Journal of ICT, Design, Engineering and Technological Science (JITDETS)
VOL. 8, NO. 2, pp. 25-31, 2024
DOI: https://doi.org/10.33150/JITDETS-8.2.5

ORIGINAL CONTRIBUTION

Enhancing Residential Safety and Comfort Through Smart Home Security and Automation Technologies

Shahbaz Ali Khan[1], Shahjahan Samoo [2], Abdul Salam Shah [3*], Adil Maqsood[4], Muhammad Adnan Kaim Khani[5], Asadullah Shah [6]

[1] Department of Information Technology Security, Jubilee Life Insurance, Karachi, Pakistan

[2,5]Department of Computer Science, ILMA University, Karachi, Pakistan

[3]School of Computer Science, Faculty of Innovation and Technology, Taylor's University, Subang Jaya, Malaysia

[4]Visionerz Pvt LTD, Pakistan

[6] Kulliyyah of Information and Communication Technology, International Islamic University, Malaysia

***Abstract*— In the digital era, technology is changing rapidly, and humans are trying to make lives easier, but it brings a new challenge: security. Computer programs or developed hardware can be compromised if not appropriately designed or because of the simple mistakes of an authorized person. The project aims to secure a home using face recognition to unlock the doors and alarm in an emergency. The home security automation technology uses a wireless network to support the alarm and deactivation requirements. The face detection unit uses an internet connection via an ESP32 CAM; the primary controlled systems are utilized with Wi-Fi technologies. ESP32 manages home electronic appliances and camera devices, featuring a cost-effective structure, easy-to-use interface, and simple deployment. In this project, the system primarily fulfills home security demands using face-detection gadgets, utilizing a controller with a camera. The device can manage a high-power scoring load using security locks**

***Index Terms*— ESP32 Cam, Face net, Face recognition, Bug connector**

Received: 28 July 2024; **Accepted:** 29 September 2024; **Published:** 26 December 2024

I. INTRODUCTION

Home automation systems are becoming progressively popular in this modern era because of their various advantages and making human life easy and comfortable. Using IoT, this system suggests an affordable home automation security system for comfortable living [1, 2]. Humans desire a secure and stress-free lifestyle; hence, automation techniques are regularly implemented in industries, aviation, and commercialized settings to control devices [3, 4]. Automated systems in offices or homes make work simple and save time and cost, and they want as many advantages as possible from the latest technologies [5]. The industrial side intends to secure their machinery and other things, which are basic daily requirements [6].

Nowadays, people want basic needs controlled or watched out with a single click via phone devices and smart sensor-based systems [7]. Sensor-based systems help the user to connect with anyone, anytime and anywhere, and control everything through a phone. Automation lets you connect and control home security levels through the UART TTL Programmer. For the smart security system, you need the ESP 32 Cam to control this solenoid lock inside and outside the home and send alerts to the GSM Module [8].

The proposed project presents low-priced and efficient home autonomous systems that could be easily approachable and controlled with a smart device through face recognition [9]. The system can be used in industries and offices to control and automate security doors through smart devices and face detection. The user interface helps users to interact with the system easily. The system focuses on controlling home security doors and surveillance systems using ESP32 cameras, and it recognizes and detects unauthorized faces. The system sends alerts with safety alarm sensors and buzzers [10, 11]. The camera serves as an active agent and ensures 24/7 door lock monitoring. This system is difficult to crack; a solenoid lock of the main door remains connected to power.

The system leverages IoT to ensure and improve residential security and safety and monitor and operate automatic locking mechanisms and doorway detectors that inform users of open-door events via an Android app. The system works with low-power smart home gadgets like doors or window sensors that communicate via RF transceivers.

The main functions of the system are:

- Continuous security door lock system.
- Automation system to ensure face detection security system properly.

[*] Corresponding author:Abdul Salam Shah
[†] Email: salamshah.sayed@taylors.edu.my

- When an intruder tries to unlock, the system generates an alarm, sending an SMS to the mobile phone.
- The system can be used in homes, offices, schools, and industries.

