Artificial Intelligence based Visualization Device*

Sarvesh Araballi[1], Akshitha A[2], Geetha G[3], Deepika M[4], Ranjith[5]

[1-5]*Department of Electrical and Electronics Engineering, Sri Venkateshwara College of Engineering,* Bengaluru, India

---

***Abstract*—** In this rapid moving world visually impaired people are left deprived because of their dependency. As they are unable to lead a normal daily life and require some or other assistance. There are already few systems which provide some level of mobility comfort but are limited in providing sufficient information about the surroundings. So the device we propose is an Artificial Intelligence based visualization device which helps visually impaired by voice assisting the information of their surroundings. The device uses Raspberry pi, camera module, Artificial Intelligence technology and few sensors. The device is portable and purpose of its usage is to warn the user when the objects are present on the walking path so bumping into obstacle can be avoided. There are two modes in this device, the first mode is object detection mode where in the characteristic of the object and distance of the object from the device is announced through the audio. The second mode is optical character recognition where in it accepts a page of printed text and the software text to speech converts it into audio and is rendered to the user through earphones or speaker. As there is a GPS sensor in the device the current location of the user can be tracked by the guardian or caretaker through local IP address. This device is wore using a tag or a expandable belt which is user friendly. The proposed device is affordable, compact, easy to carry and comfortable to use.

Keywords—visually impaired, Artificial Intelligence, object detection, optical character recognition (OCR), location tracking.

1. INTRODUCTION

According to the „WHO" (World Health Organization) the estimated number of visually impaired people in the world are about 285 million, 39 million are blind and 246 million having low vision. In this fast moving world, the life of the visually impaired people is full of risk. People with visual disability have a constant need of assistance; they face difficulties to be independent in their daily tasks. Sometimes it's difficult to track the location of the visually impaired people.

In order to provide convenient daily life and to be independent, assistance is needed. There are many solutions which provide some degree of assistance. One of the method is orientation and mobility, in this someone helps the visually impaired people and also trains them to move on their own. "Artificial Intelligence" technology is getting more and more attention nowadays. This paper proposes a portable electronic assistive device based on "Artificial Intelligence" technology. This device contains different sensors, such as IR sensor and ultrasonic sensors for distance measurement of the object, camera module takes the video stream and analyze the image using Tensorflow. Raspberry Pi a small computer which processes all the sensor data and provides the information about the surroundings through earphone. This device contains two modes, OCR (Optical Character Recognition) mode, which converts text document into audio and Object Detection mode, which gives the exact characteristics and distance of the object. It also contains GPS module, which helps in tracking the location of the visually impaired people. All the three functions are carried out in one portable device.

2. *Related Work*

In the recent years many technologies have been implemented in developing an electronic devices and smartphone applications. The research deals in providing a smart assistive device for both blind and visually impaired people. A simple, cheap, friendly user smart stick is designed in [1]. The designed model helps in improving the mobility and navigate alone to avoid bumping into obstacles using RFID technology.

The assistive tool is developed to operate the digital devices by the visually impaired people, which help in implementing digital information while working, learning and living. The digital information is converted into text and then to audio by using TTS (Text-To-Speech), this helps the visually impaired people to handle digital devices. Focusing on the design an assistive system is developed using smart phones in [2]. The Voice Helper includes the text file reader, message reader, voice dialer, and OCR reader to make ease in their daily activities. Navigation Reader helps visually disabled people in walking and running based on Google Maps

Stick is the main tool for the blind which must be cost effective. Loss of stick may result in mislead of their walking path. To overcome such instances our paper focused on designing a portable device. The Artificial Intelligence and various sensors are used in developing a smart assistive system. The system performs three operations such as obstacle detection, collision detection and image recognition in [3]. Image recognition operation is performed using Artificial Intelligence based smart phone application. Ultrasonic sensor is used for obstacle and collision detection.

Smart assistive system for visually impaired people based on microcontroller. The system involves the haptic and audio feedback. The system is controlled by the Smart Phone with a predefined audio commands and Bluetooth connectivity in [4]. The main purpose of the device is to warn blind and visually impaired people to avoid collision with the objects in their walking path. Microcontroller process the data provided by the ultrasonic sensor.

