THIRD EYE

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Abstract— This study report therefore establishes and applies an assistive aid commonly known as the "Third Eye" in assisting the vision impaired persons in their mobility. The system is built with an ESP32-CAM board and Arduino Nano board at its core to combine the advantages of both systems to offer a compact and affordable solution.

The Traditional ESP32-CAM which serves as the vision sensor acquisition agent captures the real time images and videos. On the users' side, haptic feedback is provided with the help of the Arduino Nano, as well as data interpreting. The main goal of the project is to grant the visually impaired clients a better chance of mobility and security by providing an efficient and low-cost solution for obstacle detection.

Some of the sections that are captured include; pre conception of Third Eye, design, development & testing. It digs into the integration process, the problems faced in development, the low-down of the physical aspect or the hardware, and the control aspect or the software. An analysis of performance proves that the system works well in various cases, indicating the possibility of using the system as an assistance to the blind and persons with low vision.

This practice-based investigation reveals how IoT technologies especially the ESP32-CAM and Arduino Nano can be creatively applied to actual issues of assistive technology. The current global economy has given new opportunities for the new creation and intensification of these systems.

Keywords— Arduino, python, deep learning, ESP 32 CAM, sensor, power supply design

Introduction

The raw number of cases of visual impairments has grown in recent years, increasing the demand for advanced systems that would help improve the quality of life and safety of sufferers from such conditions. An important reason for this is that, due to the inherent difficulties of navigating real-world space, visually impaired people have to negotiate city and country spaces with the aid of tactual and other senses or technologies where obstacles cannot be readily seen ahead of them. Canes and guide dogs are two traditional mobility assistance devices that despite their application, however, are characterized by range and accuracy constraints.

Recent years have seen a higher rate of visual impairment all over the world, which in turn have raised the need for improved sophisticated technologies to improve the mobility of individuals with such health complications. This is why technology must be created to help the visually impaired detect obstacles in their environment in real time, since such environments are incredibly difficult to navigate. Saws and sticks are two good examples of the conventional walking sticks that despite their usefulness, they have limitations of range and accuracy.

Defects of vision are becoming increasingly common worldwide, which has generated a demand to improve, with the help of modern technological solutions, the quality of life of patients with these pathologies. It is therefore important that a technology be designed to enable the visually impaired detect and avoid obstacles in real-time because movement in complex terrains is very cumbersome. Another two conventional walking aids that have documented range and accuracy limitations, apart from the usefulness are canes and guide dogs.

To highlight the potential of the Third Eye project to enhance the movement and independence of people with blindness and impaired vision this qualitative study examines the development, execution, and feedback of the project. By integrating ESP32 CAM and Arduino Nano The Third Eye is capable of providing a fresh perspective to the use of assistive technologies that are easily understandable and feasible.

The study forms the basis of further developments within a relatively young and quickly growing field of research in the area of assistive devices that employ microcontrollers.

Fig.: Power supply block diagram as the term holds the temporary storage of power supply block diagram. It consists of circuitries that reduce ripple and regulates output voltage once a DC power unit has rectified the AC source into a DC voltage with some ripple.

SYSTEM OVERVIEW:

SONAR Sensor: To detect objects in a given proximity, it is necessary to use several SONAR sensors which are for instance HC-SR04. These sensors can be connected with an Arduino NANO board.
NANO Arduino Board: When an item is distinguished by this SONAR, this will work as the primary command center for vibrating feedback and additionally for SONAR object identification so that the ESP32 CAM module can draw its power from here.
Vibration Motor: This process requires that an Arduino UNO board have to be interfaced with a vibrating motor. This motor will be activated when the SONAR sensors pick some object around it.

ESP32 CAM: Taking pictures with this module and recognizing objects will subsequently display the results on a screen. It may also use the ESP32 CAM to vibrate the name of the detected object when connected to the buzzer module.

Vibration Motor: Before proceeding any working on the Arduino UNO board, a vibrating motor should be connected to it. This motor will switch on when objects are within its range which is feel by the SONAR sensors.

