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Machine Vision-Based Smart Door Lock System for Home Automation

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ABSTRACT: People place high value on having a secure home, in order to have one that is also smart, we must first install a secure door lock system. Therefore, a door locking mechanism which is convenient and user-friendly, with improved accuracy and security is suggested. The smart door lock system uses biometric facial features for identification and is designed using advanced technologies including cloud computing by Amazon Web Services (AWS) and data processing by Raspberry Pi. AWS performs data storage, face detection and recognition, and determination of whether an individual is authorized or not. Deep Neural Network algorithms are used by Amazon services in computer vision, image processing, and image captioning. Motion sensor triggers Raspberry Pi camera which is used as an input device, capturing real-time image of the person accessing the door. The electronic lock makes an appropriate decisions regarding whether to unlock the door or keep it closed simply, based on the information received by the processing unit from AWS cloud. The smart door lock system based on machine vision provides contactless service, without any manual interference. Facial recognition is performed irrespective of factors like illumination, face pose, facial expression and occlusion. It shall then contribute to the achievement of smart home automation.

KEYWORDS: AWS, Facial Recognition, Machine Vision, Raspberry Pi, Smart Door Lock.

I. INTRODUCTION

A. Overview

The concept of home automation has witnessed significant advancements in recent years as more individuals seek ways to enhance their comfort and security. One area of home automation that has shown considerable progress is the development of smart door lock systems. These systems offer homeowners the ability to remotely manage their door locks using various methods such as pin codes, passwords, RFID cards, and biometric authentication techniques like fingerprint, iris scan, and voice recognition.

However, many of the existing smart lock systems rely on manual inputs or physical interactions, which can be inconvenient and pose security risks. For individuals with physical disabilities or those seeking contactless solutions, these limitations become more apparent. To address these challenges, a machine vision-based smart door lock system is proposed as a modern solution that leverages advanced image recognition technology to identify and authorize individuals accessing the door. The suggested system aims to provide a higher level of convenience, security, and user-friendliness compared to the traditional lock systems.

Facial features are unique to each individual, making it an effective and reliable biometric identifier. By employing facial recognition as the primary authentication method, the system eliminates the need for physical interaction or the use of external devices. By incorporating machine vision algorithms and cloud computing, the proposed system can accurately analyze and authenticate facial images in real time. The captured image is processed to extract facial features, which are then compared against authorized user data stored in a secure database. If a match is found, access to the door is granted, while unauthorized individuals are denied entry.



The integration of facial recognition technology into the smart door lock system not only enhances security but also offers a user-friendly and seamless experience for homeowners. With a simple glance at the camera, authorized individuals can gain access to their premises, eliminating the need for keys or passwords, or any manual efforts.

B. Problem Statement

The existing electronic locking systems used employ technologies like NFC, Bluetooth, and RFID for wireless communication. These systems are based on RFID card and passwords/PIN numbers as authentication methods and has high risk of getting hacked, manipulated or misplacing card. An automatic lock system that uses biometric features are sometimes sensitive like unable to determine the user's fingerprint's biological pattern because of sweat or damage. Voice-assistant door locks are inconvenient for speech disabled person or in noisy area. The majority of facial recognition technologies being used today operate in a controlled environment. Face recognition technology's precision and efficiency are significantly impacted by a variety of characteristics alterations in lighting, face pose, facial expression, face occlusion, and ageing. Face occlusion like sunglasses, mask, scarf, hat, beard, etc., is also one of the crucial factors that influences the performance of the system.

C. Objectives

- This project's main goal is to design and implement lock system that performs face detection and recognition by using Raspberry Pi, Pi camera, PIR sensor and AWS cloud platform, to allow access only to the authorized people.
- Another important objective of Machine vision-based Smart Locking System is to perform face recognition accurately irrespective of factors like lighting, pose, facial expression, occlusion and aging.
- The locking system should improve convenience for users by reducing the time and effort for manual authentication. The house owner can remotely grant access to visitors, an unauthorized user.
- This robust and efficient smart door lock system based on facial recognition aims to integrate with other smart home systems to contribute to the field of smart home automation.

