IoT - based Sustained Belt for Visually Impaired People

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Abstract. This paper is an IoT based Sustained Belt for Visually impaired people, which uses Raspberry Pi for image identification and image processing techniques to help a blind person to identify and rectify people and things in front of them and help them navigate everyday life and have a better lifestyle like any other common man. The key techniques that will be used are real-time images and object recognition as well as image processing. First would be an image, object recognition is to capture the image and then rectify the image, rectifying the image is done through image processing and then the rectified image is converted as audio output. The scope of this paper is to scale up a level where a blind person has a normal lifestyle, just like any other normal person, right without hustles or anything and as well as they can use this as his adjacent person, where this has inbuilt GPS and it is a mini computer as well it can be also useful for general questions, usually blind people when they can't see things they have a lot of questions and be curious, it will be easier to know about them. What differentiates our paper from usual blind people's normal stick is that the stick helps them not to crash anything but we are not focused on that, what we focused on is to have a very normal lifestyle like normal person

1 Introduction

A physical disability called blindness prevents a person from being able to see anything. It also describes an ocular defect that is undefinable by any other simple methods. Limited or incomplete optic power is suggested by fragmented optic insufficiency. Complete loss of vision implies that there is nothing to view. Visual impairment is a major type of incapacity affecting many people globally. It is also one of the most severe disabilities.

People who are entirely blind or have issues with visual perception are said to be visually impaired. Visually challenged people face several difficulties in their regular responsibilities. People with poor vision have difficulty navigating and cannot move around easily in familiar or strange environment. In order to know whether they are traveling in the right route, whether they will run into obstacles, whether there is water in their way, etc., they need assistance. It is possible to view the quick advancements in hardware and software technology as advantages in the form of barriers. For persons who are blind or visually challenged, navigating metropolitan areas or complex situations can be challenging

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without human aid. They frequently use a cane or a guide dog to get around on their own. A smart device should make it simpler for a blind person to navigate the city on a regular basis. We recommend a method that can be quite helpful for those who are blind and uses a sustained belt. Tools that can be employed include image processing and real-time object and picture recognition. Images are taken using object recognition, rectified using image processing and output as audio.

2 Literature survey

Universally, smart devices replaced the conservative devices in every field. Smart devices are a hybrid of sensors and network aimed to work without human intervention. The transmission of data to and fro decides the time and the method to accomplish a work. Such smart devices transmit data and accomplish the work without any manual intervention is termed as Internet of Things (IoT) [10]. Providing security in Internet of Things (IoTs) devices is a critical and an essential issue to solve for winning trust among people and organisations. The application data of Internet of Things (IoTs) could be industrial, enterprise, consumer or personal [8] and [9]. The smart stick was created and put into use by researchers Radhika and team [1] for navigating and avoiding obstacles. Along with GPS and GSM components, their system includes water, ultrasonic, and infrared sensors. The GSM module alerts those who are blind or visually challenged to potential danger while the GPS module offers position and navigational information. An Arduino Uno micro controller board (ATmega328P) is used in the system, which is powered by a rechargeable battery. Emergency calls are made possible by the GSM/GPRS module of the smart stick, and the GPS module aids in discovering new locations. The stick generates louder alerts as it gets closer to an obstruction, and Bluetooth headphones play the corresponding auditory alerts. An extended service life is guaranteed by the rechargeable battery. The suggested approach can find concealed barriers such as holes and stairs. One disadvantage is that the stick is difficult to keep in place because it does not collapse. Information of state and health of equipment can be communicated to systems and people using IoT [13] and [14].

