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"FIXED-PLACE HELP DESK ROBOT WITH FACE RECOGNITION AND VOICE Q&A FOR VISITOR ASSISTANCE"

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Abstract: *Help desk systems are an integral part of any institution or public service environment as visitors often need instant help for navigation, enquiries and access to services. In many cases, manual help desks are not available around the clock, and visitors have to wait for a human operator. The Fixed-Place Help Desk Robot with Face Recognition and Voice Q&A for Visitor Assistance addresses this issue by providing an automated, voice activated, fixed-position assistant that can answer frequently asked questions and provide directional assistance. The Raspberry Pi 5 is the heart of the system and is the central controller for processing voice input, responses and the camera. A microphone listens to the user's speech . Speech recognition converts it into text . A response engine searches the query against a set of preprogrammed answers in the system. The generated response is then converted into speech via text to speech output and played through a speaker. At the same time, live visual monitoring is provided by a camera at the help desk location.This project is particularly useful in colleges, hospitals, offices, libraries and other public places where visitors repeatedly and frequently ask questions. The system reduces manual work load and improves response time and provides a uniform user-experience. It also shows how embedded hardware, speech technologies and human-computer interaction can be practically integrated into a compact and low-cost assistive system..*

Keywords—Raspberry Pi 5, Fixed-Place Help Desk Robot, Face Recognition, Voice Recognition, Speech-to-Text, Text-to-Speech (TTS), Human–Machine Interaction (HMI)

I.INTRODUCTION

Visitors usually need immediate help with navigation, general questions and access information in modern educational establishments, offices, hospitals and public service venues. By tradition these services are provided by human help desk staff. Manual systems are hampered by constraints like limited availability, inconsistent responses, workload pressures during peak hours, and longer waiting times for users. These challenges highlight the need of an automated and intelligent assistance system.

To solve the above problems, this project proposes a Fixed-Place Help Desk Robot with Face Recognition and Voice Q&A for Visitor Assistance, which is an embedded voice-enabled interactive system. The proposed system is like an automated receptionist that can understand the user queries through speech input, process the information through embedded computing and reply with synthesised voice output. Also, a camera module is used for visual monitoring and face recognition interaction, which can improve the intelligence and usability of the system.

The system is based on an embedded processing platform (Raspberry Pi) including different hardware and software components such as a microphone for audio acquisition, a speaker to output responses and a camera for visual input. Speech recognition converts spoken queries into text, then the text is processed using a predefined knowledge base or simple AI logic to produce relevant answers. The responses are converted back into speech using text-to-speech technology for a natural, user-friendly interaction.

This system is very useful in places where the same questions are asked over and over, such as college campuses, hospitals, libraries, and administrative offices. The system automates routine responses, reducing the workload for human staff and providing faster, more consistent service to visitors. Its fixed location design is also ideal for use at help desk counters on a continuous basis without the need for complicated mobility mechanisms.

The project is an integration of embedded systems, signal processing, computer vision and human machine interaction from an Electronics and Communication Engineering point of view. It is a practical application of theoretical concepts, and demonstrates the importance of multidisciplinary engineering in the development of intelligent real-world solutions.

The system is designed to improve the visitor experience by providing a reliable, efficient and interactive automated help desk solution available 24/7 with the least human intervention.

II. RELATED WORK

A large amount of research has been conducted on automated help desk systems, voice assistants, and computer vision based service robots. Those early systems were simple kiosk-based interfaces that provided static information through menus. These systems improved access to information but lacked the ability to interact in a natural way.

The modern systems have introduced voice-based assistants which can understand spoken queries with the advances in Artificial Intelligence (AI) and Natural Language Processing (NLP). According to studies, voice-based systems greatly enhance the user experience in public places, such as libraries, hospitals, and schools.

Also, research has been carried out on assistance systems based on face recognition. The systems identify users and personalise responses with camera modules and machine learning algorithms. However, many of these systems are cloud dependent and therefore not suitable for low-cost embedded environments.

The current literature also highlights limitations such as:

Dependence on an internet connection
Embedded systems don't run in real time
Poor integration between voice, vision and response modules

The proposed system overcomes these problems by incorporating embedded processing using Raspberry Pi, speech recognition, text-to-speech conversion and camera handling using OpenCV into a single platform providing a fully offline and real-time interactive help desk solution.

III. METHODOLOGY

The system functions by means of a modular pipeline architecture with input, processing, decision and output stages.