II. LITERATURE REVIEW

ThaweesakPenpokai et al. [1] proposed a solution for common issues faced with traditional door-locking mechanism such as loss of a key, not remembering locking the door, and lack of remote monitoring. The approach involves using a web application and passcode in addition to regular keys for locking and unlocking. This system allows for remote locking, unlocking, status monitoring, and email notifications when someone knocks on the door. Temporary users can be created with generated passcodes, and the system is compatible with the old metal key as a backup. Testing shows that all functions work except for the knocking notification via email, with a 10% error rate when the door is knocked too softly.

Despite using sturdy metal locks, concerns like key misplacement and robberies remain. To address these issues, Aswini D et al. [2] introduced a new solution that offers enhanced security and remote access. This research investigated a door lock system that utilizes radio frequency identification (RFID) and a technology driven by one-time passwords (OTPs) to enhance home security. The proposed system generates a time-limited OTP for door access. A mobile application, a Raspberry Pi microcomputer, a radio frequency identification (RFID) reader, a keypad interface, a liquid crystal display (LCD), an electromagnet to secure the door, and a servo motor to control the door's positioning are all included in the operational configuration. The mobile app generates an OTP that grants access for a specified period, ensuring only authorized visitors can enter the premises within that period.

Muhammad S. Hadis et al. [3] suggested an innovative and user-friendly door lock system design that eliminates the need for a contact with the locking equipment. The system utilizes low-power Bluetooth technology with features incorporated to enhance user comfort and security. The lock system consists of two identification areas: the vicinity of the Bluetooth signal and the validation vicinity. By detecting the user's Bluetooth device in the signal area, the system initiates communication and compares identities. The door is automatically unlocked when the user is in proximity to the validation area.

The research conducted by Amritha Nag et al. [4] concentrated on augmenting the security of important premises by utilizing facial detection and recognition technology for door protection. Utilizing Face Recognition with OpenCV, the

system employs Eigen faces for accurate recognition and scales down face images while preserving important details. The Telegram Android app allows remote access to the door lock, and a Raspberry Pi camera captures and sends images for identification. Authorized individuals can control the door's lock and unlock mechanism through the Telegram app. If an unknown visitor arrives, their image is captured and emailed to the authorized person. Known contacts can use the Telegram app to open the door with a command like "ON."

A method for developing an intelligent security lock was presented by Varad Pandit et al. [5], who also discussed the design of the door lock and application system, which includes a mobile app with Bluetooth connectivity. By incorporating cutting-edge technologies like face recognition for secure authentication, the lock ensures total security. The mobile app offers real-time camera monitoring, intrusion detection notifications, and timestamped records of each instance of lock and unlock actions. As a backup to facial recognition, there is also an OTP authentication mechanism available, guaranteeing convenience and security. Instant notifications and data updates are made possible by the system's constant synchronization of its various parts.

A system that employs an Arduino to implement a door lock security system based on secret knock intensity was proposed by Tommy Cha et al. [6]. The system wirelessly transmits information to a mobile application for unlocking/locking the door. Users can choose either a secret knock or an Android phone to unlock the door. For the secret knock method, the user must be familiar with the specific pattern and timing. Alternatively, the Android phone method requires connecting to the internet connection and entering the correct password. Both methods allow users to reset the password or secret knock sequence for access. The project emphasizes the transmission of information based on knock intensity.

The scholarly work by Harnani Hassan et al. [7] details the creation of a Graphical User Interface (GUI) designed for a door lock security system that relies on face recognition technology. The system employs a Peripheral Interface Controller (PIC) as an input/output mechanism to regulate a magnetic lock. The implementation entails establishing a connection between a microcontroller and a GUI developed in MATLAB R2009a, with the GUI and PIC microcontroller linked through a USB serial connection. The study showcases the utilization of a PIC microcontroller and USB serial connection to enable auto-switching mode functionality. It was found that the GUI successfully controls the magnetic lock based on the detection of an authorized picture from the GUI database. The Eigenfaces technique is employed as one of the methods in the face recognition system, projecting face images into a feature space known as face space.