Android based Voice Command Device (VCD) is a universal voice control solution for a non-visual to operate Android operating system [5]. Voice Command Device contributes two systems. First, in an Android Voice Control is enabled which is suitable to any application. It builds set of available commands according to the application. Second, with the help of multiple audio commands provides

a natural and more efficient interaction for the blind and visually disabled people.

There are few assisting systems based on RFID technology. However the RFID technology is not applicable in outdoor applications. In order to help blind and visually disabled people in their mobility. The embedded electronic device is designed using Sonar sensor, IR sensor and camera as in [6]. The signals of all the sensors reflected to microcontroller to identify the front objects. A research dealt with converting an image into an alternate rendering modality in [7]. The alternating modalities can be either haptic, auditory or combination of both. Therefore the alternate modality can help the blind user. Many researcher's proposed different systems using different hardware and technologies to provide a compatible life to the visually impaired people. This paper aims in providing a more comfortable life by assisting them about their surroundings.

3. METHODOLOGY

This paper presents a portable device called Artificial Intelligence based visualization device. Artificial Intelligence plays a vital role in directing the visually impaired people by explaining them about their surroundings through speakers or earphone. The whole system is processed by the Raspberry-Pi. Raspberry-pi has the inherent to access the system with the inbuilt SD card. Python programming language is widely used to program the entire system which helps in communicating all the sensors that are interfaced with Raspberry-Pi and it also contains machine learning supporting libraries.

The system requires following Hardware and Software components.

Hardware Components:

i. Raspberry-Pi Model B+
ii. 8MP Camera
iii. HC-05 Ultrasonic Sensor
iv. IR Module
v. GPS Module
vi. 3.6V, 20amps 3.2AH Battery
vii. Speaker/earphone

Software components:

- Jupyter Notebook – Development environment
- Python – Programming language
- TensorFlow – Machine Learning framework

i. Raspberry-pi 3 Model B+

Raspberry-Pi 3 Model B+ is a 64-bit Quad core processor running at 1.4GHz, dual-band 2.4GHz and 5GHz wireless LAN, memory of 1GB RAM with the storage of 64-bit. It is a "Single Board Computer" which works similar to the general-purpose computer such as desktop and laptop, hence it requires Operating System to work. Raspberry supports Linux OS and raspbian OS, which can be installed. Along with the OS it also requires monitor, keyboard and mouse to operate the OS initially, which can increase the cost of the system. The solution for this is „Headless" computer, one that operates without monitor, keyboard and mouse. Once the „headless installation" is done, Raspberry-Pi can be operated remotely by the host computer. This supports python programming language.

ii. Camera

8 MP (resolution size = 3456*2304) camera is which is interfaced to Raspberry-pi through CSI (Camera Serial Interface). Camera sends video signals to the Raspberry-pi and further process will be done by program.

iii. Ultrasonic Sensor

It is used for measuring distance of object in "centimeter". The distance is measured using sound waves. It emits the sound waves at certain frequency and wait for the sound wave to bounce back. The distance is calculated by the interval of the emission and receiver. Its range is about 3cm to 300cm. Interfaced through GPIO and output is in terms of pulse width.

iv. IR Sensor

It is used for obstacle detection and warns through audio. It is done by emitting or detecting an infrared radiation. It is interfaced through GPIO and output is digital "HIGH".

v. Global Position System (GPS) Module

It is satellite based navigation system. It is used for location tracking, interfaced through UART/USB and output is in NEMA format.

vi. Battery

For powering all the device 3.6V battery is required, average power consumption of the total device is around 1Amps. If 3000 mAh battery is used then the device will be stable for 3 hours continuously.

vii. Boost converter

It is a DC-DC converter with an output voltage greater than the input Voltage. Raspberry-pi require input voltage of 5V, but the output voltage of the battery is 3.6V. However to boost up the voltage boost converter is required.

