Artificially Unified Reception Assistant Using Raspberry PI

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Abstract

Humanoid robots are becoming increasingly popular in campuses and the hospitality industry due to their ability to interact naturally with people and perform automated tasks. A humanoid robot on campus welcomes visitors with gestures like 'Namaste' and provides essential information, showcasing advances in robotics education and development since the department of automation and robotics was established in 2009. In hospitality, robots and AI-based chatbots improve customer service by offering 24/7 assistance, speeding up processes like check-in, and reducing human workload. To create a cost-effective solution, a Raspberry Pi–based humanoid robot is being developed with dual-hand motion, autonomous navigation, obstacle avoidance, and voice interaction. Ongoing work focuses on adding learning capabilities and coordinating vision with hand movements. Research in humanoid robotics continues to grow because these robots must navigate human environments safely, adapt to user behaviour, and balance like humans, making them valuable for personal and assistive applications while also helping scientists understand human-like information processing.

1. INTRODUCTION

1.1 Background & Motivation

Traditional reception desks depend entirely on human staff for visitor assistance, identity verification, and information delivery. This results in high operational cost, limited availability, and inconsistent service. With the growth of AI and IoT technologies, automated reception systems can provide consistent, accurate, and efficient assistance.

The motivation of this project is to create a fully autonomous Reception Assistant capable of interacting with visitors using face recognition and natural speech. The system improves efficiency, enhances visitor experience, and reduces human dependency.

2.2 Applications / Use Cases

The AI-Based Reception Assistant can be deployed in a wide range of environments where visitor management, guidance, and interaction are essential. By integrating face recognition, speech processing, and intelligent conversational abilities, the system provides automated support that can reduce manpower requirements, improve efficiency, and enhance user experience.

2.2.1 Educational Campuses

Educational institutions—such as schools, colleges, and universities—require constant interaction with students, faculty, parents, and visitors. The proposed system can play a significant role through the following functions:

• Automated Attendance for Staff or Visitors

The system can automatically recognize registered faces of staff or students as they arrive, logging attendance without manual entry. This reduces queueing and ensures accurate digital records.

• Guiding Parents or Students to Departments

Visitors often struggle to locate classrooms, administrative offices, or departments. The AI receptionist can

offer verbal directions or display navigation information, ensuring smooth campus movement.
• Handling Inquiries (Exams, Fees, Locations)
Common student queries—such as exam schedules, fee-related details, or room locations—can be answered instantly. This reduces the workload on administrative staff and provides 24/7 support.

2.2.2 Offices & Corporate Buildings

Corporate environments require structured visitor management and secure entry. The Reception Assistant offers several advantages:
• Visitor Verification
Using face recognition or ID verification, the system can authenticate registered visitors, notify hosts, and maintain digital logs, improving building security.
• Security Monitoring
Unregistered or suspicious visitors can be flagged instantly. The system can send alerts to security personnel and help maintain controlled access to restricted areas.

2.2.3 Hospitality Sector

Hotels, resorts, and tourism Centers rely heavily on guest interaction. The AI Reception Assistant can act as a smart, multilingual guide:
• Hotel Check-In Support
Guests can be welcomed using face recognition, simplifying check-in procedures. The system can capture basic visitor information, provide room allocation details, and notify staff.
• Information Desk Automation
Instead of waiting for staff, guests can receive answers to common queries—such as restaurant timings, Wi-Fi information, or hotel amenities—instantly through voice interaction.
• Tourist Guidance
The assistant can provide nearby tourist spot suggestions, travel routes, weather updates, and city information. This enhances guest experience by acting as a 24/7 digital concierge.

