Smart Glass for Visually Impaired Person

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Abstract The main idea of our project is designing a Raspberry Pi based glasses for blind people. A digital camera will record a video and the video will be analyzed by a program written in python language, and using object detection functions. The program will detect many objects in front of the intended person, and send data to Raspberry Pi processor, which include object name, and its distance with respect to the person, this will trigger a voice message mentioning the name of the object and its distance. Also a microphone will use to receive commands from the user, and send this commands to the raspberry pi processor to do it. Finally, if the user needs help, just say (HELP) on the microphone to send a WhatsApp message to phone number it is predetermined.

Keywords Smart glass · Raspberry Pi · Python

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1   Introduction

In our world there are approximately 40 million blind persons who faced problems, in movement and contact with other people. Our project aims to help these people in their daily life, this can be done by designing a Raspberry Pi based system, which consists of digital camera and a headset, this system will detect many objects and measure it is distance with respect to intended person, the camera using Raspberry Pi to convert the output to voice, through a headset which connected with the Raspberry Pi. The camera takes a live stream and detects the object and the distance continuously, and the target people will receive the information as voice message by headset contain the name of the object and the distance.

Many projects are designed to help blind people such as:

1. Smart glasses for blind people at Prince Mohammad Bin Fahd University, developed a glasses that help people to read and translate anything in English. These kinds of the inventions consider a solution to motivate blind students to complete their education in spite of all their difficulties. The glasses used many technologies to perform its tasks which are Optical Character Recognition (OCR) and OpenCV to detect the text in the image, with Efficient and Accurate Scene Text Detector (EAST). In order to convert the text into speech, it used Text to Speech technology (gTTS), and for translating the text it used Google translation API, and the Raspberry Pi 3 B + module is the processor that used in this project.
2. Smart glasses at Islamic University of Gaza, this project aim to help blind people to faced daily problem by using ultrasonic sensor pinned in the middle of the glasses which measure the distance and send a voice that alert him, when the object become closer the voice will raised.

In our project we use raspberry pi 4 module B, camera, microphone, and headset. The main code (voice assistant) will call the other codes if the user send a command by the microphone such as:

1. If the user say (Time) the raspberry will tell him what is the time in that moment by the headset.
2. If the user say (Weather in "CITY") the raspberry will tell him the value of the temperature in the chosen city in Celsius by headset.
3. If the user say (search for "anything") the raspberry will search about it in Wikipedia and read the first two lines, the voice will out from the headset.
4. If the user say (Go) the Raspberry will call the detection code and tell the user what is the name of the object detected by the camera and its distance.
5. If the user say (Help the Raspberry will call a code to send a message in WhatsApp to a phone number.

The main objectives of this project are:

- Developing an intelligent system that detect the objects, measure the distance and send a voice message to the user.
- Making the blind person's life easier than before.

2 Methodology

Raspberry Pi OS is a free operating system based on Debian, optimized for the Raspberry Pi hardware, and is the recommended operating system for normal use on a Raspberry Pi. The OS comes with over 35,000 packages: precompiled software bundled in a nice format for easy installation on your Raspberry Pi [1].

Raspberry Pi OS is under active development, with an emphasis on improving the stability and performance of as many Debian packages as possible on Raspberry Pi.

Python is a popular programming language known for its simplicity, readability, and versatility. It is a high-level, dynamically-typed language that is used in a wide range of applications, from web development and scientific computing to artificial intelligence and data analysis. One of the benefits of using Python is its large and active developer community, which has contributed a vast number of libraries and frameworks that make it easy to add advanced functionality to your programs. These libraries and frameworks cover a wide range of domains, including scientific computing, web development, and data analysis. Another benefit of Python is its simplicity and readability. The language has a concise syntax and uses whitespace indentation to denote code blocks, which makes it easy to read and understand. This makes Python a good choice for beginners and experienced programmers alike. In addition, Python is highly versatile and can be used in a wide range of contexts. It is a popular choice for web development, scientific computing, and data analysis, and has libraries and frameworks for just about every application you can think of. Whether you're building a simple command-line application or a complex machine learning model, Python has the tools you need to get the job done. Overall, Python is a powerful and easy-to-use programming language with a large and active developer community, making it a great choice for a wide range of projects [2].

