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Smart Stick for Visually Impaired

[1]Mukesh Bhati,
[1]Department of Computer Engineering,
Dr.D.Y.Patil School of Engineering and Technology
Pune-412105, Maharashtra, India

[2]Shubham Jagtap,
[2]Department of Computer Engineering,
Dr.D.Y.Patil School of Engineering and Technology
Pune-412105, Maharashtra, India

[3]Omkar Bhudhar,
[3]Department of Computer Engineering,
Dr.D.Y.Patil School of Engineering and Technology
Pune-412105, Maharashtra, India

[4]Bajarang Jadhav
[4]Department of Computer Engineering,
Dr.D.Y.Patil School of Engineering and Technology
Pune-412105, Maharashtra, India

Abstract: - Eyes are one of the most precious blessings of nature. Blind friends face a lot of difficulty in doing normal life activities. A lot of work has been done to ease blind people so that they can complete their tasks by themselves and not be able to depend on other people. Keeping this motivation in mind, in this project, we have proposed and developed an intelligent blind stick.

The smart walking stick helps visually challenged people to identify obstacles and provide assistance to reach their destination. There are multiple walking sticks and systems which help the user to move around, indoor and outdoor locations but none of them provide run-time autonomous navigation along with object detection and identification alerts as well as face and voice Recognition. The Stick works based on the technology of IOT, Echolocation, Image Processing, Artificial Intelligence and Navigation system to detect near and distant obstacles for user. If that blind person falls down or any other problem happens means the device will give alert to the authorized person. System uses the Voice recognition to identify near and dear ones.

Keywords:- *Image Processing, Sensors, YOLO, Convolutional Neural Network, Recurrent Neural Network, Optical Character Recognition, GNSS*

I. INTRODUCTION.

Blindness is defined as the state of being sightless in which both eyes suffer from complete loss of vision. The disability is mostly caused by diabetes, macular degeneration, traumatic injuries, infection and glaucoma. World Health Organization has estimated that about 285 million people worldwide are visually impaired; in which 39 million are blind while another 246 million people worldwide are visually impaired; in which 39 million are blind while another 246 million have a low vision. The number of people suffering from loss of sight is increasing dramatically. The Royal National Institute of Blind People (RNIB) has predicted that by 2020, the number of visually impaired in UK will be over 2 million people.

There are many guidance systems existing for blind people. They usually have a special stick or cane which is used by them for their guidance. With the advances of modern technologies many different types of devices are available to support the mobility of visually challenged people. These mobility aids are generally known as Electronic Travel Aids (ETAs). These ETA's are used to detect the obstacles, roads and deliver the information to them also avoid from difficulties faced by them to some extent.

The Blind people face various difficulties in their life. The System that will be developed will help them in following manner.

- Provide features such as object recognition.
- Provides the distance between object and the user.
- Send the message to relatives when in emergency.
- Provide with features ensuring safety and comfort.
- Helping them to overcome all obstacles in their way and live confidently.

II. LITERATURE SURVEY

'Smart cane with range notification' as the name suggests, only the distance between the object and user is calculates and then is communicated to user using earphones. Also a cane is specified which is said to have vibrator for detection .The distance is calculated using Ultrasonic sensor [1].

From this paper we come to know a cane named "Assistor" which uses an image sensor, ultrasonic sensor and navigation system using mobile.But usage of mobile here increases the dependency of user for navigation purposes [2].

The level detection is done by using infrared sensor. It operates by detecting the distance from the target by reflection of an infrared beam. Ultrasonic sensors are used for object detection and GPS is used for SMS services. Although the system is quite perfect but use of vibrators are done which can be quite confusing in chaotic places. Use of GSM with Arduino is bit slow and causes system to work slow [3].

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The task of image sensor is to find what those obstacles are with precision. The image sensor is used to capture the image at regular intervals and recognize the objects. Bluetooth is used with Mobile application, which again increases the dependency of user [4].

