iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** VI **Month of publication:** June 2024

DOI: https://doi.org/10.22214/ijraset.2024.63372

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue VI June 2024- Available at www.ijraset.com

Advanced Surveillance System using ESP32

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Abstract: ***Surveillance systems have been essential part of industries, factories, organizations and homes. They actually provide additional assistance in the work of security personnel because of information storing capabilities. Manual surveillance and real-time monitoring is one of the most important and challenging branches of Surveillance. We are proposing advanced surveillance system using the ESP32 microcontroller, designed to enhance home security and monitoring capabilities. This system utilizes infrared (IR) to detect human presence and triggers a camera module to capture images. These images are then transmitted to the user's smartphone via the Blynk app, providing real-time monitoring and notifications. The user can remotely control a digital door lock based on the captured images, enhancing access control. The system offers advantages such as remote monitoring, instant notifications, customizable settings, and integration with smart home devices. Overall, this project is cost-effective, scalable, and user-friendly solution for enhancing security and monitoring in various environments.***
Keywords: Microcontroller (ESP32 and ESP32-CAM) IR Sensor, Ultrasonic Sensor, Remote Monitoring,2-level security.

I. INTRODUCTION

Surveillance systems have become indispensable in modern society, serving as a critical tool for enhancing security, monitoring, and safety in various environments. These systems are widely used in industries, factories, organizations, and homes to deter crime, prevent unauthorized access, and ensure compliance with safety protocols. While surveillance cameras are commonly used for monitoring and recording events, manual surveillance and real-time monitoring pose significant challenges for effective security management. In order to monitor an area or a region we use different surveillance methods and technics depending on the area that we need to monitor. For monitoring wide range areas, we use surveillance systems like CCTV, Drones, IP Camera, License Plate Recognition (LPR) etc. For short range we use Wireless IP Cameras, Smart Home Security Systems, Video Doorbells, DIY Security Camera Systems, Motion Sensors, Wi-Fi Cameras.[1]

This project introduces an Advance surveillance system to monitor small region using the ESP32 microcontroller, aimed at enhancing security and monitoring capabilities. The system integrates infrared (IR) for human presence detection, triggers the ESP32-CAM module to capture images. These images are sent to the user's smartphone via the Blynk app, enabling real-time monitoring and notifications. The user can remotely control a door using Blynk app buttons based on the received images.

The project aims to provide cost-effective, scalable, and user-friendly solution for enhancing security and monitoring in various environments. By leveraging the capabilities of the ESP32 microcontroller and the Blynk app, the system offers advantages such as remote monitoring, instant notifications, customizable settings, and integration with smart home devices. Overall, this project seeks to address the challenges of manual surveillance and real-time monitoring, making security management more efficient and effective.This research presents a promising solution to enhance security and maintenance practices through the integration of ESP32-CAM, IR and ultrasonic sensors for real-time monitoring and enhancing access control. The proposed system contributes advancement of Surveillance System, offering a proactive approach to mitigate risks and ensure the quick response.

II. LITERATURE REVIEW

In the paper “Pertab Rai and Murk Rehman, “ESP32 Based Smart Surveillance System” International Conference on Computing, Mathematics and Engineering Technologies 2019”. In this paper they have proposed the hardware and software implementation of smart surveillance system using Arducam ESP32 UNO for processing and controlling, Arducam-Mini-2MP Camera Module for monitoring and capturing and Adafruit 1.8-inches SPI TFT Display Module to display the continous video. The proposed implementation acquires low resolution video using detachable Arducam-Mini-2Mega Pixels (MP) camera module which is interfaced with Arducam ESP32 UNO board. Acquired video is transmitted using integrated Wi-Fi of ESP32 and video is displayed on Adafruit 1.8-inches SPI TFT display module.Though the camera and Adafruit 1.8-inches SPI TFT Display Module are low in cost, they doesn’t offer high range coverage and can’t offer better clearance of the picture as compared to ESP32-cam and Mobile and in this module there is no built-in storage facility. [2]