Comparison Table:

Feature / Criterion	Existing / Previous Generation Systems	Your Proposed Raspberry Pi Reception Assistant
Type of Operation	Manual receptionist or basic kiosk	Fully automated AI-powered reception assistant
Face Recognition	Not available or very limited; requires expensive hardware	High-accuracy face recognition using camera + AI models on Raspberry Pi
Voice Interaction / ASR	Usually not supported; only touch-based	ASR-enabled; system listens, understands, and responds naturally
Connectivity	Often standalone; no networking	Wi-Fi + LAN + optional cloud connectivity
Visitor Logging	Paper-based logging or simple software	Automatic digital log with time, face image, and purpose
Guidance &Navigation	Requires human assistance	Provides voice-based instructions and directions
Information Desk Features	Limited; depends on staff availability	Can answer queries about departments, events, schedules, and more
Operating Hours	Limited to working hours	24/7 continuous operation
Hardware Platform	Desktop PC or kiosk system	Compact Raspberry Pi + Camera + Microphone + Speaker
Security	Depends on human accuracy	AI-based verification + secure database logs
Scalability	Not scalable; fixed installations	Easily scalable to multiple reception points
Suitable Environments	Only offices or hotels	Campuses, industries, offices, hospitals, hotels, public buildings

Touchless Interaction	Rarely available	Complete touch-free experience (face + voice)

2.LITERATURE REVIEW

1. Implementing human questioning strategies into quizzing-robot (Ohyamaetal.,2012)
This study examined how museum guides use pre-questions to engage visitors and applied the strategy to a robot. The robot monitored visitor responses to ask appropriate follow-up questions, successfully drawing attention and adapting interactions based on human reactions like gaze or gestures.

2. Understanding users' perception of privacy in HRI (Lee et al., 2011)
This research explored users' attitudes toward privacy in workplace social robots. It highlighted the importance of privacy-sensitive design for social robots to gain acceptance and reduce potential privacy risks during human-robot interactions.

3. Effect of multiple robot interaction on HRI (Yang & Kwon, 2012)
The study analyzed human behaviour when interacting with multiple robots simultaneously. Factors such as attention shift, favorability, knowledge sharing, and perception of robot status were examined, showing that human responses are influenced by the presence of multiple robots.

4. Robot gesture and user acceptance of information in HRI (Kim et al., 2012)
The study investigated how coordinated and uncoordinated robot gestures affect users' reception of information. Results showed that while coordinated gestures did not necessarily improve information delivery, they influenced user perceptions of intimacy, involvement, and engagement.

5. Modular control for human motion analysis in HRI (Rivera-Bautista & Marin-Hernandez,2010)
This research presented a modular system to analyze human walking trajectories and predict behaviours such as confidence, curiosity, or nervousness. Based on these cues, the robot could decide when and how to initiate interaction.

3.PROPOSED WORK

The proposed work focuses on designing and developing an Artificially Unified Reception Assistant using a Raspberry Pi to automate and enhance the visitor–reception experience. The system integrates face recognition, speech processing, and AI-based conversational capabilities to enable seamless, touch-free interaction between visitors and the reception assistant. The Raspberry Pi acts as the central processing unit, interfacing with a camera for face detection and recognition, a microphone for capturing speech queries, and a speaker for delivering AI-generated responses. Once a visitor approaches the reception desk, the system identifies them through facial recognition and then listens to their query using Automatic Speech Recognition (ASR). The recognized text is processed by an AI model to generate appropriate responses or actions, such as providing department directions, answering campus or office inquiries, verifying appointments, or recording visit logs. The assistant also supports database management, real-time visitor logging, and remote monitoring through network connectivity. Overall, the proposed work aims to create an intelligent, cost-effective, and autonomous reception solution that enhances efficiency, reduces manpower dependency, and improves user experience across campuses, offices, and hospitality environments.

3.1METHODOLOGY

1.Robot Design and Creation
• The robot is designed using a Raspberry Pi 3B+ as the main controller, integrated with multiple hardware modules.
• It is equipped with DC motors for movement, controlled through an H-Bridge motor driver.
The robot's body houses the Pi Camera, IR sensor, and RFID reader (EM-18) on the front side for efficient detection and identification of visitors.

• An LCD display and speaker are mounted on the top to provide visual and audio communication with the visitors. Power is supplied through a regulated DC power source, ensuring stable operation of all components.