A "smart walker" was put into use by researchers Sheth and team [2]. We suggest a highly practical and cost-effective "smart white cane" as a walking aid. They suggest using a stick that can detect impediments and give blind people freedom of movement. APR33a3 sound IC, four HC-SR04 ultrasonic sensor modules, an ATMega328PU micro controller, a vibration motor, headphones, and a battery were all used to construct the system. Response from the audio. Their strategy notifies customers by using pre-recorded sound notifications and physical feedback in the form of vibrations. The stick has the ability to identify low, knee-high, and even waist-high impediments, as well as holes, potholes, drops, stairs (up and down), and other obstructions. The cost of blind navigational aids is low. The whole circuitry and battery compartment are concealed inside the stick, which reduces bulk and circuitry damage. A system on the handle provides an audio jack, an on/off button, and vibration feedback.

Roopashree and team [3] as a conceptual model and theoretical framework for helping those who are visually impaired. Object identification, artificial vision, and emergency messaging are the system's main priorities. Ultrasonic sensors are used to gauge the distances between obstacles, beeping audibly to direct people down clear paths. GPS and GSM technologies can find the blind individual in an emergency and send their whereabouts to family members. Two speakers, an Arduino Mega Board ATmega2560, ultrasonic and infrared sensors, GPS and GSM modules, and more make up the hardware. For exact measurements, the stick has sensitive and precise sensors. The technology enables emergency communication and assistance for those who are blind by utilizing GPS and

GSM. The envisioned smart stick offers and creative approach to help the blind navigate their environment and maintain their safety.

In the paper [4], a mobility aid for the blind is demonstrated. The suggested stick has an AT89C52 microprocessor that houses a particular detecting sensor that receives, analyses, and transmits signals to the alarm system. The technology was created by a blind person and has undergone thorough testing for accuracy. Ultrasonic sensors, water sensors, light-dependent resistors (LDR), and an alarm are included in the hardware. These walking aids are comfortable for those who are blind and are easily accessible, trustworthy, and user-friendly. Obstacles are detected by ultrasonic sensors, slick surfaces are detected by water sensors, and LDRs can identify darkness. To distinguish between various sensors, a distinctive sound pattern is used, which improves usability and functionality. A way to increase safety and navigation. Gayathri and team suggested a solution utilizing a straightforward walking stick outfitted with sensors is suggested. To aid in route selection, the system uses GPS technology with pre-programmed locations. A PIC16F877A micro controller, an ultrasonic sensor, a pit sensor, a water sensor, a GPS receiver, and numerous output devices are included in the hardware. For those who are blind, the device gives real-time ambient data that simulates artificial vision. Evaluation tests showed that the capabilities for localizing and detecting obstacles were successful. The suggested method attempts to give visually impaired people an accessible and useful navigational aid, improving their mobility and independence. The intelligent object recognises obstacles and provides position data. A walking stick is a useful tool for increased safety and navigation. To develop a reliable and accurate ultrasonic sensor-based obstacle detection system that can detect obstacles by using ultrasonic sensors [8]. An ultrasonic sensor module, HC-SR04 is used for obstacle detection in the path of the blind person and a buzzer is used to make the person alert [12].

A smart walking stick for people with visual impairments is proposed by Gbenga and team [6] utilizing ultrasonic sensors and an Arduino micro controller. The goal is to develop a lightweight, inexpensive device that can detect obstructions and warn the user audibly. During testing, the system demonstrated precise 2-meter-range obstacle detection. With the help of this technology, visually impaired people will be more independent and supported in their daily lives. An Arduino micro controller, LCD screen, RF transmitter, ultrasonic sensor, and humidity sensor are all components of the system. The ultrasonic sensor locates obstructions up to 400 cm in front, while the humidity sensor locates water on the ground. After analysing the sensor data, the system sounds an alarm with a buzzer to the user. This suggestion offers a practical and affordable way to assist the blind in navigating and staying safe. To use the OLED sensor to display the name of the gesture made by the user [11].

