Practical Implementation of 3D Smart Walking Stick for Blind People

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Abstract

The gift of god that is precious is vision through which, one can see the beautiful world and enjoy. But many people throughout the world are deprived of this According to October 2017 reportof World Health Organization (WHO) an estimated253 million people live with vision impairment. 36 million are blind and 217 million have moderate to severe vision impairment. Un-operated cataract is the main reason for blindness in low income and developing countries Even in China by the end of 2017, the population over 60 will reach 241 million, accounting for 17.3 percent of the country's total population and nearly 40 million are disabled and semi disabled, according to data released by the Committee for the elderly in 201 d. So, in this case most of the visually challenged people cannot afford an expensive device to use as their supporter. So, in this paper we have proposed a cost-effective 3D intelligent Walking device. This mainly depends on the sensors because they can improve the world through diagnostics in many applications and it helps to improve performance. This device is implemented using ARM Controller, IR Sensors, Vibration Sensor, as well as GSM and GPS for location Sharing. Also a voice module is introduced along with this to give the directions through audio format. This Entered device is programmed by simple machine Learning algorithms to optimize the machine.

Keywords: Intelligent Walking Stick, 3-Dimensional, IR Sensors, Voice Module, Machine Learning, IoT, GSM and GPS

1 Introduction

In a life, the goals, objectives and dreams are achieved through independence. But, in this world, millions of blind orvisually impaired persons face challenges of walking independently in dangerous paths, as they rely on others for help. Previously, blind persons used walking stick for navigation which is then improved by attaching a remote sensor (to the stick). Though with a brilliant hepatic sensitivity, blind people encounter problems while usingstairs or walking in unknown environment or traffic areas (i.ewith people and vehicles). The electronic walking stick may provide convenience and efficiency for free movement of life. Thus, further improvements are required in existing technologies for developing a convenient portable stick and providing proper navigation in private and public areas.

Across the globe, many individuals are suffering from visualdebilitation resulting in vision loss or blindness. Though all blind individuals may not walk or travel independently (require others help), equipment called 'traditional whitecane' can be used as a preferable walking aid. White cane is one such tool which can be used by blind or who have imperfect vision to be independent. The cane helps blind to find obstacles and to overcome them safely. It was recognized as the standard gear for the visually impaired. Therefore, various technologies used as solution to assist theblind people. Some researchers have developed walking stick for blind people for safe navigation. In work [1], walking stick consists of a camera, earphone for output and four ultrasonic sensors. This system gives the result for all 360 degree horn the position of the cane. The camera is used for text and object recognition. In [2], authors have developed walking stick with an ultrasonic sensor for detecting obstructions using various buzzer sound for each type of obstruction. This system

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includes wireless RF remote control which alarm buzzer uniquely when pressed and also for locating the blind stick when it is misplaced.

In this world, 39 million out of 285 million are blind and some children are born blind. The independency and positive dimensions in the lives of these people can be developed by improving a blind stick which is advanced. The stick must be modified such that it reduces any obsoletein traditional methods of detecting an obstacle. In this paper,the project is developed to help the blind people to identify any obstacles and make the next movement without any baffle and with respect to obstacle. Authors have introduced system which includes crutch and bracelet. So that crutch will detect obstacles in front of them with sensors. The other invention [3] is smart cane which can detect all obstacles in range of 4m during 39ms and output is through audio-based frequency clips for announcing obstacles detection. In [4], the authors have developed portable device for blind peoples that will provide direction to new locations and alert them about obstacles in their path during outdoor navigation. Using a ST microelectronic system that has MEMS digital compass module which will allow giving more accurate direction for the blind person. We have proposed a system for blind people to navigate in safe path by alerting presence of obstacles.