Blindar is an ETA (Electronic Travel Aid) developed for blind people. Arduino Mega is used for interfacing the sensors. Also cloud storage Is used here which is a very fine idea, but this requires a high internet connectivity which in some areas isn't strong. [5].

Most of the ETA's use Sensors for their functioning similar to them a water sensor is used here to detect water in the path to avoid slipping by using a buzzer , Also a RF sensor is used to locate the stick if lost anywhere [6].

Bluetooth module is used to send the signals to the user through the mobile phone connected via the module and a speech text to speech converter is used to notify if the value of distance has crossed the set threshold.ahere too, a mobile is used for text to speech conversion, which shows dependency. [7].

AI based Stick is used only for making smart decisions and showing them the correct path and keeping away from obstacles [8].

Using TOF (Time Of Flight) ,the position and angle of sensors on the stick, threshold limit of distances using Ultrasonic Sensor and suitable Algorithms, the distance is calculated of the object[9].

Speech or Voice Recognition technology can be used to implement man-machine communication based on commands or text. It is a key technology in most of man-machine interface Also pattern matching technology can be used. AI plays an important role for decision making aspects [10].

CNN is a concept of Artificial Intelligence which can be used for the operations related to images, like detection of an object in an image, recognition of object, can be used as part for image captioning and many more applications, which would be an important factor for the project[11].

RNN is a concept of Artificial Intelligence which can be used for the operations related to text, like Conversion of a text to Speech, etc., it can be used as part for image captioning and many more applications, which would be an important factor for the project. [12].

TTS is a factor that can be used for Text-To-Speech applications. Various API's are available to fulfil the need of this conversion [13].

III. SYSTEM AND FUNCTIONAL DESCRIPTION

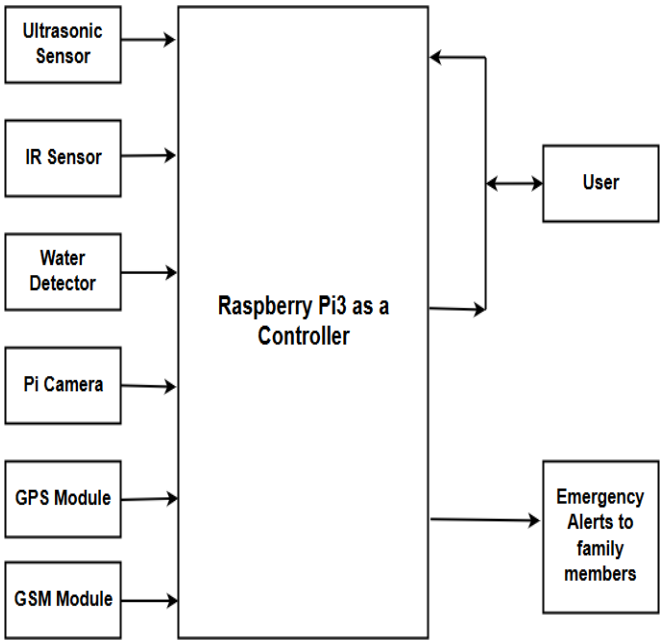

Fig 1:- Block Diagram of Stick.

A. Ultrasonic Sensor:

Ultrasound waves are the waves that audible to human ear. They have frequency greater than 20KHz. Ultra Sonic Sensors are used for detecting the objects or obstacles using these waves, similar to that of SONAR or RADAR.

Laplace's proposed that sound of waves is equal to 343m/s. The function of transducers is to convert the electrical energy to mechanical energy for ultrasonic vibrations.