Ahmmed and team [7] as a low-cost electronic guidance device for those who are blind or visually impaired. The system makes use of a smartphone, sensor, micro controller, Bluetooth module, and micro controller. It provides continuous directional guidance and accurately detects obstruction up to 100 cm distant. Two ultrasonic sensors identify the user's front and back obstacles, and a water detection sensor determines whether there is any water nearby. The user can be warned of obstacles using auditory warning devices like buzzers and sound alarms. The system consists of three modules: a sensor module, a communication module, and a smartphone component. Security and mobility are intended to be improved by the Blind Shoe system.

3 Proposed method

Problem Statement: Blind people often face difficulty in identifying objects around them which can hinder their daily activities. Wearable devices that use sensors to detect objects are available but they are limited in their functionality. A sustained belt for blind people that uses real-time object detection with the help of a Raspberry Pi[2] and a webcam, and provides audio output to the user is proposed. The system is portable, easy to use, and capable of detecting a wide variety of objects. Blind persons often struggle to recognize the objects around them, which can make daily tasks more difficult. The functionality of current technologies, such as wearable gadgets that use sensors to find objects, is constrained. The suggested solution is to create a belt for blind persons that employs webcam and Raspberry Pi real-time object detection and outputs audio to the user.

These are the methodologies adopted to fulfill the objective of a Smart Belt, this is the following steps are taken:

- Define the objective: define the objective of the Smart Belt [1] clearly, such as understanding the surroundings and environment or the nature of use the device.
- Capturing Image from surroundings: we use a camera for image capturing which is further used for image processing.
- Image Processing: In this process, the raw image which is collected is the used to image processing which then is used to object recognition.
- Object Detection: Once the image is completed its processing part then we use the images detect the object present in it and the object present are recognized.
- Evaluate of Object using per-trained Dataset's: Evaluate the object identification done using the rectification of the object recognized using pre-trained dataset's to the raspberry pi to recognition of object.
- Conversion of rectified image to audio output: Once the objects in the image are rectified and recognized using the dataset's from the image processing the raspberry pi is used to convert the obtained output to and audio output.

Overall, IoT based Smart Belt for visually impaired people requires a combination of Image preprocessing, implementation technique and audio conversion to achieve the desired objective of creating an IoT device of smart belt which helps for the visually impaired person for day to day life.

3.1 Objective of the paper

The scope of this paper is to scale up to a level where a blind person has a normal lifestyle, just like any other normal person right without hustles or anything and as well as they can use this as his adjacent person, where this has inbuilt GPS and it is a mini computer as well it can be also useful for general questions right usually blind people when that can't see things they have a lot of questions and be curious it will be easier to know about them. And what different our paper from usual blind people normal stick is that stick helps that not to crash anything but we are not focused on them not crashing to any object, we what focused on is they have very normal life style how a normal person would have.

- To develop a sustained belt for blind people that can detect objects in real-time.
- To provide an audio output to the user indicating the detected object.
- To make the system portable and easy to use.
- To develop an object detection system that can identify a wide variety of objects.

3.2 Architecture diagram

Raspberry Pi: The Raspberry Pi [1] is a low-cost, single-board computer that serves as the main processing unit for the system. The Raspberry Pi serves as the main processing unit for the system. It runs the object detection model and plays the audio output to the user. This is the main part of the IoT device.

Webcam: The webcam is used to capture real-time images of the surroundings and pass them to the object detection module. The webcam captures real-time images of the surroundings and passes them to the object detection module. YOLOv4: YOLOv4 is a state-of-the-art object detection model that is used to detect objects in the images captured by the webcam. YOLOv4 is a state-of-the-art object detection model that is used to detect objects in the images captured by the webcam.

Speaker: The speaker is used to provide an audio output to the user indicating the detected object. The speaker plays the audio output to the user indicating the detected object. The speaker can either be connected through the GPIO ports or through the Bluetooth enablement in the device of raspberry Pi. The procedure it follows it by starting the instrument the camera starts capturing real time images of the surroundings which then using the YOLOv4 is used for image processing and object detection which then using the Pyaudio is converted to the audio format for the output to the user through speakers or audio devices connected through the GPIOs or the Bluetooth enabled by the raspberry Pi device.