Meera Mathew et al. [8] have presented a novel approach to address the security shortcomings of existing single-factor authentication locking systems, such as passwords, RFID, biometrics, OTP, cryptography, wireless, and IoT. Their solution is a secure door locking system that incorporates two-factor authentication and robust encryption using RFID technology. The primary objective of the system is to ensure real-time activation, verification, and validation of users, granting access exclusively to authorized individuals. Key matching and a Java-based encryption technique serve as the system's fundamental components. Additionally, a secure wallet software for Android is included, empowering users to establish a secret key for data encryption. The RFID reader retrieves tag information, encrypts it, and transmits it to the database. Following verification, a one-time password (OTP) is generated on the central server and simultaneously dispatched to the owner's smartphone and the door lock.

Donhee Han et al. [9] have put forth a solution for enhancing the security of current door lock systems by introducing a blockchain-based smart door lock approach. This solution ensures secure data transmission and reception, protecting against tampering and hacking. It offers authentication, non-repudiation, and data integrity, leveraging the blockchain technology. The system incorporates an algorithm that analyzes sensor data to make informed decisions and operates accordingly. Unauthorized users are prevented from accessing the blockchain network, guaranteeing authentication and security. The inclusion of three sensors along with the smart door lock enhances the system's ability to detect and respond to any unauthorized entry, both internal and external. Overall, this blockchain-based smart door lock solution offers robust IoT security and safeguards against various threats.

A face-recognition-based door lock mechanism that automatically opens the door if the individual's face is identified was discussed by Amritha P. et al. [10]. The system employs the Viola-Jones face detection algorithm to achieve efficient detection of faces, while the Local Binary Pattern Histogram (LBPH) algorithm is utilized for precise face recognition. LBPH's illumination invariance ensures reliable performance in different lighting conditions. The system is



trained with images of people in various poses, allowing it to recognize faces with up to 45 degrees of head orientation. Experimental results confirm the system's ability to detect and identify faces in different poses and lighting conditions.

III. DESIGN AND IMPLEMENTAION

A. Proposed System

The PIR motion sensor, which recognizes human movement, is central to the system's operation. The Raspberry Pi camera records an image of the person when it detects motion, and then sends it to the AWS cloud for analysis. After processing the image, AWS determines whether the person is authorized and makes a distinction between authorized and unauthorized people. Based on this information, the solenoid lock either unlocks the door for authorized individuals or keeps it locked for unauthorized individuals. This integrated system combines hardware and cloud processing to provide secure and efficient access control based on facial recognition technology.

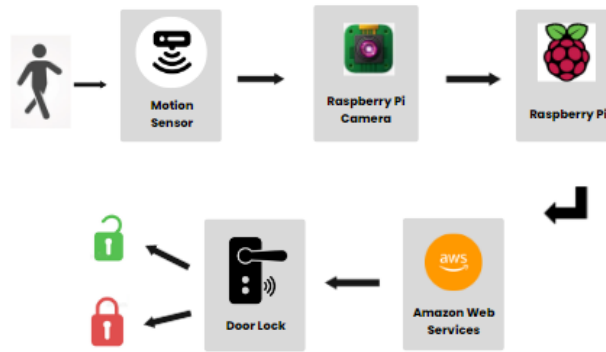


FIGURE 1 – Block diagram of the System

B. Methodology

The methodology of building of the suggested facial recognition door lock system involves following sequential steps:

- 1) **Hardware Design:** A solenoid lock, PIR sensor, and Raspberry Pi camera are included in the door lock system as necessary parts. It is carefully configured for seamless communication with the integrated hardware components and connected peripherals, using the Raspberry Pi as the main controller.
- 2) **Cloud Platform Setup:** Amazon Web Services (AWS), an Amazon subsidiary is accessed and set up to store images of an authorized person which will be used as a verification factor whenever an individual tries to open the door. The necessary AWS services and resources are configured to enable secure image storage, pre-processing, and comparison operations
- 3) **Software Development:** An integrated development environment (IDE) called Geany is used for coding and software development on raspberry Pi. The programming language Python is employed to write the necessary code for image capture, pre-processing, and communication with the cloud platform.

C. Components Required

Hardware Components:

TABLE 1 – Hardware Components Required

Sl. No.	Component Name	Purpose of Use
1.	Raspberry Pi 4 Model B	Processes image to the cloud, and controls locking mechanism.
2.	Raspberry Pi Camera	Captures images at 5 megapixels resolution.
3.	Solenoid Lock	Locks or unlocks door with respect to power supply.