2. Person Detection and Data Acquisition

• As shown in the flowchart, the reception process begins when the IR sensor detects the presence of a person.
• Once detection occurs, the Pi Camera starts capturing live video, which is analyzed using the HAAR cascade algorithm for facial recognition.
• At the same time, the visitor is prompted to scan their RFID card using the EM-18 reader, which provides a unique ID number for authentication. These data inputs are processed by the Raspberry Pi for further decision-making.

3. Processing and Control Operations

• The Raspberry Pi 3B+ serves as the central processing unit, coordinating all input and output operations.
• The captured facial image is processed using the OpenCV library to perform detection through the HAAR algorithm.
• The RFID data is verified to confirm the visitor's authorization. Based on the verification results, the Raspberry Pi triggers the necessary control signals.
• If the visitor is authorized, the system proceeds to greet and assist; otherwise, it requests the visitor to rescan the ID card.

4. Output Response and Visitor Assistance

• After successful identification and authentication, the system executes multiple output responses:
• The LCD display presents visitor information and instructions.
• The speaker provides an audible welcome message or guidance.
• The H-Bridge driver circuit activates the DC motor, enabling the robot to move and guide the visitor to the required location

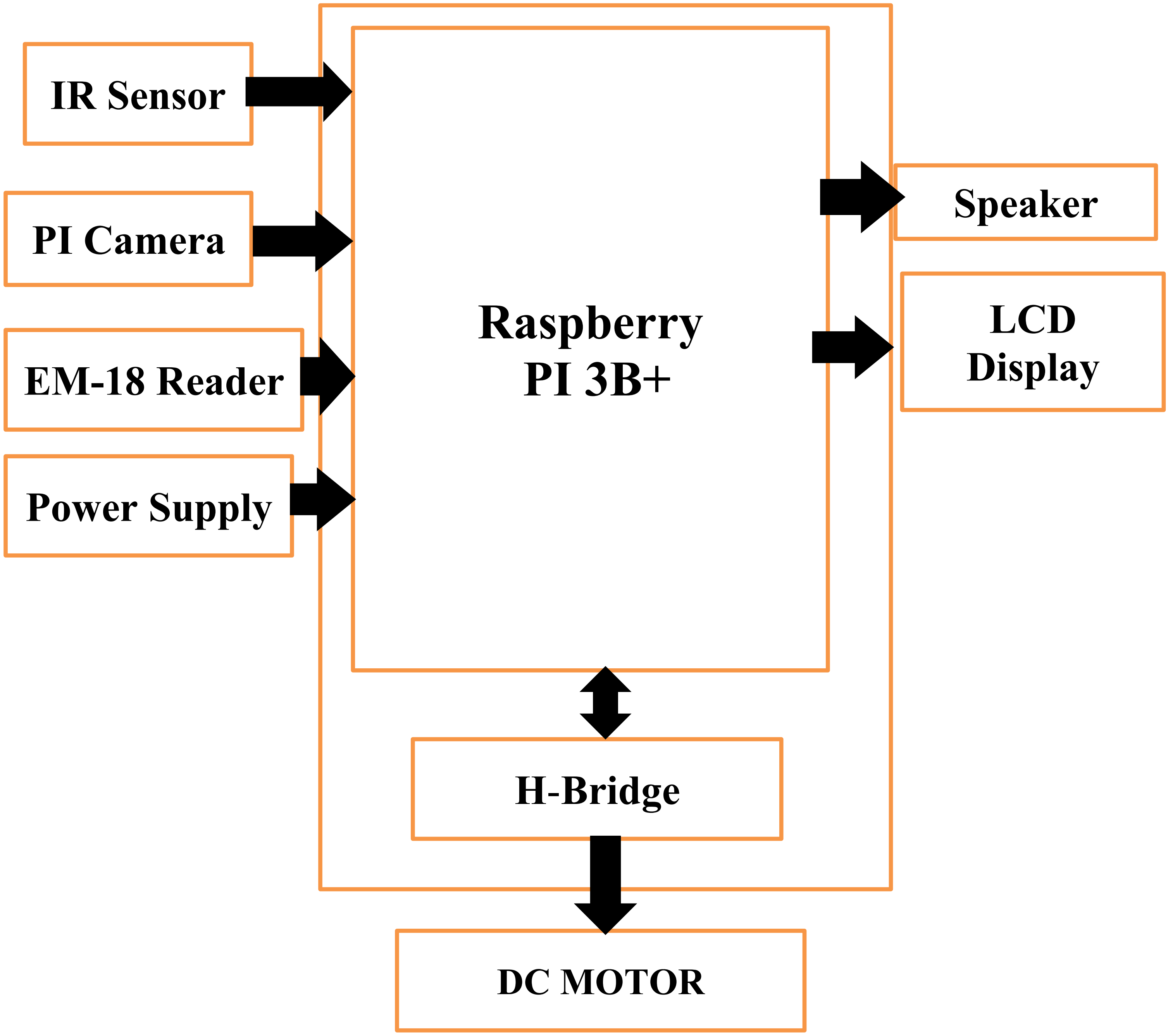
3.2 BLOCK DIAGRAM

The block diagram delineates the functional architecture of the Artificially Unified Reception Assistant, wherein the Raspberry Pi 3B+ operates as the central computational node responsible for data acquisition, signal processing, and peripheral control. The input subsystem comprises an IR proximity sensor, an EM-18 RFID module, and a Pi Camera interface. The IR sensor serves as the primary event-triggering mechanism by detecting visitor presence and generating an interrupt for system activation. The EM-18 RFID reader acquires the visitor's unique RFID tag identifier through a 125 kHz radio-frequency interface and communicates the decoded UID to the Raspberry Pi via a serial communication protocol for identity verification. Concurrently, the Pi Camera streams real-time frames to the processing unit to facilitate face detection and recognition using Haar cascade–based computer vision algorithms.