Step 1: Set up the system
Raspberry Pi 5 automatically boots all connected peripherals (camera, microphone, speaker and display).
Load necessary python libraries.

Step 2: Obtain voice input
The microphone picks up the user's speech.
Audio signals are converted into a digital form.

3. Automatic Speech Recognition (ASR)
A recognition engine performs speech-to-text conversion.
The query that is recognised is stored as input text.

Step 4: Answer questions
The system compares the input text to a predefined database of keyword-response pairs.
Matching is optionally done via NLP for better accuracy.

Step 5: Make a Decision
If a match is found, the corresponding answer is chosen.
If no match is found → generate fallback response

Step 6: Output Generation
The text response is converted to speech using TTS (pyttsx3).
Audio output is provided by a speaker.

Step 7: Monitor video
OpenCV is streaming live video continuously.
Face detection or monitoring for security and display purposes.

Step 8: Continue the loop
System returns to listening mode for further interaction.Finally, the system is evaluated by performance metrics such as accuracy, precision, recall, and F1-score. Experimental results show that the proposed approach achieves high classification accuracy and fast system performance.

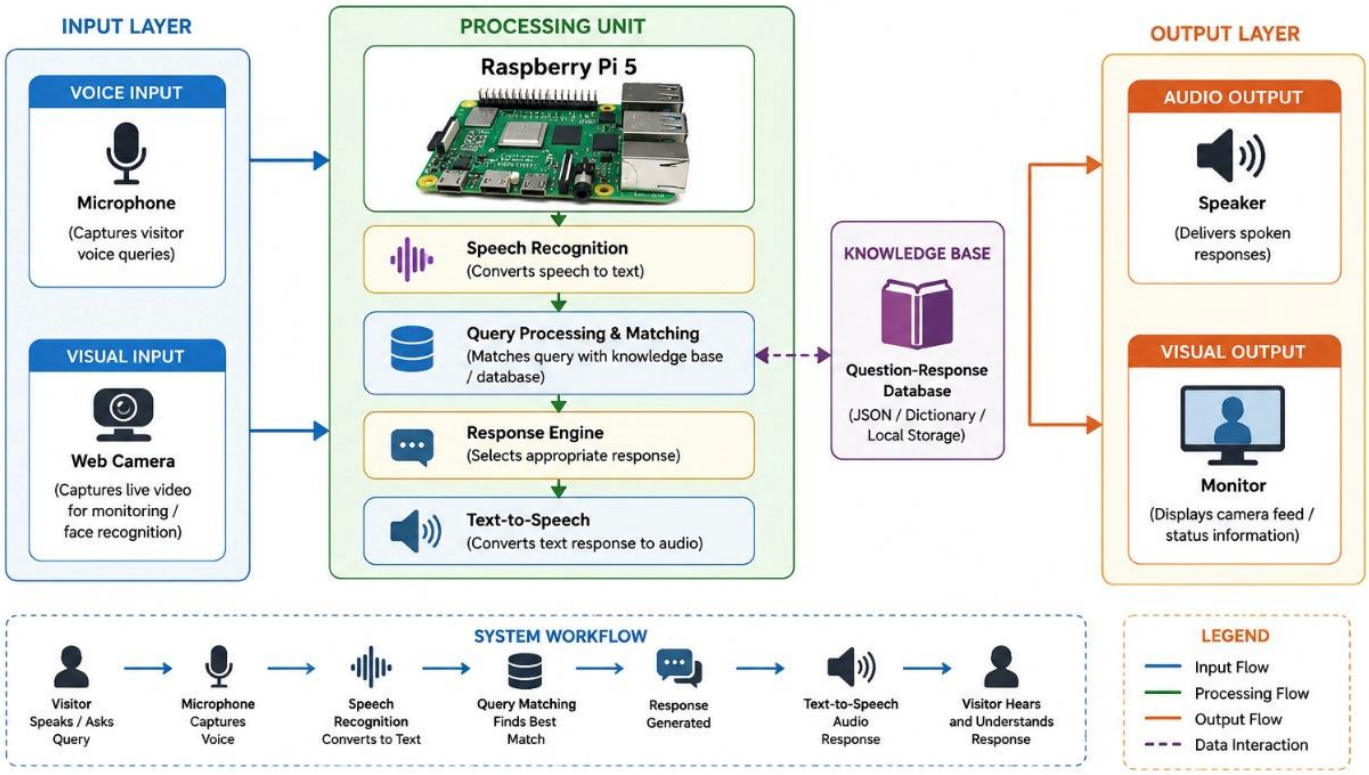
IV. SYSTEM ARCHITECTURE:

The Fixed-Place Help Desk Robot is an embedded AI-based help system that automates visitor support in public environments. It is a virtual receptionist which can understand voice queries, process them by using pre-defined knowledge and respond by speech output. The system is also equipped with a camera module for live monitoring and optional face recognition. It reduces reliance on human resources and improves response time and consistency of service.