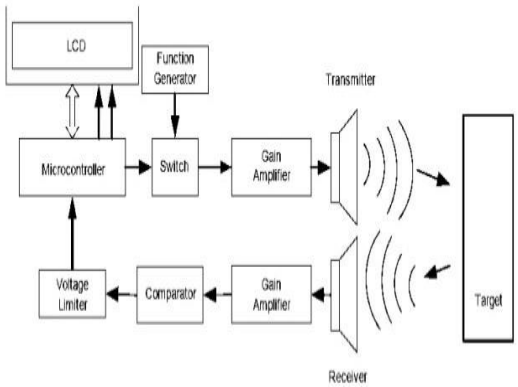

Fig 2:- Working of UltraSonic Sensor

The method used here is the "Pulse Reflection Method" in which we measure the distance between object using the transmitting pulse and the receiving pulse. The relationship between the distance up to the object L and time T can be expressed by

Distance Calculation:

L=0.5*T*C

Where, L=distance, T=time between emission and reception, C= Sonic Speed (343 m/s).
VO = (1+ R3/R2) × VIN

When the intensity of emitter led is high, more energy will fall on detector led and resistance of detector is low, so the value of the potential (VIN) is high. Similarly when the intensity is low, the resistance of the detector is high and so the value of potential is low. This potential is compared with a reference potential. According to these compared potentials the output will be 1 or 0 i.e. 'ON' or 'OFF'.

B. Water Detector:

Water Detector is used to detect the presence of Water and provide an alert to the user. The common device which relies on electrical conductivity of water to decrease the resistance across the two contacts but when the contacts get bridged by water it sounds an audible alarm.

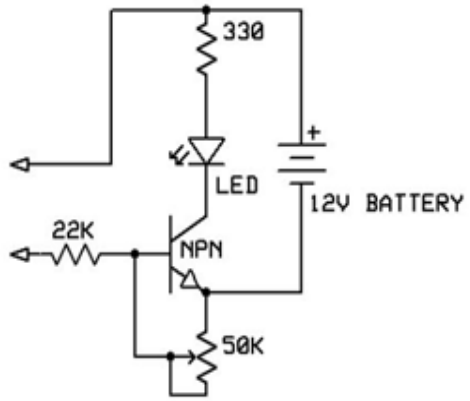

Fig 3:- Working of Water Detector.

C. GNSS (Global Navigation Satellite System):

GNSS is a term for Satellite Navigation Systems that provides autonomous geo-spatial positioning with global coverage. It shows latitude, longitude, altitude, etc. using time signals transmitted by radios from satellites. GPS and GNSS are very different.

Use of GNSS provides user with high accuracy and availability at any time. In case, if any satellite fails or do not work properly, GNSS takes the signal from other satellites.

D. GSM (Global System for Mobile Communication):

GSM (Global System for Mobile communication) is a specialized module for communication purposes. It has a SIM (Subscriber Identity Module), GSM module works on subscription to some network operator. GSM is connected to the Microcontroller for the communication or sending messages purposes. For the operations to get performed, GSM needs "Extended AT Command set" support for sending/receiving messages. The AT commands are sent by the microcontroller to the module. The module sends back an Information Response i.e. the information requested by the action initiated by the AT command. This is followed by a Result Code. The result code tells about the successful execution of that command. Text message may be sent through the module by interfacing only three signals of the serial interface of module with microcontroller i.e., TXD, RXD and GND. In this scheme RTS and CTS signals of serial port interface of GSM Modem are connected with each other.

AT+CMFG command configures the GSM module in text mode. It works in both manual and automatic mode. If the object is too near and it continuously gives the alerts, it sends the messages to the stored mobile number.

E. Raspberry Pi 3as a Microcontroller:

Microcontroller to be used is the Raspberry-Pi, the reasons to choose it as a micro-controller are:

- Practical, Portable, and inexpensive.
- Provide an inbuilt Operating System which makes it easy to get started.
- Built in Wi-fi module, Bluetooth.
- The 2.5 amps Power source to power up more complex USB devices.
- 1GB Memory,400 MHz GPU,4 USB Ports,
- HDMI video output with 3.5mm jack,17 GPIO Pins,4.1v Bluetooth.
- 5V power source, Micro USB or GPIO header.
- Weight: 45 gm, Dimensions: 85.60mm x 56.5mm

IV. SOFTWARE REQUIREMENTS

A. Image Captioning:

Process of converting the input image in the textual description with an artificial system is Image captioning. It is an intermediate step to convert a visual input to the audible output.