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In the paper "Adithya Umare, Harsh Ukey, Om Umale, Ujjwal Patil, Omkar Umbarje, Shankar Upase, Lokesh Khedekar, "WI-FI PAN TILT SURVEILLANCE CAMERA USING ESP32", International Journal for Research in Applied Science & Engineering Technology (IJRASET) 2023". In this paper they proposed a module of continuous survelliance with ESP32-CAM, pan tilt and servo motor in order to achieve continuous feed using ip address. The major drawbacks behind this model is its complexity due to IP of the device, IP changes as it turns off and then ON. In terms of scalability of this module, we have to deal and manage IP addresses of individual ESP32-CAMs. As this module directly exposing the ESP32-CAM to the internet through its IP address any one access the data There is no notification and user-friendly interface in this system.[3]

In the paper, "Dr.P.D. Selvam, K. Nikhil, K. Ranjitha Reddy, A. Mounika, P. Reddy Shekar, M. Reddy Siva Sai, "SURVEILLANCE MONITORING USING ESP32-CAM MODULE" IJCRT 2022", they proposed a system using Arduino, ESP32-CAM module, GSM module and IR Sensor. If any intruder is detected or any fire is detected through IR sensors, an image of the intruder or the fire is captured using ESP32 camera. With the help of a GSM module an SMS alert stating "Intruder alert "or "Fire alert" is sent to the registered mobile number. The picture captured is sent to the registered Email account stating "Photo captured with ESP32-CAM and attached in this Email". Availability of ready-made user friendly IOT applications like blynk brings the disadvantages for this module due to the usage of GSM for its high cost and complexity.[4]

In the paper, "Abhinab Shukla,Ritesh Diwan, "IOT Based load Automation with Remote Access Surveillance Using ESP 32 CAM and ESP 8266Module" 2021". The project uses NodeMCU for load automation and smart garden watering system. The surveillance system has ESP-32 CAM module as main component. Blynk apphas been used as a platform to provide load automation with control of garden watering pump and to have real time surveillance for the allocated areas.[5]

In the paper, "Paputungan, I. V., Al Fitri, M. R., & Oktiawati, U. Y."Motion and Movement Detection for DIY Home Security System." IEEE Conference on Sustainable Utilization and Development in Engineering and Technologies (CSUDET).2019". They proposed home security system that is integrated with remote monitoring is developed. It captures the state within an area of a house and send notification. This system uses a wireless motion detection microcontroller as a sensor that is placed at the corner of every doors and windows in the house. The data transmitted by the sensor via the network is handled by a cloud server. A notification will be turned ON if the server receives significant distinctive signal from the detection. The signal will also be sent to a web-based monitoring system to support security monitoring.[6]

In the paper "Suresh S.; J. Bhavya; S. Sakshi; K. Varun; G. Debarshi," Home Monitoring and Security system", IEEE 2016", They have developed an economical and affordable Home security system which have integrated the security component by making use of sensors like PIR, Temperature, humidity etc to sense the motion, change in temperature and humidity in room from normalcy rather relying on PIR sensor for change in motion only . The owner of the house is informed about any intruder by sending a text message by using of GSM module. All these activities are controlled by AtMega microcontroller of Arduino. This system would help all the users at any level of income to have one at their home and secure home from any vandalizing.[7]

III. PROPOSED METHOD

The proposed method involves the ESP32 microcontroller to process and control the smart surveillance system. An infrared (IR) sensor is connected to the ESP32-CAM to detect human presence, triggering an ESP32-CAM module to capture photos when motion or a person is detected. These images are processed by the ESP32-CAM and sent to the user's Blynk account for viewing. The system also allows the user to retake the picture if it is not clear and to open the door through the Blynk app if the person in the photo is authorized or known. Security measures are implemented to protect the system from unauthorized access, and privacy regulations regarding image capture and storage are followed by using Ultrasonic Sensor. Thorough testing and validation are conducted to ensure the system's functionality and reliability before deployment. Maintenance plans are established to keep the system operational and up-to-date, with regular updates and upgrades to improve performance and security.