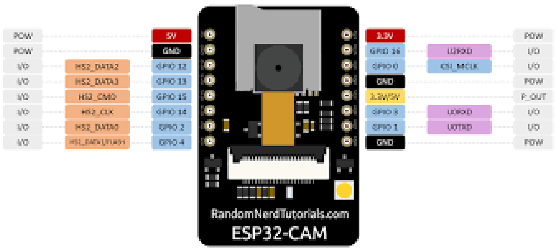
• The SONAR sensors discharge ultrasonic waves, which spread out up to an item is met.
• When an object has been recognized, it emitted ultrasonic waves that are captured by the SONAR sensor.• How far the object is, is calculated by the time taken by the ultrasonic waves using an Arduino Nano board to travel to the object and back.
• The NANO Arduino triggers the vibrations of this motor to facilitate touch to notify the user of the object's proximity based on a fixed distance range.d picked up by the SONAR sensor when an item is identified.
•The distance to the object is determined by measuring the time it takes for the ultrasonic waves to return using an Arduino Nano board.
•The NANO Arduino activates the vibration motor to produce tactile feedback and notify the user of the object's proximity based on pre-established distance thresholds.

A. *ESP 32 CAM For Object Detection:*

- For object recognition, the ESP32CAM (ESP32 with a camera module) will be used.
- It makes use of the camera module to take pictures.
- With the help of the OpenCV module, it can spot and recognize an object.

COMPONENT USED:

A. *ESP32 CAM:*



Users can create projects, which involve image taking,

Figure 1: ESP32-CAM

image processing, and image recognition with the ESP32 CAM. It is a small form factor but powerful development module which has a camera module option together with an ESP32 microcontroller. Internet of Things applications, surveillance systems, as well as projects involving the analysis of visuals often use this module.
The ESP32 CAM is of great assist in remote control and monitoring because it is equipped with in-built WiFi and Bluetooth, which facilitates its connection to other networks and devices at one-point. This type of camera is compact and relatively inexpensive it is suitable for DIY home security systems and various prototypes that will need a built-in camera.

Table 1: ESP32-CAM Specification

No.	ESP32-Cam Specification		
1.	Ultra-small 802.1b/g/n Wi-Fi + BT/BLE SoC module	Up to 240MHz, up to 600 DMPIS	Built-in 520KB SRAM, external 4M PSRAM
2.	Low-power dual-core 32-bit CPU for application processors	Supports interface such as UART/SPI/I2C/PWM/ADC/DAC	Support OV2640 and OV7670 cameras with built-in flash.
3.	Support for images WIFI upload	Support TF card	Support multiple sleep modes
4.	Embedded Lwip and Free RTOS	Support STA/AP/STA+AP working mode	Support Smart Config/AirKiss One-click distribution network
5.	Support for local serial upgrade and remote firmware upgrade (FOTA)	Support secondary development	

Table 2: OV2640 Specification

OV2640 Specification and Datasheets		
No.	Parameters	Specifications
1.	Array Size	1600 x 1200 (UXGA) Core: 1.3V DC ±5%
2.	Power Supply	Analog: 2.5~3.0V DC I/O: 1.7V to 3.3V
3.	Power Consumption	Free running: 125mW Standby: 600µA
4.	Image Sensor Format	Type ¼”
5.	Maximum Image Transfer Rate	1600 x 1200@15fps, SVGA@30fps, CIF@60fps
6.	Sensitivity	0.6V/Lux-sec
7.	S/N ratio	40dB
8.	Dynamic Range	50dB
9.	Pixel Size	2.2 x 2.2 µm
10.	Output Format	YUV/RGB/Rawdata/MJPEG
11.	Shutter Type	Rolling Shutter

Board control over the ESP32 CAM module can be initiated through the Arduino IDE software or similarly utilizing the ESP-IDF, infusing makers and developers with a comfortable environment that allows for testing and writing the program. Due to the implementation of the camera sensor and the computational capability of the ESP32 microcontroller, it can be used for a number of creative and creative concepts. Choices available include image processing, object detection, facial recognition, and many others.

B. NANO Arduino:

Figure 2: NANO Arduino

A rectifier can change a current that is other than direct current by positioning the diodes in another manner. As a result, they generate a full current modifying DC, so they are necessary in bridge rectifiers. However, with diode costs being incredibly low these days, full-current rectifiers are much simpler and can be created using only two diodes if a centre-tap converter is used. A unit diode may also act as a rectifier when + sections of the alternate current flow are used to create half-wave currents thus changing the direct current.