II. RELATED WORK

Various projects for smart homes are available in the literature, but there are still specific challenges, like 433 Hz RF frequency, which has drawbacks. The gadgets communicate by RF signals, and when multiple devices communicate with Raspberry Pi, it may select to accept [12]. A registration system may ensure proper communication between transmitters and the Raspberry Pi. The system tracks all incoming signals and their sources, helping avoid confusion or interference.

The paper explores building an IoT-based smart solar power system to automate and monitor a solar-powered home [13]. The system offers a complete IoT-based solution for smart-home automation, which can be easily scaled by increasing the number of sensors and devices.

Moubarak [14] stated that smart solar houses are highly adaptable for larger residential or commercial buildings. Designing and implementing intelligent household networking systems for measuring power usage using continuous monitoring of gadgets at homes are introduced in connected devices. The technique's constant tracking and voice-controlled operation allow electrical devices and controls to be wirelessly operated and analyzed utilizing Android-based applications [15]. The model features an Ethernet-based system that enables users to monitor real-time electrical data and control their home appliances directly from an Android smartphone [16, 17]. It also enhances home security by alerting users when they enter their homes or when an intruder is detected.

The systems use heat and smoke sensors to detect potential fire hazards and PIR motion sensors to identify unauthorized movement [18]. A dedicated Android mobile application lets users track and manage all connected electrical devices in real time. The user-friendly systems offer voice command support and a simple "click-to-connect" interface that makes home automation accessible and easy to operate [19]. The systems include a customized web interface that tracks the real-time status of household appliances [20, 21]. It also integrates temperature and humidity sensors to monitor environmental conditions indoors. For safety, a gas sensor is included; if the detected gas level exceeds a predefined threshold, the Arduino controller triggers an emergency alert sent to a web server [4].

The system by Pavithra and Balakrishnan [22] using Raspberry Pi is cost-effective, but it doesn't provide the level of security. Similarly, [23] focuses on cost-effectiveness but requires all devices to be in the exact location and doesn't prioritize system security. [14] presents a complete and secure home automation system, and it's user-friendly but expensive and entirely dependent on a constant network connection without any backup solution. [24] attempt to include solar power, which is a step forward. Nowadays, most homes have IPS, and many newer buildings also use solar panels to monitor the home 24/7. The system has a motion detector for better security when detecting an intruder. The system has fire and gas sensors to trigger warning alerts if any danger is detected. This approach allows the system to work smarter and more intelligently.

III. SYSTEM DESIGN

Many researchers have demonstrated how IoT can automate homes, each contributing unique enhancements to the core system. The proposed IoT-based home automation system focuses on security while keeping it cost-effective. The remaining systems are not secure enough to be reliable when focused on cost-effectiveness. On the other hand, when they emphasize security, the systems become expensive. The proposed model addresses both aspects, making it accessible and practical for users.

This section of the paper will present the smart home security automation system's conceptual design, system design, and physical design. The system uses three power sources: main grid, IPS, and solar panel. The alternative sources make it reliable. When one of the sources gets disconnected, the system switches to alternative power sources. The multiple power sources help the system generate alerts and send notifications to the user. The system uses night vision cameras, motion sensors, an ESP32 host platform, and Wi-Fi to connect using mobile devices.

Utilizing an online interface, the individual using it will interact entirely with the technology in this case. ESP32 has connectivity across the network and has detectors attached to it. The motion detector alerts so that the user can access the camera from room to room to check whether it is a false alert [23].

The conceptual design puts forward the design's prime conception before being built into the functional face detection system. The development of this system focused on creating a platform that makes it easy for humans to access door security locks by authentication with their faces, which have traditionally been offered physically in a cross-shelf model. The smart home security system technology is linked through (ESP32-CAM) microprocessor and is controlled by this system's firmware. The suggested technique has three phases. An algorithm interfaces the UART TTL Programmer component of the relay module and the alarm buzzer. The UART TTL device signals through the ESP32 controller during the next stage. The ESP32-CAM controller then sends the solenoid for the handling components of the lock. Figure 1 shows the door controller.

