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Guidance System for Visually Impaired People

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ABSTRACT: This project aims to develop an innovative guidance system for visually impaired individuals, leveraging a multi-modal approach to enhance their navigation and interaction with the environment. The system integrates a Convolutional Neural Network (CNN) based emotion recognition model implemented in Keras, allowing it to detect and respond to the emotional cues of those around the user. Additionally, the system incorporates Google Text-to-Speech (gTTS) technology for converting textual information, gathered through both image-to-text and speech recognition functionalities, into spoken words. Furthermore, it employs YOLOv5 for real-time object detection, providing users with crucial environmental awareness. By combining these technologies, the guidance system seeks to empower visually impaired individuals with a comprehensive and adaptive solution that not only assists in navigating physical spaces but also facilitates social interactions by interpreting emotional signals and converting visual information into accessible formats. Visually impaired individuals encounter numerous challenges in navigating and interacting with their environment independently. To address these challenges, advanced guidance systems have been developed, leveraging emerging technologies to enhance mobility, safety, and overall quality of life for this population. This abstract provides a comprehensive overview of the state-of-the-art guidance systems designed specifically for visually impaired individuals.

KEYWORDS: gTTS, Pyttsx, Image Captioning, Face Recognition, Facial Expression Recognition, Object Detection, Yolo v3, Optical Character Recognition.

HISTORY: The history of guidance systems for visually impaired people is a testament to human ingenuity and the evolving landscape of technology. While the concept of aiding the visually impaired in navigation predates modern technology, significant advancements have occurred in recent decades, driven by a combination of scientific research, technological innovation, and a growing awareness of accessibility needs. Early efforts to assist visually impaired individuals in navigation date back centuries. Canes were among the first tools used for this purpose, providing physical feedback about obstacles. In the 20th century, guide dogs were introduced as trained companions to assist individuals with visual impairments in navigating their environment safely. The advent of electronics and miniaturized sensors in the mid-20th century paved the way for the development of electronic guidance systems. In the 1960s and 1970s, researchers began experimenting with ultrasonic sensors and auditory feedback to help visually impaired individuals detect obstacles in their path. Braille-based guidance systems, utilizing tactile feedback, were developed to assist visually impaired individuals in reading signs and labels in public spaces. The integration of computer vision technology in the late 20th and early 21st centuries revolutionized guidance systems for visually impaired individuals. Computer vision algorithms enabled the recognition of objects and obstacles in real-time, offering enhanced situational awareness and navigation assistance. Wearable devices, such as smart glasses and haptic feedback systems, have emerged as promising tools for assisting visually impaired individuals in navigation and orientation tasks. These devices leverage technologies such as LiDAR, inertial sensors, and augmented reality to enhance spatial awareness and provide intuitive navigation cues.

I. INTRODUCTION

Vision is a beautiful gift of being able to see. Vision enables individuals to see and comprehend the encompassing scene. Till date daze individuals battle a considerable measure to carry on with their hopeless life. In the displayed work, a basic, shabby, well disposed client, virtual eye is composed and actualized to enhance the versatility of both visually impaired and outwardly disabled individuals in a particular region. This project is helps blind people to map their world using the sense of hearing. It's a visual based project consisting of few main components such as camera, raspberry pi and earphones mounted together and additional working technologies of the internet interlinked. The input of the project will be an image/video (multiple frames), the image captured and analyzed with the help of the camera interfaced to the raspberry pi/IOT technology. Hence the object is detected and audio information is conveyed to the blind person through earphones. This system deals with an approach to make better life for blind people as it well equipped with the latest technology and it is meant to aid the visually impaired to live a life without constraints. Visual deficiency is a condition of lacking visual recognition because of physiological or neurological components Virtual impairment may cause people difficulties with normal day activities. the incomplete visual impairment speaks to the absence of development in an optic nerve or visual focus of the eye. According to recent estimation 253 million people live with vision impairment. 36 billion are blind & 217 million have moderate to servere vision impairment. The loss sight causes enormous human suffering for the affected individuals and there families .Vision allows human being to view the surrounding world. In the world, so many people of different age range who are visually impaired are estimated to be 285 million, and out of them 39 million are blind according to WHO. These people may be from various backgrounds such as farmers, teachers, sportsmen, housekeeper, housewives and many more. They may be from different age groups. Some of them may be children, some are youngsters and some of them are old people. So for each and every individual who is visually impaired need to face different challenges every day. Even though they have different abilities and they can achieve many good things in life, sometimes they need help of someone for some tasks. To help such people and make their day-to-day activities easier is the main motivation behind this project. Blind people need to be provided with special facilities so that they can live comfortably. We wanted to give them a helping hand that they use as their assistant.

