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SAVI: Smart Assistant for Visually Impaired

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Abstract: As technology advances in the modern world, it has an impact on the lives of the visually impaired. A lot of products are brought in to help them, to make their lives easier. Smart Assistant for Visually Impaired (SAVI) is one such device that contains various available technologies and integrates them into a multipurpose device that can be used by visually impaired people. It supports both the legally blind and completely blind category of visually impaired people. The drawback of the existing products is that they are very costly. It also does not provide a mechanism to alert the user's well-wishers during a time of emergency. The aim is to build a system that will be compatible in all aspects as well as provide scope for extension in the future. The device mainly detects and recognizes objects. In case of an emergency situation, there is a provision for the user to send an SOS alert message to the concerned people. The device accommodates a text reader which would help visually impaired people read non-braille text. It also accommodates an E-tracker which would help their well-wishers to track the visually impaired person. Implementing such a system will help people with visual disabilities to be more confident and independent.

Keywords: object detection and recognition, route navigation, Audio input and feedback, SOS, smart assistant, visually impaired.

I. INTRODUCTION

There are over 235 million blind people in this world. Since the beginning, there have been people with disabilities, but they were not treated fairly. A long time back the approach towards the differently-abled people was huge disregard, rejection, isolation, and abuse, however, 100 years back the approach changed to sympathy and pity. Recently, the approach towards the differently-abled including the blind has turned to a bright outlook. People have changed their outlooks towards the disabled community. There have been rapid changes in the attitudes of the common regarding the disabled and visually impaired across the globe.

India being the largest democrat is booming on the growth and developmental front and would soon be among the leaders in the economy. This imposes far greater responsibilities on us. It almost becomes mandatory to ensure that the benefit of all these developments has to be enjoyed by every citizen, which constitutes all sectors of the society, including the abled and the disabled ones.

It is enshrined in the Constitution of India to ensure equality, freedom, justice, and dignity of all individuals and implicitly mandates an inclusive society. With an improved outlook towards the quality aspects in all spheres of life including availability, access, and provision of services to the disabled, it is relevant to look into the efforts taken by the government in keeping the commitment towards all sectors of the society.

Visually impaired and blind people come from all kinds of backgrounds. There are elderly, as well as young people. They can associate in different fields, like being sportsmen and women, gardeners, farmers, chess players, teachers, typists, musicians, lawyers, housewives, computer programmers, physiotherapists, social workers, telephonists, parents, etc.... These people may have abilities and can achieve many things despite visual impairment or blindness, but there are times when they will appreciate and welcome practical assistance. To help them experience the outside world with the help of technology is significant but a very challenging task.

In the past decades, there have been several projects attempting to help the disabled to recover their lost senses via other sensory channels, and the relevant equipment is named Sensory Substitution (SS) devices.

Many products have been introduced in the market that aims to help the blind community. But most often they won't be reaching the needy hands as it might not be affordable to the common.
Smart Assistant for Visually Impaired (SAVI) is a device that contains different available technologies and collectively joins them into a multipurpose device that could be used by visually impaired people. It supports both the legally blind as well as the completely blind categories of visually impaired people.

II. METHODOLOGY

2.1 Hardware

The main processing unit of SAVI is the Raspberry pi 4 variant with a 16GB SD card. The 8 GB RAM version for better performance. Its quad-core 64-bit Broadcom 2711, Cortex A72 Processor has a built-in WLAN 802.11 b/g/n/ac (2,4 + 5,0 GHz) LAN RJ45 10/100/1000 Mbit (Gigabit LAN over USB 3.0) Operating Power 5V@3A via USB Type-C Port. Dual-Display Micro HDMI Ports which supports H 265 Decode for 4K Video @60p.

Fig.1: Raspberry pi version 4

5MP Pycam is used for the Object recognition and detection function as well as the text reader function. Headphones are used for voice assistance.

Fig.2: Pycam

The e-tracker consists of a GPS module and a T-call+GPRS module. NEO -6M is used as the GPS module and TTGO T-call ESP32 and SIM800L GPRS module.

Fig.3: TTGO T-call ESP32 Module

Fig.4: NEO-6M

2.2 Software

The main programming language used is python in Thonny IDE. Several python packages are used including OpenCV for accessing camera for Text Reader and Object Detection, pytesseract for Object Character Recognition in the Text reader to acquire characters from an image, pyttsx3 used for convert text to speech, speech_recognition for converting speech to text. Programming in embedded C in Arduino IDE is used for E-Tracker.

2.3 Procedure and methodology

Any device being made for aiding visually differently-abled people is best expected to be small and simple to use. It is also important to provide them with audio feedback and also take up audio input, along with speech-to-text and text-to-speech converters. As commonly used in android systems, the device should also be independent of touch screens. Therefore, building such a system with all these constraints is a real-time challenge.

The aim here is hence to build a system that is compatible as well as provides a future scope for extensions. The various features incorporated in the device include object recognition, E-tracking, SOS for emergencies, and text reading.

2.3.1 Block Diagram

SAVI consists of a Raspberry Pi module that acts as the central processing unit to which the camera and other components like GPS+GSM modules, headphones, etc are connected. The device functions effectively when these components are well interfaced with the Raspberry pi unit. The basic block diagram of the system is described in Fig.1.

