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Smart Home Security & Face Recognition

Rohit H Dhaygude[1], Avinash M Gaikwad[2], Suraj Y Gawali[3], Prof. Jawed H Shaikh[4]

BE Student, SVPM College of Engineering, Malegaon bk, Pune, India[1,2,3]
Assistance Professor, SVPM College of Engineering, Malegaon bk, Pune, India[4]

ABSTRACT

This project presents the design and development of a robust door safety system leveraging the capabilities of an ESP32-CAM microcontroller in conjunction with an ultrasonic sensor, buzzer, and servo motor. The system aims to enhance door security by detecting obstacles in the door's path, alerting users of potential hazards, and enabling remote monitoring and control.

The ESP32-CAM microcontroller serves as the central processing unit, orchestrating the functionalities of the system. An ultrasonic sensor, strategically positioned near the door, detects obstacles and provides real-time feedback to the microcontroller. Through precise control of a servo motor, the system can efficiently manage the door's locking mechanism, ensuring smooth operation and enhanced security. A buzzer integrated into the system serves as an audible alarm, alerting users to unauthorized access attempts or obstacles obstructing the door's path. Additionally, the ESP32-CAM's capabilities enable the provision of a web interface for remote monitoring and control, enhancing accessibility and convenience for users. Key considerations include voltage regulation to safeguard components, mechanical stability to prevent accidents or damage, and the implementation of backup power sources for uninterrupted operation. Through comprehensive testing and debugging, the system's functionality is validated, ensuring reliability and efficacy in real-world applications. By integrating cutting-edge technologies and robust design principles, the proposed door safety system offers an effective solution for enhancing security and convenience in residential and commercial settings alike.

Keywords: Door safety system, ESP32-CAM, Ultrasonic sensor, Buzzer alarm, Servo motor, Access control, Security, Remote monitoring, Authentication, Smart home integration

I. INTRODUCTION

Ensuring the safety and security of doorways is paramount in both residential and commercial environments. Traditional lock-and-key mechanisms have served as the primary means of securing doors for centuries. However, advancements in technology offer opportunities to enhance door safety systems with smarter and more efficient solutions. In this context, the integration of microcontrollers, sensors, and actuators presents a promising avenue for designing comprehensive door safety systems. Leveraging the capabilities of components such as the ESP32-CAM microcontroller, ultrasonic sensor, buzzer, and servo motor, it becomes feasible to create sophisticated systems capable of detecting obstacles, providing real-time feedback, and enabling remote monitoring and control. This project focuses on the design and development of a cutting-edge door safety system that harnesses the power of these technologies. By combining the processing power of the ESP32-CAM microcontroller with the sensing capabilities of an ultrasonic sensor, the system can detect obstacles in the door's path with precision. The integration of a buzzer allows for audible alerts, notifying users of potential hazards or unauthorized access attempts. Furthermore, a servo motor enables precise control over the door's locking mechanism, enhancing security and convenience.

The aim of this project is to provide a comprehensive solution that addresses the evolving needs of door safety in modern environments. Through meticulous design, rigorous testing, and thoughtful implementation, this system seeks to set new standards for efficiency, reliability, and user-friendliness in door security technology. By exploring the design principles, technological components, and implementation strategies of this door safety system, this project aims to contribute to the advancement of security solutions that prioritize both effectiveness and accessibility. Through innovation and integration, we strive to create safer and more secure environments for individuals and businesses alike.

II. LITERATURE REVIEW

1. Smart Door Locking System using IoT: This study explores the implementation of IoT technology for door locking systems, focusing on remote monitoring and control. It discusses the integration of sensors, microcontrollers, and communication protocols to enhance security and convenience (Ahmed et al., 2019).

2. Development of a Door Access Control System Based on RFID and IoT: The research presents a door access control system utilizing RFID technology and IoT frameworks. It discusses the integration of RFID readers, microcontrollers, and cloud-based platforms to manage access permissions and monitor door activities remotely (Jain et al., 2018).

3. Design and Implementation of an Intelligent Door Access Control System: This paper proposes an intelligent door access control system that combines biometric authentication and RFID technology. It discusses the integration of fingerprint sensors, RFID readers, and microcontrollers to provide secure and user-friendly access control (Tiwari et al., 2017).