IV. COMPONENTS

A. ESP32 Microcontroller

The ESP32 is a versatile microcontroller developed by Espressif Systems, known for its wide range of features and capabilities. ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth. The ESP32 boasts 38 pins, including GPIO (General Purpose Input/Output), power, ground, and other specialized pins, providing ample flexibility for various project requirements. Operating at a clock frequency of 80 MHz (with the ability to overclock to 160 MHz), the ESP32 offers a balance of performance and energy efficiency. It operates within a voltage range of 2.2V to 3.6V.

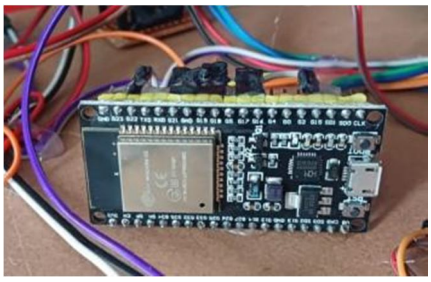


Fig 1: ESP32 Microcontroller

B. ESP32-CAM Module

The ESP32-CAM module is a compact development board that integrates an ESP32-S chip, a camera module, and a microSD card slot, making it ideal for projects requiring image capture and processing capabilities. With a total of 11 pins, including GPIO, power, ground, and camera-specific pins, the ESP32-CAM offers flexibility for various project requirements. The ESP32-S chip operates at a clock frequency of 160 MHz, providing sufficient processing power for image-related tasks. Operating at a voltage range of 5V.

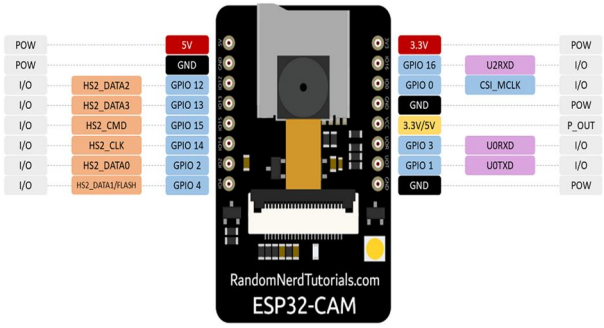


Fig 2: ESP32-CAM Module

C. IR Sensor

The infrared (IR) sensor is a vital component in the smart surveillance system, responsible for detecting human presence by sensing infrared radiation emitted by the human body. With typically three pins for VCC (power supply), GND (ground), and OUT (output signal), IR sensors operate on the principle of detecting infrared radiation emitted by humans. This radiation is converted into an electrical signal, which is then processed to determine the presence of a human. Operating at a voltage range of 3.3V to 5Vs. In the smart surveillance system, the IR sensor's role is crucial, as it triggers the ESP32-CAM module to capture photos when human presence is detected, enhancing the system's security and monitoring capabilities.



Fig 3: IR sensor

D. Ultrasonic Sensor

The ultrasonic sensor is another essential component of the smart surveillance system, providing additional capabilities for distance measurement and object detection. With typically four pins for VCC (power supply), GND (ground), TRIG (trigger), and ECHO (echo), ultrasonic sensors operate on the principle of emitting ultrasonic waves and measuring the time taken for the waves to bounce back after hitting an object. This time measurement is used to calculate the distance to the object. Ultrasonic sensors are known for their accuracy and reliability in distance measurement applications. Operating at a voltage range of 3.3V to 5V.



Fig 4: Ultrasonic Sensor

E. Servo Motor

The servo motor is a crucial component in the smart surveillance system, enabling precise control over mechanical movements such as camera adjustments or door operations. With its three pins for VCC (power supply), GND (ground), and signal (control input), the servo motor operates using a closed-loop control system. This system continuously monitors the motor shaft's position using a feedback mechanism, like a potentiometer, and adjusts the motor's position accordingly. Operating at a voltage range of 4.8V to 6V.

