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SMART BIOMETRIC DOOR LOCK SYSTEM WITH FACIAL RECOGNITION AND FINGERPRINT AUTHENTICATION

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ABSTRACT

The intelligent biometric door lock system with facial recognition and digital fingerprint authentication offers a highly stable, safe, efficient and easy -to -use solution for access control. This advanced system integrates two biometric modalities (facial recognition and digital fingerprint authentication), ensuring solid security through the verification of multifactor factors. The facial recognition system uses sophisticated algorithms to analyze unique facial characteristics, while the digital footprint scanner coincides with different crest patterns to verify the identity. The combination of these technologies reduces the risk of unauthorized access, since it is almost impossible to replicate or forge biometric features. The system is designed to be very receptive, offering perfect integration with mobile applications for remote access management and monitoring. In addition, its user -centered interface allows an easy registration of users and the management of access permits. With its scalability, the system is suitable for various applications, including residential, commercial and high security environments. The intelligent biometric door blocking system represents a significant advance in the security field, providing convenience and tranquility for users.

Keywords- ESP32 Camera, Arduino Uno, Fingerprint Detector, Blynk, R307.

I. INTRODUCTION

The "Smart Biometric Door Lock System with Facial Recognition and Fingerprint Authentication" is designed to enhance access control, help unauthorized entry and advanced security. By combining two important biometric technologies — point scanning and facial recognition this system provides a largely secure and stoner-friendly way to manage door access. The system leverages IoT technology through an ESP32 camera for facial recognition, a point detector for biometric authentication, and an Arduino board to control the locking medium. Also, it includes a blynk iot software through which we can control the solenoid lock, icing a comprehensive and dependable access control result that can be covered and managed ever for increased security and convenience.

The problem this design addresses is the need for a secure, effective, and accessible system of controlling access to physical spaces. Traditional key- grounded cinch systems are vulnerable to theft, duplication, and unauthorized access, while word- grounded systems can be fluently compromised. Current biometric access systems, similar as point scanning or facial recognition, are frequently either separate results or lack integration, leading to limited security and usability. This design aims to develop a smart door cinch system that combines both point and facial recognition technologies, icing multi-factor authentication. also, the system will be equipped with an IoT- enabled software for real- time covering and logging of stoner access, offering a more secure, dependable, and effective result for managing entry and exit.

This design is for the secure home entry along with video surveillance and an advanced technology of door locking system which prevents from the unanticipated and unknown entries.

The main theme of this design is to develop the automatic door locking system which unlocks using the point and the facial features. It starts from surveying the point of the house proprietor to unlock the door automatically It can be penetrated by either point or the facial features of the house proprietor parallelly. When the proprietor accesses the point or cam, also the solenoid cinch which is connected to the point detector opens and gives access to get in. However, also there will be no access, If the point or image isn't matched with the point or image which is stored in the database. However, also the esp32 cam which was fixed to the cinch system, captures the image of that person, If any unknown person is in front of the door. The proprietor will choose whether the access should be given or not using his smartphone.

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Aim and Objects of Research

1. Enhanced Security- Combines point scanning and facial recognition for multi-factor authentication, significantly reducing the threat of unauthorized access compared to traditional crucial or Leg systems.

2. Convenience- Eliminates the need for physical keys or flashing back canons, offering a flawless, presto, and dependable way for druggies to pierce secured areas.

3. Real- Time Monitoring and Logging- Allows directors to track entry and exit conditioning, view access logs, and insure responsibility with time- stamped records of each access attempt.

4. Inspection Trail for Responsibility- Logs all successful and failed access attempts, furnishing a clear inspection trail for security monitoring and compliance purposes.

5. Remote Operation- Enables directors to manage stoner access and cover the system ever via a pall-grounded or original database, enhancing inflexibility and control.

II. LITERATURE REVIEW

The literature strengthening biometric security systems and IoT- enabled smart cinches reveals significant advancements and ongoing challenges. Then a summary of crucial studies and findings applicable to the development of a Smart Biometric Door Lock System integrating point detectors and face recognition

1. Fingerprint Recognition Systems

Exploration on point recognition, similar as the study by Meenakshi, N, M Monish, K J Dikshit, and S Bharath.(2019), highlights the trust ability and delicacy of point biometrics due to its oneness and low probability of duplication. Capacitive and optic point detectors have been extensively espoused, but studies also note challenges like spoofing attacks and performance declination with dirty or damaged fingerprints.