The Raspberry Pi 3B+ functions as the core processing entity, executing multi-modal data fusion and decision-making routines. It integrates sensor inputs, processes video frames, handles RFID authentication, and orchestrates the sequence of reception-related tasks. GPIO, I²C, UART, and PWM interfaces are utilized to control downstream peripherals with deterministic timing. The output subsystem includes a 16×2 LCD display for textual information rendering, an audio output module for synthesized speech-based interaction, and a motor-control stage implemented through an H-Bridge driver. The H-Bridge enables bidirectional actuation of a DC motor to perform mechanical gestures or robotic motions as part of the reception workflow.

A regulated power supply unit delivers stable operational voltages to the Raspberry Pi, sensing modules, display hardware, and motor driver circuitry. It ensures noise-free DC power rails and maintains electrical integrity under varying load conditions. The integrated hardware architecture provides a cohesive, real-time, and autonomous reception system capable of multi-sensor interaction, identity verification, and intelligent user engagement.

3.3 FLOW CHART



System Start

The reception system begins by initializing all required components such as the Raspberry Pi, IR sensor, Pi camera, RFID module, and LCD display. This start stage ensures that hardware and software modules are properly configured before the reception assistant can begin functioning.

Person Detection Using IR Sensor

Once the system is active, it continuously monitors the environment using an IR sensor to detect the presence of a visitor. If no person is detected, the system simply keeps checking. When the IR sensor senses someone approaching, the process moves to the next stage.Video Capture Using Pi Camera and HAAR Algorithm.After detecting a person, the Raspberry Pi activates the Pi camera to capture live video of the visitor. This video feed is processed using the HAAR cascade algorithm, typically used for face detection. This step helps the system identify or track the visitor visually.Greeting the Visitor .Once the person is identified by the camera system, the reception assistant greets the visitor with a welcome gesture. This greeting can be a voice message, display message, or any programmed response aimed at making the visitor feel acknowledged.