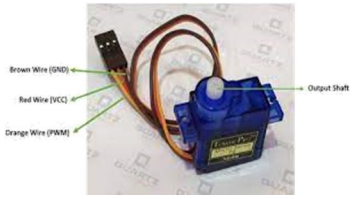


Fig 5: Servo motor

F. Buzzer

The buzzer is a fundamental component within the smart surveillance system, serving as an auditory alert mechanism. With its two pins for connection—positive (VCC) and negative (GND)—the buzzer operates on the principle of converting electrical energy into mechanical vibrations that produce sound. Operating at a voltage range of 3V to 12V, the buzzer's frequency and intensity can be controlled to suit specific needs. In the surveillance system, the buzzer can be employed to provide audible notifications when human tries to touch the module, alerting users to potential security breaches or system events. This auditory feedback enhances the system's responsiveness and usability, ensuring that critical alerts are promptly communicated to users.



Fig 6: Buzzer

G. Blynk app

The Blynk app is a versatile platform for creating IoT applications, offering a user-friendly interface for designing custom dashboards to control and monitor connected devices. With its drag-and-drop functionality, users can easily add buttons, sliders, graphs, and other widgets to create personalized interfaces. Compatible with a wide range of hardware platforms such as ESP32, ESP32-CAM etc. Blynk enables real-time communication between the hardware and the app using the Blynk Cloud service. This connectivity allows users to remotely control devices, monitor sensor data, receive notifications, and log data to the cloud.

H. LCD

The 16x2 LCD module is a widely used display component in electronics projects, offering a simple and effective way to present information. With its 16 columns and 2 rows of characters, the display can show up to 32 characters at a time, each character typically represented by a 5x8 dot matrix. The module is controlled by a microcontroller or similar device, which sends data and control signals to the display. Operating at around 5V, the 16x2 LCD module is compatible with most microcontrollers and digital systems.



Fig 7: LCD

V. WORKING

The smart surveillance system project utilizes several components, including the ESP32 microcontroller, IR sensor, ESP32-CAM module, and Blynk app, to create a comprehensive surveillance solution. The IR sensor continuously scans for human presence, triggering the ESP32-CAM module to capture a photo upon detection. This photo, containing the detected human, is then transmitted to the user's Blynk app account via the ESP32-CAM, utilizing the internet connection. The Blynk app displays the received photos in real-time, enabling the user to monitor the surveillance area remotely. Additionally, the user can choose to interact with the system through the app, such as opening or closing a door if the person in the photo recognized is authorized and retaking the photo if it is not clear. This system provides a comprehensive surveillance solution, combining detection, image capture, remote monitoring, and control functionalities.

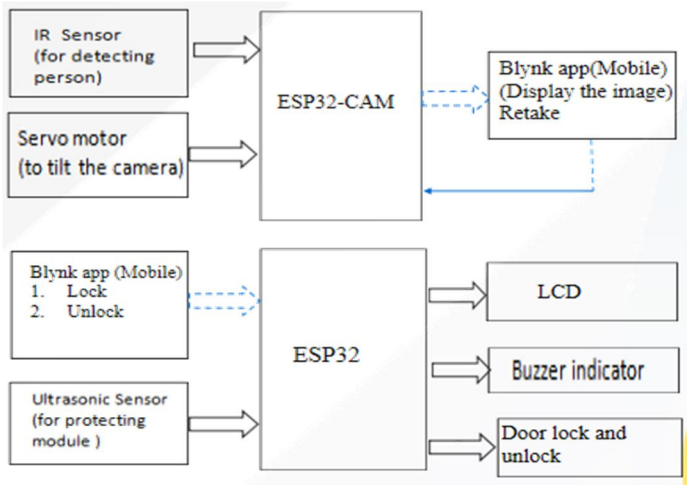


Fig 8: Block diagram of proposed method.

VI. RESULT

The following figure 9 is the proposed Advanced surveillance system using ESP-32.We connected Ultra-sonic sensor,Buzzer, Door lock system and LCD to ESP32 and IR-sensor to ESP32-CAM. We used servo motor to tilt the Camera 180 degrees.

