IoT Based Intelligent Door Lock Ingress Control System with Digital Notification

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ABSTRACT

Intelligent security control system has become necessary in daily life. Security is one of the main challenges for people who are often away from home due to their work schedules. In today's world technological advent has not only resulted in the development of automation, computers, mechanics, robotics, industrial science, scientific knowledge but also increases the offence rate, misconduct, criminality and violation. So, there is an crucial requirement for the Security system. Hence, we have developed an intelligent door lock ingress control system. The development of a security door lock system, based on facial recognition and always-on technology, to confirm the identity of guests and control the access of doors has been reported. This article aims to provide a secure door lock system based on Raspberry pi Pico technology that integrates camera, keyboard, LCD screen, non-contact temperature sensor and metal sensor. The main purpose of this system is to access the lock when it recognizes the authorized person and when it recognizes the unauthorized person, it will take their picture by facial recognition, temperature and it also detects the presence of metal and send telegram and email notifications and allow the authorized person to authorize the person by sending OTP to the door or reject the person. The faces of authorized people are stored in Pico. This system can be useful in places like laboratories, computer areas, banks, schools, private homes, etc.

KEYWORDS*: Buzzer, Facial Recognition, Keypad, LCD display, Mental Sensor, Mlx Temperature Sensor, One-time password, Raspberry pi Pico WIFI, SSD.

I . INTRODUCTION

Security has become a major concern as a result of the rise in crime, theft and everyone wishes to take the necessary precautions to avoid outside interference in a variety of settings, including homes, offices, rooms, research experiments, museums, banks, etc. Privacy and a high degree of security are fundamental rights that guarantee everyone's safety. In older security systems, opening the entrance frequently requires a key. This weakens security for a variety of reasons. such as the ease of key replication, the possibility of loss or change of owner. The three main problems encountered in traditional security systems are:

- There is no intelligent way for an authorized person to be notified of visitors if he is outside or unavailable.
- There is no intelligent means by which authorized persons can communicate and impart instructions to guests at the door.
- There is no intelligent means by which authorized persons know the body temperature and weapon/metal presence of the individual before granting them access.

This proposed project will provide solutions to the problems encountered above by using the "Raspberry pi pico" microcontroller. Thus, the smart door lock solves the problem of unanswered visitors in case the person involved is out of reach. This smart door lock system will alert authorized person when unauthorized person is detected and allow authorized person to view visitor from their smartphone anytime, anywhere. With the most important feature being able to display the visitor's image on the owner's mobile device configured for the Raspberry Pi Pico. The system also includes a built-in "facial recognition" module to distinguish between authorized and unauthorized persons. Along with photos of visitors, their temperature and the presence of metal with them are also sent as message to the authorized person. After that an one time password is sent to the door directly and it is displayed in the inbuilt LCD display and the visitor can enter through after entering it. The One Time Password will be workable for a certain amount of time.

OBJECTIVES

- As this system is based on face recognition technology it provides great accuracy in recognizing the authorized person to unlock the door

- To alert the authorised person by sending notification via telegram and email
- To provide an intelligent way through which the owner can directly communicate to the door.
- To provide a smart means access for visitor to enter door
- To detect the weapon/metal presence of a person/visitor before providing them access.

- To measure the body temperature of the individual's before allowing them access.
- To avoid manual use of thermometer for measuring temperature of individual which became mandatory after COVID period and by replacing it with contactless sensor.

II . LITERATURE REVIEW

[1] In this work, they have proposed real-time face recognition technique using hierarchical network framework microcontroller used here is raspberry pi .

[2] In this work, the system used ESP32-CAM where the user has to enrol their face four times which has a face recognition and detection features.

[3] This security system is based on Face-ID of owner. When a face is in front of the camera ESP32-CAM, the current system quickly detects and recognizes faces in real time.

[4] The electromagnetic lock on the door will unlock if owner is identified and notification delivered in the form of an email to owner of the house if intruder detected.

[5] If a face is recognized by the system as a person approaches the entrance, the door will unlock. If not, a beeping sound will be heard, and an image of the visitor will be sent to the registered cell phone number.

[6] In this work If an image matches with database image, microcontroller send data to unlock the electromagnetic lock.