2. Face Recognition Technology

Studies on face recognition, particularly those using deep literacy approaches like convolutional neural networks (CNNs), have demonstrated significant advancements in delicacy and robustness. Beforehand styles, similar as PCA- grounded Eigenfaces, were limited by variations in lighting and disguise. Recent advancements, similar as the use of algorithms like FaceNet and OpenFace, have enhanced performance in real- world conditions (Dilip Prapathapagiri, Kosalendra Eethamakula, 2021).

3. IoT Integration in Access Control

IoT- grounded security results, as bandied by Baidya J, Saha T, Moyashir R, Palit R.(2017), offer real- time connectivity, enabling remote monitoring and control. Research emphasizes the significance of secure data transmission protocols, similar as HTTPS and MQTT, to guard against cyberattacks. Studies have also stressed the eventuality of IoT to enhance stoner convenience by integrating smart cinches with being home robotization systems.

4. Multi-Modal Biometric Systems

A check by Namrata Singh, Dr. Ramveer Singh, et al.(2022) on multi-modal biometrics highlights the advantages of combining multiple biometric traits, similar as fingerprints and face recognition, to ameliorate delicacy and reduce vulnerabilities to spoofing. This approach addresses the limitations of single- biometric systems and provides a more robust authentication medium.

5. Challenges in Being Smart Cinches

Research has linked several limitations in current smart cinch systems, including high costs, limited battery life, and vulnerability to hacking. Studies stress the need for energy-effective designs and robust encryption styles to address these issues.

III. PROPOSED METHODOLOGY

User Registration

- **Fingerprint Registration-** The admin registers authorized person by placing their fritters on the point detector. The detector captures the point, which is converted into a unique template and stored in the database.
- **Facial Recognition Registration-** After point enrolment, the stoner stands in front of the ESP32 camera. The system captures their facial image and send it to the admin through wifi module.

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Authentication

- **Fingerprint Authentication-** When an unknown attempts to pierce the door, they place their finger on the point detector. The system reviews and compares the point with the stored templates in the database. However, the system proceeds to facial recognition, If the point matches.
- **Facial Recognition-** contemporaneously, the ESP32 camera captures an image of the unknown's face. The image is captured and the owner gets the notification on blynk app with the unknown face image. However, the system subventions access, If both the point and facial recognition match. Now, if the owner wants he can unlock the door through the blynk .

Door unleashing

- Once both authentication styles are successful, the Arduino sends a signal to the motorized lock (relay) to unlock the door.

Monitoring

- The admin can pierce the logs through a web or mobile app for real- time monitoring.

Remote Operation

- Unauthorized access attempts are logged, and the owner are notified to take farther action.

Re-locking the Door

- After the stoner enters, the door is automatically re-locked after the set time period, icing nonstop security.

The methodology section describes the design and perpetration of the point door cinch system using Arduino Uno microcontroller. The system consists of tackle and software factors. The tackle factors include Arduino Uno, point detectors module, relay module, solenoid door cinch, some muumuu cables, and an appendage. The software factors include a program for uniting the point detector with Arduino.

1 point detector was used in this thesis design. It can be fluently integrated into colourful biometric systems. It's compatible with Arduino development boards and can be used to apply secure access control systems, attendance operation systems, and other biometric operations. The detector module is equipped with a high-resolution optic scanner that can capture fingerprints with high delicacy and speed. The point detector module has a compact design and is easy to install. It communicates with Arduino boards via a diurnal interface and can store up to 127 point templates in its internal memory. The module also features a erected- in LED index and buzzer that give real- time feedback during point scanning. Overall, is a protean and dependable point detector module that can be used in a variety of biometric systems. Its ease of use and comity with Arduino boards make it an ideal choice for potterers and professionals likewise.

