the superiority of the final design to be depicted and reasons for overruling the alternative designs to be justified.

2.1.Gloves Detection

The first alternative design is the glove detection as illustrated. The idea behind this design is to install sensors and vibration motors on the glove. Once the glove detects an object, it should vibrate accordingly to alert the user that there is an object ahead. Nonetheless, this design has its own limitations when considering certain situations. For instance, it will be difficult for the gloves to detect sudden drops and other obstacles that other solutions can alert. Also, it would force the user to always wear gloves. Therefore, it was not chosen as the optimum tool to help the visually impaired.

Fig. 2. Model of Glove Detection Design

2.2. Shirt Detection

The shirt detector design has distance sensors all over the shirt. Similar to the glove design, distance sensors and vibration motors are used to detect and alert the blind for object proximity. Only the sensors that sense object nearby will vibrate which will allow the visually impaired to know the location of the object without carrying any tool by hand. However, the blind will have only one type of shirt to wear. Also, if the visually impaired person sits down and someone passes by they might be alerted when there is no need to do so. That fact with the relatively inaccurate sensing and feedback means that a better solution should be considered. Hence, this design was not chosen as the best solution for the visually impaired.

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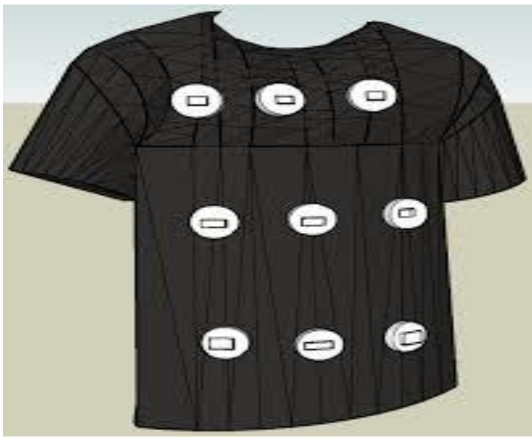

Fig. 3. Model of Shirt Detection Design

2.3.Overall proposed block diagram

The block diagram below serves a vital role in understanding the building blocks of the voice assisting Smart Stick system. At the heart of the block diagram is the brain of the vision stick, the arduino, which is responsible for all the logical operations that will be needed to execute the design. On the left diagram is about the transmitter system. Distance sensors will be responsible for detecting the distance of the objects and feeding it as an input to the arduino to be processed.

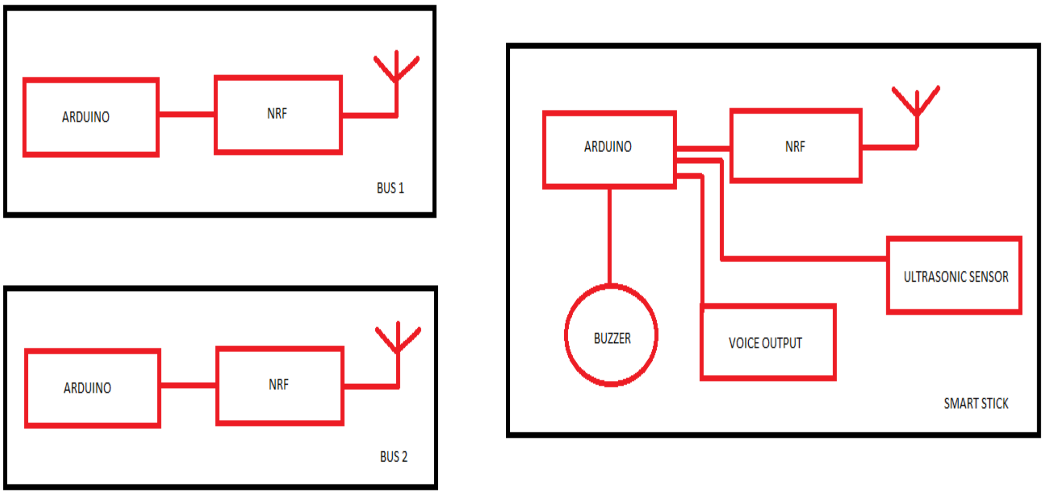

Fig. 4. Block diagram of proposed system (Transmitter and Receiver)

The arduino will then signal the ultrasonic to respond accordingly as an output signal to the detection system. On the right of the diagram is the main section. The playback voice recorder is connected to the arduino which act as the receiver, the receiver receives signals from the bus transmitter and then the signal transferred to the playback module, the playback module decodes the signal and identify the logic of the receiver. Each bus has separate logic which is encoded with the signal after transmission the signal is get decoded. NRF is used to increase the range of the signal for both the transmitter and the receiver. .