The basic block diagram and pin diagram is shown in the Fig. 1 and Fig. 2 respectively. The main processor Raspberry-Pi is interfaced with ultrasonic sensor, IR sensor, camera, GPS module, battery, boost converter, earphones

4. Implementation

i. Object detection (exact characteristics and distance is determined).
ii. Optical character Recognition (converts the text document into audio)
iii. Navigation (tracking the current location of the user)

i. Object detection

Images are captured continuously through camera and it is sent to Raspberry-Pi. Raspberry-Pi accesses the data using Artificial Intelligence. Artificial Intelligence is a branch of Computer Science creating an intelligent machine to learn and think like Humans. Object detection can be achieved using Computer Vision and Machine Learning. Machine learning and Computer Vision are closely related in the field of Artificial Intelligence as shown in Fig. 3 Computer vision allows the system to understand and label the images. The labeled images are further processed by Image processing. This performs some operation on an image. In order to obtain an enhanced image or to extract some useful information from the image. Computer vision libraries contain computer image processing functions and algorithms. Here we use Open CV which is an open source library that provides hundreds of machine learning algorithms. Open CV includes number of modules such as an image processing module, machine learning module and object detection module.

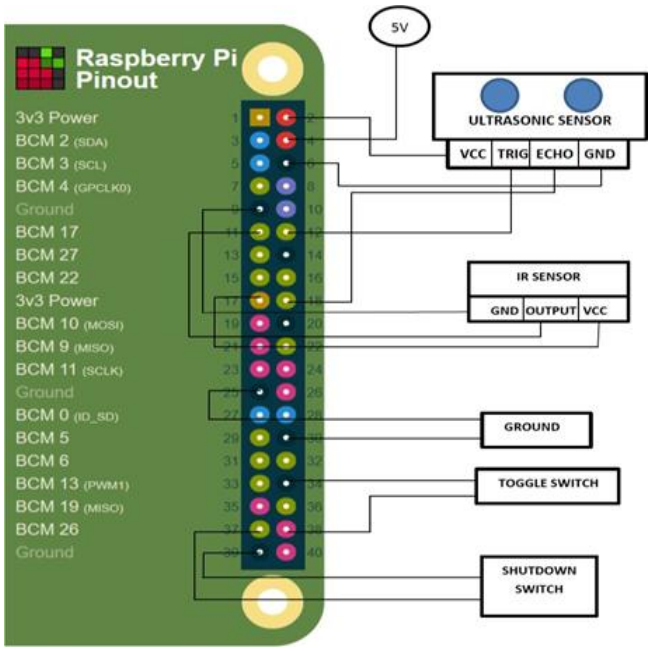

Fig. 2 - Pin diagram of the system

Machine Learning allows to effectively train the context for a data set. The open source tensor flow frame work is used to create a Deep Learning model. Deep Learning is the subset of Machine Learning that process the data and helps in making decisions using neural networks. Object Recognition using Deep Learning does not need specially defined features. The common approach to use Deep Learning is based on Convolution Neural network. A Convolution neural network is a type of deep neural network which is an artificial neural network with multiple layers between the input and the output i.e., hidden layer as shown in Figure 4. Each layer is made up of a group of neurons. The artificial neural networks send the input through different layer of network, where each network defines the specific feature of the image. First layer detects the high level patterns like rough edges and curves. As the network performs more convolutions it will identify the specific objects like faces and animals as shown in Figure. 5. The predicted object is in the "ASCII-Text" format; this will be converted into "audio" using TTS (Text-To-Speech) synthesis and played through speakers or earphones.