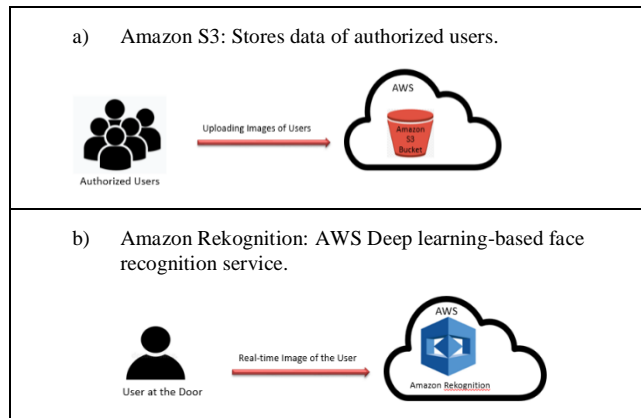
4.	PIR sensor	Detects motion by observing changes in the intensity of the IR radiation that humans emit.
5.	1 Channel Relay Module	Allow low voltage signal from microcontroller to control a high voltage lock system.
6.	MicroSD Card	Stores images in Raspberry Pi.
7.	Video Capture Card	Captures footage of user.
8.	Power Supply Adapter	Provides 12V electrical power to components.
9.	Sound Speaker	Generates voice to assist the user in front of door.
10.	LEDS	Red and Green LED provides visual feedback to users about the status of door.
11.	Pushbutton	An alternative method to trigger locking function.

Software Components:

1. Amazon Web Services (AWS)

Two AWS services are used by the system for cloud computing.

TABLE 2 – AWS Cloud Services Used



2. Geany

Geany is an open-source and user-friendly interface that is used for Python coding and programming on the Raspberry Pi. The code includes implementing the PIR sensor for motion detection, capturing images using the Raspberry Pi camera, and integrating the voice prompt and LED indicators.

D. Working

The working principle of the smart door lock system involves several steps. When a human is detected by the PIR motion sensor within its field of view, a voice prompt is generated through the sound speaker, saying, “Hello there, please show your face towards the camera and wait for 5 seconds.”. Simultaneously, the Raspberry Pi camera is activated and captures an image of user facing it. The captured image is then transmitted to the cloud where preprocessing takes place to remove any background noise and normalize the lighting condition of the image.

The facial features are extracted from the detected face by AWS Rekognition service using feature extraction algorithms and techniques. These algorithms analyze key facial landmarks, shapes, and patterns to create a unique representation of the individual's face. Once the facial features are extracted, the system compares them with the features of authorized users stored in the AWS database. This comparison is done using matching algorithms or similarity measures, which evaluate the level of similarity between the extracted features and the features of authorized individuals. The system recognizes the user as authorized if a match is made.



In case of an authorized user, the system activates a 12V electromagnetic solenoid door lock, allowing the door to unlock. Concurrently, a voice prompt is generated, stating, “Recognizing face from the database. Your face has been recognized, please come in.” Additionally, a visual indicator, a glowing green LED, provides feedback to indicate that access has been granted. On the other hand, if the identified user is unauthorized, the system keeps the door locked. A voice prompt is played through the sound, informing the user, “Your face has not been recognized, please wait for an update from the owner.” A red LED is turned ON to indicate that access has been denied.