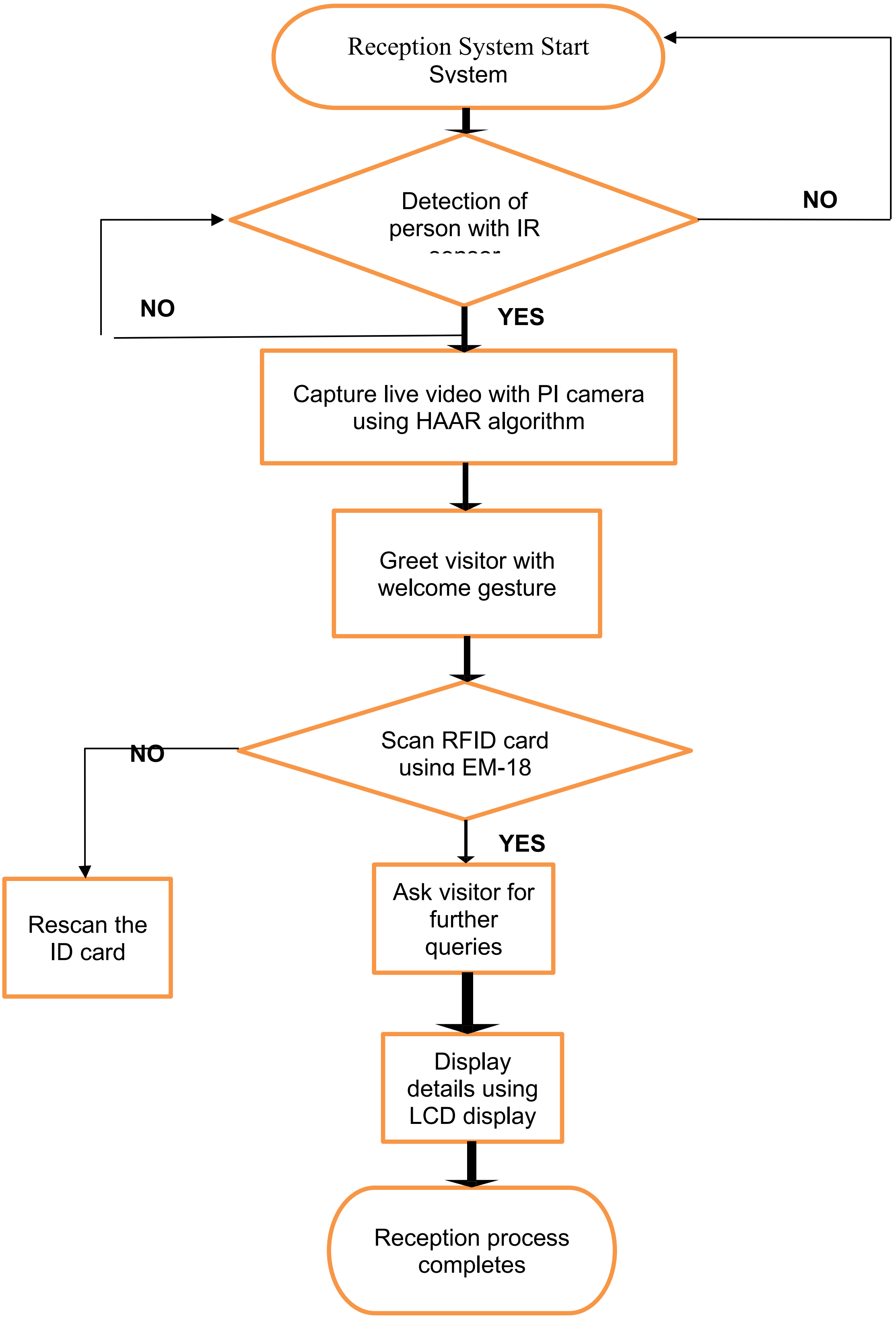
RFID Card Scanning

Following the greeting, the system prompts the visitor to scan their RFID card using the EM-18 RFID module. This scan is necessary for verifying the identity or category of the visitor. If the card is not detected or scanned incorrectly, the system instructs the visitor to rescan the card until a valid scan is obtained.Query Handling and

Displaying DetailsUpon successful RFID verification, the system asks the visitor if they have any further queries. Based on the stored data retrieved via the RFID tag, relevant information is displayed on the LCD. This may include visitor details, meeting information, or guidance.

