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Sentinal AI Intelligent Home Security & Automation

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ABSTRACT

This project presents the design and implementation of an automatic door system integrated with camera-based human detection YOLO v3 and smart lighting control. The system enhances convenience, energy efficiency, and accessibility by automating the door and lighting operations based on human presence and movement using PIR sensors and DL algorithms like CNN, FacNet, Haarcascads. When a person approaches the entrance, a camera detects their presence using face recognition librareies, triggering the door to open automatically and turning on the lights. Once the individual enters, the door closes securely using a motor and a door closer mechanism. The system uses a open cv to confirm presence inside the room. Upon exit, the manually opens the door, which then closes automatically while turning off the lights. The integration of GPIO-controlled components such as motors, sensors, and LEDs, along with YOLO-OpenCV for vision processing, demonstrates an effective blend of hardware and software to create a responsive and intelligent entryway system.

Keywords: Passsive Infrared Sensor ,Face Recognition, Servo Motor, Yolo, Open Cv.

1. INTRODUCTION

The incorporation of an automated swing door mechanism that opens automatically when a person enters, closes automatically when the person leaves, and controls the room's lighting based on presence detection. The system uses various components such as a DC motor with a PIR (Passive Infrared) sensor for presence detection, and a door closer mechanism. The goal of this project is to create an efficient, automated door system that enhances the user experience by providing a hands-free entry and exit while also ensuring energy efficiency through smart lighting control. This system aims to combine both mechanical and electronic elements to offer a solution that is both practical and innovative for smart home applications. By integr0ating motion sensing, automatic door opening, and closing, along with automatic light control, the system offers a seamless user experience while minimizing manual effort.

The development of an automated swing door system addresses these emerging needs by offering a practical solution that blends mechanical automation with smart sensing and control technologies.

1.1 OBJECTIVES

- This project aims to construct a model that can be operated using face recognition.
- Automatic Door Operation upon Entry
- Utilized to operate and position the item at the designated trigger.
- Presence-based Light Control.
- Integration of Mechanical and Electronic Components.

2. LITERATURE REVIEW

The robotic arm for picking and placing items is a crucial technology in manufacturing industries, specifically designed to execute these operations efficiently. This study emphasizes the importance of adhering to safety protocols, when performing tasks such as sending robotic vehicles into hazardous areas to collect samples for chemical analysis, Wireless cameras accessible via the application facilitate remote monitoring and control of camera movements [1]. This research utilizes a vehicle is outfitted with a Bluetooth module, microphone, and speaker for receiving voice directives and delivering responses. It employs the Easy VR voice recognition module for interpreting and understanding voice instructions. The Arduino interacts with the motor controller togovern the vehicle's motion. The system's efficiency is validated through multiple trials and evaluations [2]. Thisstudy investigates the voice command analysis for a collaborative robot, emphasizing the examination of different voice directives, their consistency, and dependability in human-robot collaboration [3]. This study developed and constructed a voice-operated pick-and-place robot using Raspberry Pi. Python, an open-source programming language known for its simplified syntax used to utilized to program the Raspberry Pi-based robot[4]. This study focuses on creating a voice command system using the ROS middleware framework. The voice control system was tailored for the JACO ^{2}, a 6-degree-of-freedom assistive robotic arm. Two individuals affected by neurodegenerative conditions tested the usability of the robot, controlling it via the JACO ^{2} joystick and the newly developed voice command system [5]. The setup enables an Android device to command a robotic arm. The Android device transmits Bluetooth instructions, which are received by the Bluetooth receiver integrated into the receiver circuit. The Bluetooth receiver is connected to the 8051 microcontroller, which processes incoming signals. It then directs the motor to move the robotic arm in accordance with the received commands [6]. This system is designed for controlling a robot using speech commands. The speech is captured by a microphone and processed on a computer using Mel Frequency Spectral Coefficients algorithms. Subsequently, the commands are converted into a format that the robot can understand and execute movements accordingly. It operates via an Android device that sends voice commands to a Raspberry Pi to enable this functionality [7]. This study designed and constructed a pick-and-place robotic arm vehicle that can be controlled via an Android application using voice commands. The controller (ATMEGA328P) was programmed using Arduino programming language, a simplified and open-source variantof C++ known for its user-friendly architecture. Integration of the control unit with a Bluetooth device enabled the capture and interpretation of voice commands [8]. This paper discusses the transmission of commands to control the movement of the robot via an Android application. Four motors are connected to the microcontroller: two for controlling the arm and gripper movements, and two for