FIGURE 2 – Hardware System Design

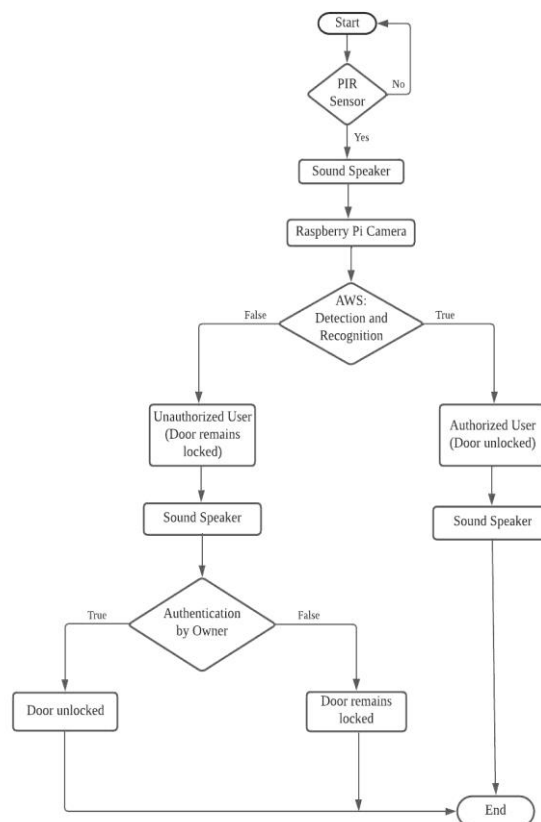


FIGURE 3 - Flowchart of Facial Recognition Smart Door Lock System

IV. EXPERIMENTAL RESULT

The smart door lock system is tested in a variety of settings, incorporating different face poses and facial expressions, to assess its efficiency and accuracy. Furthermore, the system is also evaluated for face recognition performance on various facial expressions and on both upper and lower occluded faces.