II. MAIN OBJECTIVE OF THE PROJECT

1. Obstacle Detection and Avoidance: Guiding visually impaired individuals safely around obstacles such as pedestrians, vehicles, furniture, and other hazards in both indoor and outdoor environments.
2. Localization and Mapping: Enabling visually impaired individuals to determine their current location and orientation accurately, as well as providing contextual information about nearby landmarks, points of interest, and destinations.
3. Real-Time Feedback: Offering real-time auditory, tactile, or haptic feedback to convey information about the surrounding environment, including the presence of obstacles, changes in terrain, and navigation instructions.
4. Accessibility and Usability: Ensuring that guidance systems are designed with the needs and preferences of visually impaired users in mind, incorporating features such as intuitive interfaces, customizable settings, and compatibility with assistive technologies.
5. Integration of Emerging Technologies: Leveraging advancements in technologies such as computer vision, machine learning, wearable computing, and sensor fusion to enhance the capabilities and effectiveness of guidance systems.
6. Safety and Reliability: Prioritizing the safety and well-being of visually impaired users by designing guidance systems that are robust, reliable, and capable of functioning effectively in diverse environmental conditions and situations.

III. LITERATURE SURVEY

A literature survey on guidance systems for visually impaired people reveals a rich and evolving landscape of research and development aimed at enhancing mobility, independence, and quality of life for this population. Here is a summary of key findings and notable contributions from the literature.Overall, the literature survey underscores the interdisciplinary nature of research on guidance systems for visually impaired people, drawing upon expertise from fields such as engineering, computer science, psychology, and rehabilitation. By addressing the diverse needs and

challenges faced by visually impaired individuals, guidance systems hold the potential to empower users, promote independence, and foster greater inclusivity in society.

[1] In 2014, Rupali kale et al, proposed an efficient and a low-cost system which provides information about the environment scenario of static and dynamic objects around them. This system was based on Global Positioning System (GPS) and obstacle detection and object avoidance technologies. Advantage of this system lies in the fact that it has low production cost, low design time, less space, low power consumption; this system is suitable for both indoor and outdoor environment. This system was a combination of various working units that provides a real time position monitoring of the user and provides a dual feedback which makes the navigation more accurate and safe.

[2] In 2015, Pooja Sharma et al, built a cheap fast & easy to use system which is an innovative solution to usually impaired people. The system is a wearable equipment that has head hat, mine hand stick & foot shoes that provides a help to usually impaired person to navigate on his own & prevent him from obstacles and prevent accident . ultrasonic sensors is used for scanning predetermined area around them the signals that are received communicate the states back to earphone using SD card technology the plus point about the work is that is suitable for both indoor & outdoor systems , design& production cost is low.

[3] In 2016, Shradha Andhare et al, designed a small, lightweight white cane that provides the information about the direction along with the information that helps to avoid obstacles based on ultrasonic sensor. This system has inbuilt a buzzer, accelerometer and Pit sensor for accurate results. GSM-GPS module is used to accurately spot the location of the blind person and for efficient wireless communication. This approach is conventional method of guiding the blind against the odds. Few drawbacks related to this system is that GPS signals is not received in the indoor regions and there is delay in response and receiving data from satellite side.

[4] In 2016, Harshali kumbhar et al, proposed a model which gives information about dynamic object and the environment receiver to the blind people . The system consists of ultrasonic sensor to sense the obstacles & these sensors are fit in the shoes of the blind , one in case & other in cap , the other component is the camera which is used to find difference between the wall end the door . The main motto of the proposed is to make the usually challenged lead an independent life . This system is well adopted because setting in the destination is easy and less space & power consumption. The drawback of the system is that the sensor data is not collected properly and understanding complex direction is difficult.