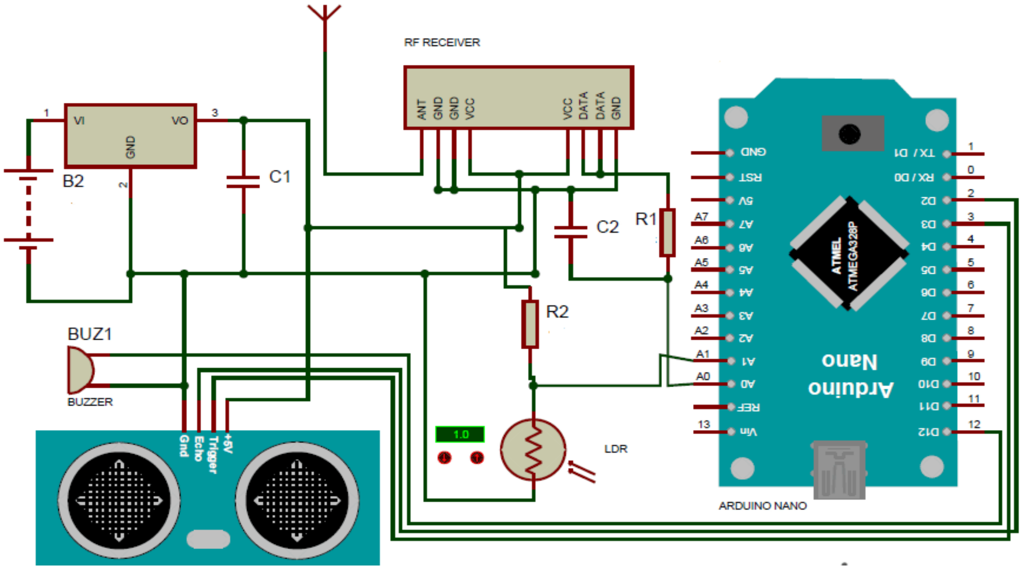

Fig. 5. Obstacles detection pin diagram

3. System architecture and flowchart

Thesystem architecture of the detection and alert system is summarized. As shown, the detection and alert system uses ultrasonic sensors to detect surrounding obstacles. The signals are sent to the Arduino Nano microcontroller to assess the situation. The feedback is sent to the user through a buzzer to alert him or her from noticeable-size obstacles. The process of detecting obstacles and alerting the user accordingly is illustrated.

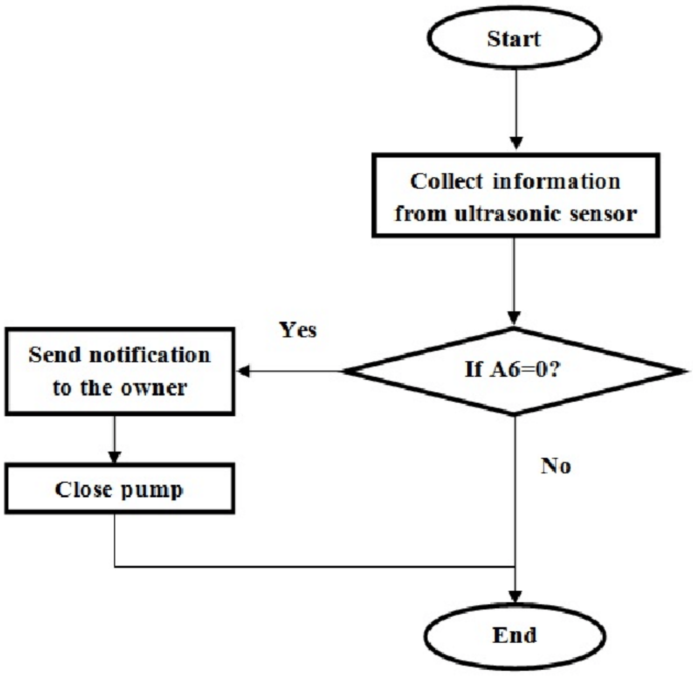

Fig.6. Ultrasonic loop diagram

As seen in the flowchart, the system starts by powering the microcontroller and runs in a continuous loop. In the loop, the ultrasonic sensors continuously sense the surrounding objects using the ultrasonic transceivers and the signals are fed into the arduino microcontroller If the computed distance falls within the ranges, the user is alerted. Otherwise, the next distance is computed and compared.

3.1.Vision stick usability

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The visually impaired person using this voice assisting stick he can able travel In the public transport without help of others. The basic needs are also getting attached like ultrasonic for the obstacles detection. there are two transmitter in the prototype, transmitter 1 is taken as 1 and transmitter 2 is taken as bus 2 the receiver is attached with the walking stick when the bus arrived the signal around the transmitter is get transmitted and the receiver in the stick catches the signal and the signal is get decoded and the bus route is get analysed so the person using the voice assisted smart stick can be able to travel without the other help.