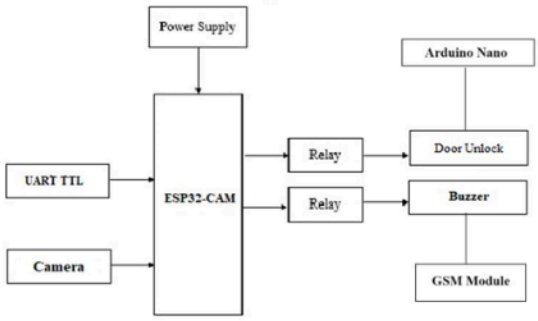

Fig. 1. System control

A. System software and hardware

The hardware of the system consists of various components like ESP32 cam control component, UART TTL programmer, relays, solenoid locks, GSM, bug connector, Arduino nano, SD card module, LEDs, circuit breadboard design construction, Arduino IDE program, various wirings, alarm buzzer, face net for software, and a supply for power consumption are all part of the entire project designing as in figure 11.

Designing the architecture of the face detection security device, including the hardware components and their interactions, has unique results in implementing hardware for the automated door security system side, including integrating the different elements. The face gets scanned using the camera to detect the authorized face to open the door locks. Developing firmware for the ESP32 and Arduino Nano for both the device and human sides, responsible for scanning face data processing, motor control, and data authentication. FaceNet enables user interaction and control over the security doors [25].

Comprehensive system testing ensures that the hardware components have proper functionality and integration and can verify human faces. When an unregistered person tries to enter the house, the door will be locked in minutes, and the alarm will buzzer on the spot to alert and send

an SMS alert to the user through the GSM Module. The system's performance, responsiveness, and overall adherence are speedy. The face recognition procedure can be seen in Figures 2 and 3.

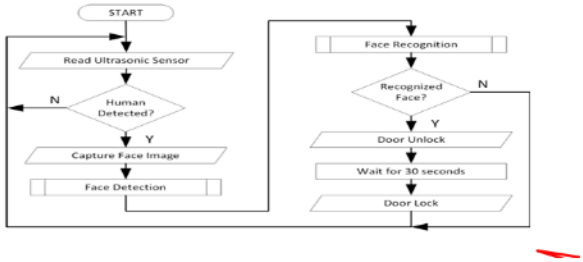

Fig. 2. Face recognition

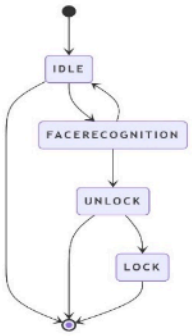

Fig. 3. Working mechanism

B. Tools and technologies

Before starting the project, the main intention was to use regularly available components for different load factors in the structure of the security peripherals, and the live loads on the alarm alerts could fulfill the performance of human face recognition. The placements of the additional parts are such that they do not interfere with the device's default working.

1) Esp 32 module

The ESP module is a user-friendly device that provides a low cost and internet connectivity as a station and access point. It can fetch the data easily and then upload it on the internet through IoT technology [26]. Another impressive feature is that this module has a built-in camera and can be programmed using Arduino IDE, which makes it very user-friendly. However, due to the multitasking involved in upgrading the Wi-Fi stack, most systems use a different microcontroller for encoding, interfacing sensors, and digital input-output. The features include: a camera, frequency of 80-160MHz, ten silica extensa diamond standard 106 micro processor, 16 GPIO pins, and 10-cycle ADC. The system transmits data on the cloud (server) through Wi-Fi and uses it for programming to collect data.

2) Arduino Nano and IDE

Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3. x). It has the same functionality as the Arduino Demilune but in a different package. It only has a DC power jack and works with a Mini-USB cable instead of a standard USB.