A. Testing in Bright Illumination with Different Face Poses

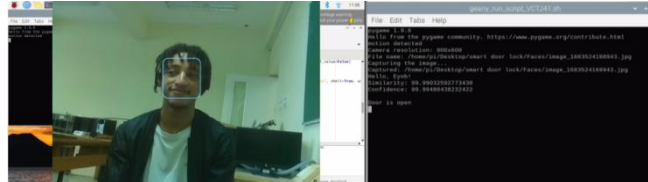


FIGURE 4 – Frontal Face Pose Recognition

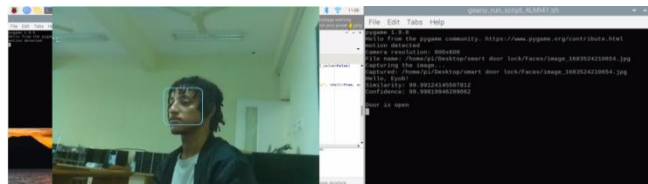


FIGURE 5 - Quarter-turn Face Pose Recognition

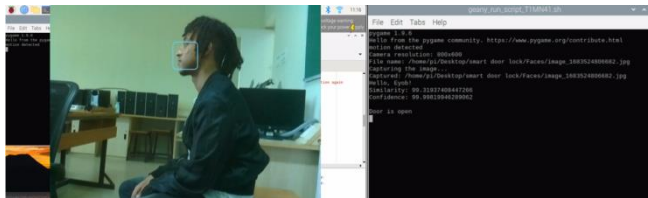


FIGURE 6 - Profile Pose Recognition

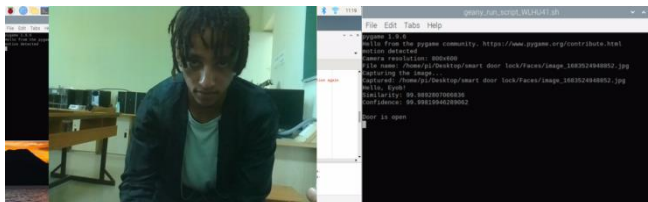


FIGURE 7 - Downward Face Pose Recognition

B. Testing in Low Illumination with Different Face Poses

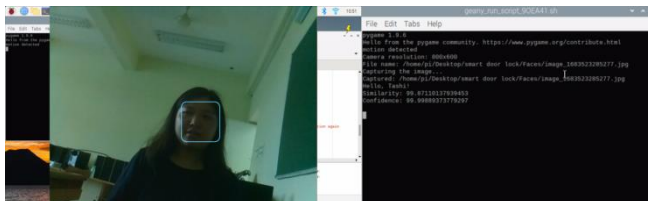


FIGURE 8 – Frontal Face Pose Recognition

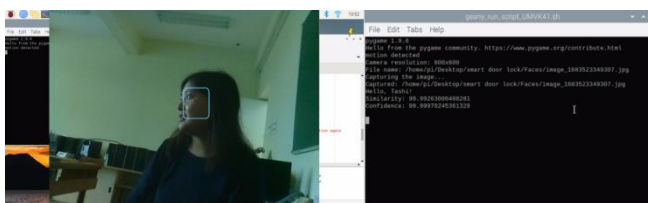


FIGURE 9 - Quarter-turn Face Pose Recognition

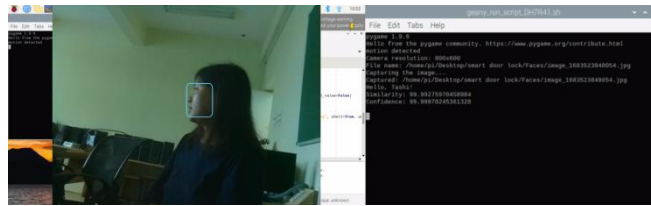


FIGURE 10 - Profile Pose Recognition

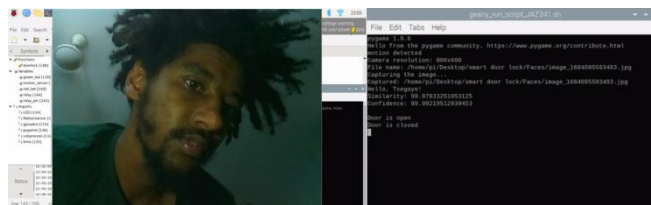


FIGURE 11 - Downward Face Pose Recognition

C. Facial Expression and Face Occlusion Testing

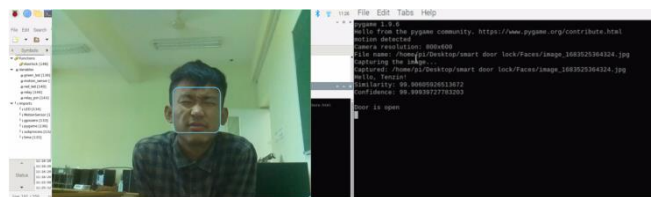


FIGURE 12 - Face Expression1 Testing

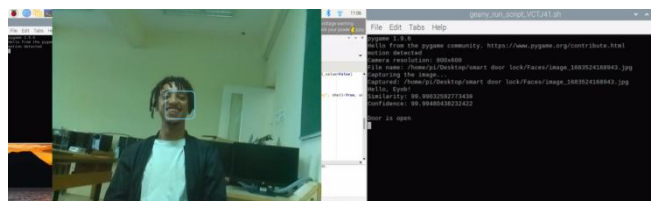


FIGURE 13 - Face Expression 2 Testing

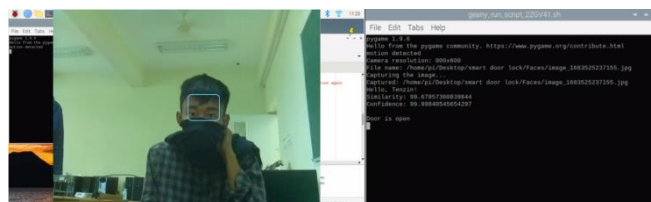


FIGURE 14 - Lower-Face Occlusion Test

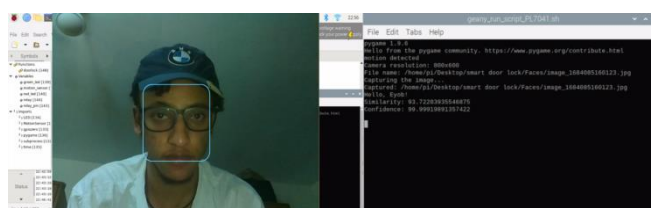


FIGURE 15 - Upper-Face Occlusion Test



D. Test for Unauthorized User

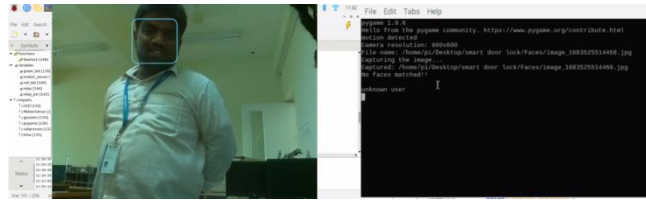


FIGURE 16 - Unauthorized User Test

TABLE 3
Varying Face Pose in Different Illumination Test

Lighting Condition	Face Pose	Face Recognition Result
Bright Light	Frontal pose	Recognized
	Quarter-turn pose	Recognized
	Profile pose	Recognized
	Tilted pose (either left or right)	Recognized
	Upward or Downward pose	Recognized
Low / Dim Light	Frontal pose	Recognized
	Quarter-turn pose	Recognized
	Profile pose	Recognized
	Tilted pose	Recognized
	Upward or downward pose	Recognized