2 Literature Survey

A blind person faces difficulty to move freely because he does not the size and distance of the object. To solve this problem, the walking stick with smart technology was presented by Jismi Johnson et al., (2013), in which it detects the object using camera and gives a voice output. This stick has a ultrasonic sensor to measure the presence of obstacles in its range and intimates its name through the speaker. The camera that is connected to Raspberry pi atcaptures the images. Thus, the blind person can he the sound from head phone about the presence of obstacles and move freely and safely all the time. The independent mobility for visually disabled people is improved by a project developed by K.Ramarethinam et al. which provides navigation using hepatic feedback and audible messages. The self-contained features of a portable system allow blind people to move in any environment. The proposed system contains both software and hardware. It also contains a capacitive touch screen using Braille for user free communication and for performing all operations.GPS receiver is a component used to receive current position and path detector is used to detect current position and shortest path. When a voice command of destination is received from user, the system initiates the navigation process. In an emergency, the system triggers an SMS about present location through emergency button to a remote phone number. The device also provides the information like calendar, audio format, navigation direction, temperature conditions, alarm, ambient light, obstacle detection and object cooler, thus making this project friendly to the blind people to move independently in any areas.

Kher Chaitrali S et al., (2013), discuss on challenges faced by visually impaired persons in unknown location. Few navigation systems are only available for them that provide speech output on navigation. In this paper, a navigation device is proposed that provides speech output on obstacle detection and navigation using android devices, infrared sensors and RFID technology for visually disabled people. Proximity infrared sensors are available in the device. The public buildings and stick of blind person are installed with RFID tags. The devices are connected using bluetooth to android phone to give voice navigation about person's location on server using RFID tags. Another application for family members is designed to know the location of blind person through server. Thus this sytem solves the blind people's daily life problems and ensures safety.

Jini.S et al., paper discusses about implementation and architecture of system for visually disabled people to use GPS technology. The system uses a microcontroller having preloaded navigation path for guidance to visually impaired people. GPS gives longitude and latitude location of user which are compared continuously for navigation with the already available values in microcontroller. The main goal of the system is to be

simple, economical, portable and easy to navigate in any environment without others help and by detecting obstacles using voice. The right, left and front position of a blind is provided with three ultrasonic sensors to detect obstacles. APR9600 voice playback IC gives messages and commands to the blind. A keypad with 12 keys in Braille language is present on the system represents each location and helps the user to select the required location. The paper mainly tries to ensure the proper evaluation and development of navigation that detects obstacles by using GPS, ultrasonic and voice sensor.

An electronic stick is developed for blind that has haptic perception which uses a vibrator motor, a power unit, a controller and ultrasonic sensors. The obstacle distance is sent to blind in tactile sensation and avoids crosstalk with sequential firing in ultrasonic sensors. The change in vibration intensity intimates the blind on variation of distance.

In other proposed system, the user can set the range from 20- 350cms using two ultrasonic sensors on the stick. An infrared sensor is also available at lower side of the stick to detect the small obstacles of 2 to 10cms range. In need of help a button is present on the stick to send the message. A buzzer beeps on hitting an obstacle by the stick.

In one more model, two infrared sensors are integrated to detect obstacles in multiple direction. Horizontal sensor detects front side obstacles while inclined sensor detects downward, upward stairs and on floor obstacles. The data from these sensors is sent to 16F877A microcontroller to process.

3 Methodology

Herr, in a TED talk said "Humans are not disabled. A person can never be broken. Our built environment, our technologies, is broken and disabled. We the people need not accept our limitations, but can transfer disability through technological Innovation". He claimed of living a normal life by using Prosthetic legs. Human disability can be neutralized by using a technology to build a stick for blind persons using sensors and Arduino.

Safety and efficient mobility for blind people using SMART STI CK. Blind people have difficulty in walking without the stick. The smart stick allows them to move freely and recognize the objects. People having difficulty in identifying small objects or obstacles on their way with their healthy eyes are called visually impaired, who require electronic aiding devices. While, the people having 6/60 visual activity or $\leq$ 200 horizontal extent with both eyes are called blind, who mainly requires aiding devices. From a total of blind people, 10% of them do not have usable eye sight to move freely and safely.

The smart stick is a proposed solution for blind people in which proximity sensors helps in identifying obstacles and stair- cases, ultrasonic sensors helps to locate patch holes within 1meter range and sensors present at the bottom of the stick to avoid puddles. When an obstacle is identified, vibration motor and warning messages in speech gets activated. This system supports micro embedded system raspberry pi, GPRS and vibration motor to trackthe blind people. The stick can find obstacles present at 1 meter range in 1s and transfer a message so that the blind person can move twice his speed for safety. The smart stick is of light in weight, can fold, gives fast response, low cost and low power consumption.