4. Enhancing Door Security using Ultrasonic Sensors and IoT: The study investigates the use of ultrasonic sensors and IoT technology to enhance door security. It discusses the implementation of ultrasonic sensors for detecting unauthorized access attempts and triggering alarm systems, along with remote monitoring capabilities (Shrestha et al., 2020).

5. ESP32-CAM: A Versatile Microcontroller for IoT Applications: This article provides an overview of the ESP32-CAM microcontroller and its applications in IoT projects. It discusses the microcontroller's features, capabilities, and programming environment, highlighting its suitability for developing security and surveillance systems (Baez-Lopez et al., 2021).

6. Servo Motor Control Techniques for Door Locking Systems: The research explores various servo motor control techniques for door locking systems. It discusses the implementation of servo motors for remotely controlling door locks, including PWM modulation, position feedback, and power management strategies (Sharma et al., 2019).

7. Buzzer Alarms in Security Systems: This paper examines the role of buzzer alarms in security systems. It discusses the importance of audible alerts for deterring intruders and notifying occupants of security breaches. The study also explores different types of buzzer alarms and their integration into security systems (Singh et al., 2018).

These studies provide valuable insights into the design and implementation of door safety systems, incorporating components such as ultrasonic sensors, microcontrollers, servo motors, and buzzer alarms. By leveraging IoT technology and advanced control techniques, these systems offer enhanced security features and seamless functionality for door access control.

III. METHODOLOGY OF PROPOSED SYSTEM

The block diagram of the system is shown in fig. The components used to develop this project are shown in above fig. the components used are ESP32-CAM as a controller, ultrasonic sensor for object detection, buzzer for indication purpose, camera for photo capturing, servo motor door opening and closing application. The ultrasonic sensor is used to detect the human activity. The ultrasonic sensor cannot detect human directly it measures the distance in centimeter. The user sets the one set distance if any human or object comes near to ultrasonic sensor and if the sensor measures the distance below set distance then signal is sent to the ESP32-CAM which is connected to the Wi-Fi which then operates the buzzer its starts buzzing and also send alert message to user on telegram.

If the human or object is not detected then the alert is not sent on the telegram and also buzzer stop buzzing. If the alert is sends on the telegram to the user after detecting the human the user has few options as turn on flash light, turn off flash light, click photo and share photo on telegram, open or close door using solenoid door lock.