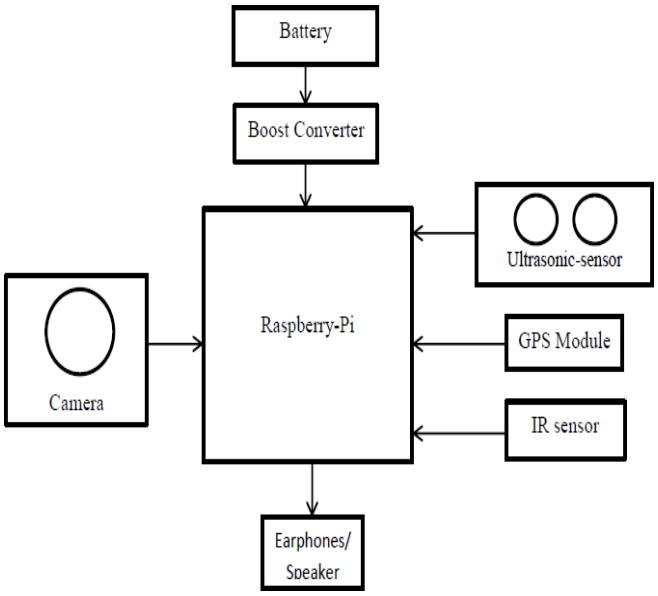

Fig. 1 - Block diagram of the system

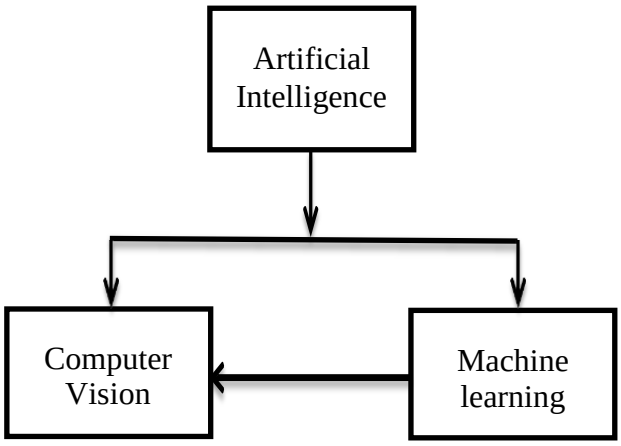

Fig. 3 - Overview of the relationship of Artificial Intelligence and computer vision

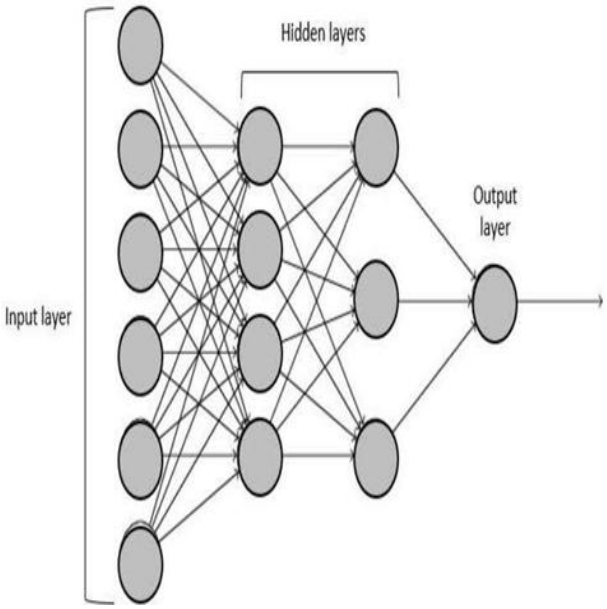

Fig. 4 - Overview of an artificial neural network

ii. Optical character recognition

Optical character recognition uses Artificial Intelligence for text search and its recognition of images, which is captured through camera. It finds templates in pixels, words, letters and sentences. Here Open CV is used to capture the text image and recognize the character. Tessaract is an open source library is used for the optical character recognition. The detected character is in text format that is converted into audio using TTS (text to speech) engine.

iii. Navigation

The current location of the visually impaired people is tracked by the care taker using GPS (Global Positioning System) module through Web application. The GPS module, manipulates the data and fetches the location coordinates (latitude and longitude).

Python programming language is used to program the whole system, following is the flowchart of the whole system as shown in Figure 6.