Arduino has a special software called the IDE (Integrated Development Environment) system to interconnect the interfaces of different sensors or modules with the board programmed to run the system. The framework of programmers depends on processing; it is simple basic electronics writing terminology related to C language to program.

3) Relay

The relay module is a transfer interface board controlled by various microcontrollers such as Arduino, AVR, PIC, and ARM. It uses the low-level control signal to control the contacts of the relay. Making start-up transfers works for contacts that are usually open or closed in an automatic control cycle. An automatic switch controls the highest frequency with the current low signal. A relay switch closes and opens the circuit mechanically or electronically; if a relay is in close position, NC responds, and a circuit is off until a relay gets energized. When the relay is usually in an Open state with NO contact, there is indeed an open circuit till the relay gets energized. We must connect the device to its normally open terminal to control it through a relay using software.

4) GSM modem

A GSM modem, such as a Sim900a, accepts a SIM card and operates through a subscription to a mobile operator, like a cell phone [27]. A GSM modem looks much like a cell phone from the mobile operator's point of view.

5) UART TTL Module Programmer

UART TTL Modular Programmers with a smaller factor for this (USB) connector for interfacing portable devices, handheld gadgets like cellphones, music players, satellite navigation systems, picture printing equipment, and camera equipment [28]. Micro-USB connections of various varieties: micro-A, micro-B, and micro-USB 3. The USB 3 mini is like a micro-B, although it has an extra port set along the side, allowing double the number of cables and making USB 3 faster. The tiny editions, such as normal USBs, are easy to set up and divert.

6) Solenoid door lock

A solenoid locking device is a remote entry securing device that utilizes an electromechanical solenoid to secure and unlock the doors. In addition to unrivaled stages for usefulness and strength, advanced technologies make solenoid latches an ideal requirement within a higher flow of majority, highly secured environments. Appropriate with usage in every variety of accessible controlling systems digitalized, CARD swiping, plus proximities over solenoid locking, enable access while also keeping all the doors secure. Solenoid latches are intended to interact with different accessible management technologies and are appropriate for interior and outer gates. Such locking mechanisms provide remote safety monitoring controls and vehicle doors.

7) Alarm buzzer

The beepers or buzzers are electro-mechanicalized, piezo electrics devices and a mechanical auditory signaling system. This primary functional technology works to transform the audio signals into sounds. It operates by DC voltages and utilizes schedules, alerting products, printing equipment, warnings, and desktops.

8) Light emitting diode

As a Digital light-emitting diode, every accessible light-emitting diode has a driver setup for integration, which has the display and spectrum of every light-emitting diode to perform classic and compact light system features.

9) *SD card module*

SD card module is a breakout board with a microcontroller for SD card processes such as reading and writing. The board is compatible with microcontroller systems like Arduino. A standard SD card can be directly inserted into the board, but to use microSD cards, you need to use an adapter.

IV. SOFTWARE DESIGN AND ASSEMBLING HARDWARE

A. Software development

The development of the Face Net app enables user interaction and control over the smart home security system. Develop firmware for the ESP32 for both the device and face of human sides, responsible for detection data processing, door control, and scanning transmission.

B. Assembling the hardware

The structure is built regarding Arduino Nano applications, which pursue surfaces and devices. The hardware is user-friendly and can be interfaced with technical understanding, as shown in Figures 4 and 5.

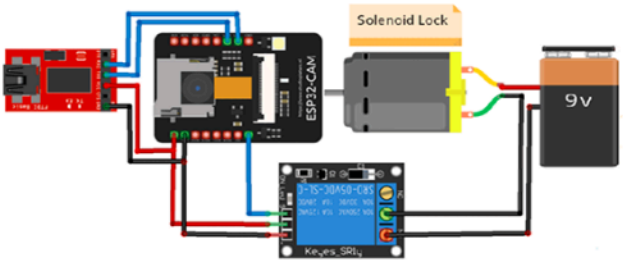

Fig. 4. ESP32-CAM [27]

Fig. 5. User journey map

C. Working mechanism

The mechanism works on an IOT-powered smart home security automation system created through information passing with (Android IDE, UART TTL, Relay, GSM, Bug Connector, SD Card, Arduino nano, and ESP32-CAM) for a security door locking alarm system applying a face detection system. The instructions delivered by the Face Net framework language transmit and gather the following knowledge of indications from giving the commands. The circuit of the ESP32 Camera module can be seen in Figures 6 and 7.