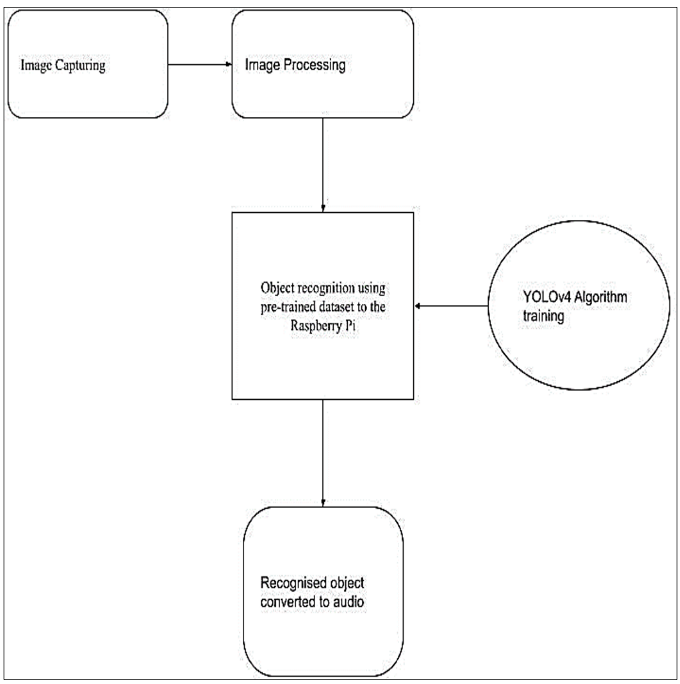

Fig. 1. Architecture diagram.

3.2.1 Image capturing using webcam

Visual tasks are not able to be completed by blind people. For instance, reading text necessitates the use of a computerized speech synthesizer or a braille reading system. Braille and audio versions are not commonly found in printed works that have been released, and digital versions are still uncommon. On the other hand, blind people cannot interpret the straightforward signs or cautions that are all around us. Therefore, there is a lot of promise and value in developing an IOT belt application that can do picture to speech conversion, whether the text is written on a wall, a piece of paper, or another support. Applications including video surveillance, medical imaging, robotics, and augmented reality frequently use real-time picture capture. A camera or other image-capturing equipment is used to capture picture or video frames, which are subsequently processed in real-time to draw out pertinent information, spot items or patterns, and inform decisions.

3.2.2 Image processing using opencv library in raspberry pi

The image-capturing equipment must be able to collect and transmit images at a fast rate, commonly measured in frames per second (fps), in order to enable real-time image capture. To ensure real-time performance, the processing system also needs to be able to process the data at a similar rate. A well-known open-source library for computer vision and image processing applications is called Open CV (Open Source Computer Vision). It offers a wide range of features and resources for computer vision applications like object detection, facial recognition, and image processing. Popular single-board computers like the Raspberry Pi can be used for a variety of tasks, including computer vision and machine learning. Pretrained models for a variety of applications, including object identification, facial recognition, and speech recognition, are readily available for use with Raspberry Pi. Using well-known machine learning frameworks like TensorFlow and PyTorch, this model can be used for tasks like object detection and image categorization and is simple to integrate into Raspberry Pi. Another popular pretrained model that can be used with Raspberry Pi is the Open CV library, which provides a range of computer vision algorithms and functions that can be used for tasks such as image processing, object detection, and facial recognition. Open CV has been optimized for use with Raspberry Pi, and can be easily installed and used in python-based.