TABLE 4
Face Occlusion Test

Occlusion Type	Face Recognition Result
Upper-Face Occlusion	Recognized
Lower-Face Occlusion	Recognized

The smart door lock system had accurately recognized the authorized user in all the mentioned conditions, with little variation in similarity value and similar (high) confidence level.

V. CONCLUSION AND FUTURE SCOPE

The smart door lock system developed in this project has demonstrated excellent performance and reliability. Extensive testing was conducted to evaluate its effectiveness under various scenarios, including different lighting conditions and face angles such as face turned 45 or 90 degrees to the camera, tilted left or right and facing upward or downward. Additionally, the system accurately recognized authorized users with different facial expressions and even when the face was occluded by mask, scarf, beard, sunglasses, cap and so on. The results of the testing process were highly satisfactory showcasing the robustness of the facial recognition algorithm employed in the system. The smart lock effectively responded to unauthorized users with the facial recognition process correctly identifying the mismatch and triggering the appropriate action to keep the door locked, thus ensuring the security. The overall functionality of the smart door lock system met the expectations and initial design goals. It provided accurate and reliable authentication, granting access to authorized users while maintaining a secure environment by denying access to unauthorized individuals. The successful implementation of this system highlights its potential in real-world applications, particularly in the realm of home automation and security. With its ability to provide contactless and user-friendly access control, it offers a convenient solution for homeowners and disabled people.

The developed smart door lock system has the potential for future enhancements and expansions. It can integrate with existing home automation systems, creating a comprehensive smart home automation. Integrating the system with smartphones and smart watches adds convenience and accessibility, enabling remote access to logs, real-time

notifications, and access permission management. For enhanced security and monitoring, the system can be merged with a CCTV camera network, enabling automatic camera recording and visual verification of door access.

