A Novel Low-cost Visual Aid System for the Completely Blind People

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Abstract This article presents an innovative visual aid framework for completely blind people, which takes the form of a pair of glasses. The following are some of the most essential characteristics of the proposed device. The complicated algorithm processing is carried out on the Raspberry Pi 3 Model B+, which has low-end computing power. Using a combination of camera and ultrasound sensors and GPS-based location tracking for use in a navigation system, this Internet of things-based device offers advanced dual detection and distance measurement capabilities. This device makes it possible to have better access, solace, and navigational ease to blind people.

Keywords Artificial intelligence · GPS · Internet of things · Raspberry Pi

1 Introduction

Artificial intelligence (AI) is a term that refers to the development of intelligent machines in the field of computer science and mathematics. It has developed into

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a critical component of the technology sector over the last few decades. When a machine has access to a large amount of information, it will behave in a human-like fashion. The ability to perform logical analysis, learn from their mistakes, and adapt to a constantly changing environment is referred to as artificial intelligence (AI) in machine learning (ML). This technology is already being used in various applications, including self-driving cars, chatbots, personal voice assistants, and high-performance computer systems. On the other hand, artificial intelligence is developing systems that are capable of making decisions on their own behalf. However, for AI to be effective, it must be combined with hardware to produce intelligent machines. It is the most up-to-date and cutting-edge technology available in the field of embedded systems at the moment. Artificial intelligence (AI) is a term that refers to a computer or machine's ability to replicate human mental capacities such as learning from examples and experience, object recognition, language comprehension and response, decision-making, and problem-solving. Artificial intelligence (AI) is a word that refers to a subset of computers that includes machine learning, deep learning, and reinforcement learning. Artificial intelligence (AI) is a term that refers to a computer or machine's ability to mimic human cognitive abilities, such as greeting a hotel visitor or driving a car (also known as artificial general intelligence or artificial general intelligence).

The purpose of this paper is to offer information about moving barriers from a distance to the readership through the use of an integrated real-time reading assistant. The next step is to recognize objects in a live video stream and simultaneously offer the output to the user in full resolution with the necessary level of detail and accuracy (almost 98%). The user's location will be tracked by GPS and reported to their guardian via the Internet of things Website. The rest of the paper is organized as Sect. 2 shows the literature survey, section shows the proposed system, and results are interpreted in Sects. 4 and 5 concluded the paper.

2 Literature Survey

A smart glass system that can detect and recognize road signs in real time while in public restrooms, restaurants, and bus stations in urban areas are shown in [1, 2] on a computer screen. This system is designed to be tiny, lightweight, portable, and easily adaptable to maximize its utility. For a blind person, however, simply reading out road signs may not be sufficient information to make them feel secure in an unfamiliar scenario outside the home. It is possible that a sign will not be recognized in the system's database if it is not recorded in the system's database because public signs differ from city to city. If a sign is not recorded in the system's database, it will not be recognized even when it is recorded in the system's database. Because blind users are given limited information, they are likely to experience tension and fear. It is possible to provide visually impaired users with context-aware navigation services using the framework provided by Xiao et al. [2]. It is necessary to have a working understanding of the semantic properties of the elements in the user's environment in order to integrate advanced intelligence into navigation. The ability to communicate about objects and places improves when people connect, allowing them to make better travel decisions as a result of their increased ability to communicate. Our team has developed a cyber-physical system that includes a component that a human controls. It is possible to communicate with people in both the actual and virtual worlds using the examples below: specifically, (1) visual cues and distance sensing of physical objects as line-of-sight interactions for interpreting geographical context information and (2) social media data (such as tweets) as event-based interactions for evaluating situational vibes.

An innovative electronic travel aids (ETA) in the shape of a pair of spectacles is introduced in the article [3] to ease some of the travel difficulties experienced by members of the visually impaired population. This technology may benefit these individuals because it will allow them to obtain adequate and safe training. The authors present a novel multi-sensor fusion-based obstacle avoidance algorithm that uses both the depth sensor and the ultrasonic sensor to overcome the difficulties associated with recognizing small and transparent barriers [4], such as the French door, while still maintaining a high degree of precision. Individuals who are fully blind can benefit from learning to distinguish between three different types of aural cues that will assist them in selecting the best course of action to take. Visual augmentation that makes use of the augment reality (AR) technique [5] and combines the traversable direction, on the other hand, is beneficial to visually impaired folks [6]. A large number of people tried out the prototype, which consisted of a pair of display glasses as well as a variety of inexpensive sensors and other components. A large number of users evaluated the efficiency and accuracy of the prototype.

3 Proposed System

A visual aid that was both accurate and reliable was developed in order to assist visually impaired individuals. If the person wears glasses, he can attach our visual aid to them and use it for both indoor and outdoor navigation because it does not require your hands or the use of batteries to function. It is also small, lightweight, and completely hands-free. This technology will aid blind individuals since it can distinguish between fixed and moving objects in real time and provide aural feedback. Accurate distance measurements can be taken in real time with the use of a camera. Because fewer sensors and cameras are required, the system's design is simplified, and the system's cost is reduced. A blind person may track their GPS location and send messages to family members or guides directing them to a Website that uses the Internet of things by using the software (IoT).