3.2.3 Object recognition using yolo v4 pertained set

Object recognition involves identifying and locating objects in an image or video. This is a fundamental problem in computer vision and has many practical applications, such as autonomous driving, surveillance and robotics. YOLOv4 (You Only Look Once version 4) is an object detection algorithm. Advanced Objects uses deep learning to identify objects in images and videos. It is based on a neural network architecture called Darknet, which allows it to achieve high accuracy and speed. Image preprocessing: Before running a YOLOv4 model on an image or video, you may need to per-process the data by re-sizing or applying other transformations. You can use Open CV functions to perform these operations. Run the YOLOv4 model: Once the image or video has been preprocessed, you can run the YOLOv4 model on it using the detect() function in Darknet. This function will identify objects in the image or video and return their bounding boxes and class labels. Finally, you can display the results of the object recognition by drawing the bounding boxes on the image or video using Open CV functions.

3.2.4 Audio output using speaker

We initially receive a text output, which is then translated to audio using the Raspberry Pi's built-in Pyaudio library. The Raspberry Pi supports Bluetooth connectivity as well as aux port connections for audio output devices. A cross-platform audio I/O library called Port Audio has bindings for Python libraries called Pyaudio. Playing audio files or creating audio signals in real time with Python is simple using Pyaudio. Following object recognition, we receive an output in the form of a text that is then converted to audio format, along with auditory directions on how to get away from the object. A technological advancement that can offer a variety of benefits to those who are visually impaired is the smart belt for blind people using a Raspberry Pi with audio output. Mobility is one of the smart belt's most important advantages since it may let the blind move around much more easily. The belt can assist users move through their environment with more confidence and ease by delivering aural feedback regarding the location and proximity of impediments.

4 Results and discussions

In this paper, we attempted to produce our own data sets utilizing internet of things- based devices like the Raspberry Pi and Pi camera. Own data-set by taking pictures with the Pi camera while wearing the smart belt in various lighting situations and angles. Based on the positioning and separation of obstacles identified by the smart belt, we may then classify the photographs. This can assist us in teaching a machine learning model to identify and categorize various types of obstacles and to give the user the right kind of feedback. As an alternative, we might investigate already- created datasets that might be pertinent to our research, like the COCO (Common Objects in Context) data-set, which includes labeled pictures of common objects in diverse settings. We can use this data-set to train a machine learning model such as YOLO to recognize different objects and their positions relative to the user.

The three useful parts of this framework are screen capture, picture handling, and sound yield. The screen capture component records the curiously objects as either pictures or recordings. Our proposed calculations, such as Region-of-interest to gather objects from cluttered foundations or other environments, Picture Localization to realize the object regions to contain dark scale, and Protest Acknowledgment to convert image-based discernable codes, all make utilize of the Information Handling Framework. The reason of the sound yield component is to caution individuals who are dazzle to perceived content codes. The Raspberry Pi board, which gets sound signals and opens up them for discourse, is associated to the 3.5 mm sound harbour. The three utilitarian parts of this framework are screen capture, picture preparing, and sound yield. The screen capture component records the curiously objects as either pictures or recordings. Our recommended calculations, which incorporate 1) Region-of-interest to gather objects from cluttered foundations or other situations, 2) Picture localization to attain question locales to contain dark scale, and question acknowledgment to convert image-based lucid codes, all utilize the information preparing framework. The reason of the sound yield component is to caution individuals who are daze to perceived content codes. The Raspberry Pi board, which gets sound signals and intensifies them for discourse, is associated to the 3.5 mm sound harbour.

Fig. 2. Image processing after image is captured.

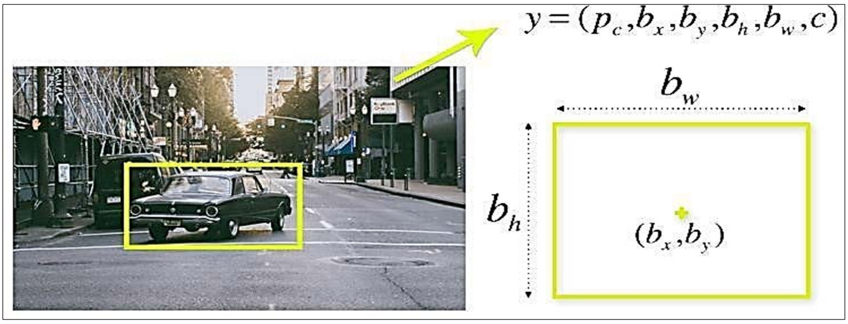

Fig. 3. Image being recognized in an image using algorithm.