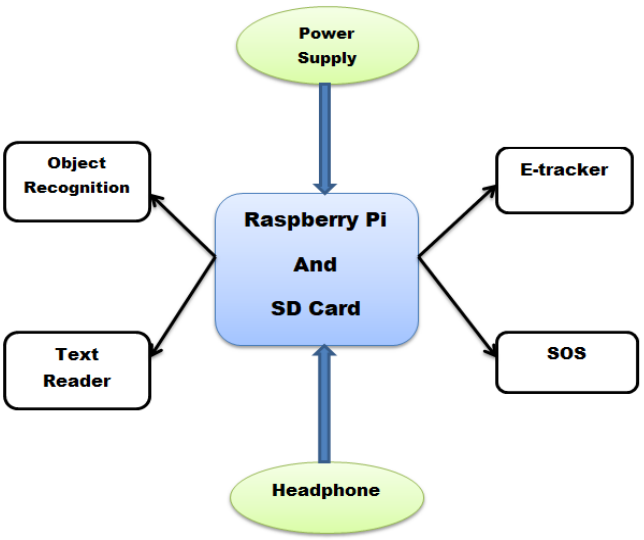

Fig.5: Block diagram of SAVI

A 16GB SD (Secured Digital) card is inserted into the Raspberry pi slot to store data. All the connections between the components and microcontroller are via GPIO (General Purpose Input Output) pins.

2.3.2 Raspberry Pi with GPS+GSM Module

To ensure proper tracking of the locations and to communicate it with mobile networks the GPS (Global Positioning System) and GSM (Global System for Mobile Communication) are interfaced with the microcontroller. The latitude and longitude obtained from the antenna of the GPS are used by the microcontroller and GSM can send this information to mobile phones as SMS text messages. The interface is done using GPIO pins.

2.3.3 Raspberry Pi with Camera

The picture of the objects and texts that are in front of the webcam is taken by the camera. These pictures are then stored in the SD card of the microcontroller which is then used during the recognition process. To interface the camera with pi a webcam package is installed. OpenCV (an Open Source Computer Vision) is used for processing the stored pictures. OpenCV is a library of programming functions mainly aimed at real-time computer vision.

2.4 Working of SAVI

The entire system can be divided into several subsystems namely object recognition, Text reading, and SOS.

2.4.1 Object Detection and Recognition

The object detection and recognition module use the images that are captured and stored by the camera in the SD card of Raspberry pi to recognize the object in front of the system. The process takes place step by step as described in Fig.6. When the user wants to search for an object, he/she presses a start button upon which the process gets initiated. The audio input regarding which object has to be identified can be given with the help of the connected headphone, which is converted to text. Once the conversion gets completed, real-time object detection and the listing out of the detected objects are being done. The text and list of objects identified are compared, if there is a match, it is indicated as an audio output "Object Detected". If the object that the user wants to identify is not matching with the list of objects detected, then it is also indicated using an audio output, "Object Not detected".

Fig.6: Flowchart of SAVI

2.4.2 Text Reading

The text reading module makes use of the images captured and stored by the camera in the SD card of the Raspberry pi. To initiate the process the start button is pressed. When an audio input is given as "Read me the text" with the help of the connected headphone, the camera captures an image of what is in front of it, and the text in that image gets readout. He/ she can hear it through the headphone.

2.4.3 SOS

The SOS (Save Our Souls) Module is designed for the safety of the user. In case the user feels emergency or danger he/she can connect with a well-wisher by pressing any one of the 2 buttons given for safety measure. Upon pressing button 1, a call is initiated to the well-wisher's android phone. And if button 2 is pressed, a distress message is sent to the well-wisher's phone along with the user's location. Thereby, the well-wishers can track down the location of the user. All these are done with the help of the GPS+GSM module interfaced with the microcontroller.