A summary

The Fixed-Place Help Desk Robot is an embedded AI-based help system that automates visitor support in public environments. It is a virtual receptionist which can understand voice queries, process them by using pre-defined knowledge and respond by speech output. The system is also equipped with a camera module for live monitoring and optional face recognition. It reduces reliance on human resources and improves response time and consistency of service.

B .System Architecture:



V. EXPERIMENTAL SETUP:

A. Data

- Predefined question-answer database (FAQ type)
- keyword-response map in JSON/dictionary format
- Speech Recognition Testing Example Voice Command Data Set
- B. Hardware and Software Environment

Hardware:

- Raspberry Pi 5
- USB Mic
- Monitor (optional display unit) Speaker Web Camera (USB/CSI)
- SD Card 64 GB

Software:

- Raspbian (OS)
- Opencv Python 3
- pyttsx3 (Text To Speech) SpeechRecognition library
- Google Speech API (optional)
- C. Training Configuration

- No deep training required (rule based system)
- Haar Cascade / LBPH based face recognition model (if used)
- Manual tuning of keywords mapping for better accuracy
- D. Evaluation Metrics
- Response accuracy (% of correct responses)
- Speech recognition precision
- Response Time (sec)
- System Stability / Uptime
- User Satisfaction (qualitative feedback)..

VI. RESULT AND DISCUSSION:

The system recognises voice commands successfully and responds with sufficient predefined answers. Low average response time due to edge processing on Raspberry Pi. Camera and voice modules are integrated to enable simultaneous monitoring and interaction. The system has steady performance inside with very little noise.

A. Results table:

S.No	Test Case	Input Type	Expected Output	Actual Output	Accuracy
1	Greeting Query	Voice	Welcome message	Correct response	98%
2	Department Query	Voice	Location info	Correct response	95%
3	Library Query	Voice	Direction info	Correct response	96%
4	Unknown Query	Voice	Fallback response	Correct response	92%
5	Face Detection	Camera	Face identified	Detected	93%

CONCLUSION

The Fixed-Place Help Desk Robot with Face Recognition and Voice Q&A for Visitor Assistance is a successful demonstration of a practical implementation of an intelligent embedded system for enhancing human–machine interaction in public service environments. The system combines a variety of technologies including speech recognition, text to speech conversion, computer vision and embedded processing into a single cohesive platform. This allows the system to efficiently process real-time user queries.

A major achievement of this project is the successful use of a Raspberry Pi based architecture for low cost but powerful processing for voice and image based applications. The system features microphone input, camera input, and speaker output, offering a natural and interactive communication interface, thus minimising the need for human intervention in basic help desk tasks.

The modular design approach adopted in this system increases its flexibility and maintainability. The functional blocks like input processing, speech recognition, query matching, decision making, and output generation work independently, but they are part of the overall system workflow. This separation of concerns enables you to debug and test in isolation, and to make future improvements without having to change the entire system.

Moreover, the system shows a dependable performance in processing predefined queries with high accuracy and low response delay. The use of a structured knowledge base ensures consistent responses, while fallback mechanisms improve robustness against unknown inputs. The inclusion of camera-based monitoring adds an additional layer of functionality, including support for security and user identification features.

From a practical point of view, the system is cost effective, scalable and suitable for deployment in environments like educational institutions, hospitals, government offices, corporate reception areas etc. It reduces reliance on human staff to answer repetitive queries, thereby improving operational efficiency and service availability.

Furthermore, the project emphasises the significance of Human–Computer Interaction (HCI) principles in developing user-friendly systems. The system allows for voice communication and is easy to use for people with little technical knowledge, thus being inclusive and easy to operate.

In summary, this project confirms that the combination of embedded systems with AI-based speech and vision technologies can yield effective, intelligent, and practical automation solutions for real-world applications. This system can be further expanded to a smarter service robot with additional improvements like multilingual support, a cloud platform and advanced deep learning models for recognition tasks to deal with more complex interaction in future deployments.

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