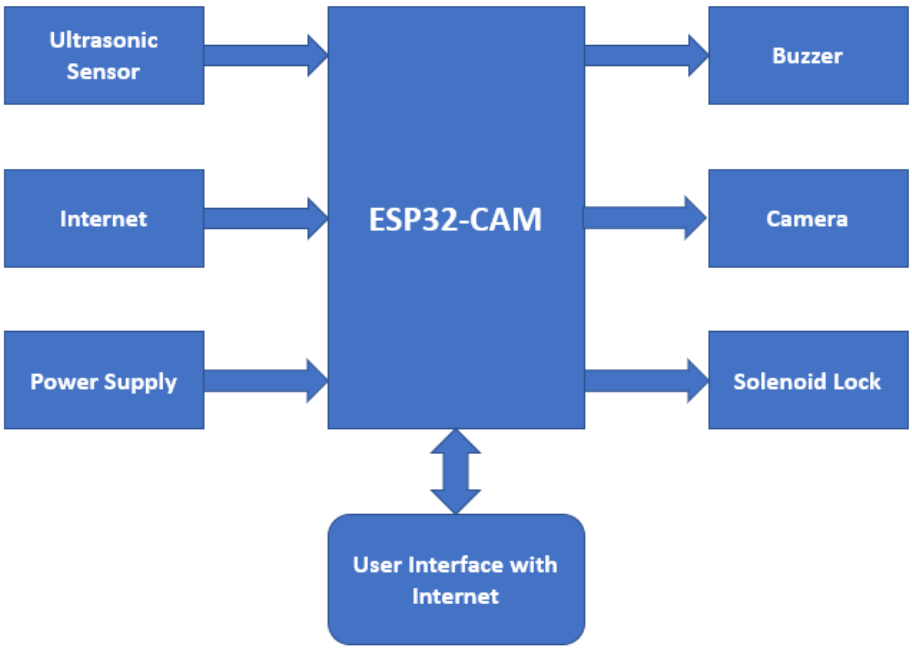

Figure 1: Proposed System Architecture

Circuit Diagram

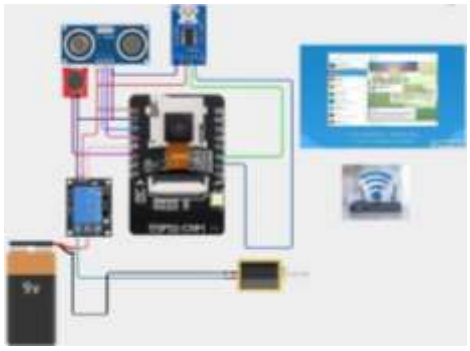

Figure 2. Circuit Diagram

In above figureshows the circuit diagram. In above circuit ESP32-CAM is used to detect the signals from sensors and to operate the actuators. The ESP32-CAM has inbuild Wi-Fi module with 2.4Ghz bandwidth. The ultrasonic sensor is used to detect the human by measuring the distance. Buzzer is used for indication purpose, when any person comes close to the ultrasonic sensor or cuts the set distance of ultrasonic sensor it sends signal to ESP32-CAM which then actuate the buzzer and it stars buzzing also alert sends on the telegram bot. According to action taken from telegram bot by the user the further operations are performed such as photo clicking, door opening or closing.

Table No. 2.1 – Circuit Connections

Sensor/ Actuator	**Sensor and Actuator Pin**	**ESP32-CAM**
Ultrasonic Sensor (HC-SR04)	VCC	5V
	Trig	GPIO12
	Eco	GPIO13
	GND	GND
Relay Module	VCC	5V
	GND	GND
	PWM	GPIO14
Buzzer	VCC	GPIO15
	GND	GND
FTDI Model	5V	5V
	GND	GND
	RX	RX
	TX	TX

FTDI Model:

FTDI Model is used to upload the code and read the serial data of ESP32-CAM through RX and TX pins of controller. The 5V pin of FTDI controller is connected with 5V pin of controller, GND pin of FTDI is connected with GND pin of controller, RX and TX pins of FTDI module is connected with RX and TX pin of ESP32-CAM respectively.

Ultrasonic Sensor:

It is used to detect the person who comes in front of door. It detects the person by measuring distance. As we know the ultrasonic sensor is used to measure the distance when the distance comes below the set distance it detects the any object and this whole operation is read and controlled by the ESP32-CAM. The ultrasonic sensor has four pins VCC, GND, Trig, Eco which are connected to ESP32-CAM as VCC pin connected to 5V supply of ESP32-CAM, GND pin connected with GND pin of controller, Trigger pin of sensor is interfaced with GPIO12 pin of controller and Eco pin of ultrasonic sensor is connected with the GPIO13 pin of controller.

Buzzer:

Buzzer is used in his project for indication purpose only. If the objects is detected by the system the buzzer starts buzzing else it remains silent. The positive or VCC pin of buzzer is connected with GPIO15 pin of ESP32-CAM and GND pin of the buzzer is connected with GND pin of controller.

Relay Module and Solenoid Lock:

The role of relay in this system is to open and close the door lock. The VCC pin of relay is connected to 5V pin of ESP32 CAM, ground pin of relay module is connected to ground pin of ESP32 CAM and input pin of relay is connected to the GPIO pin number 14 of the ESP32 CAM. The 5V supply of the battery is connected to the common pin of the relay module and the normally open pin of the relay module is connected to the red pin of the solenoid lock and the negative pin of the battery is connected to the black pin of the solenoid lock.

Working:

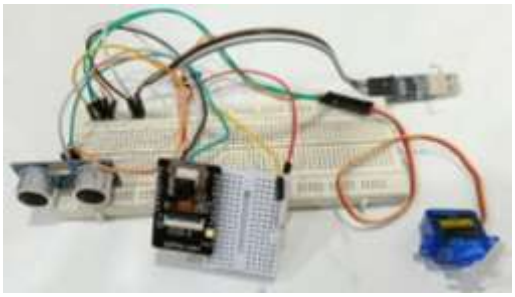

Figure 2.2 Working Model

The circuit diagram of the same we are discussed in the above points. As we know the ESP32-CAM has inbuilt camera module and Wi-Fi module. In this project we are using same for internet connectivity, photo clicking and sending photos to telegram bot. The ultrasonic sensor is used to detect human comes in front of sensor and camera detects the human. It detects the person by measuring the distance for example if the set distance is 20cm and the sensor measuring distance above 20cm then alert does not come if any human comes in front of sensor and it measures the distance below 20cm and camera detects the human the alert message will be sent on telegram bot and also buzzer starts buzzing. After getting the message alert on telegram the photo is also shared on the telegram by ESP32-CAM camera. After this the user act what to do i.e. open the door or close the door. The door opening and closing operation are operated using relay and the solenoid lock.