controlling the body movement of the robot [9]. The project aims to develop a pick-and-place robotic arm vehicle equipped with a soft-catching gripper designed to minimize pressure on sensitive objects (such as bombs) for safety purposes. The robotic vehicle is controlled remotely via an Android application. A key feature of this robot is its soft catching arm, which prevents exerting excessive pressure on delicate objects, ensuring safety during operations[10]. This study focuses on enabling the Easy VR module to convert voice commands received from the transmitter into digital signals. These signals are then transmitted to the robot via a ZIGBEE module. On the receiver side, another ZIGBEE module receives these commands and executes the corresponding operations [11]. This study aims to utilize a Bluetooth module, interface controller, and Android integration. The controller interfaces with the Bluetooth module via UART protocol. Based on commands received from Android, the motion of the robot can be controlled [12]. The project aims to create a pick-and-place robotic vehicle equippedwith a soft-catching gripper, designed to handle delicate objects such as bombs safely to prevent accidental detonation. Commands from the Android application is transmitted to the receiver to govern the vehicle's movements [13]. This paper details the development of a robotic arm controlled wirelessly through hand gestures. The robotic system consists of two main assemblies: a transmitter assembly mounted on gloves, whichincludes an APC-220 Module, Arduino Board, Gyroscope, and Accelerometer; and a receiver assembly (the robotic arm) featuring an APC-220 Module, Arduino Board, Servo Motors, and arms mounted on a circular revolving base constructed from acrylic sheets

The disadvantages of the existing methods:

- Sometimes the face recognition system can make errors due to the libraries or environmet in the background of the room
- Many of the existing models require an expensive budget.

To overcome the recognition system, we keeps the model accurately.

3. PROPOSED WORK

An intelligent automated swing door system that enhances user convenience, accessibility, and energy efficiency through presence detection and automated control. It is designed primarily for use in residential and small commercial spaces, offering seamless operation with minimal user interaction. It’s a simple yet intelligent system where a swing door opens automatically when someone enters and turns the light on without needing to press a switch. This is made possible by a PIR sensor or camera that detects the person’s presence.A Passive sensor is installed inside the room to detect human presence. When a person approaches or enters the room, the sensor triggers the system to activate the door and lighting mechanisms. This ensures the system operates only when needed, conserving energy and increasing efficiency.

This ensures that the door closes automatically after entry and the light is turned on without requiring any physical interaction. The sensor continues to monitor the presence of the individual; as long as motion is detected, the system assumes the room is occupied and keeps the light on. When no motion is sensed for a set period, the system determines that the room is unoccupied and turns off the light.

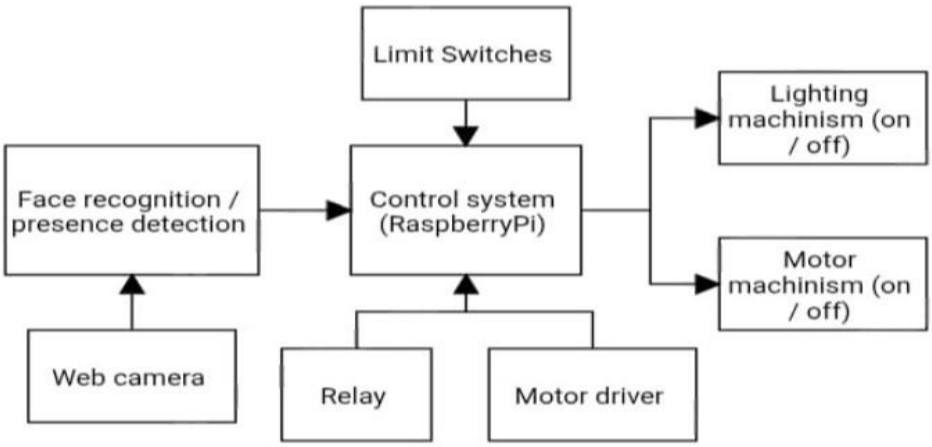


Fig 1. Block Diagram

The door is mechanically driven by a DC motor connected through which allows smooth and controlled opening and closing of the swing door. When a person is detected entering, the motor automatically opens the door. Once the person is inside, a door closer ensures the door closes gently and securely. After the person exits, the same door closer takes over to gently close the door again. This combination of automated entry and exit offers a balanced approach to automation—simplifying access while keeping the mechanism cost-effective and energy efficient. Fig 1. shows the blocked diagram.