Figure 1 represents a circuit operating with 5V DC power supply. Here, 9V supply is considered to support three ultrasonic sensors, a vibrating motor, a piezo-electric buzzer and a Arduino (requires 5V). Arudino is considered as the brain of the circuit. "HC-SR04" is 3.3V ultrasonic sensor that detects the obstacles present at a 3m range and at an average angle of 250 in sphere by using ultrasonic waves. The programming of Arduino is done such that when it is 'ON', a LOW to HIGH signal is sent on IR Tx pin of the three Ultrasonic sensors. These sensors transmit Ultrasonic waves through air using its transmitter. The waves collide with obstacles present within 1.4m range and reflect. The Arduino is programmed to play the buzzer for sideways obstacles with different delay and the straight ones with no delay. The performance can be

enhanced by providing a vibrating motor which activates on a too close obstacle (i.e <0.7m from the sensor). The electrical response i.e round trip of wave from sensors to obstacles and back to sensors, of sensor is given to IR Rx pin. Here, only the distance for one-way is considered.

LM234 series is an amplifier containing four separate high gain frequency compensated (internally) op-amps (operational amplifiers) which operates from a single to a wide range of power supplies. It supports split power supply and also current drain does not depend on voltage of power supply.

Basically, we divide our project in five significant parts. Every part of this module is connected to each other. Firstly, as blind can't see the obstacle while walking, so the most significant part of the project is to recognize the obstacle around the user. We use three ultrasonic sensors around the stick Left, Right and Front. This sensor can measure the distances of the obstacle by performing echo. Maximum range of detection is 4m and Minimum, detection 2cm. lf this sensor detect an obstacle within 30cm towards the FRONT of the stick, it sends data to the Arduino and the speaker produce a sound same as the user's mother tongue like — Obstacle in the front. lf this sensor detect an obstacle within 30 cm towards the LEFT of the stick, it sends data to the Arduino and the speaker produce a sound same as the user's mother tongue like - Obstacle in the LEFT. lf this sensor detect an obstacle within 30cm towards the RIGHT of the stick, it sends data to the Arduino and the speaker produce a sound same as the user's mother tongue like —Obstacle in the RIGHT.

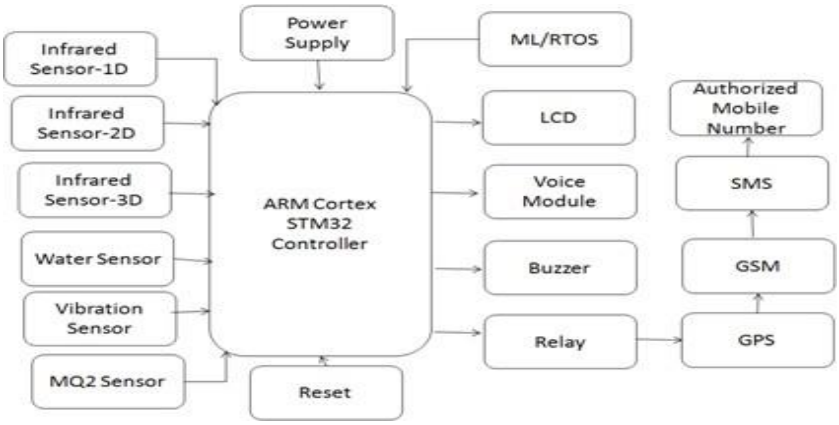

Figure 1. Block Diagram

Secondly, our stick can detect any type of hole in the street while walking. In our developed model, we placed a minimum distance from stick's IR sensor to the street. When, the distance level is larger than the minimum distance, it automatically knock the user and alarm about the detection in the street.

Third function is detection of water on surface or on street. Moisture sensor is used for this purpose. Arduino will wait for data from moisture sensor. When moisture sensor comes in contact of water it sends data to Arduino board. In turn Arduino sends alert to android application which sends voice alert to the user.

Fourth feature of the stick is street light detection. LDR sensor is used for this purpose. LDR sensor could sense light by change in resistance. The resistance of LDR increases in dark place, while decreases in the presence of light. If there is no light on the street then LDR will sense it and will send an alert or will brighten up a LED in our stick.