Several factors were taken into consideration when selecting this particular Raspberry Pi 3 Model B+, but the price and portability were two of the most significant. Other systems do not have the possibility of running numerous programs simultaneously, as this one does, which makes it unique. Broadcom has consolidated everything into a single piece of hardware with the BCM2837 quad-core 64-bit processor, 1 GB of RAM, wireless LAN, Bluetooth low energy (BLE), and the board. As a bonus, the board's underside contains an expanded 100BaseEthernet GPIO with 40 pins that may be used for future expansion. On the back of the device, there are four USB 2 connections, a four-pole stereo output, and composite video input, among other things. With a full-size HDMI connection, it is possible to connect your Raspberry Pi to a display of your choice. If you choose not to use the USB port, you can connect a camera directly to the Raspberry Pi by putting it into the camera connector on the board. If you carefully follow the instructions mentioned above, you should store your operating system and data on a micro-SD card. A switchable micro-USB power source with a maximum output of 2.5 A and an on/off switch is provided (Fig. 1).

We intend to use the Raspberry Pi to support the person in charge of visual aids in our proposed work. In addition to detecting obstructions, the sensor also communicates with visually challenged individuals through headphones. The USB camera is used to identify items in the local surroundings and convey that information to the disabled individual who cannot see them. The detected object is displayed on the monitor, and then, the GPS modem communicates the location information of the individual who has been visualized. We create an object identification and tracking framework that is capable of running in real time on the Raspberry Pi microcontroller board. The identification and tracking operations carried out by the region convolutional neural networks (RCNNs) approach are depicted in graphical form. Object detection is accomplished by using Python, which is integrated with the

Fig. 1 Raspberry Pi architecture

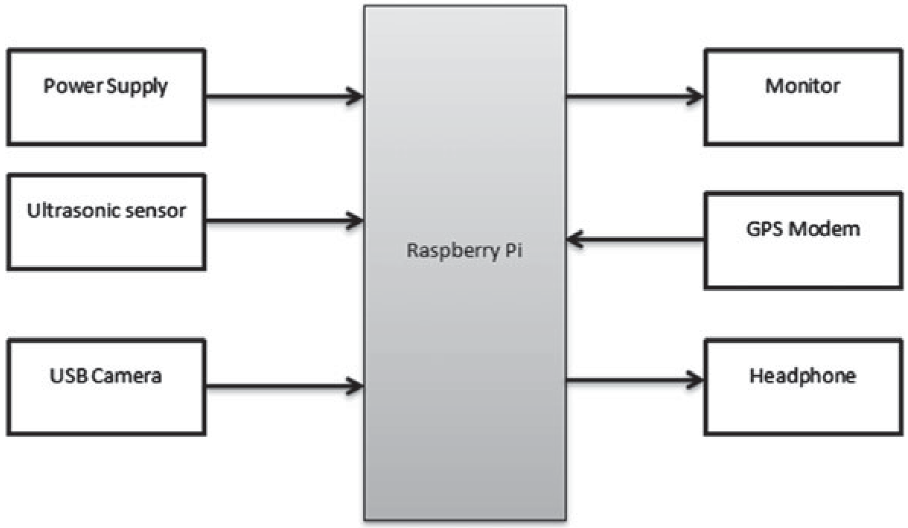

Fig. 2 Block diagram of the proposed visual aid system

embedded system. The object detection technique makes use of TensorFlow, Keras, and text to speech libraries (pyttsx3 or GTTS or eSpeak), all of which are open source. The block diagram of the objection detection algorithm based on tensor flow is shown in Fig. 2.

This camera's data was collected using an ultrasonic rangefinder (HC-SR04) placed beneath it. In order to use the ultrasound module, the four pins were connected to the Raspberry Pi's general-purpose input/output (GPIO) ports on the board. Pin 2 was assigned to the VCC port, and pin 6 was assigned to the GND port. Pin 12 (GPIO18) was connected to the TRIG signal, and pin 18 (GPIO18) was connected to the ECHO signal, as shown in the diagram (GPIO24). The output signal of an ultrasonic sensor is referred to as the 'ECHO' signal. If the sensor is not active, it can always generate a LOW (0 V) signal; nevertheless, when the sensor is active, it can generate a HIGH (0 V) signal (5 V). One of the GPIO pins was configured as an output, which resulted in the sensor being activated.