[7] This work is based on web-based remote monitoring, system transmits the pictures of the visitors to owner via email along with an SMS notification.
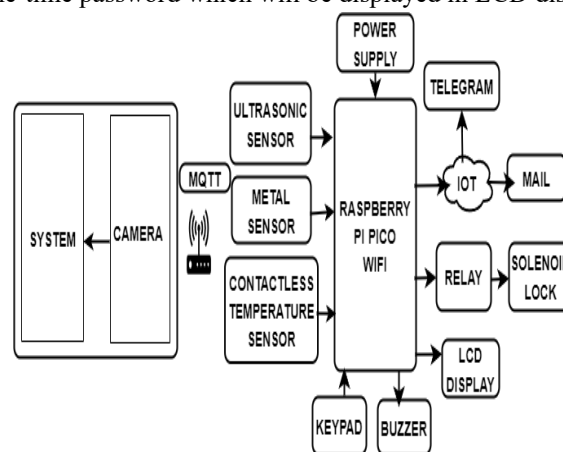
III. PROPOSED WORK

In this proposed work design and development of IOT based intelligent Door lock system

Here We are having database which contains authorised person's image , when there is an object movement in front of the door the controller enables the camera for capturing the event and check that image with the database using face recognition technique

if that person is an authorised person the door will get open otherwise the door remains closed and send the unauthorised person's image to authorised person mobile device via email and telegram along with visitors body "temperature" and "Metal sensor".

When an authorised person wants to allow a visitor, they will directly communicate to the door by sending One-time password which will be displayed in LCD display,

So that the visitor can enter the One Time Password in the keypad and enter into the door.

Figure – 3.1 Block diagram

- Figure represents the block diagram of proposed system, In this proposed work the Raspberry pi pico microcontroller interface with the contactless temperature sensor, metal sensor, ultrasonic sensor, buzzer, LCD display, relay and solenoid lock.

- MQTT(Message queuing telemetry transport)protocol , with the use of this server System and controller are wirelessly connected.

- Ultrasonic sensor used to sense the object in front of the door, whenever an object movement is sensed, the camera will get triggered to capture the image of visitor/individual's.

- If the captured person is an authorized person the relay will be triggered to open the door by using solenoid lock.

- If the captured image does not match the image in the database, the buzzer alerts the authorized person by giving beep sound. By using IOT platform, captured image, visitor's temperature and metal presence is sent to owner's mobile device via email and telegram.

• If the owner is not available in that location and wants to allow that person, the authorised person can directly communicate to door by sending One-time password to the door by using 'LCD display' and the visitor can type the OTP using 'KEYPAD' and that OTP will be valid only for certain period of time.

• 'Temperature sensor' is used to sense the unauthorized person/visitors body temperature, during Covid time to measure body temperature of visitor, manual detecting thermometer have used. So, to overcome this issue we have used inbuilt temperature sensor in the door which is contactless by this we can measure the visitor's temperature.

• 'Metal sensor' is used to sense metal presence, in case if an unauthorized person/intruder contain any metal product like knife it will alert the owner by sending notification like 'Metal Found' else 'No Metal Found'.


Figure -3.2 Flowchart diagram
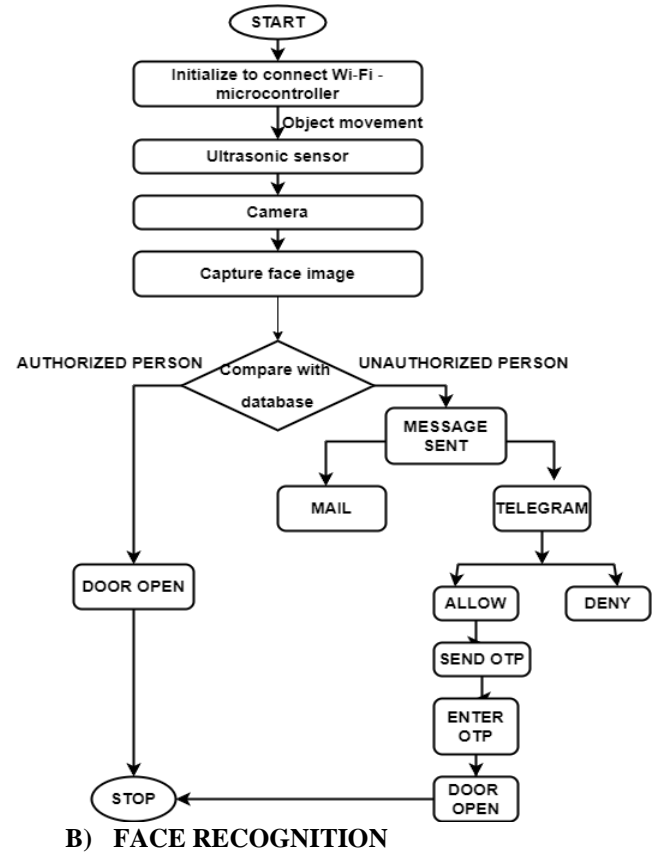
IV.METHODOLOGY

A) DEEP LEARNING

Deep learning is a subset of artificial intelligence (AI) that mimics every action humans acquire knowledge. It can automatically learn features from data, makes them suitable for tasks like image recognition and natural language processing..