Thonny is a simple Python Integrated Development Environment (IDE) that is included with the Raspbian operating system, which is the default OS for the Raspberry Pi. It is designed to be easy to use and suitable for beginners, and provides a number of features that make it easier to write, debug, and test Python code. Some of the features of Thonny include: A simple, easy-to-use interface. Syntax highlighting and code completion. A built-in debugger that allows you to step through your code and inspect variables [3].

A built-in Python shell for testing code snippets and interacting with the interpreter. Support for plugins and extensions to add additional functionality. Thonny is a great choice for beginners who are just starting to learn Python and want a simple, easy-to-use development environment. It is also well-suited for educational environments, as it provides a number of features that make it easier to learn programming. If you're using a Raspberry Pi and want to get started with Python.

The code is consists of the followings:

- Simple voice assistant that can perform a few tasks such as getting the weather, getting the current time, and searching Wikipedia.

  1. Here is a brief overview of how the code works:

2. The PyAudio module is used to set up the audio input and output for the assistant.
3. The speech_recognition module is used to recognize speech input and convert it to text.
4. The requests module is used to make HTTP requests to the OpenWeatherMap API to get weather data for a given location.
5. The json module is used to parse the JSON data returned by the OpenWeatherMap API.
6. The gTTS (Google Text-to-Speech) module is used to convert text to speech and play it through the speakers.
7. The os module is used to run shell commands to play the audio output.
8. The datetime module is used to get the current time.
9. The Wikipedia module is used to search Wikipedia and return a summary of the search results.

• This code is an object detection using OpenCV Python.

We create a modular function that will allow us to select the objects we want to detect. First of all we will explain what is OpenCV and how we use it.

OpenCV (Open Source Computer Vision) is a library of programming functions mainly aimed at real-time computer vision. It was originally developed by Intel and is now maintained by Willow Garage and Itseez. OpenCV is available for C++, Python, and Java and supports Windows, Linux, Mac OS, iOS, and Android.

In this code, OpenCV is used to capture video frames from the camera and to draw bounding boxes and text on the images. It is also used to convert the image to grayscale, to detect edges in the image using the Canny edge detector, and to find contours in the image.

We use a trained object detection model to identify objects in video frames from a camera and estimates their distance from the camera using the size of the bounding boxes around the detected objects and some trigonometry.

The object detection model is initialized with the weights stored in frozen_inference_graph.pb and the configuration stored in ssd_mobilenet_v3_large_coco_2020_01_14.pbtxt. The model expects the input image to be resized to (320, 320) and to have values in the range of 0 to 1. The input image is first normalized by subtracting the mean value (127.5, 127.5, 127.5) from each channel and then dividing by 127.5. The input image is also swapped in the order of the channels from Blue-Green–Red (BGR) to Red–Green–Blue (RGB).