Figure 3: FTDI Module

C. FTDI Module:

Figure 4: FTDI Module

The FTDI (Future Technology Devices International) module is a small-sized universal serial bus to serial converter often used in electronics development and experiments. Serial port adapter is an interface that connects a USB port of a computer or microcontroller board to various serial communication devices using UART.

To program and debug the WiFi capable microcontroller with a camera named as ESP32 CAM a FTDI module has to be used to interface with a computer. It works as an USB to serial adapter, allows uploading sketches from the Arduino IDE and USB connection with the ESP32 CAM.

Due to the FTDI module, the EE microcontroller’s serial interface and the USB port on the computer integrating may have a problem-free communication. Because upstream builds come preconfigured to work with this board, the testing and development that makers and developers can do for the ESP32 CAM board is streamlined when it comes to configuring and uploading firmware and troubleshooting code.

Table 3: FTDI Module

No.	Parameter	Specification
1.	Chipset	FT232RL
2.	Operating Voltage	USB 2.0 Full Speed
3.	Input Voltage	4.5V-5.5V(for 5V mode) / 3.0V – 3.6V (for 3.3V mode)
4.	Data Transfer Rate	Up to 3Mbps
5.	Communication Protocol	UART, Bit-Bang Mode
6.	Power Consumption	15 mA
7.	Flow Control	Supports CTS/RTS, DSR/DTR, XON/XOFF
9.	Driver Support	Windows, macOS, Linux
10.	Connection Interface	USB Mini-B Connector
11.	GPIO Pin	DTR, RXD, TXD, VCC, CTS, GND
12.	LED Indicators	Power, RX, TX
13.	Built-in Oscillator	Yes, 12 MHz

14.	EEPROM	Configurable EEPROM for customizing device descrptors

D. Ultrasonic Sensor (SONAR):

Figure 5: UltraSonic Sensor

People have been using Ultrasonic Sensors also called SONAR as a common tool for sensing objects and measuring distances. Ultrasonic sound waves are transmitted and reflected back in order to measure the distance between two objects. Since these are non-contact measuring devices, the usage of these sensors can be found in robotics as well as automation and proximity sensing.

E. Vibration Motor:

Figure 6: Vibration Motor

A vibration motor is an electromechanical device that induces vibrations in circuits and the various electrical appliances. It is usually an extremely small motor with eccentric weight on the shaft; mechanical to and fro movements are produced due to the unbalanced load as the motor spins. Vibration motors are applied in the mobile phones, video games controller and the vibrating alert systems of the wearable gadgets, as well as industrial purpose signals. They are physical to the touch and make an interesting addition by mimicking vibrations and increasing user interest.

F. Buzzer:

Figure 7: Buzzer

Buzzers are small thermally-small sound-producing devices that are used when an electrical signal is present. They are common features in gadgets serving the purpose of user input, notification and alarms. There are active and passive buzzers, they are used in robotics, clocks, alarms, and other interactive electronic projects due to their versatility in sound signaling.

TECHNOLOGY USED:

A. Python:

High-level and very flexible, Python is identified as syntactically clear and understandable language with strong and responsive community. Described as a language for the expressional, web and embedded programming, scientific computing and data analysis, Python which was established in 1991 by Guido van Rossum has served the purpose of a language choice in many ways. This is easy on the syntax, and therefore inviting to new comers, but has a lot of power built in to heal the bruises of experienced developers. Readability was the founders' goal while writing Python, the language's guiding principles, expressed in 19 sayings called the Zen of Python, make it popular. Scientists and engineers use Python because it is an open-source language that is easy to learn, flexible and can be used in a myriad of applications ranging from scripting, scientific computing, data analysis, artificial intelligence and web development.

B. Arduino:

An integrated development environment for programming and developing projects containing the Arduino boards is called the Arduino IDE. By way of writing, compiling, and uploading code to Arduino microcontrollers, it provides a simple frontend.
The simple code editor of the Arduino IDE has a syntax color coding and auto completion that makes writing and debugging of sketches easier. Also, it supports a broad number of Arduino libraries and boards, meaning that the users of Arduino can get the ready code for different spare parts and uses.
Through downloading and uploading code to the Arduino boards through USB or other interfaces Arduino IDE therefore simplifies the process development of electronic advancements. When designing with Arduino microcontrollers then it does so in order to speed up project development as well as enable more efficient prototyping.