[5] Title: " JARVIS: AN INTERPRETATION OF AIML WITH INTEGRATION OF GTTS AND PYTHON – 2019", This is the first system proposed to intelligently speak to the users in natural language. It is inspired by the character JARVIS played by Edward Jarvis in the Marvel Studio Productions Iron Man who served Tony Stark [Robert Downey Jr] as his most intelligent hypothetical assistant lending him help into every possible aspect such as Technology, Medical, Social and other coherent curriculum aspects. Similarly, the system provides spoken solution to any real world problem. This is made possible with the integration of the most enhanced platform of the computer industry i.e. Artificial Intelligence which is consequently provided by Google but re-transformed into multiple appearances by the world- wide community.

IV. METHODOLOGY

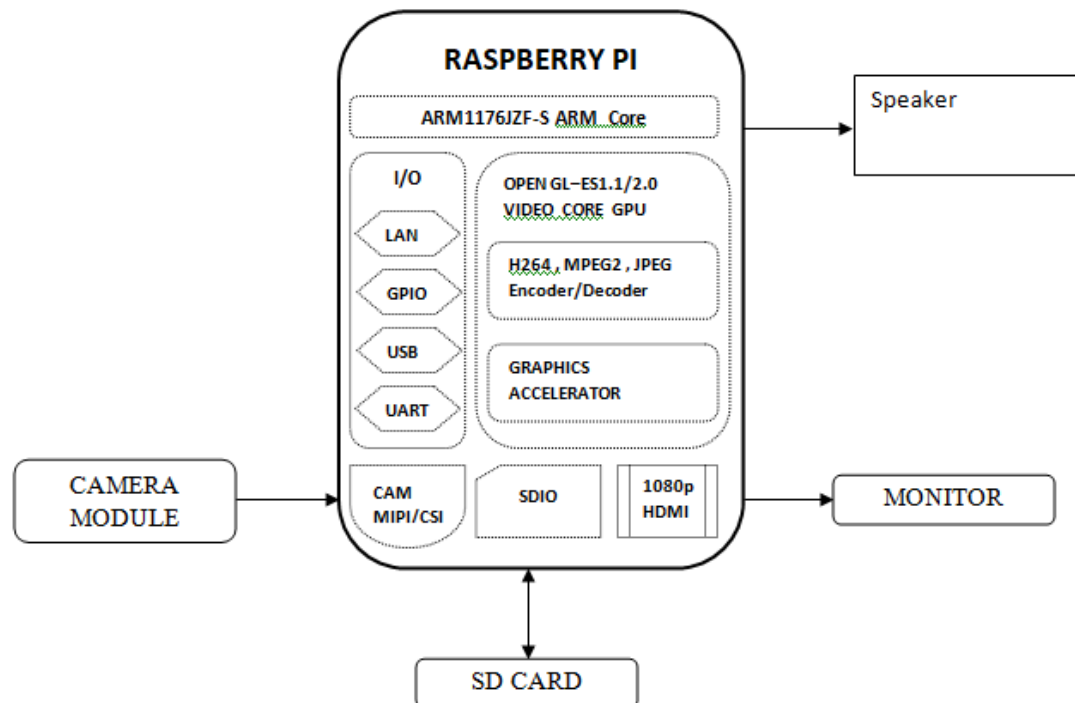


Fig 1: System Design

Projects consist of mainly Raspberry Pi , Camera , Speaker

Mainly Project contains two modules

1. Object Detection and Recognition
2. Text Reading

Module 1:

Text Reading: Optical Character Recognition which is the original method of character recognition many times gives poor recognition rate due to error in character segmentation. Segmentation is an important task of any OCR system. It separates the image text documents into lines, words and characters. The accuracy of OCR system mainly depends on the segmentation algorithm being used. Segmentation of Handwritten text is difficult when compared with Printed or Printed English or any other Printed document its structural complexity and increased character set. It contains vowels, consonants. Some of the characters may overlap together. The profile based methods can only segment non-overlapping lines and characters. This paper addresses the segmentation of Handwritten text document, the most popular script of Indian sub-continent into lines, words and characters. The proposed algorithm is based on projection profiles. Experimental results it is observed that 100% line segmentation and about 98% character segmentation accuracy can be achieved with overlapping lines, words and characters.