IV. SYSTEM DIAGRAM

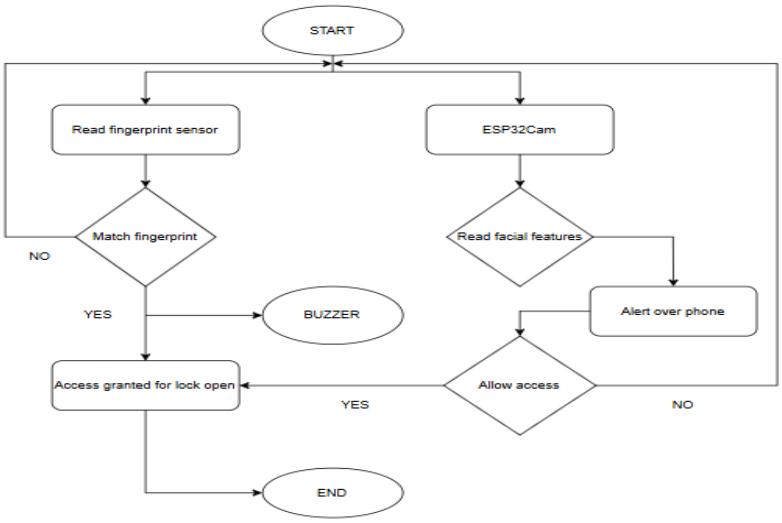

Fig. 1 Flowchart of the smart biometric door cinch system

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Internet of Things

The Internet of Things (IoT) refers to a network of physical devices, vehicles, appliances and other objects that are built into sensors, software and connection, allowing them to collect and exchange data over the Internet. These devices can communicate with each other and with centralized systems, allowing automation, remote monitoring and improved decisions. IoT transforms industries by allowing smarter cities, effective health care, optimized supplier chains and increased home automation. Its applications are huge, from intelligent houses to industrial automation, all designed to improve the efficiency, comfort and knowledge based on data.

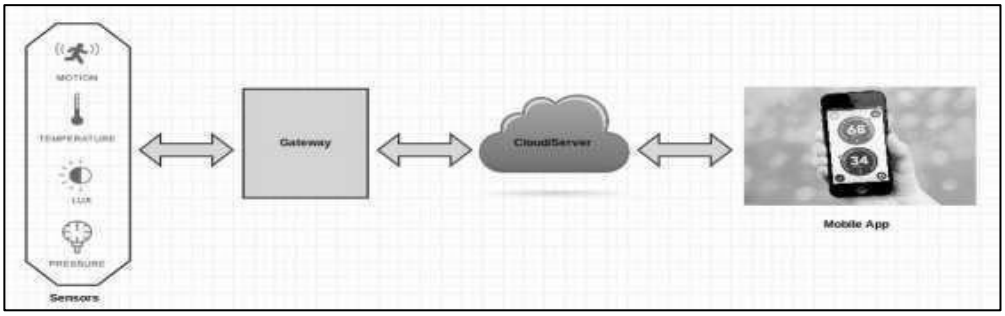

Fig.2 Working of Internet of Things

V. EXPERIMENTAL RESULTS AND DISCUSSION

The biometric door lock system using Arduino Uno and ESP32-CAM demonstrated effective functionality in recognizing authorized faces and unlocking the door with reasonable accuracy under optimal conditions. Face recognition had a high success rate in well-lit environments, but performance declined in low-light or backlit scenarios, highlighting the need for auxiliary lighting. The system was cost-effective and easy to implement, which makes it suitable for small- scale applications. However, limitations are processing delays, restricted database capacity, and potential Wi-Fi security vulnerabilities suggest room for improvement. Future enhancements could include better hardware, encryption protocols, and multi-modal authentication to improve reliability and security.

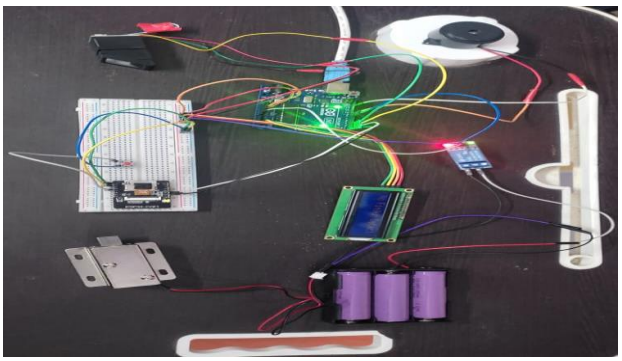

Fig.3 Connection of the systems and showing result

VI. CONCLUSION

Our project is about representing a significant leap in access control technology, combining the reliability and security of biometric authentication methods. By integrating facial recognition and fingerprint scanning, the system ensures a high level of security while reducing the risks of unauthorized access. The dual-layer authentication process adds an extra level of protection, making it nearly impossible to bypass. Additionally, the user-friendly interface and mobile integration enhance the system's convenience and accessibility, making it suitable for both residential and commercial applications. As the demand for smart security solutions continues to rise, this project highlights the potential for advanced biometric technologies to transform the way we secure our spaces. Ultimately, the Smart Biometric Door Lock System offers a practical, scalable, and efficient solution for modern security needs, providing peace of mind and a future-proof approach to access control.

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