The model is used to detect objects in each frame of the video in the while True loop. It returns the class IDs, confidence scores, and bounding boxes for each detected object. For each detected object, if its class is among the objects specified in the objects list, the program draws a bounding box around the object, writes the class name and confidence score on the image, and estimates the distance to the object using the size of the bounding box, the known size of the object, and the field of view of the camera.
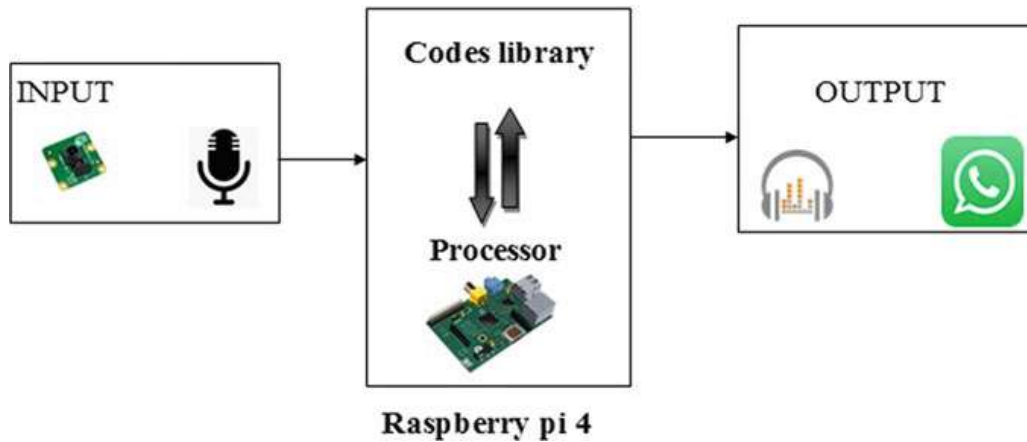
Fig. 1 Overall system components

- This code will be run when we use the assistant voice if the input is (Go) the assistant returns the object detection code.

This code uses the pywhatkit and pyautogui libraries to send a message to a predetermined phone number using WhatsApp. The pywhatkit library allows you to schedule the message to be sent after 60 s, while pyautogui is used to automate the process of bringing the WhatsApp window to the foreground, typing the message into the text field, and pressing the "Enter" key to send the message.

The date–time module is used to get the current time, and the time module is used to pause the script for 60 s before bringing the WhatsApp window to the foreground.

The phone number to which the message will be sent is specified by the phone_ number variable, and the message itself is specified by the message variable. The message is scheduled to be sent at the current time plus one minute.

This code will be run when we use the assistant voice if the input is (Help) the assistant returns the emergency code.

The overall hardware of the system is shown in Fig. 1.

3 Conclusion

This Smart Glass will convert the voice commands coming from the user to a voice message or WhatsApp message. This message is the execution of the user's command, by using microphone, headset, camera and Raspberry Pi. We partially solved the visually impaired people problems so that this system help him to communicate with other people, but there are some limitation such as:

1. The camera will not detect the object if it away more than 100 cm.
2. If the camera detect many objects it will send the name and distance of the nearest one.
3. The user must use a professional accent when he say the words at the microphone.

4. After you say (Go) or (Help) and the raspberry calling the code you must reboot the system to use it again.
5. The number of the object that will the camera detect it is limited and we have built a simplified dataset with basic objects used daily.
6. You must have a high Internet speed to detect the objects without lag.

4 Problems and Solutions

We faced many problems when we work at the project and we solve it such as:

- Initially, we bought a camera and it didn't work because it 5MP, we solved this problem by using a new camera 8MP.
- The operation system (OS) did not work initially because it 32 bit, we solved this problem by download a new operation system (OS) with 64 bit.
- Difficulty in using Python language because we are Electrical Engineers.

5 Recommendations

- We are looking forward to improve this system by increasing the number of the object in dataset.
- We also need to improve this system using a new processor because the Raspberry Pi 4 Module B isn't good enough.
- We also can improve this system using camera more than 8MP to cover more than 100 cm.
- We are looking forward to improve this system by using both Arabic and English language in the output voice message.

6 Cost Analysis

The cost of each component of the project is presented in following table.

Equipment	No. of equipment	Price (NIS)
Raspberry Pi 4 Module B and its accessory	1	945
Camera	1	380
Ultrasonic sensor	2	30
Wires	40	15
Camera Wire	1	50
Headset	1	15
Microphone and USB connection	1	55

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Equipment	No. of equipment	Price (NIS)
Micro HDMI to HDMI connection	1	50
Total cost NIS		1540

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