The camera captures the images continuously and it is sent to Raspberry-Pi. The Raspberry-Pi process the system using Artificial Intelligence with suitable programming language i.e., Python. In Artificial Intelligence Computer Vision and

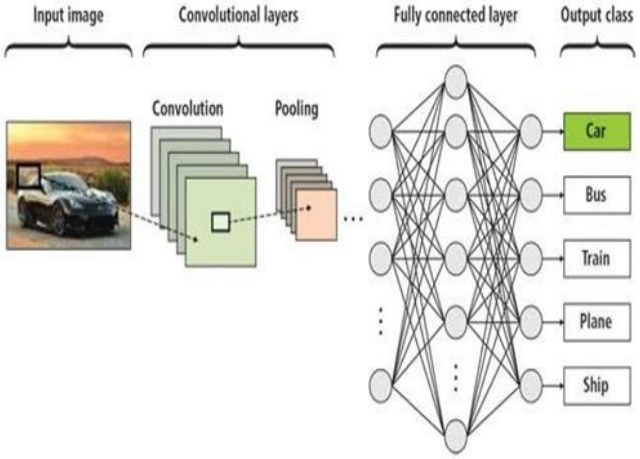

Fig. 5 - Example of a convolution neural network

Deep Learning is used with supporting libraries such as Open CV, Tensorflow (Object Detection) and Tessaract (Optical Character Recognition). The IR sensor is used for the fast response of obstacle detection. Ultrasonic sensor is used for measurement of an object in centimeters. The obtained data is converted into audio using TTS (Text-to-Speech) engine. The audio is played through speakers or earphone. The GPS is interfaced with Raspberry-pi to track the current location of the user.

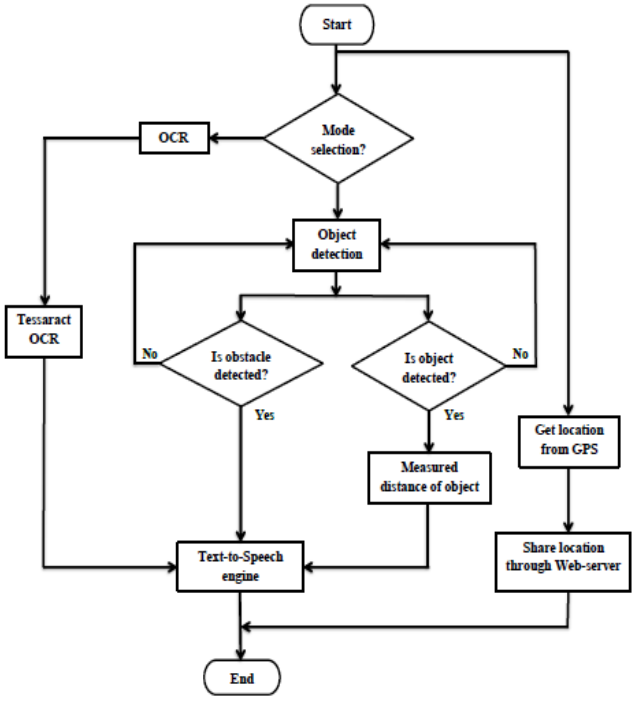

Fig. 6 - Flow Chart

5. Results

The circuit is built in a clear manner to preform without any interruptions. The circuit connections inside the device are shown below in Fig 7. The main objective of the system is to assist the visually disabled.

1) Object detection

If the blind person moves around with the device, the device detects the obstacle with the help of IR sensor and this gives the alert about the obstacle to the person. If the obstacle is very near then the command "STOP" is fed with in the device, which helps the person to stop and escape from danger. Object detection is the main objective. This device repeatedly detects the object through the camera. The captured images are labelled by CV and further processed IP as shown in Fig. 8. When the object is detected the distance is measured through ultrasonic sensor and characteristic of the object which is obtained with the help of CNN algorithm is announced to the user through audio message. The sample of the obstacle detection with its range is shown in the Table I.

2) Object Character Recognition (OCR)

The OCR mode has the capability of recognizing the printed text data.This mode helps the blind community to read the books, newspapers etc. Which gives them a hearable environment. This helps them to be independent in their daily walk of their life.