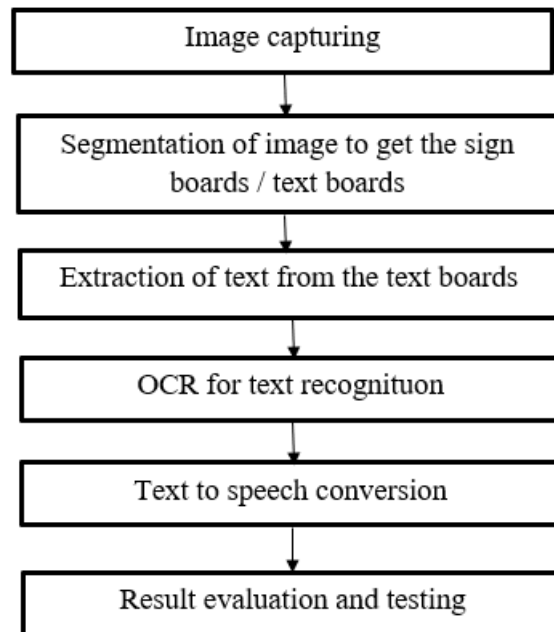
Image acquisition: In this step, the inbuilt camera captures the images of the text. The quality of the image captured depends on the camera used. We are using the web camera which 5MP or more camera with a resolution of 2592x1944.

Image pre-processing: This step consists of color to gray scale conversion, edge detection, noise removal, warping and cropping and thresholding. The image is converted to gray scale as many OpenCV functions require the input parameter as a gray scale image. Noise removal is done using bilateral filter. Canny edge detection is performed on the gray scale image for better detection of the contours. The warping and cropping of the image are performed according to the contours. This enables us to detect and extract only that region which contains text and removes the unwanted background. In the end, Thresholding is done so that the image looks like a scanned document. This is done to allow the OCR to efficiently convert the image to text.



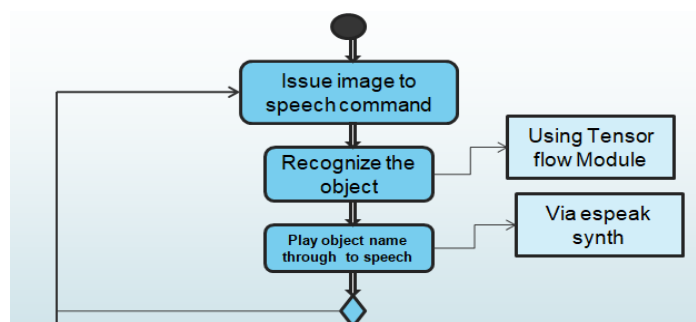
Image to text conversion: The above shows the flow of Text-To-Speech. The first block is the image pre-processing modules and the OCR. It converts the pre-processed image, which is in .png form, to a .txt file. We are using the Tesseract OCR.

Text to speech conversion: The second block is the voice processing module. It converts the .txt file to an audio output. Here, the text is converted to speech using a speech synthesizer called Festival TTS.



Object Detection and Speech Output:

Video surveillance is a process of analyzing video sequences. It is an active area in computer vision. It gives huge amount of data storage and display. There are three types of Video surveillance activities. Video surveillance activities can be manual, semi-autonomous or fully-autonomous. Manual video surveillance involves analysis of the video content by a human. Such systems are currently widely used. Semi-autonomous video surveillance involves some form of video processing but with significant human intervention. Perform simple motion detection. Only in the presence of significant motion the video is recorded and sent for analysis by a human expert. By a fully- autonomous system, only input is the video sequence taken at the scene where surveillance is performed.



Following Fig.2 describes the system architecture of the device which explains the interfacing of different modules of the system with camera interface and headset for voice over conversations. There are four different sets of commands divided with respect to modules. Whenever the system will ask the user for the choice, user will give the choice. The given choice is compared with existing available choices and then the task associated with the specific command will be performed. If the command is not recognized by the system then again user is given a chance to choose another

command. The cycle continues until the user chooses to exit the system. The modules in the system are image captioning, object detection, face-emotion detection, face recognition, voice-over chat bot and reading.