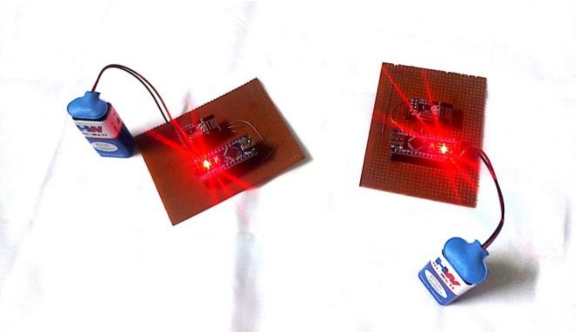

Fig. 7. Transmitter prototype

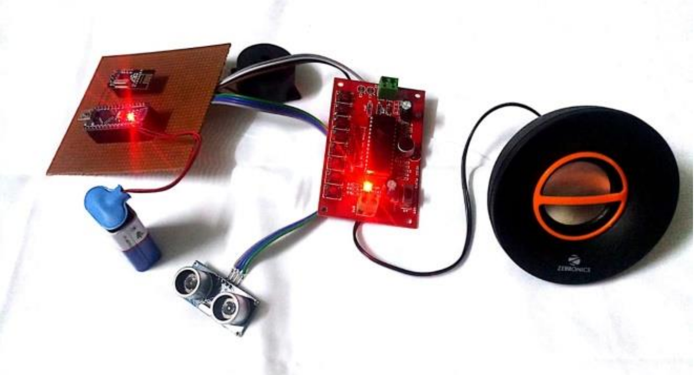

Fig. 8. Transmitter prototype

Upon designing the vision stick, different people tested the stick and were able to learn using the system within the first few minutes. Even though they were suing the vision stick for the first time, the small learning curve of the detection and alert system allowed them to be trained fast. It can be deduced that the use of vibration motors simplifies the learning process for detecting objects at the ground and waist levels.

However, a visually-impaired volunteer is still needed to practically use the stick. Currently, it is not implemented. For example, the vision stick is not capable of detecting objects lower than the ground level such as a hole or stairs going down. Also, the mass distribution of the vision stick is not well-balanced and can tire the user if used for long periods. Future improvements of the vision stick must improve upon the overall 1kg mass of the stick which may be able to pose wrist pains for the user.

3.2.Cost and mass

For every part of the project, the different components needed were found and listed along with their prototype cost and mass in Table below. It was found that the total approximated mass of the current prototype stick is below 1kg.Final Mass of the voice assisting Smart Vision Stick Prototype.

Table 1.Cost and mass of a project

Required Components	Unit Mass	Total Mass
Ultra Sonic Sensor	1 x 10	10
Buzzer	1 x 5	5
Arduino Nano Microcontroller	3 x 7	21
Portable Rechargeable Batteries	3 x 90	270
Blind Cane	1 x 250	250
Plastic Food Container	1 x 50	50
Miscellaneous	1 x 250	250
Total		**856**

In the total project development costs such as current purchases and shipment costs is shown. Also, the total purchase cost was approximated to be about Rs. 2500, and the total approximated prototype cost for this project was calculated to be about Rs. 2000. Much equipment was purchased for the voice assisting vision stick design that was eventually not used in the prototype.

4. Conclusion:

The design process, detailed implementation methodologies, project planning, and progress of the "voice assisted smart stick for visually impaired" design project was presented. The vision stick project focuses on detecting surrounding obstacles and alerting the visually impaired of their proximities. The two designed placements of the ultrasonic sensors detect objects at the ground and waist levels up to a maximum of 2m. During the experimentations and different tests which is 11 times stronger than the compared industrial prototype. The extra features added improve the overall usability of the smart stick, The final engineering prototype was delivered in week 15 which met all the proposed features in addition to the extra features discussed., this project uniquely stands out for being universally-portable for any user capable of physically carrying the vision stick.

Many challenges and deadlines were faced on the course of the project such as patiently waiting for components shipping delays; learning to interface with new hardware, combining the separate project codes and coming up with new optimized generator design. Therefore, the completion of this senior design project within 15 weeks is an accomplishment for all team members and supporting members. For future development, the object detection and alert must be enhanced to account for more details which were currently ignored such as moving objects on the stick's sides and falling stairs. The packaging team must ensure that the final product is lighter than the current 1kg prototype and has an ergonomic design. Also, an indoor emergency feature must be integrated to ensure call for help at all times, and smartphone integration can further widen the features of the voice assisting smart stick for visually impaired.

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