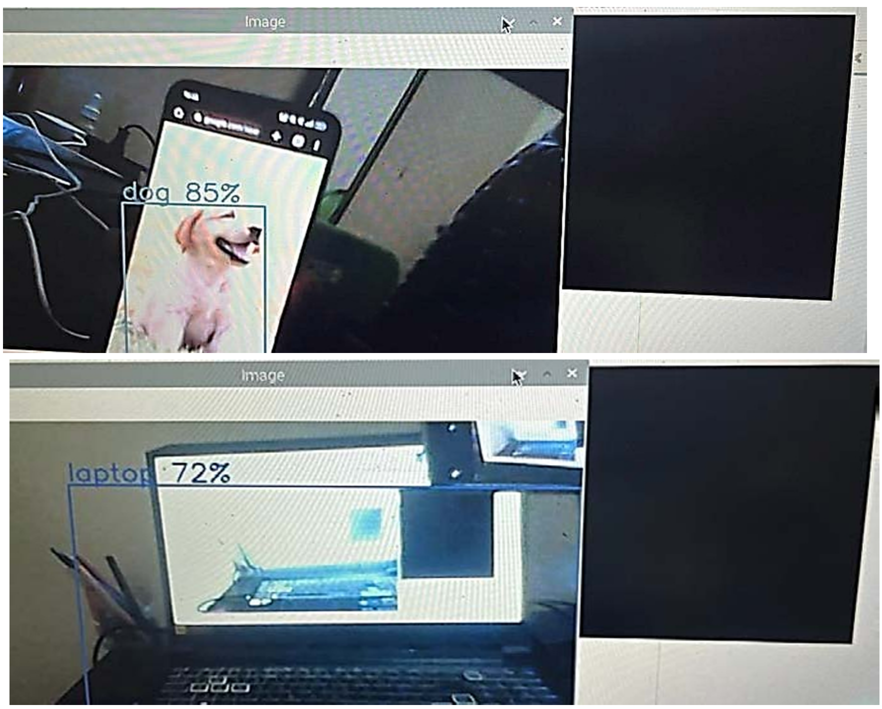

Fig. 4. Recognition of images after processing.

The YOLO method is the most commonly used algorithm in picture recognition. YOLO is a technology that uses neural networks to detect objects in real time. This is owing to the algorithm's popularity, accuracy, and speed. YOLO is an abbreviation that you hear a lot. This algorithm (which runs in real time) can recognize and identify various items in an image. The object detection procedure in YOLO, which is performed as a regression problem, provides the likelihood of the discovered image class. YOLO employs Convolutional Neural Networks (CNN) for quick object recognition. This method, as the name implies, uses only forward propagation of neural networks to detect objects. That is, the algorithm used to make predictions is run in all frames.

YOLO algorithm works using the following three techniques:

- Residual blocks
- Bounding box regression
- Intersection Over Union (IOU)

5 Conclusion and future enhancements

The Raspberry Pi-powered sustained belt for the blind with audio output is a cutting-edge device that has the potential to transform the lives of those with visual impairments. The smart belt can significantly improve the user's freedom, safety, and mobility by giving real-time audio input about barriers and risks in their environment. The sustained belt uses a combination of sensors, machine learning algorithms, and aural feedback to assist blind people in navigating their surroundings and avoiding obstacles. Several important advantages of this ground-breaking technology include increased mobility, increased safety, increased independence, cost effectiveness, and customization.

Finally, future improvements might concentrate on enhancing the smart belt's overall appearance and use. This can entail upgrading the user interface and controls, streamlining the user interface and the device's materials, or adding new features like wireless charging or haptic feedback.

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