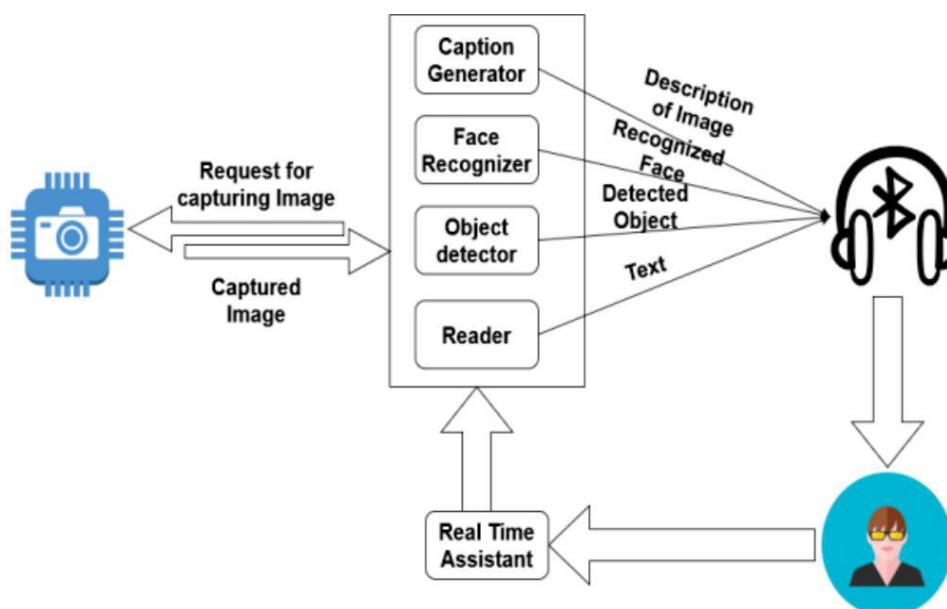


Fig 2: Architecture

V. EXISTING SYSTEM

In the earlier days, blind people can only read **Braille script**. Braille is a tactile writing system used by people who are blind. It is traditionally written with embossed paper. Now-a-days Braille user can read computer screens and other electronics support using refreshable braille displays. In Braille system, the language will go from left to right across the page, just like printed words. The symbols which represent each letter are prepared up of between one and six dots based on the figure of six dots which we would pick up on a dice or a domino. Later in the evolution there exists screen reader system which is a computer program that enables the blind masses to interpret what is shown on the screen through speech. The next technology which is beneficial to the BVI is Finger Reader. It is a wearable device in finger. It helps the BVI to access the plain printed text. People who ware this device, scan a text line with their finger and in a result they get an audio feedback of the words and also a haptic sense of the layout. These senses may be the start or end of the line, new line and so on. It also alerts the reader if he moves away from the baseline thus it helps him maintain straight scanning.

VI. PROPOSED SYSTEM

The proposed system consists of **input** – microphone to record voice modulation, camera to capture image, keyboard to type a message and **output** – speaker and device screen to display the texts and the images. The user can give reply as text message and the device does text to speech (TTS) conversion. The output is obtained from a small and powerful speaker. The image is captured through the camera and the reading of a text can be achieved by text to speech (TTS) conversion. The device also recognises the gestures of the users and will displays the words related to it. Then the device does speech to text (STT) conversion and displays it on the device screen, based on what the normal person conveys. It takes inputs from the microphone.

1. Sensor Fusion and Perception: The system will utilize a combination of sensors, including ultrasonic sensors, LiDAR, and cameras, to detect obstacles and environmental features in real-time.
2. Wearable Device Integration: The guidance system will be designed as a wearable device, such as smart glasses or a haptic feedback system, to provide hands-free navigation assistance

3. Navigation and Route Planning: The system will offer navigation assistance for both indoor and outdoor environments, utilizing GPS, inertial sensors, and mapping data to calculate optimal routes.

4. Auditory and Haptic Feedback: The system will provide auditory and haptic feedback to convey navigation cues and alerts to the user. Different types of feedback will be employed to indicate the proximity and direction of obstacles, changes in terrain, and upcoming navigation instructions.

5. Personalization and Customization: The system will allow users to personalize their navigation experience based on their preferences and needs. Customization options may include adjusting the volume and frequency of auditory cues, selecting preferred navigation modes, and setting preferences for route preferences (e.g., avoiding stairs or crowded areas).

6. Accessibility Features: Accessibility features will be incorporated into the system to ensure usability for users with diverse needs and abilities. This may include voice-guided navigation, text-to-speech functionality, high-contrast interfaces, and compatibility with assistive technologies.