A) SINGLE SHOT DETECTOR (SSD)

SSD (Single Shot Multibox Detector) is a most widely preferred algorithm for detection of objects. Image classification using computer vision takes the image as input and predicts object in it. While object detection not only predicts the object but also finds its position according to its bounding boxes. Single Shot Multibox Detector (SSD) uses a classifier based on a deep convolutional neural network (CNN). SSD uses a fast and efficient single-stage target detection engine on multiple feature classes of varying rates. SSD is an object detection algorithm that uses deep neural networks to detect objects figure in the image. To classify the objects, SSD uses a softmax classifier or a sigmoid classifier. The softmax classifier is typically used when there are multiple classes to predict, while the sigmoid classifier is used when there is only one class."In this proposed system SSD use Sigmoid classifier since the goal is to detect objects in images, the sigmoid classifier is a suitable choice as it is simpler and faster than the softmax classifier. The sigmoid function is applied to the output of the final convolutional layer, which produces a score for each default box indicating the probability that it contains an object".

B) FACE RECOGNITION

The face recognition technology uses feature extraction and classification to identify unique characteristics of an individual face. Face recognition technology helps to identify authorized persons by comparing the facial features of an individual with a database of pre-authorized faces. When an individual attempts to gain access, their face is captured by a camera and processed by the face recognition system. The system extracts key facial features and compares them to the facial features of authorized individuals stored in its database. In this process face recognition phase obtain a square face area which helps to remove the need for
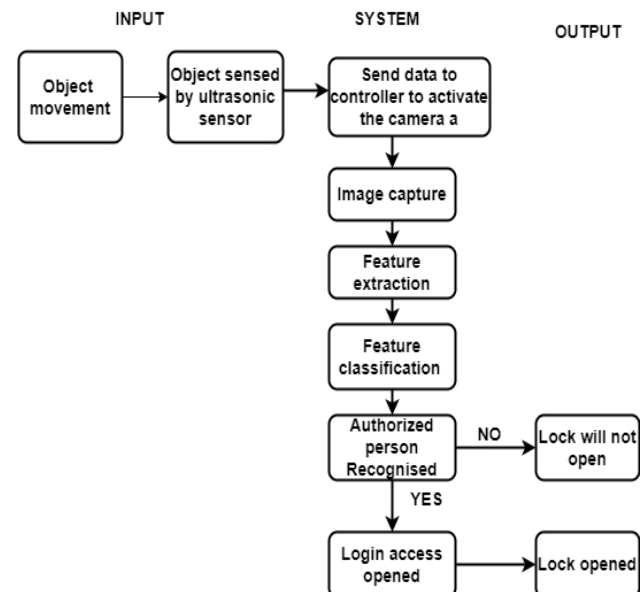
additional image processing.The below diagram shows the flow of face recognition process in the proposed work.

Figure – 4.1 Face recognition process

a) Capturing Images

When an object sensed by sensor the webcam get activated and the camera captures an image of the person's face, the input for the suggested system is built. Before storing the images in the dlib library,the captured image will go through image pre-processing and feature extraction automatically.

b) Feature Extraction

The main role of feature extraction in image detection is to learn the features automatically. In order to identify Textures, Shape and colors of an image using single shot multibox detector is used in this work which perform automatic feature extraction and extract random points from an image and stored in image feature database.After performing feature extraction, the extracted image is stored in the dlib library.

c) Feature Classification

At this face classification stage, sigmoid classifier is used to classify the extracted features of a face as belonging to a particular person. When picture of an authorized person recognised the lock will be opened

V . SYSTEM IMPLEMENTATION

A) SOFTWARE IMPLEMENENTION

- Camera and Controller are wirelessly connected through MQTT protocol.
- At first authorised face are registered in 'user interface' then converted into numerical features by feature extraction using SSD and get stored in database.
- When deep learning model capture a picture , checks with database if picture matches , database will send 'known' raspberry pi pico controller to unlock the door, else send 'unknown'.