Fig. 7- Circuit Connections

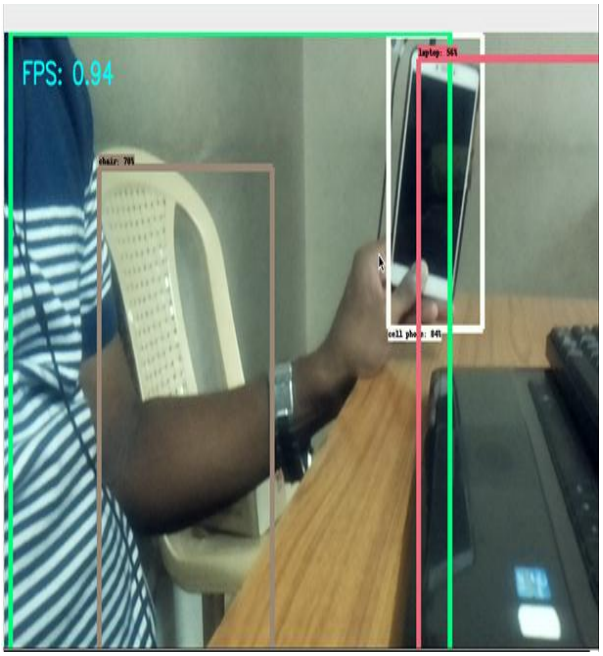

Fig. 8- Object Detection output Frame

TABLE I: OBSTACLE WITH DISTANCE

Obstacle	Distance in cm
Bottle	60 cm
Phone	120 cm
Vase	135 cm
Laptop	145 cm
Dog	150 cm
Bus	220 cm

3) Location Tracking:

The location of the user can be tracked through GPS Module and this information can be served to the guardian or caretaker of the visually impaired people. Location tracking plays a very important role in safety of the user. If the person or device is lost somewhere it can be tracked easily through GPS .

6. CONCLUSION

The main motto behind this idea is to help visually impaired in their daily life. In this advanced world, the blind community faces many challenges. As there are many medical technologies which is not affordable by everyone. They have problems in identifying objects, have no idea about the obstacles in front of them and may sometimes bump into obstacle. They have difficulties in every aspect of life. This paper explains about "Artificial Intelligence based development by building up self-confidence and hence versatile life. This device contains two modes which can be changed accordingly. The two modes are object detection and OCR (Optical character recognition).The object detection detects the obstacles and warns through audio to make sure that the person doesn't bump into obstacle and it recognizes the characteristics and distance of the objects. Optical character recognition helps the user to read the

printed text. Location tracking helps in tracking the location of the user by the caretaker or guardian.

7. References

[1] Ashwini B Yadav, Leena Bindal, Namhakumar V. U, Namitha K and Harsha H "Design and Development of Smart assistive device for visually impaired people", 978-1-5090-0774-5/16/$31.00 © 2016 IEEE.

[2] Kuei-Chun Liu[1], Ching-Hung Wu[1], Shau-Yin Tseng[1] and Yin- Te Tsai[2] "Voice Helper: A Mobile Assistive system for Visually Impaired", 978-1-5090-0154-5/15 $31.00 © 2015 IEEE

[3] Sandesh Chinchole, Samir Patel "Artificial Intelligence and Sensors based Assistive system for Visually Impaired People", [2017] IEEE Xplore Compliant - Part Number:CFP17M19-ART, ISBN:978-1-5386-1959-9/17.

[4] D. Munteanu, R. Ioneal, "Voice-Controlled Smart Assistive Device for Visually Impaired Individuals", [2016] ISBN 978-1-5090-3748-3/16.

[5] Aditi Bhalerao[1], Samira Bhilare[2], Anagha Bondade[3], Monal Shingade[4] and Aradhana Deshmukh[5] "Smart Voice Assistance: a universal voce control solution for non-visual access to Android operating system" IRJET, vol. 04, pp.1713-1720, Jan-2017.

[6] Samartha Koharwal, Samer Bani Awwad and Aparna Vyakaranam "Navigation System for Blind-Third Eye" IJITEE, vol. 08, pp.1086-1093, March 2019.

[7] Ashwani Kumar[1] and Ankush Chourasia[2] "Blind NavigationSystem Using Artificial Intelligence" IRJET, vol. 05, pp. 601-605, March 2018.