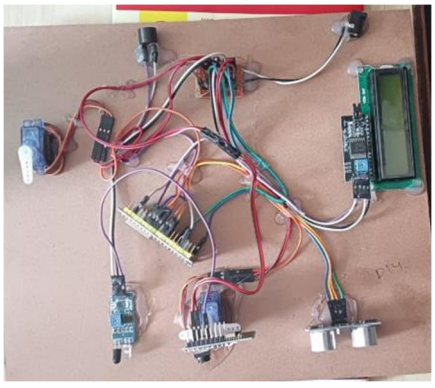


Fig 9: Advanced Surveillance System prototype

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue VI June 2024- Available at www.ijraset.com

Person arrived at the door and he detected by the IR sensor, it sent the signal to ESP32-CAM to capture the photo. This is shown in the following fig 10.

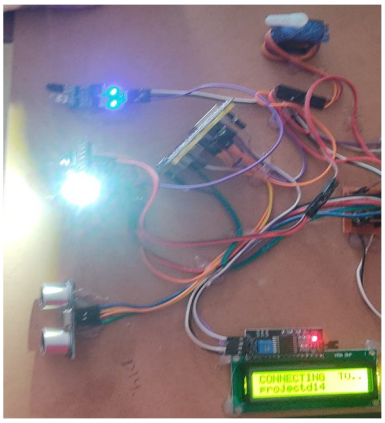


Fig 10: Captured by the ESP32-CAM

The captured photo is sent to the receivers Mobile through wi-fi in Blynk app as shown in fig 11.

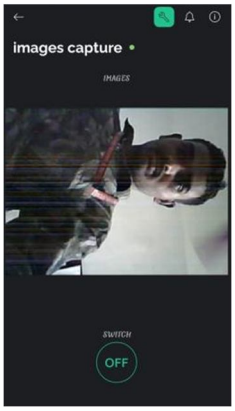


Fig 11: Image on Blynk app.

From fig 11, by using switch we retaken the photo.

Using this system, we locked and unlocked the door using widgets in Blynk app.

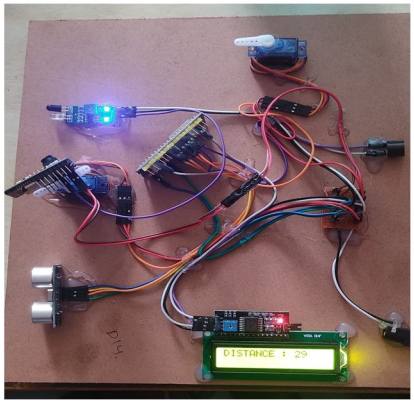


Fig 12: Door lock state

Figure 12 shows the Door which is in locked.By using the Blynk app Door ON/OFF widget we unlocked the door.Figure 13 shows the Door Which is in unlocked state.

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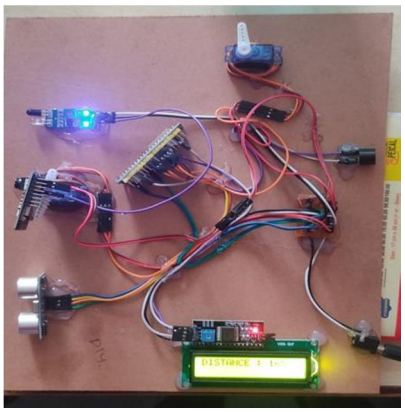