B) HARDWARE IMPLEMENTATION

Hardware part consist of ultrasonic sensor, Mlx90614 contactless temperature sensor, buzzer, Lcd Display, Raspberry pi pico WIFI, metal sensor, relay, solenoid locker, keypad and power supply.

a) Raspberry Pi Pico Wifi

The raspberry pi pico WIFI module is a main microcontroller used in this system and its act us a brain of the system. Input and output devices and sensors are connected into the controller.

When captured image match within the image in database , the 'database' will send 'known' to controller where controller allow relay to unlock the door. If database send 'Unknown' the door remain locked .In this proposed work raspberry pi Pico WIFI is connected wirelessly with the system using MQTT protocol.

b) Ultrasonic Sensor

Ultrasonic sensor is an object detection module when any object movement took place in front of the door way the camera get triggered and capture the event .The sensor sends ultrasonic waves to calculate the distance with known speed and time.

In this system when any object appears within 10cm to 20cm of distance the camera will get triggered and streaming starts for recognizing faces which will reduce the power consumption of camera.

c) Mlx90614 Temperature Sensor

The MLX90614 is a Contactless temperature sensing element which sends IR waves in order to detect the human body temperature. It can communicate with the host microcontroller using I2C protocol. This sensor generates object temperature as well as ambient temperature.
Pseudo code for MLX90614 are as follows;
- Initialize sensor
- Read raw object temperature data from sensor
- Read raw ambient temperature data from sensor
- Convert raw object data to temperature in Celsius
- Convert raw ambient data to temperature in Celsius
- Output temperature in Celsiu
d) Metal Sensor

- Metal sensor use electromagnetic waves to sense metal presence.
- In case of this project the condition is given as ($mvalue > 250$).
- If any metal object detected it will send '1' to controller else send '0'.
- The controller which is interfaced with the owner's mobile device will send 'Metal Found' if controller get value '1' from sensor else it will send 'No metal found' as notification if the controller get the value '0'.

e) Buzzer

- Buzzer is an alerting device, used to notify us that some suspicious activity has took place
- If controller receive 'unknown' from database, buzzer will go off.

f) Lcd (Liquid Crystal Display)

Here 16x2 LCD(Liquid Crystal Display) is used. It is a output module which is used to display OTP.

g) Relay

A Relay is just a electromechanical switch which helps to open the door when an authorised person is recognized , the relay will get triggered and the door gets open.

VI . RESULT

The result of the system are given below:

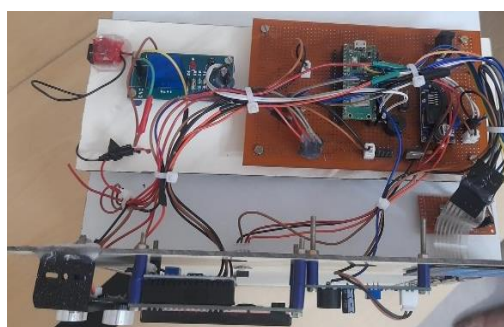
Figure - 5.1 Hardware and prototype

Figure - 5.2 Prototype

The above images is the illustration of hardware setup intelligent door lock system. If the camera encounters authorised person, the door automatically opens. If the camera encounters unauthorised person, it automatically captures their image and it is sent to authorized person mail and telegram. If the authorized person wants to allow the person, he clicks allow and OTP is sent to door as shown below
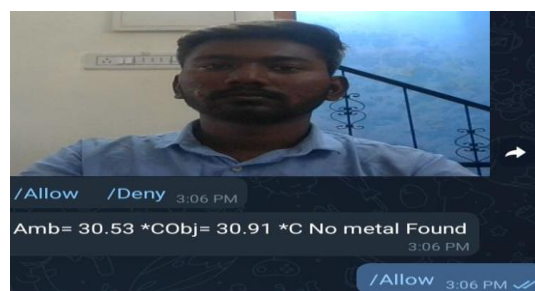

Figure - 5.3 Unauthorised person

The above figure 5.3 shows that the unauthorized person along with their body temperature and metal presence.

Figure – 5.4 OTP displayed in LCD

VII. CONCLUSION

The whole project is about developing a improved door lock security system with digital notification. Smart door can be integrated with other smart devices, which is a key for smart home automation. It eliminates the threat of invaders, lock picking, theft, unauthorised intrusion in various places like banks, libraries, residencies, museum. Our proposed system offer a convenient and secure way to control access to places like homes, workplaces, bank lockers, laboratories, museum and other isolated places. One can unlock the door by allowing from your remote device by the owner which will assign individual OTP for each and every person. Owner can know who is coming in. There is no need to hideaway keys. We can provide enhanced security. We can know who is at the door before unlocking.

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