Basically it works on two internal Networks, CNN and RNN.CNN(encoder) and RNN(decoder).

A technique called Tiny YOLO is been used in the system.

- *YOLO(You Only Look Once):*

YOLO (You Only Look Once) is a deep learning algorithm which is based on multiple convolutional rounds that has been used in the system for Object detection. It is a superfast, and accurate framework. Unlike the previous CNN models, YOLO works in quite different manner. The CNN wouldn't take the entire image in consideration but only the grids that have the chances of detecting objects. But YOLO considers the entire image and creates the bounding boxes around them and predicts the class probability for these bounding boxes. The boxes are made bold, if the objects have a high probability, and the objects that have the probability above threshold (defined)are displayed, and the remaining are discarded.

Basically tiny YOLO is used in the system, as it is faster than the original one. The reason why it is fast is because it uses only nine convolutional layers whereas, the original version uses 24 convolution layers, hence it is slower than tiny YOLO, but is more accurate compared to tiny YOLO.

➢ *CNN(Convolutional Neural Network):*

CNN is a Network used for image classification. Pretraied CNN would be used to extract the features from the input image, and a feature vector is created. CNN is used for the Image based model[11][12].

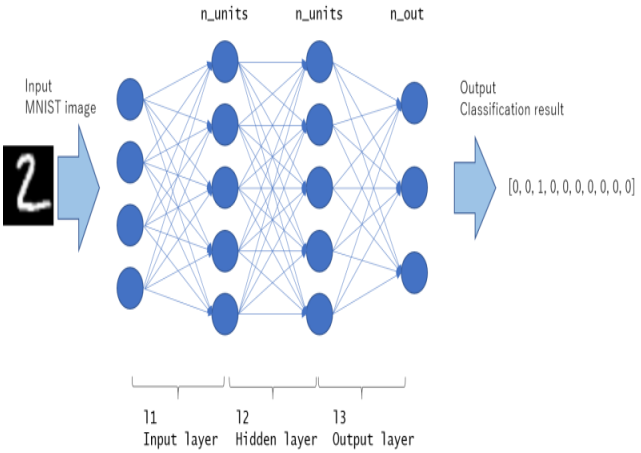

Fig 4:- Working of CNN

➢ *RNN(Recurrent Neural Network):*

RNN is a Network generally used for the text operations.LSTM(Long Short Term Memory) is a model that is to be used in the RNN for our Language based model.[12]

For training the LSTM model, we predefine our label and target text.

E.g: ”A Man and a Horse.” Then our label and target would be:

Label-[<start> A , Man, and , a, Horse, .]
Target-[A , Man, and ,a, Horse,.<end>]

This is done so that our model understands start and end of labelled sequence.

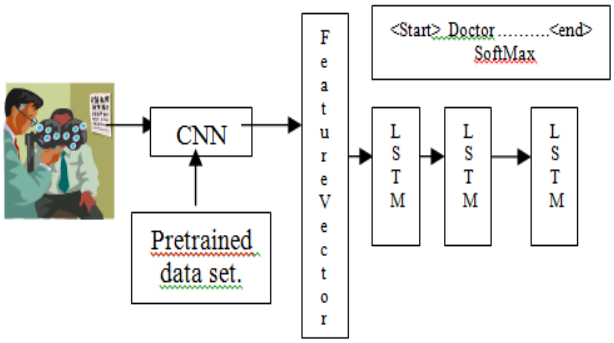

Fig 5:- Working of CNN and RNN Combined

B. Text-to-Speech Conversion:

Speech synthesis is artificial synthesis of human voice. It is the conversion of the coded text to speech. Input given to the module is in text format and output is given in human voice form [13]. gTTS is used for the system. The working is given below:

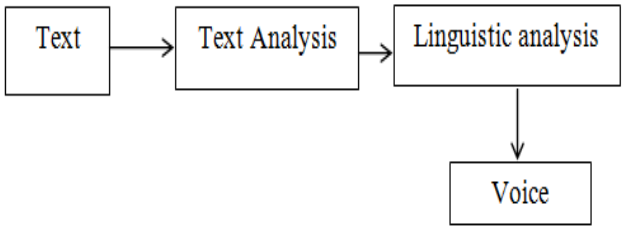

Fig 6:- Working of Text to Speech Module.