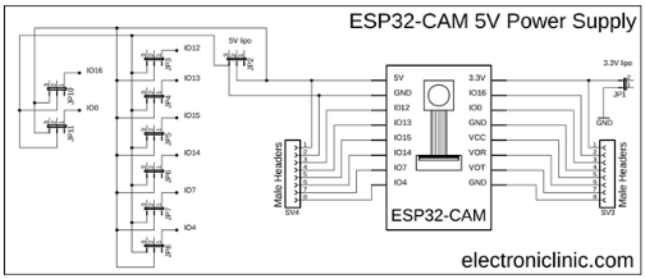

Fig. 6. Circuit of ESP32 camera module top [29]

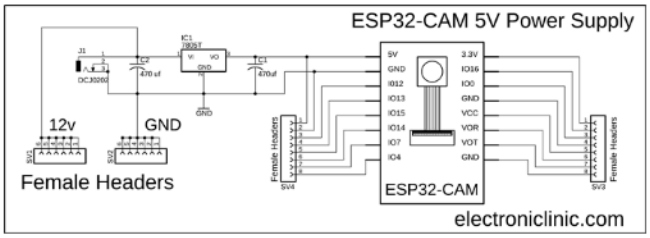

Fig. 7. Circuit of ESP32 camera module bottom [29]

V. RESULTS AND EVALUATION

The development team comprehensively tested all hardware components to ensure proper functionality, seamless integration, and effective system communication. System-level testing verified accurate customer tracking, smooth detection processes, and the reliability of the security mechanisms. This phase evaluated the system's performance, responsiveness, and compliance with the specified functional and non-functional requirements.

Functional testing involved validating each device and component individually. The team measured the ability to detect project-specific parameters and confirmed the operation of all modules connected to the ESP32-CAM. The testers repeated each test multiple times to ensure consistent and reliable outcomes.

Algorithm testing assessed the implementation of the FaceNet algorithm to confirm the accurate identification of authorized individuals. The testers evaluated the face detection system, the alarm buzzer, and the smart locking mechanism to ensure a coordinated response during security events. Two-way communication tests verified that each IoT module operated effectively as both a sender and a receiver. These tests ensured that all components and sensors communicated reliably within the IoT network. The testers evaluated access control functionality by simulating face recognition scenarios to determine whether the system correctly granted access to authorized individuals. The tests also assessed the system's tolerance for input variation and its ability to activate alert mechanisms, such as the buzzer, in response to unauthorized access. This rigorous testing process provided a complete evaluation of the system's performance. The results confirmed successful component integration, stable communication protocols, and reliable real-time operation under various conditions. Program analysis, the essential element of program quality control, is the last review of these requirements and concepts, including code. For one to find any mistakes, the program is examined by having it executed. Such thorough verifying may reveal faults. Finding or fixing program faults is usually the aim of debugging. The program's outcome depends on the evaluation.

Figure 8 illustrates how the RealTerm terminal connects to the serial port, enabling direct communication between the computer and the ESP32-CAM module. This connection allows developers to monitor data transmission, send AT commands, and debug serial output in real-time.