REFERENCES

- [1] ThaweesakPenpokai, Thongchai Jenweerawat, Aunnisa Hami - "Door Lock System via Web Application", Faculty of Engineering Kasetsart University Si Racha Campus, *5th International Electrical Engineering Congress*, Pattaya, Thailand, 8-10 March 2017
- [2] Aswini D, Rohindh R, Mridula C S, Manoj Ragavendhara K S, "Smart Door Locking System", 2021 *International Conference on Advancements in Electrical, Electronics, Communication, Computing and Automation (ICAECA)*
- [3] Muhammad Sabirin Hadis, ElyasPalantei, Amil Ahmad Ilham, Akbar Hendra, "Design of Smart Lock System for Doors with Special Features using Bluetooth Technology", 2018 *International Conference on Information and Communications Technology (ICOIACT)*
- [4] Amritha Nag, Nikhilendra J N, MrutyunjayKalmath," IoT Based Door Access Control Using Face Recognition", 2018 *3rd International Conference for Convergence in Technology (I2CT)* The Gateway Hotel, XION Complex, Wakad Road, Pune, India. Apr 06-08, 2018
- [5] Varad Pandit, Prathamesh Majgaonkar, Pratik Meher, Shashank Sapoliga, Prof.SachinBojewar, "Intelligent Security Lock", *International Conference on Trends in Electronics and Informatics ICEI 2017*
- [6] Tommy Cha HweayRhunn, Anis Farihan Mat Raffei, Nur Shamsiah Abdul Rahman, "Internet of Things (IoT) Based Door Lock Security System", 2021 *International Conference on Software Engineering & Computer Systems and 4th International Conference on Computational Science and Information Management (ICSECS-ICOCSIM)*
- [7] Harnani Hassan, Raudah Abu Bakar, Ahmad ThaqibFawwaz Mokhtar, "Face Recognition Based on Auto-Switching Magnetic Door Lock System Using Microcontroller", 2012 *International Conference on System Engineering and Technology* September 11-12, 2012, Bandung, Indonesia
- [8] Meera Mathew, Divya R S, "Super Secure Door Lock System For Critical Zones", 2017 *International Conference on Networks & Advances in Computational Technologies (NetACT) |20-22 July 2017|* Trivandrum
- [9] Donhee Han, Hongjin Kim, Juwook Jang, "Blockchain based Smart Door Lock system", *IEEE Access*, ICTC 2017
- [10] Amritha Purushothaman, SujaPalaniswamy, 'Pose and Illumination Invariant Face Recognition for Automation of Door Lock System', *Proceedings of the 2nd International Conference on Inventive Communication and Computational Technologies (ICICCT 2018) IEEE Xplore* Compliant - Part Number: CFP18BAC-ART; ISBN:978-1-5386-1974-2
- [11] SialeLeekongxue, Li Li, Tomas Page, "Smart Door Monitoring and Locking System using SIM900 GSM Shield and Arduino UNO," *International Journal of Engineering Research & Technology (IJERT)* ISSN: 2278-0181 Vol. 9 Issue 04, April 2020
- [12] Ravi Kishore Kodali, Vishal Jain, Suvadeep Bose, Lakshmi Boppana, "IoT based Smart Security and Home Automation System", 2016 *International Conference on Computing, Communication and Automation (ICCCA)*
- [13] Zhaoqing Peng, Takumi Kato, Hideyuki Takahashi, Tetsuo Kinoshita, "Intelligent Home Security System using Agent-based IoT Devices", 2015 *IEEE 4th Global Conference on Consumer Electronics (GCCE)*
- [14] N. H. Ismail, Z. Tukiran, N. N. Shamsuddin, and E. I. Saadon, "Android-based home door locks application via Bluetooth for disabled people," 2014, pp. 227–231
- [15] Varad Pandit, Prathamesh Majgaonkar, Pratik Meher, Shashank Sapoliga, Prof.SachinBojewar, "Intelligent Security Lock", *International Conference on Trends in Electronics and Informatics ICEI 2017*
- [16] Jaiswal, Arvind, and Sandhya Tarar. "Realtime Biometric System for Security and Surveillance Using Face Recognition", *International Conference on Advances in Computing and Data Sciences Springer Singapore*, 2020
- [17] Khowaja, S., Shah, S., Shah, R. And Shah, A., "Dc Coefficients Comparison Based Approach for Fingerprint Identification System", *Sindh University Research Journal-Surj (Science Series)*, 47(1)
- [18] KetkiPrasadeet al., "Face Recognition Based Door Locking System", *International Research Journal of Engineering and Technology (IRJET)*, July 2018
- [19] Hassan, Harnani, Raudah Abu Bakar, and Ahmad ThaqibFawwaz Mokhtar. "Face acknowledgment dependent on auto-exchanging attractive entryway lock framework utilizing microcontroller." 2012 (ICSET). *IEEE*, 2012
- [20] Sura Mahmood Abdullah, "Design secured Smart Door Lock based on Jaro Winkler Algorithm," *Tikrit Journal of Pure Science*, vol. 21, pp. 154– 159, June 2016
- [21] Jawad Nagi, Syed Khaleel Ahmed, "A MATLAB based Face Recognition System using Image Processing and Neural Networks", *4th International Colloquium on Signal Processing and its Application*, March 7-9,2008
- [22] M. J. Mahammad, Y. A. Mashhadany, A. M. Eyada, "Real time model of a lock gate system upon fingerprint with microcontroller", *Indonesia Journal of Electrical Engineering and Computer Science*, vol. 21, 2021, pp. 37-43



- [23]Jawad Nagi, Syed Khaleel Ahmed, "A MATLAB based Face Recognition System using Image Processing and Neural Networks," *4th International Colloquium on Signal Processing and its Application*, March 7-9,2008
- [24]Pradnya R. Nehete, J. P. Chaudhari, S. R. Pachpande, K. P. Rane, Literature survey on door lock security systems, *Computer Applications*, Volume 153, No 2, pp. 13-18, November 2016
- [25]C.A. Athira et al., "Security Alert using Face Recognition", *International Journal of Advances in Computer Science and Technology*, Vol. 5, No. 12, pp. 176-179, 2016



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