Fig 13: Door unlock state

VII. FUTURE SCOPE

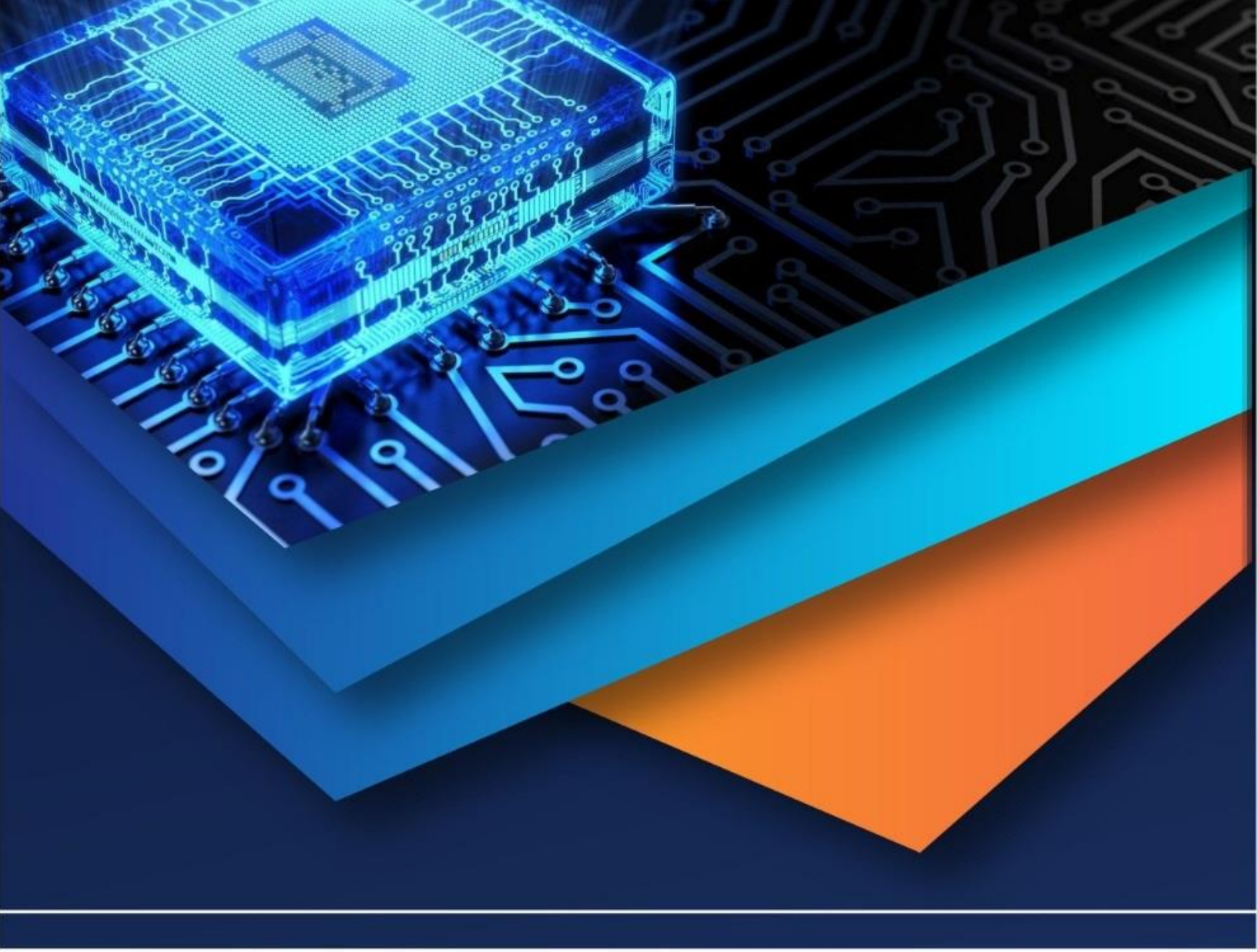
The presented work can be extended by employing high resolution camera and algorithms for detection of authorized humans and their movement. This proposed functionality, supports multiple cameras to provide a broader coverage area and more detailed surveillance along with the Implementation cloud storage.

VIII. CONCLUSION

The Advanced surveillance system project demonstrates the effective integration of various components to create a versatile and user-friendly surveillance solution by utilizing the ESP32 microcontroller, IR sensor, ESP32-CAM module, and Blynk app, the system achieves real-time human detection, image capture, remote monitoring, and control Door lock and can also it provide 2 level security.

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