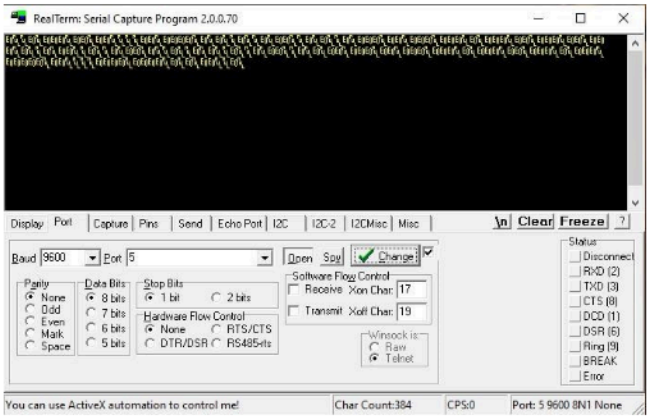

Fig. 8. Real term connect the serial port

Figure 9 shows the system actively performing face detection to identify the user and grant access if the face matches an authorized profile.

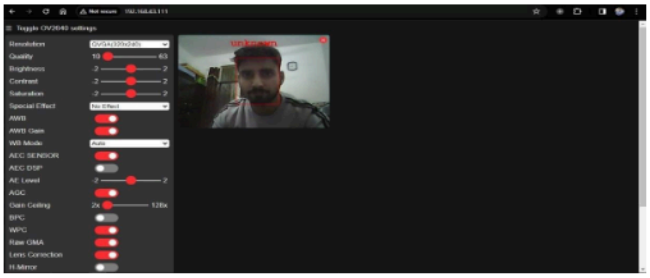

Fig. 9. Face detection in process to grant access

The system records each event in a log sheet, ensuring traceability and accountability. As shown in Figure 10, the log captures timestamps, event types, and relevant system responses to provide a comprehensive audit trail.

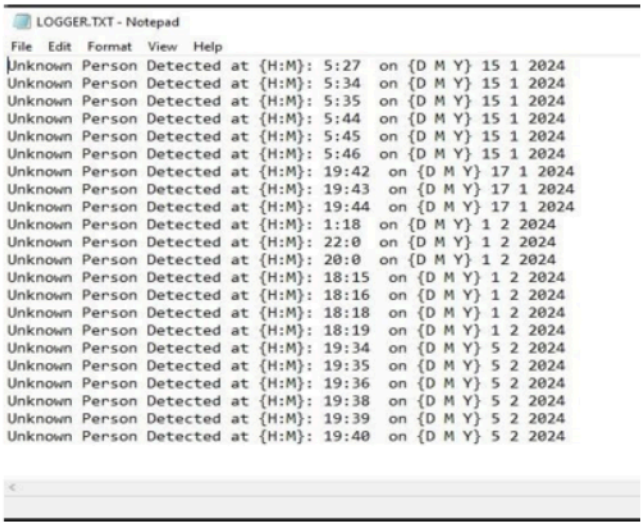

Fig. 10. Logsheet

VI. CONCLUSION

The device can continuously monitor and manage home automation security systems (such as face detection) and alarm systems. It uses ESP32 vision cameras, facial recognition, various safety alert sensors like a siren or buzzer, and SMS alerts via a GSM module for when the user is away from home. The system aims to provide reliable home security through IoT integration. According to this research paper, the ESP32 camera, combined with different power sources, ensures 24/7 monitoring and protection. The technology leverages the internet to control automated home security doors. Components used in this project include UART TTL, relay sensors, a solenoid lock as the mainboard, a scanning detector, a bug connector, Arduino Nano, and the ESP32-CAM for facial recognition.

This proposed system could be a highly effective alternative to traditional smart home security technologies. In addition, the system can automatically send alarm messages via an application. These alerts allow the user to take further action and help protect the home from unauthorized access or incidents that might pose harm. It's a reliable and proactive method to keep families safe from intruders. This research is vital and can support other researchers advancing IoT-based security systems to deploy on a larger scale in buildings, offices, and schools. With continued research, engineers could enhance the system further, such as by integrating voice recognition to improve existing modules.

References

[1] D. Mocrii, Y. Chen, and P. Musilek, ``IoT-based smart homes: A review of system architecture, software, communications, privacy and security,'' *Internet of Things*, vol. 1, pp. 81-98, 2018.