Fifth function of stick is to send the location of a blind person to an emergency contact number listed in the android application. When the person presses emergency button, android application sends location of user to the emergency contact number as a text message.

The following software's are used in the implementation of this project,

Arduino IDE compiler is used for compilation.

Express PCB is used for designing circuit

Proteus 7 (Embedded C) is used for simulation part

The system which is proposed contains an IR sensor that interfaces with microcontroller, Arduino sketch helps in writing the codes and physical sensor connected to microcontroller. The microcontroller board i.e Arduino UNO depends on ATmega328p (datasheet)and contains 14 digital inputs and outputs pins of which:

6 pins for PMW outputs
6 pins for analog inputs
A 16MHz quartz crystal
A power jack
ICSP reset button
USB connection

Moisture sensor is used to sense the specific resistance of thewater by using two wire probes. RF transmitter and LCD areinterfaced while RF receiver is connected to the microcontroller. This system is user friendly, easy, affordable and can be used for easy navigation (outdoor and indoor) to reach the destinations for visually impaired persons.

In figure 2, the smart stick is an embedded system t h a t contains a pair of ultrasonic sensors which helps in detecting obstacles for blind people from the height of the ground to head i.e 400 cm a head. The presence of water on ground is detected by water sensor. The microcontroller processes the data from water and ultrasonic sensors and then activates buzzer. The power to the circuits is supplied by battery. We get voice alertingand authority peoples get text message also with location. To implement the smart walking stick for visual impairedpeople the flow as shown in figure 2, we can use three IRsensors which can detect the obstacle which is connected tothe power supply and if the sensor will detects the systemthen, it can gave us an voice alerting note then it will bedirectly passes the information message with GPS location to the registered mobile number. And this all will appear onthe LCD display. If the sensor doesn't detect the obstaclethen the loop will be repeated. Here, the water detectingsystem, smoke sensor, and the vibrating sensor will workswith the same process like those all will be connected to thepower supply and it can detects the system which willsensing the each and every detection like smoke sensing,water sensing, and the vibration sensing .The vibrationsensor will gives the alert with a buzzer, the stick will be vibrated and the output will be appeared on the display.Here, we do have an option to record the alerting notes with the recorder. If those all the sensors don't detect then also the loop will be repeated and the processes will continuous as vice versa.