C. Speaking the Newspaper:

What if the person wants to read the newspaper? How will it be done here? Researching on this, we found that it is possible to do this using OCR and TTS.

➢ *OCR:*

OCR (Optical Character Recognition) is a widespread used technology, used for recognizing the characters in image or in scanning the text in printed papers, etc. OCR technology is used to convert virtually any kind of images containing the text into machine readable text data.

Once a scanned paper is gone through the OCR processing, the text of the document can be edited with word processors like MS Word or google Docs.

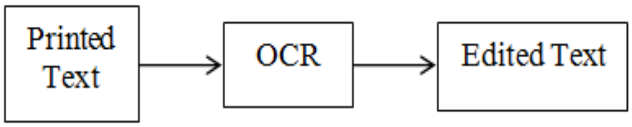

Fig 7:- Working of OCR

➢ *TTS:*

TTS (Text-To-Speech) can be used for converting the edited text to speech. Speech synthesis is artificial synthesis of human voice. It is the conversion of the coded text to speech. Input given to the module is in text format and output is given in human voice form. EMIC-2 text-to-speech module is used for the system. It has 9 different voices and in 2 languages. The working is given below:

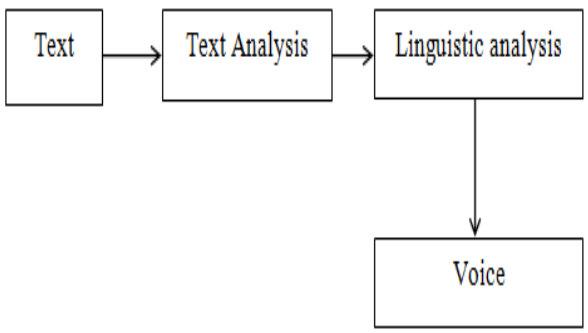

Fig 8:- Combined working steps of OCR and TTS

V. MATHEMATICAL MODEL

Ultra-Sonic sensors use the following calculations for processing the distance calculations.

L=0.5*T*C

Where L is a distance between object and user, T is the time between Emission and Reception, C is the Sound Speed i.e. (343m/s).

Let S be the System
S=Smart stick for visually impaired

- *For Sensors.*

Identify I_s as an input to system from sensors
Identify P as Process to Sensor
$P_{ultrasonic}$ = T, C, 0.5
P_{PIR} = I
Where, T=Time between emission and Reception
C= Speed of sound (343m/sec)
0.5=constant.
I= Intensity with which light is received.
Identify L as output for ultrasonic
$L_{ultrasonic}$= T, C, 0.5
Identify M as output for PIR
M_{PIR} =V
Consider A as case of Success
A=1
1= Voice command to user.
Consider B as case of failure.
B=0
0= Give a Failure message

- *For Image to Speech.*

Identify O as input
O=Q
P=create pattern for objects
Identify Z as process
Z=d, t, o, s
Where,
d= compare the pattern of objects with database
o= using pattern detect the object from database
t=if pattern is new, train to system and save in database
s=Speech Synthesis
S=O,Q
Identify X as output.
X=V
Where V=voice command to user
S=O,Z,X
Consider A as case of Success
A_o=1
1= Voice command to user about Object.
Consider B as case of failure.

B_o=0
0= Give a Failure message.