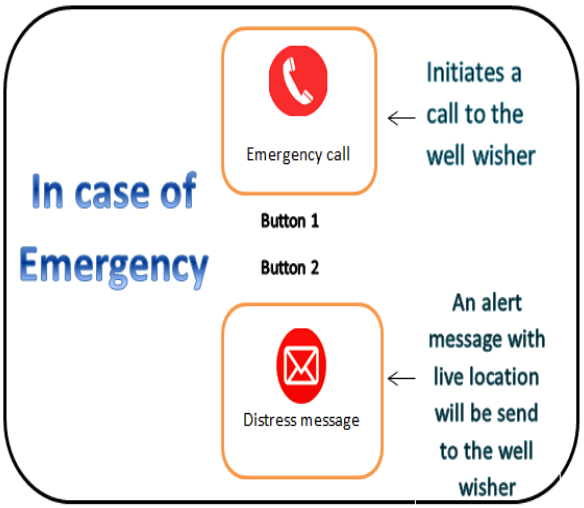

Fig.7: Basic working of SOS

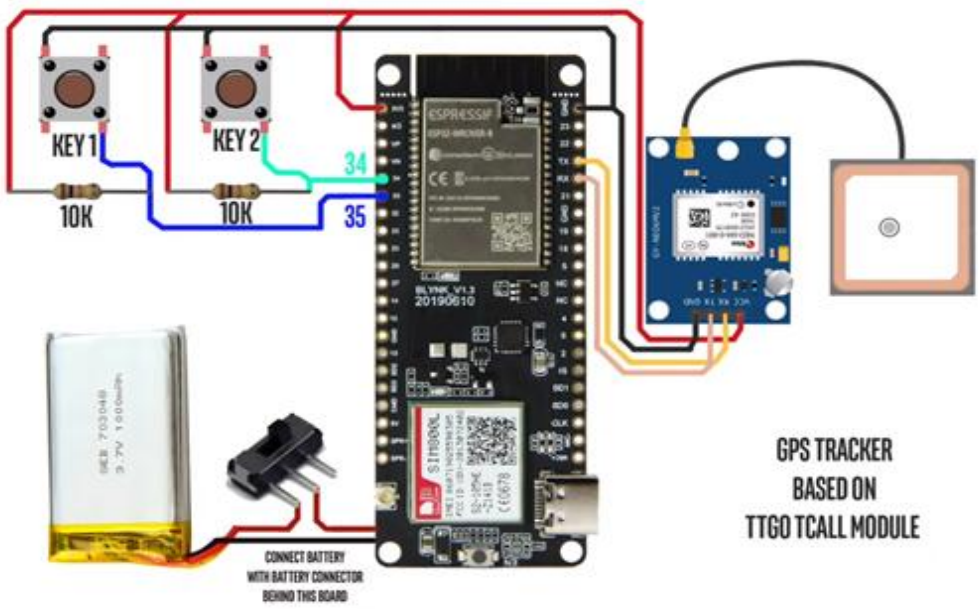

Fig.8: Circuit diagram of the SOS module

III. PERFORMANCE EVALUATION

The system is activated when the user presses a button. This initiates the process, then an audio input will be taken and converted to text by importing the STT and then does the real-time object detection.

In real-time object detection, the pycam captures the images and stores them in the SD card of the microcontroller, which is further used for detection. Identification of objects from the real-time image is with the help of OpenCV. After detecting the objects in the scene, they are listed out. The listed objects that were detected and the texts converted from audio input are compared to give an output that the required object has been detected or not. If the object in the text matches with the real-time objected detected then the output will be given as “Object Detected” else “Object not Detected”. Fig.9 shows the output when a bottle was given as the input to be detected. It listed the objects in the real-time image as cell phone, person, and bottle. Since the input matched with listed objects, audio output is given as “Object Detected”.

Fig.9: Real-time object recognition with audio output

The input is given as "read for me", then Text_Reader is imported. This does read out the text from the image captured and can be heard using the headphone. Fig.10 shows the text in front of the camera being correctly displayed and readout.

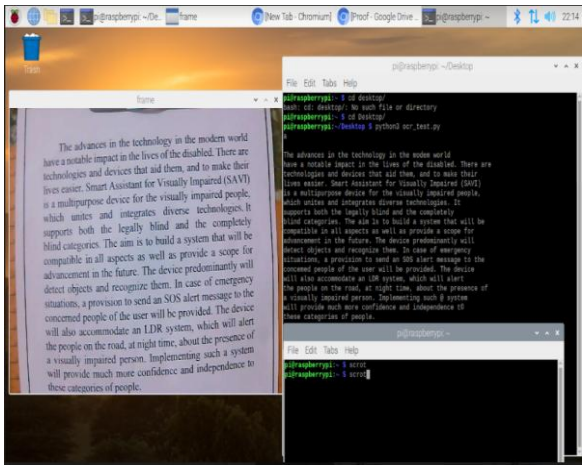

Fig.10: Text being read out in real-time

The GPS does print the longitude and latitude once obtained and in case of emergency when the call button is pressed with the help of GSM call gets placed to a well-wisher or if the message alert button is pressed a message is sent along with the location details obtained from GPS. This does the SOS function.

The proposed system has been tested for its features like real-time object recognition, text reading, and SOS successfully.

IV. CONCLUSION

The study on Blind Person navigation systems has been done on multiple occasions & multiple platforms. By using such techniques, we can help these people in every possible way. The proposed system, SAVI - Smart assistant for the visually impaired is a device that would create a significant change in the lives of the blind. This would enable the visually impaired section to experience the modern technological advancements in the best possible manner which can change their lives and make them better. The system supports object as well as facial recognition. It identifies the presence of an object that the user asks for. It takes up an audio input and compares it with the objects it has listed from the real-time image and gives corresponding audio outputs and provides a mechanism to help the user in emergencies. It consists of Raspberry pi as the central processing unit and all the other subsections being attached to it. Object detection and recognition are done with the help of a pycam and convolutional neural network that is mobilenet. The emergency security system implemented using an SOS panic button and related applications which when pressed in emergencies would send SMS alerts/place a call to the connected devices, then an E-Tracking and navigation system implemented using GPS and GSM modules. The proposed system is a compatible and cost-efficient system that makes the blind community feel secure and independent. It provides scope for future extensions.

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