C. Object Detection:

Some of the major types of computer vision problems are discussed below, namely Segmentation, Object Detection, Image Classification, Silhouette Extraction, Gesture Recognition, Face Tracking, People Tracking, Point Registration, Tracking Based Positioning, Object Recognition, Tracking by Detection, Frame Rate Tracking and Object Tracking. Compared to image classification, that assigns a single label to an image, object detection provides the pixel space coordinates of the objects in the form of bounding boxes above and beyond the classification. Such activity is useful in applications like; interactive robotics, self- driving cars, and security and surveillance systems.

Concept And Importance:

Object detection combines classification and localization to achieve its goals:

- Classification: Identifies what object is present in a region of interest.
- Localization: Determines the precise location of the object by specifying its coordinates within the image.

Due to these two qualities, object detection plays central role in operations where contextual and layout awareness is of paramount importance and the process flow is in real time. For example, object detection in the use of self-driving cars to identify other cars, people and traffic signs to avoid or to safely maneuver.
Techniques And Algorithm:
Reviews give various techniques and algorithms used in object detection, and each of them has its advantages and disadvantages.

Traditional Methods:
• Haar Cascades: Employ feature based techniques and classifier for identification of objects. This is less accurate than current practice but requires less computation, than modern approaches do.
• HOG (Histogram of Oriented Gradients): Uses information from gradient orientation in an image to identify objects. Sometimes used in conjugation with SVM or Support Vector Machines for the purpose of classification.

Deep Learning Methods:
• Convolutional Neural Networks (CNNs): A type of machine learning algorithms that learn patterns straight from the image data. CNNs have been precisely influential in the object detection area.
• Region-Based CNN (R-CNN): Enumerates candidate regions and uses CNNs to each region to classify object. There are faster versions, like Fast R-CNN, and Faster R-CNN that helps to increase both speed and accuracy.
• You Only Look Once (YOLO): We present an end to end object detection model that predict bounding box and class probabilities in one shot through the network. Real-time application is something with which YOLO is synonymous.
• Single Shot MultiBox Detector (SSD): Similarly to YOLO SSD also detects objects in one pass but unlike it, it uses different feature maps for object detection at different scales.

CIRCUIT:

SONAR Sensors (HC-SR04): Connected the Arduino NANO to supply the distances data of the object.
Arduino NANO: It receives data from SONAR sensors. It opens and closes the Vibration Motor and also to provide the power to ESP32 CAM.
Vibration Motor: Soldered the wires on the positive and negative pins of the battery, to connect the Arduino NANO. It turns ON, when an object is sensed by the SONAR sensors.
ESP32 CAM: Runs from the Arduino NANO power supply. Support capture images and perform object recognition. It may also be connected to an audio module for example for announcing the detected objects.

CONSTRUCTION:

A. Connect SONAR Sensor to NANO Arduino:

1. Connect the SONAR sensors' VCC to the NANO Arduino's 5V pin.
2. Connect the SONAR sensors' GND pin to the NANO Arduino's GND pin.
3. Connect each SONAR sensor's TRIG pin to one of the NANO Arduino's digital pins (such as 2, 3, or 4).
4. Connect each SONAR sensor's ECHO pin to one of the NANO Arduino's digital pins (such as 5, 6, or 7).

B. Connect Vibration Motor to NANO Arduino:

1. Connect one of the vibration motor's terminals to a digital pin on the NANO Arduino, such as pin 8.
2. Connect the vibration motor's other end to the NANO Arduino's GND pin. Figure 4.2. 1

C. Connection of NANO Arduino to SONAR ESP32 CAM:

1. Connect the 5V & GND Pin of ESP32 to 5V & GND of FTDI Module.
2. Similarly, connect the Rx to UOT and Tx to UOR Pin.
3. And the most important thing, you need to short the IO0 and GND Pin together. This is to put the device in programming mode.
4. Once programming is done you can remove it.

There are five core components in the Integrated Development Environment that are used to run ESP32-CAM.Camera Web Server, Application HTTP or application server, Camera Library, and Camera Pin Header. And each of these components must be a unified system. Moreover, the pseudocode used for minimal starting is shown in the following series of pseudocodes

CONSTRUCTION:

D. Connect SONAR Sensor To NANO Arduino:

5. Connect the SONAR sensors' VCC to the NANO Arduino's 5V pin.
6. Connect the SONAR sensors' GND pin to the NANO Arduino's GND pin.
7. Connect each SONAR sensor's TRIG pin to one of the NANO Arduino's digital pins (such as 2, 3, or 4).
8. Connect each SONAR sensor's ECHO pin to one of the NANO Arduino's digital pins (such as 5, 6, or 7).