Table 1. Components & Specification

NAME OF THE COMPONENTS	SPECIFICATIONS	MODEL
RASPBERRY PI	Data from several drivers and motors can be processed by Raspberry pi	Pi 5 8g RAM
PASSIVE INFRARED SENSOR	Various presence detection and angular range.	HC-SR501
DC MOTOR	Compatible with servo motor	12C
LIMIT SWITCHES	Limit switches for safety when controlling motor	ME-8167
SMPS	Converts DC Voltage (12V)	12V
WEB CAMERA	Camera to capture for face recognition	L298N

RASPBERRY PI

The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries. The original model became far more popular than anticipated, selling outside its target market for used such as robotics. Fig 2. shows the Raspberry Pi.

Fig 2. Raspberry Pi 5

PASSIVE INFRARED SENSOR

Pir sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", Or "IR Motion" Sensors Fig 3. Shows the Passive Infrared Sensor

Fig 3. Passive Infrared Sensor

DC MOTOR

The DC motor is used to drive the door's swinging motion. A motor with sufficient torque and speed is required to ensure smooth door operation. Typically, a 12V DC motor is chosen due to its efficiency and availability. The motor must be capable of handling the weight of the door while providing consistent performance over time. The motor will be controlled via an H-Bridge circuit to allow bi-directional movement.. Fig 4. shows the Dc Motor

Fig 4. Dc Motor

LIMIT SWITCHES

Construction. A push button switch is a small, sealed mechanism that completes an electric circuit when you press on it. When it's on, a small metal spring inside makes contact with two wires, allowing electricity to flow, the spring retracts, contact is interrupted, and current won't flow.An electrical switch is any device used to interrupt the flow of electrons in a circuit. Fig 5. shows the Limit Switches

Fig 5. Limit Switches

Standard wires and connectors will be used to link all the components together, ensuring reliable and safe electrical connections. High-quality mounting hardware will be used to secure the motor, sensors, and other components in place. Proper insulation and cable management are essential to prevent short circuits and ensure long-lasting performance.

SMPS

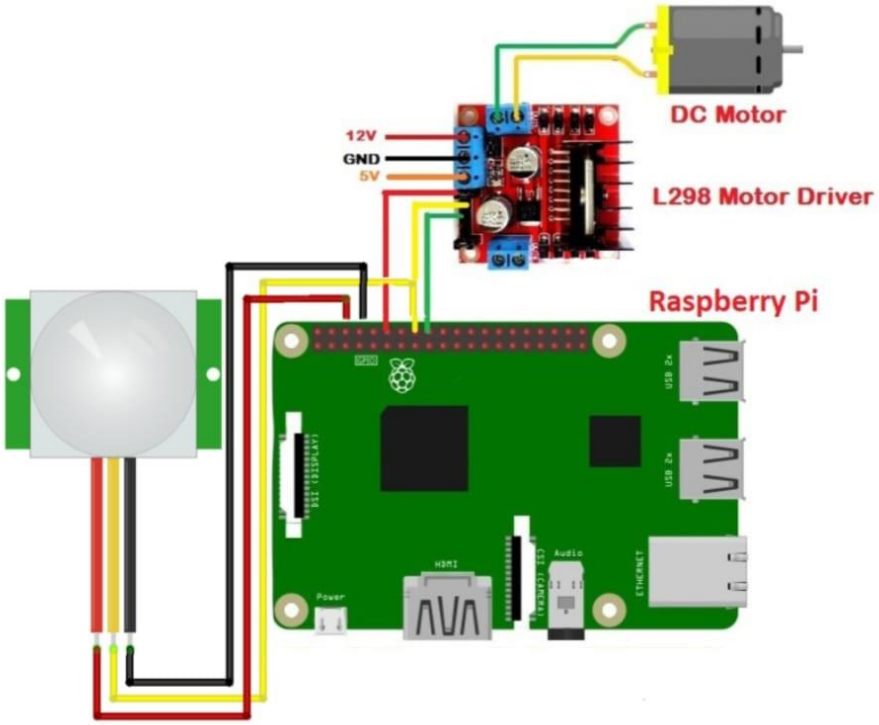
The DC convertor manages the system power needs, converting the energy from a 12V battery to a suitable level for the robotic arm’s components. This stable power source ensures consistent performances and reducesthe risk of power related malfunctions