- *Entire System :*

S=output to system.
$S=P_{Ultrasonic}$, P_{PIR} , O, Z, X

VI. RESULTS AND CONCLUSIONS

The advantage of the device is that they respond to commands much faster and those patients who have lost the ability to have visual skills may utilize them. The main purpose of this project is to design a Integrated System for visually disabled people to move them voluntarily and also help them to have control over it. In this System appropriate values distance calculation, level change, object recognition are taken under consideration with the help of Algorithms, classification techniques and training the System.

The fair Involvement for training the system provide accurate results. To Conclude the system will get all appropriate results as per the requirements with advance capabilities.

FUTURE SCOPE

The robotic shall be further upgraded by removing noise level and duplicates precisely in signal processing and thus focus on additional improvement of the detection of specific object so that, the robotic and home appliances can be controlled accurately without any contradiction.

REFERENCES

[1]. M.F. Saaid, A. M. Mohammad, M. S. A. Megat Ali, “Smart Cane with Range Notification for Blind People”, 2016 IEEE International Conference on Automatic Control and Intelligent Systems (I2CACIS), 22 October 2016
[2]. Akhilesh Krishnan, 2Deepakraj G, 3Nishanth N, 4Dr.K.M.Anandkumar, “Autonomous Walking Stick For The Blind Using Echolocation And Image Processing”, 2016 2nd IEEE International Conference on Contemporary Computing and Informatics (ic3i).
[3]. Kunja Bihari Swain, Rakesh kumar Patnaik, Suchandra Pal, Raja Rajeswari, Aparna Mishra and Charusmita Dash, “ Arduino Based Automated STICK GUIDE for a Visually Impaired Person”, 2017 IEEE International Conference on Smart Technologies and Management for Computing, Communications, Control,Energy and Materials 2-4 August 2017.
[4]. K.Swathi, E.Raja Ismitha, Dr.R.Subhashini, “Smart Walking Stick Using IOT”, International Journal of Innovations & Advancement in Computer Science IJIACS ISSN 2347 – 8616 Volume 6, Issue 11 November 2017.
[5]. Zeeshan Saquib, Vishakha Murari, Suhas N Bhargav, “BlinDar: An Invisible Eye for the Blind People”, 2017 2nd IEEE International Conference On Recent Trends In Electronics Information & Communication Technology, May 19-20, 2017.

[6]. Rashidah Funke Olanrewaju, Muhammad Luqman Azzaki Mohd Radzi, Mariam Rehab, "iWalk: Intelligent Walking Stick for Visually Impaired Subjects", Proc. of the 4th IEEE International Conference on Smart Instrumentation, Measurement and Applications (ICSIMA) 28-30 November 2017.
[7]. Do Ngoc Hung, Vo Minh-Thanh, Nguyen Minh-Triet, Quoc Luong Huy, and Viet Trinh Cuong, "Design and Implementation of Smart Cane for Visually Impaired People", Springer Nature Singapore Pte Ltd. 2018. T. Vo Van et al. (eds.), 6th International Conference on the Development of Biomedical Engineering in Vietnam (BME6).
[8]. Uruba Ali, Hoorain Javed, Rekham Khan, Fouzia Jabeen* and Noreen Akbar, "Intelligent Stick for Blind Friends", International Robotics & Automation Journal(1 – 2018).
[9]. Shashank Chaurasia and K.V.N. Kavitha, "AN ELECTRONIC WALKING STICK FOR BLINDS", IEEE 2014 International Conference on Information Communication & Embedded Systems (ICICES 2014).
[10]. Jianliang Meng, Junwei Zhang,Haoquan Zhao, "Overview of the Speech Recognition Technology", 2012 Fourth International Conference on Computational and Information.
[11]. Wang Zhiqiang, Liu Jun, "A Review of Object Detection based on Convolutional Neural Network", 36th Chinese Control Conference.
[12]. Kaisheng Xu,Hanli Wang, Pengjie Tang "Image captioning with deep LSTM based on sequential residual", IEEE International Conference on Multimedia and Expo(ICME) 2017.
[13]. Michael H. O'Malley, "Text to Speech Synthesis System in Indian English",2016 IEEE Region Ten Conference(TENCON),2016.