Hardware Reqirement:

1. The ESP32-CAM
2. Ultrasonic Sensor
3. Buzzer
4. Relay module
5. Solenoid Lock
6. FTDI module

Software Requirement:

1. Arduino IDE (Integrated Development Environment)
2. ESP32 Libraries
3. Telegram Bot API
4. Arduino Telegram Libraries
5. Ultrasonic Sensor Libraries
6. Servo Motor Libraries
7. Debugging Tool

IV. EXPERIMENTAL RESULT

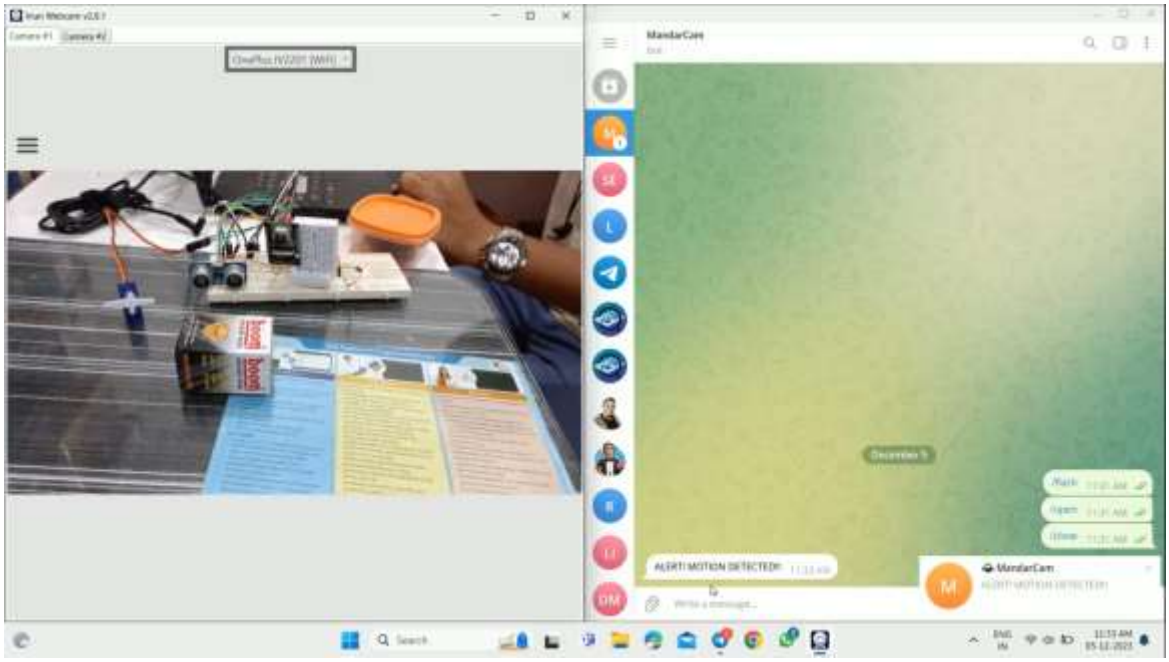

Figure 3: When Object is Detected Alert Sent on Telegram

V. CONCLUSION AND FUTURE WORK

In conclusion, the proposed door safety system leveraging the ESP32-CAM microcontroller, ultrasonic sensor, buzzer, and servo motor offers a comprehensive solution for enhancing security and providing seamless functionality for door access control. By integrating advanced components and leveraging IoT technology, the system ensures robust protection against unauthorized entry while offering convenience and ease of use for authorized individuals.

The system's ability to detect approaching individuals using the ultrasonic sensor, trigger alarms with the buzzer, and remotely control the door lock with the servo motor provides multiple layers of security. Furthermore, the ESP32-CAM microcontroller's capabilities enable remote monitoring and integration with smart home networks for enhanced accessibility and management.

Future work could focus on integrating biometric authentication, enhancing remote monitoring capabilities, developing adaptive security algorithms, and optimizing energy efficiency to further improve the system's performance and effectiveness in real-world applications. Overall, the proposed door safety system represents a promising solution for modernizing access control and enhancing security in residential, commercial, and industrial settings.

VI. REFERENCES

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