WEB CAMERA

A webcam is a video camera that feeds or streams its image in real time to or through a computer to a computer network. When "captured" by the computer, the video stream may be saved, viewed or sent on to other networks via systems such as the internet, and emailed as an attachment. When sent to a remote location, the video stream may be saved, viewed or on sent there. It operates in a range of 10-15 meters.

4. WORKING PRINCIPLE

The exploration of interactive robotic arm control begins with a detailed breakdown of its operational process, components, and safety features, offering a comprehensive understanding of its functionality. Initially, the usercommunicates commands through face inflections into a model. These commands are then transmitted wirelessly to the raspberry bi via a local server like the wifi, enabling seamless connectivity with external devices such as smartphones or laptop. The module plays a critical role in the system by facilitating remote control without the limitations of wired connections, thereby enhancing flexibility and user convenience. Fig 8. shows the flow chart of Voice Recognition



Presence Detection

A Passive sensor is installed inside the room to detect human presence. When a person approaches or enters the room, the sensor triggers the system to activate the door and lighting mechanisms. This ensures the system operates only when needed, conserving energy and increasing efficiency.

This ensures that the door closes automatically after entry and the light is turned on without requiring any physical interaction. The sensor continues to monitor the presence of the individual; as long as motion is detected, the system assumes the room is occupied and keeps the light on. When no motion is sensed for a set period, the system determines that the room is unoccupied and turns off the light.

Door Operation

The door is mechanically driven by a DC motor connected through which allows smooth and controlled opening and closing of the swing door. When a person is detected entering, the motor automatically opens the door. Once the person is inside, a door closer ensures the door closes gently and securely. After the person exits, the same door closer takes over to gently close the door again. This combination of automated entry and exit offers a balanced approach to automation—simplifying access while keeping the mechanism cost-effective and energy efficient.

Automatic Close

When the occupant decides to leave, the door can be opened. The system detects the absence of motion after a short delay and triggers the automatic door closing sequence again, maintaining security and privacy. The use of a mechanical door closer guarantees a smooth and consistent closing action.

System Control and Safety

The control logic processes signals from the PIR sensor and drives the motor and relay accordingly. Limit switches or positional feedback mechanisms may be used to prevent overdriving the motor and to ensure the door operates within safe physical limits. This contributes to long-term durability and reliability.

The door closer is used to manage the closing speed, ensuring it closes smoothly and safely without slamming, which could pose a risk to users or damage the door. Electrical components are chosen to operate on low voltage, reducing the risk of electrical hazards. Overall, the system ensures that door movement is controlled, predictable, and safe for all users, while also allowing easy overrides and natural interaction where needed.

5. RESULTS

The proposed model of our project is displayed below. Fig 14. Shows the proposed model

Fig 14. Proposed model

Open the terminal and give the command of the recognition. The command will be displayed in the vnc viewer. Fig 15.shows command displaying in LCD Display.