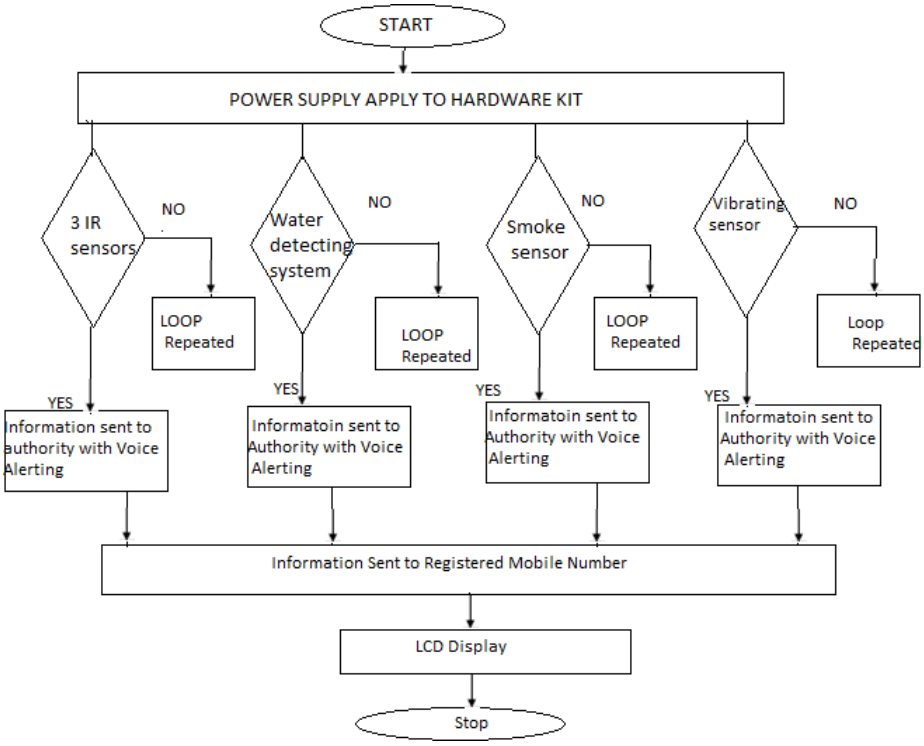

FIGURE 2: IMPLEMENTATION FLOW CHART

4 Results

The system is proposed after observing individuals in a blind school getting trained for the stick walk daily along a path with a helper. The project was initiated after having a conversation with the staff and blind people of that school and collecting indicative miseries and facts of their life. The research in visual disability causing dependent to simple chores paved the way to conduct a survey and improve the available technologies.

If an elder or blind person goes for a walk and suddenly feels ill or difficulty in returning home, the person can intimate the situation to his relatives using an alert button present on the stick. When the button is pressed, the stored mobile number gets the coordinate of stick i.e longitude and latitude of the stick location by GPS, through SMS via GSMmodule (Figure 3 -5)