This modification adds an additional pin to the circuit, which serves as an input for monitoring changes in the ECHO voltage. A single ten-second pulse is all that is required to turn on the HC-SR04 sensor and its associated modules. When the subject responds with an echo response, the sensor emits eight ultrasonic bursts at a frequency of 4 kHz in order to elicit an echo response from the subject. This leads the sensor to emit eight ultrasonic bursts at a frequency of 4 kHz. This causes the sensor to generate eight ultrasonic pulses at a frequency of 4 kHz. Because of this, the trigger pin is held high for a total of 10 s before being reset to low, which causes the trigger pulse to be generated. Because the sensor detects reflected signals from a long distance, when a pulse travels a long distance and returns, the sensor's ECHO parameter on its controller is increased by the sensor. The value of the output variable changes from low (0) to high (1) in an instantaneous manner, and it remains in this high (1) state for the entire echo pulse. Ultrasonic sources and reflecting objects in a field of view can be located by measuring the difference between two recorded timestamps. Many factors influence the speed of sound as it passes through a medium, including the medium's temperature and density. A 343 m/s operating speed, which we determined is the same as the sound speed at sea level, has been calculated for our proposed system.

This API, which extracts features from images taken from a live video stream, must first be installed and activated before it can be used. TensorFlow's API for feature extraction can be found here. Open-source object identification framework built on TensorFlow is easy to integrate and train, and it can produce models that perform well in a variety of scenarios. Additionally, it is entirely free and open source. TensorFlow represents a deep learning network that serves as the computational engine for computations when it comes to object detection calculations. TensorFlow's operations are built on the graph object, a collection of nodes connected in a network.

4 Simulation Results

Figure 3 shows the result of the object detection algorithm which can detect the cell phone with 97% accuracy.

Figure 4 shows the output of detecting multiple objects using Raspberry Pi. The Picture-Net data collection is used to train our model for image categorization. The network generates a bounding box around an item and tries to determine its kind based on the data it has learned from the previous examples. The softmax activation function and cross-entropy loss function can be used to infer the presence of each class within each bounding box. The model can use the backdrop object class to categorize objects in the scene. Every frame has a set of bounding boxes that can be identified using simply background classes. Downsampling convolutional feature

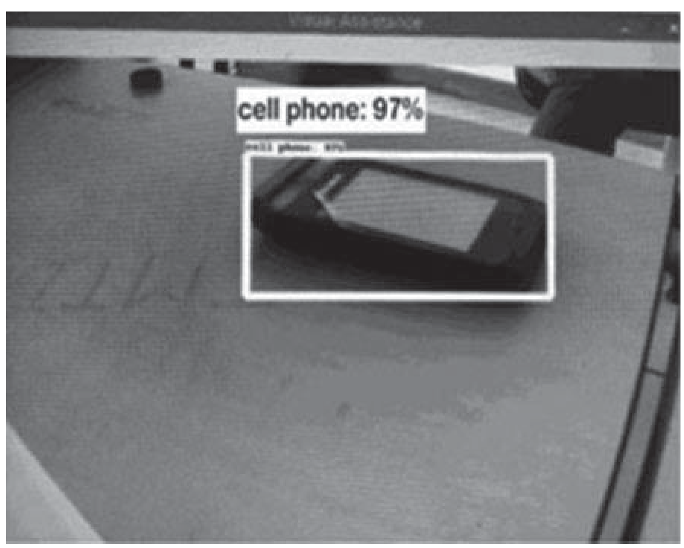

Fig. 3 Single object detection system

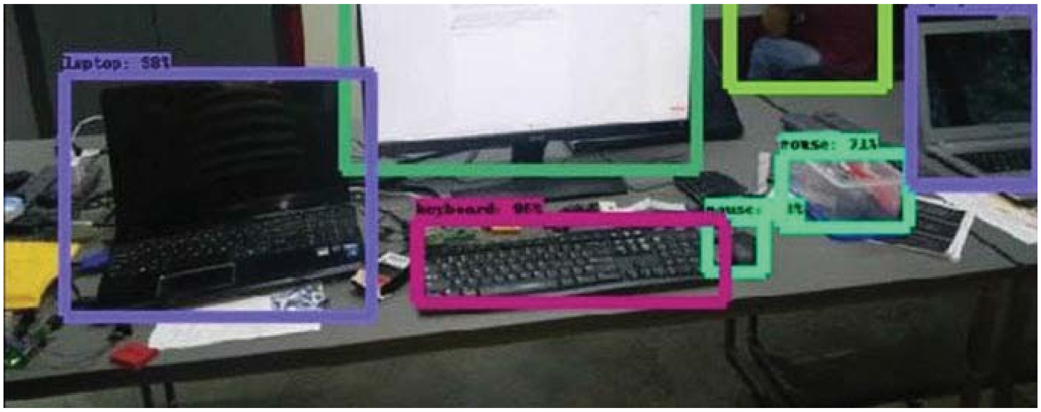

Fig. 4 Multiple object detection with various levels

maps to reduce unneeded bounding boxes are used to prevent this problem from occurring.

5 Conclusion

This article proposes a novel type of eyewear for persons who are entirely blind: a pair of glasses. A few of the device's most important features include the following: A sophisticated algorithm may be executed on the Raspberry Pi Model B+ despite its minimal computational power. IoT-based position monitoring for navigation can be used in conjunction with ultrasonic sensors and IoT-based location detection to measure distances between objects. Thanks to today's technological advancements, more people can travel more efficiently, comfortably, and with greater convenience.

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