[2] R. Majeed, N. A. Abdullah, I. Ashraf, Y. B. Zikria, M. F. Mushtaq, and M. Umer, ``An intelligent, secure, and smart home automation system,'' *Scientific Programming*, vol. 2020, no. 1, p. 4579291, 2020.

[3] M. A. K. Khani, M. Usama, A. S. Shah, A. Shah, S. H. Abbas, A. Maqsood, and A. A. Laghari, ``Intelligent vehicle number plate recognition system using yolo for enhanced security in smart buildings,'' *Journal of ICT, Design, Engineering and Technological Science*, vol. 8, no. 2, pp. 11-17, 2024.

[4] A. S. Shah, A. Dinesh, A. Shah, M. Farooq, A. Maqsood, and M. A. K. Khani, ``Smart gas leak detection and emergency response system using iot for homes,'' *Journal of ICT, Design, Engineering and Technological Science*, vol. 8, no. 1, pp. 18-23, 2024.

[5] A. S. Shah, A. Maqsood, A. Shah, M. A. K. Khani, J. Anjum, and S. Zafar, ``Enhanced airport operations: Automated baggage drop-off and boarding pass generation for travelers,'' *Journal of Advances in Technology and Engineering Research*, vol. 10, no. 2, pp. 1-6, 2024.

[6] E. D. Knapp, *Industrial Network Security: Securing critical infrastructure networks for smart grid, SCADA, and other Industrial Control Systems*. Elsevier, 2024.

[7] M. Shah and A. S. Shah, ``Appraisal of the most prominent attacks due to vulnerabilities in cloud computing,'' *Int. J. Grid Distrib. Comput*, vol. 9, no. 7, pp. 13-22, 2016.

[8] N. DJEMA, ``Security and home automation based on raspberry pi, arduino uno and node mcu,'' University of Biskra Repository, Tech. Rep., 2018.

[9] S. Bhowmik, M. Hasan, and S. I. Ayon, ``Ensuring important household item security by designing ldr sensor and gsm technology based cost-effective smart protection box,'' *International Journal of Advanced Scientific Innovation*, vol. 2, no. 1, 2021.

[10] C. R. Aldawira, H. W. Putra, N. Hanafiah, S. Surjarwo, A. Wibisurya *et al.*, ``Door security system for home monitoring based on esp32,'' *Procedia Computer Science*, vol. 157, pp. 673-682, 2019.

[11] Y. Chen, H. Zhang, and S. Zhong, ``Design and implementation of smart home system based on iot,'' *Results in Engineering*, vol. 24, p. 103410, 2024.

[12] K. Venkatesh, P. Rajkumar, S. Hemaswathi, and B. Rajalingam, ``Iot based home automation using raspberry pi,'' *J. Adv. Res. Dyn. Control Syst*, vol. 10, no. 7, pp. 1721-1728, 2018.

[13] U. Singh and M. Ansari, ``Smart home automation system using internet of things,'' in *2019 2nd International Conference on Power Energy, Environment and Intelligent Control (PEEIC)*. IEEE, 2019, pp. 144-149.

[14] M. H. Moubarak, ``Internet of things for home automation,'' German University in Cairo, Tech. Rep., 2016.

[15] A. R. Alkhazali, Y. Al Moaiad, M. M. Farea, R. R. Mohamed, Y. A. B. El-Ebiary, J. A. Jusoh, and S. I. A. Saany, ``A different vision of automated door system based on smartphone apps and voice-controlled,'' *Journal of Pharmaceutical Negative Results*, vol. 14, 2023.

[16] Z. A. Jabbar and R. S. Kawitkar, ``Implementation of smart home control by using low cost arduino & android design,'' *International Journal of Advanced Research in Computer and Communication Engineering*, vol. 5, no. 2, pp. 248-256, 2016.