E. Connect Vibration Motor to NANO Arduino:

3. Connect one of the vibration motor's terminals to a digital pin on the NANO Arduino, such as pin 8.
4. Connect the vibration motor's other end to the NANO Arduino's GND pin. Figure 4.2. 1

F. Connection of NANO Arduino to SONAR ESP32 CAM:

5. Connect the 5V & GND Pin of ESP32 to 5V & GND of FTDI Module.
6. Similarly, connect the Rx to UOT and Tx to UOR Pin.
7. And the most important thing, you need to short the IO0 and GND Pin together. This is to put the device in programming mode.
8. Once programming is done you can remove it.

Integrated Development Environment developed for ESP32-CAM.Camera Web Server has five elements, which are used to operate it, Application HTTP or application server, Camera Library, and Camera Pin Header.But each of those components must be a system in its own right.Development Environment that are used to run ESP32-CAM.Camera Web Server, Application HTTP or application server, Camera Library, and Camera Pin Header. And each of these components must be a unified system.

Further, the pseudcode used into the minimal starting

Pseudocode 1:

1. Include the esp32cam library for camera functions.
2. Set Wi-Fi SSID and password.
3. Create a WebServer object on port 80.
4. Define three resolutions: low, medium, and high.
5. Capture an image using the camera.
6. If the capture fails, print an error message and send an empty response.
7. If the capture is successful, print capture details.
8. Set the content length for the server response.
9. Send the image as a JPEG to the client.
10. Change the camera resolution to low.
11. Serve the JPEG image.
12. Change the camera resolution to high.
13. Serve the JPEG image.
14. Change the camera resolution to medium.
15. Serve the JPEG image.
16. Start the serial communication at a baud rate of 115200.
17. Configure camera settings, including pins, resolution, buffer count, and JPEG quality.
18. Initialize the camera and print whether it was successful.
19. Connect to Wi-Fi using the provided SSID and password.
20. Print the local IP address and the URLs for the different resolution images.
21. Set up the server routes to handle requests for low, medium, and high-resolution images.
22. Start the server.

is included in the next series of pseudocodes

Pseudocode 2:

1. Import necessary modules: cv2, cvlib, urllib.request, numpy, and concurrent.futures.
2. Set the camera feed URL.
3. Initialize a variable im to None.
4. Define run1 Function:
5. Display live video feed in a window named "live transmission."
6. Continuously fetch, decode, and display images from the URL.
7. Break loop if 'q' is pressed.
8. Close all OpenCV windows.
9. Define run2 Function:
10. Display video feed with object detection in a window named "detection."
11. Continuously fetch, decode, and perform object detection.
12. Draw bounding boxes around detected objects.
13. Break loop if 'q' is pressed.
14. Close all OpenCV windows.
15. Print "started" to indicate the process has begun.
16. Use Process Pool Executor to run run1 and run2 concurrently in separate processes.

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The study aims to advance the development and application of a 'Third Eye' system using ESP32-CAM and Arduino Nano for enhancing situational awareness in embedded applications.

We are grateful to everyone who helped make this research possible, whether directly or indirectly.

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CONCLUSION:

To sum up, this research offers a thorough examination of the "Third Eye" system, clarifying its functions, elements, ideas, and design approaches. The expanding significance of vision-based support systems across multiple sectors is highlighted by their increasing reliance. The study highlights how important it is for these kinds of devices to improve safety and situational awareness, whether they are used in sophisticated monitoring applications or as personal assistance technologies.

This study offers engineers a thorough reference by examining ESP32-CAM modules, Arduino Nano microcontrollers, and SONAR sensors. The 'Third Eye' technology improves object identification and real-time visual feedback, enhancing consumer electronics and industrial automation, as demonstrated by case studies and real-world applications.

As technology develops, there are opportunities and obstacles in incorporating vision-based technologies into regular applications. Electronic devices' functionality and performance can be improved by using embedded systems equipped with imaging and distance measurement technology.

This study contributes to the development of "Third Eye" technology in electronic gadgets by highlighting the significance of vision-based systems in a variety of industries.

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