Reception Process Completion

After displaying all necessary information and completing any requested queries, the system concludes the reception process. It then returns to the initial state, ready to detect and assist the next visitor.



4.RESULTS & DISCUSSION

The developed automated reception system was tested under real-world conditions to evaluate its performance in visitor detection, identification, and interaction. The IR sensor exhibited rapid response, consistently detecting visitor presence within one second, ensuring timely system activation. The RFID module (EM-18) delivered near-perfect tag recognition with an average processing time of 0.5 seconds, confirming its suitability for fast and reliable visitor verification. Facial detection using the Pi Camera and Haar Cascade algorithm achieved approximately 85–90% accuracy under normal lighting, though performance decreased in low-light environments, indicating a requirement for improved illumination or advanced detection models such as deep-learning-based methods.

The output interfacing modules also performed efficiently. The LCD displayed visitor details and messages instantly after verification, while the speaker produced clear voice responses without noticeable delay. The H-Bridge driver and DC motor performed programmed gestures smoothly and consistently, demonstrating successful integration of mechanical components with digital processing.
Overall, the system demonstrated high reliability, low latency, and effective multimodal interaction, validating its capability to function as an intelligent, automated reception unit. The discussion highlights that although the system performs well in controlled and moderately dynamic environments, enhancements such as improved lighting, noise filtering for audio, and more robust facial recognition algorithms can significantly improve accuracy and scalability.

5.CONCLUSION

In conclusion, the automated reception system presents an efficient solution for replacing or supporting traditional reception tasks in educational institutions, corporate offices, and hospitality sectors. By integrating RFID-based identification, facial detection, real-time audio guidance, and mechanical motion, the system successfully automates visitor verification and assistance. The results confirm that the architecture is practical, cost-effective, and easily scalable. Future work may include the incorporation of cloud-based databases, AI-driven facial recognition models, touchscreen interfaces, and improved environmental adaptability to create a fully autonomous and intelligent reception assistant.

6. REFERENCES

[1] Hanaa Mohsin Ahmed; Rana Talib Rasheed " A Raspberry PI Real- Time Identification System on Face Recognition", Year: 2020 | Conference Paper| Publisher: IEEE.

[2] Author: Takaya Ohyama, Yoshinori Kobayashi, Keiichi Yamazaki, "Implementing human questioning strategies into quizzing- robot", Date of Conference: 5-8 March 2012Date Added to IEEE Xplore: 30 July 2012.

[3] Author: Min Kyung Lee, Karen P. Tang, Jodi Forlizzi, Sara Kiesler "Understanding users! Perception of privacy in human-robot interaction". Date of Conference: 26-28 Nov. 2012Date Added to IEEE Xplore: 19 February 2013.

[4] Author: Jeong-Yean yang, Dong-Soo Kwon. "The effect of multiple robot interaction on human- robot interaction". Date of Conference: 26-28 Nov. 2012Date Added to IEEE Xplore: 19 February 2013.

[5] Sunitha M. R, Fathima Khan, Gowtham Ghatge R, Hemaya S "Object Detection and Human Identification using Raspberry Pi", Year: 2019 | Conference Paper | Publisher: IEEE.

[6] Meghana Shinde1, Tanvi Sukhadare2, Soham Vaidya3, Prof. Meghali Kalyankar4, "Face Mask Detection Alert System using Raspberry Pi", International Research Journal of Engineering and Technology (IRJET),Volume: 08 Issue: 04 | Apr 2021.

[7] Hasan Hashib; Md. Leon; Ahmed Mortuza Salaque " Object Detection Based Security System Using Machine Learning Algorithm and Raspberry Pi",Year:2019 | Conference Paper |Publisher : IEEE

[8] Ramiro Sandoval; Vanessa Camino; Ricardo Flores Moyano ;Daniel Rio frío;