[17] F. A. Jam, S. Mehmood, and Z. Ahmad, ``Time series model to forecast area of mangoes from Pakistan: An application of univariate ARIMA model,'' *Acad. Contemp. Res*, vol. 2, pp. 10-15, 2013.

[18] G. Rathinakumar and E. L. Ntantis, ``Designing a quadcopter for fire and temperature detection with an infrared camera and pir sensor,'' *Drones and Autonomous Vehicles*, vol. 1, no. 2, p. 10003, 2024.

[19] M. A. Hoque and C. Davidson, ``Design and implementation of an IoT-based smart home security system,'' *International Journal of Networked and Distributed Computing*, vol. 7, no. 2, pp. 85-92, 2019.

[20] M. Soliman, T. Abiodun, T. Hamouda, J. Zhou, and C.-H. Lung, ``Smart home: Integrating internet of things with web services and cloud computing,'' in *2013 IEEE 5th international conference on cloud computing technology and science*, vol. 2. IEEE, 2013, pp. 317-320.

[21] F. A. Jam, S. K. G. Singh, B.-K. Ng, and N. Aziz, ``The interactive effect of uncertainty avoidance cultural values and leadership styles on open service innovation: A look at malaysian healthcare sector,'' *International Journal of Business and Administrative Studies*, vol. 4, no. 5, p. 208, 2018.

[22] D. Pavithra and R. Balakrishnan, ``IoT based monitoring and control system for home automation,'' in *2015 global conference on communication technologies (GCCT)*. IEEE, 2015, pp. 169-173.

[23] N. Projects. (2024) IOT Home Automation Using Raspberry Pi. [Online]. Available: https://shorturl.at/xNZob

[24] M. Al-Kuwari, A. Ramadan, Y. Ismael, L. Al-Sughair, A. Gastli, and M. Benammar, ``Smart-home automation using iot-based sensing and monitoring platform,'' in *2018 IEEE 12th International Conference on Compatibility, Power Electronics and Power Engineering (CPE-POWERENG 2018)*. IEEE, 2018, pp. 1-6.

[25] F. Schroff, D. Kalenichenko, and J. Philbin, ``Facenet: A unified embedding for face recognition and clustering,'' in *Proceedings of the IEEE conference on computer vision and pattern recognition*, 2015, pp. 815-823.

[26] J. Isabirye James, ``Design and implementation of gsm based industrial process monitoring and control system,'' Tech. Rep., 2019.

[27] M. R. U.-S. UART, ``Future technology devices international ltd mm232r usb-serial uart development module datasheet,'' Future Technology Devices International Ltd (FTDI), Tech. Rep., 2010.

[28] SMD. (2024) Face recognition based on esp32-cam. [Online]. Available: https://shorturl.at/YgHwF

[29] S. Fahad. (2020) Esp32 camera module live video streaming with sensor monitoring and controlling. [Online]. Available: https://shorturl.at/FVbCX

VII. APPENDIX

TABLE I
LIST OF ABBREVIATIONS

Term	Definition
IoT	Internet of Things
Solenoid Lock	Door Locking Mechanism
ESP32-CAM Micro Controller	Express if Source Electronic Platform Process
Wi-Fi Module (ESP32)	Wireless Fidelity
Relay Module	Open and close circuit Switch
UART TTL Programmer	Universally Asynchronous Receiver
Face Net	Face Mapping Pipeline
Face Recognition	Face identification through the stored database
IDE	Integrated Development Environment
LED	Light Emitting Diode
GSM	Global System for Mobile
Arduino Nano	Microcontroller-based Device
SD Card	Interface for Microcard
Power supply	Electric current from a source
Buzzer	Electrical Buzzing Device for Noise
V	Volt
DC	Direct Current
AC	Alternate Current

Name	Component Details
ESP32-CAM Board	
Arduino Nano	
Relay	
GSM Modular	
UART TTL Programmer	
Solenoid Lock	
Siren Buzzer	
SD Card Module	
Power Supply	

Fig. 11. Working mechanism