7. Continuous Improvement and Updates: The proposed system will be designed with scalability and adaptability in mind, allowing for continuous improvement through software updates and integration of emerging technologies. User feedback mechanisms will be implemented to gather input and insights for refining the system's features and performance over time.

By integrating these components and features, the proposed guidance system aims to provide visually impaired individuals with a reliable, intuitive, and empowering tool for navigating their surroundings with confidence and independence.

VII. APPLICATIONS

The guidance system aims to assist visually impaired individuals in navigating their surroundings safely and independently. It utilizes a combination of sensors, feedback mechanisms, and intelligent algorithms to detect obstacles and provide guidance.

1. Raspberry Pi: Acts as the central processing unit and interface for sensors and feedback mechanisms.
2. Ultrasonic Sensors: Detect obstacles in the environment by emitting and receiving ultrasonic waves.
3. Vibration Motors: Provide haptic feedback to the user, indicating the direction and proximity of obstacles.
4. Speaker: Delivers auditory feedback, including spoken instructions and alerts.
5. Battery Pack: Powers the system for portability.
6. Feedback Generation: Based on processed data, the system generates feedback through audio and haptic mechanisms. TTS provides spoken instructions and alerts. Vibration motors indicate the direction and proximity of obstacles.
7. User Interface: Designing an accessible user interface is crucial for visually impaired users. Keep the interface simple, intuitive, and easy to navigate using tactile or auditory inputs. Provide options for customizing settings such as sensitivity levels, feedback preferences, and navigation modes. Consider incorporating voice commands for hands-free operation.

VIII. ADVANTAGES

Using a Raspberry Pi-based guidance system for visually impaired individuals offers several advantages:

1. Affordability: Raspberry Pi boards are affordable compared to proprietary hardware solutions, making the system accessible to a wider range of users.
2. Customizability: The open-source nature of Raspberry Pi allows for extensive customization according to the specific needs and preferences of visually impaired users.
3. Scalability: The modular design of Raspberry Pi-based systems allows for scalability, enabling additional features and functionalities to be added as needed.
4. Community Support: The Raspberry Pi community provides extensive support, resources, and documentation, facilitating development and troubleshooting of the guidance system.
5. Accessibility: Raspberry Pi-based systems can be designed with accessibility in mind, incorporating features such as tactile inputs, voice commands, and auditory feedback to accommodate visually impaired users.

6. Portability: Raspberry Pi boards are compact and lightweight, making the guidance system portable and suitable for use in various environments, including indoors and outdoors.
 7. Integration with External Hardware: Raspberry Pi boards can easily interface with a wide range of external hardware components, such as ultrasonic sensors, GPS modules, and vibration motors, enhancing the capabilities of the guidance system.
 8. Learning Opportunity: Building a guidance system using Raspberry Pi provides a valuable learning opportunity for users to gain hands-on experience with hardware integration, software development, and assistive technology design.
- Overall, utilizing Raspberry Pi for a guidance system offers a cost-effective, customizable, and accessible solution that can significantly improve the mobility and independence of visually impaired individuals.

IX. CONCLUSION

The device is used to convert text/image to voice for blind, speech to text conversion for deaf and conversion of hand gestures to text for dumb people. We have designed the prototype model for blind, deaf and dumb people into a single compact device. The advantage of this device is that it can be easily carried (portable) due to its less weight and size. The device can be used as smart assistant for differently abled people to communicate with others and it is a language independent system. The image captioning model is used to describe the image in natural language. Face detection modules will help recognize friends and family members. Reading module will extract text from the image and last one object detection will recognize the object in front of the person. Although the system is very effective and useful for visually impaired people, it will be hard for chat-bot to recognize the command in noisy environment, chat-bot may get confused between voice of an user and person nearby it. The system will need high processing power to run the computer vision deep learning models. Moreover, the modularity and flexibility of Raspberry Pi enable seamless integration with a variety of sensors, feedback mechanisms, and software components, allowing for tailored solutions that cater to the unique needs of each user. Furthermore, the collaborative nature of the Raspberry Pi community fosters innovation and support, ensuring ongoing development and refinement of the guidance system. Through user-centered design and continuous iteration based on feedback, this technology strives to enhance the quality of life for visually impaired individuals. In essence, the guidance system for visually impaired people using Raspberry Pi embodies a convergence of affordability, adaptability, and accessibility, ultimately empowering users to navigate their world with greater independence, safety, and dignity.

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