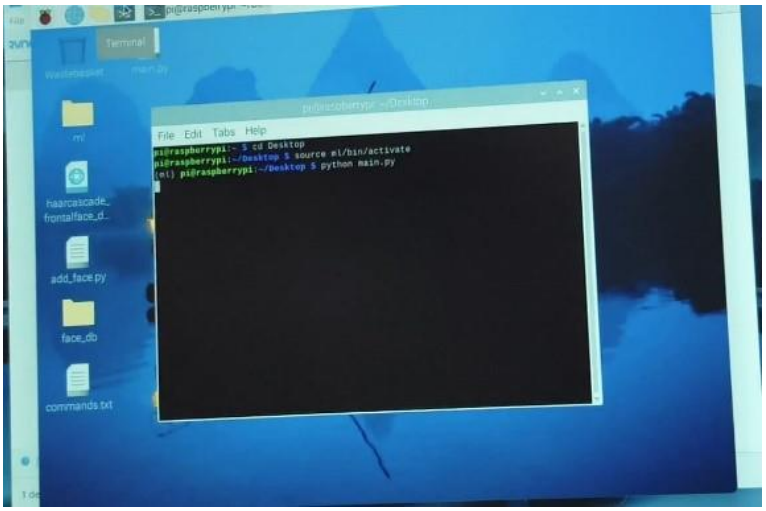


Fig 15. Command displaying in LCD

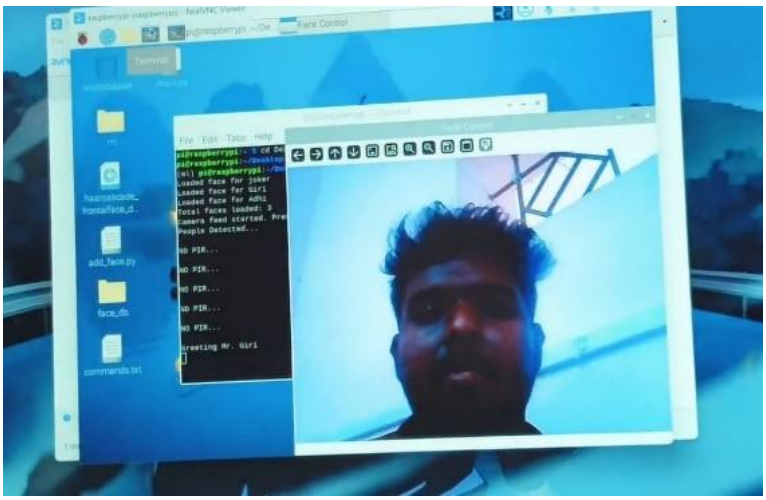


Fig 16. An object is picked

After that our model will recognitions the face. Fig 16. Shows..

Once the face recognition happens the motor and light will switch on. Fig 17. Shows.

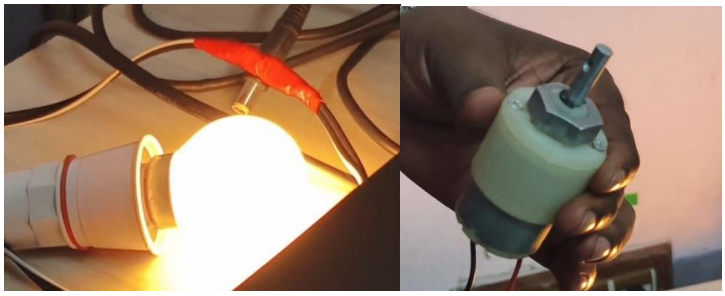


Fig 17. A motor rotate to represent the automation and light switch on

6. DISCUSSSION

The project features the an intelligent automated swing door system that enhances user convenience, accessibility, and energy efficiency through presence detection and automated control. It is designed primarily for use in residential and small commercial spaces, offering seamless operation with minimal user interaction. It's a simple yet intelligent system where a swing door opens automatically when someone enters and turns the light on without needing to press a switch. This is made possible by a PIR sensor or camera that detects the person's presence.

The devices (both hardware and software) bring out the efficient control in sensors through sustainability, providing new areas for use in industries, and accessibility devices for people with disabilities. The project is a representation of a technology that will bridge human and automation thus it willopen new options

The problems like face recognition accuracy and are the matters of time in the area of their solution. The machine learning algorithms and data processing tools are getting improved and now they are making it possible to interpret face command in different surroundings in a better way. Additionally, integration with new technologies like computer vision can be advantageous to the model by enhancing itsautonomy and situation awareness and then enabling it to perform more difficult interactions and task executions.

7. CONCLUSION

The project of an interactive control of a automated swing door system offers an innovative and efficient solution for controlling door operations and lighting based on presence detection. By integrating components such as a DC motor, PIR sensor, door closer, and relay-controlled lights, the system ensures smooth, automatic door movement and energy-efficient lighting control. The incorporation of safety features, including limit switches and an intelligent control algorithm, ensures reliable and secure operation. Additionally, the flexibility of the system allows for future upgrades, such as IoT integration, to enable remote monitoring and control.

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