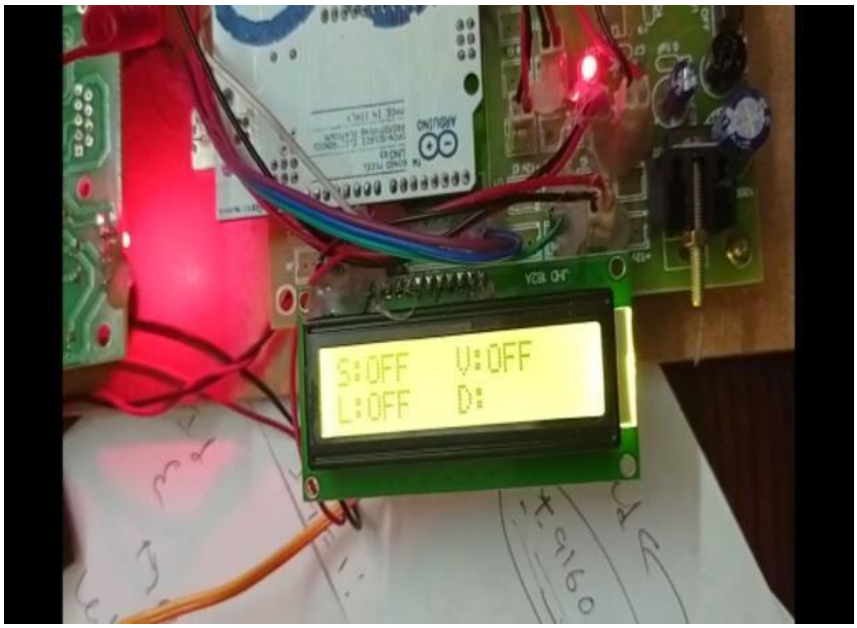

Figure 3. Showing the result of ON and OFF

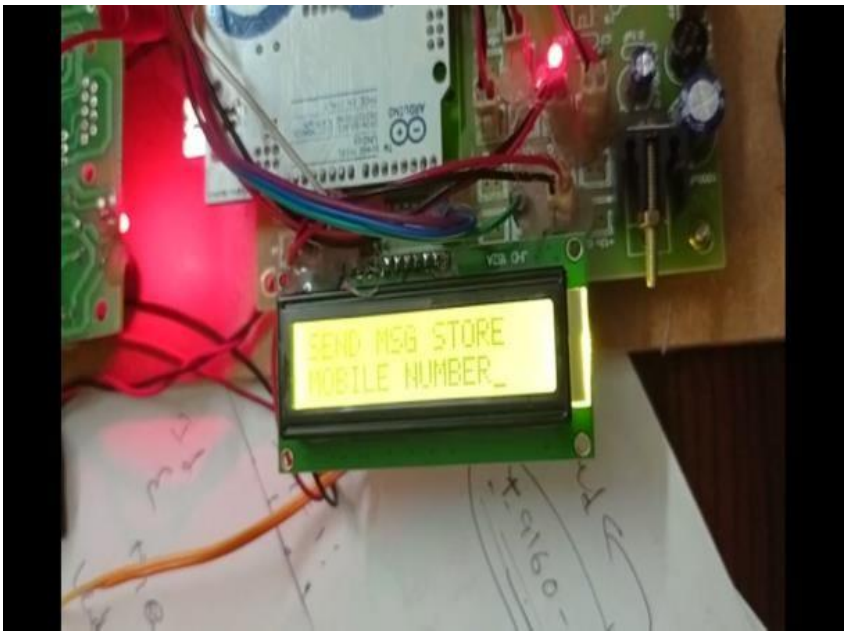

Figure 4.Output showing that the message sending to registeredmobile number

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5 Conclusion

The system has its advantage of supporting care-free, outdoor and indoor navigation and environment to the visually impaired people with moderate budget using a mobile navigation aid. The portable smart stick is comfortable to detect any distant obstacles using voice alerts and also helps to understand vibration patterns. Blind stick is an innovative stick invented for blind people which helps to guide them in reaching their destinations and avoiding any obstacle that came across the user. The existing project doesn't fulfill all the requirements like sensing all the objects. Vision is one of the greatest gifts from god. But now a day's most of the people are suffering from low eye sight.

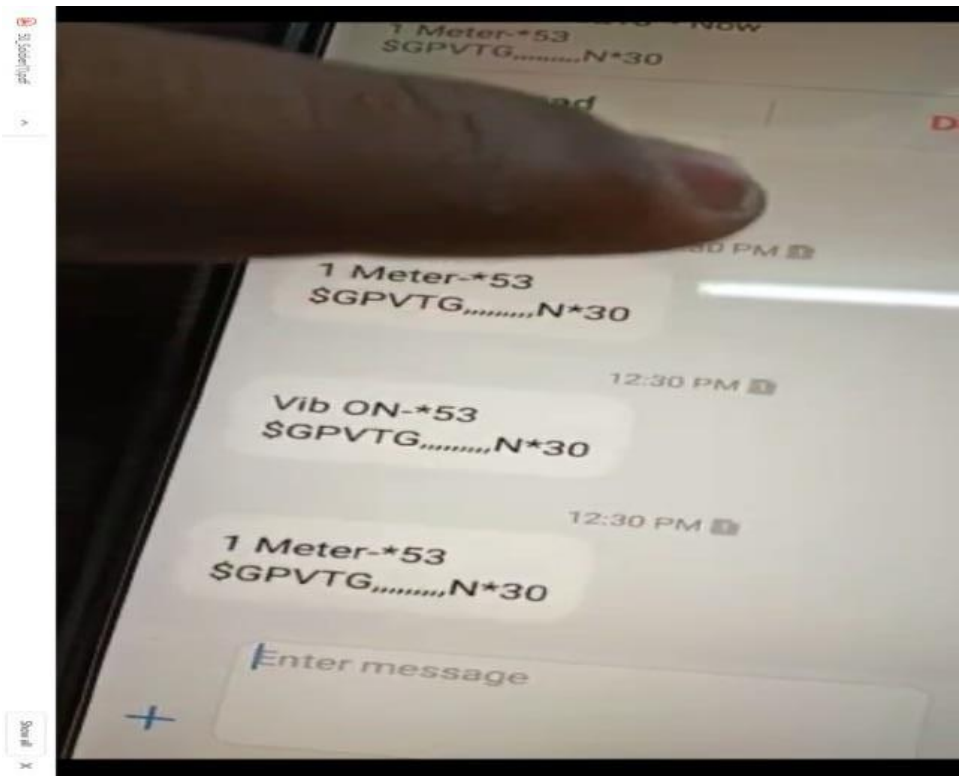

Figure 5. Output results at vibration detected time.

The paper expected the architecture and blueprint of a concept called SMART WALKING STICK for disable and blind people. The system for blind aid explains the artificialvision sense with hollow detection and dedicated obstacle circuitry. A portable and classic device for a blind stick or white cane requires working sub-systems. This system researches on dynamic and static objects effect on the environment by monitoring the time demanding system and gives feedback to develop secure, precise and safe navigation. As an extension, we have additional features in design, testing and implementation stage to this prototype such as sending text message to Hospitals, Police stations (108, 100) and also to loved ones. As of now here we implemented to send text for loved ones but in future we do have a chance to add a sensor to the stick to check the pulse and also with the help of the band attached to the stick and also implementing the water sensing system in rainy seasons also.

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