IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2024

DOI: 10.17148/IJARCCE.2024.13559

AI-Enabled Home Security and Automation with Facial Recognition and Anomaly Detection

PROF. DHANYASHREE P N [1], CHANDAN DR [2], CHANDAN HS [3], TARUN GOWDA S [4], VEDANTH H [5]

Professor, Department of Electronics and Communication, East West Institute of Technology, Bengaluru, India[1]

Department of Electronics and Communication, East West Institute of Technology, Bengaluru, India[2-5]

Abstract: AI-Enabled Home Security and Automation with Facial Recognition and Anomaly Detection, based on Arduino Uno, is a comprehensive project that employs a range of sensors and devices for enhanced safety, security, and convenience. It incorporates a fire sensor for early fire detection, triggering a water pump via a relay for fire suppression, and a gas sensor for LPG detection, which automatically opens windows through a DC motor to vent the gas. The Light Dependent Resistor (LDR) sensor distinguishes between day and night, controlling indoor and outdoor lighting accordingly. A voice reader module offers voice-activated control for lights and fans. A temperature sensor regulates the room's temperature by activating a fan through a relay, ensuring comfort. An integrated camera with facial recognition capabilities enhances security, automatically unlocking the door for known individuals and awaiting homeowner instructions for unknown persons. An IR sensor detects occupancy, turning off lights and fans if no residents are present, optimizing energy efficiency. This multifaceted project combines safety, energy efficiency, and security features, making it a sophisticated and user-friendly home automation system.

Key terms: Automation, Security, Facial Recognition, Anomaly Detection, Sensors

I. INTRODUCTION

This innovative Home Security and Automation project integrates advanced technologies like Facial Recognition and Anomaly Detection to redefine residential safety. By leveraging AI, it delivers proactive security measures, ensuring only authorized access and alerting to anomalies.

This system adapts to user preferences, managing lighting, temperature, and energy efficiently. With a focus on privacy and ethical AI practices, it sets a benchmark for responsible technology use. Continual updates and machine learning enhance its resilience and capabilities over time. In conclusion, this project offers a comprehensive, intelligent solution, setting new standards for secure and efficient smart homes in the digital era.

A. PROBLEM STATEMENT

The project addresses a growing demand for comprehensive home security and automation. Existing solutions lack integrated sensor and actuator systems, make sure absolute functionality. This project aims towards developing a multifunctional home security and Home Automation system, showcasing IoT potential to enhance living conditions, combining safety, control, and adaptability.

B. OBJECTIVES

To design and implement face authenticated real time security system with audio and video (live streaming) of unauthorised person and implement home automation using object detection. Then to enhance safety using various sensors (LDR, fire sensor, gas sensor, temperature).

II. METHODOLOGY

Facial Recognition: The laptop camera captures images of individuals entering the premises. Python scripts, employing OpenCV, analyse and recognize faces. The identified faces are then compared against a pre-existing database to authenticate and grant access.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2024

DOI: 10.17148/IJARCCE.2024.13559

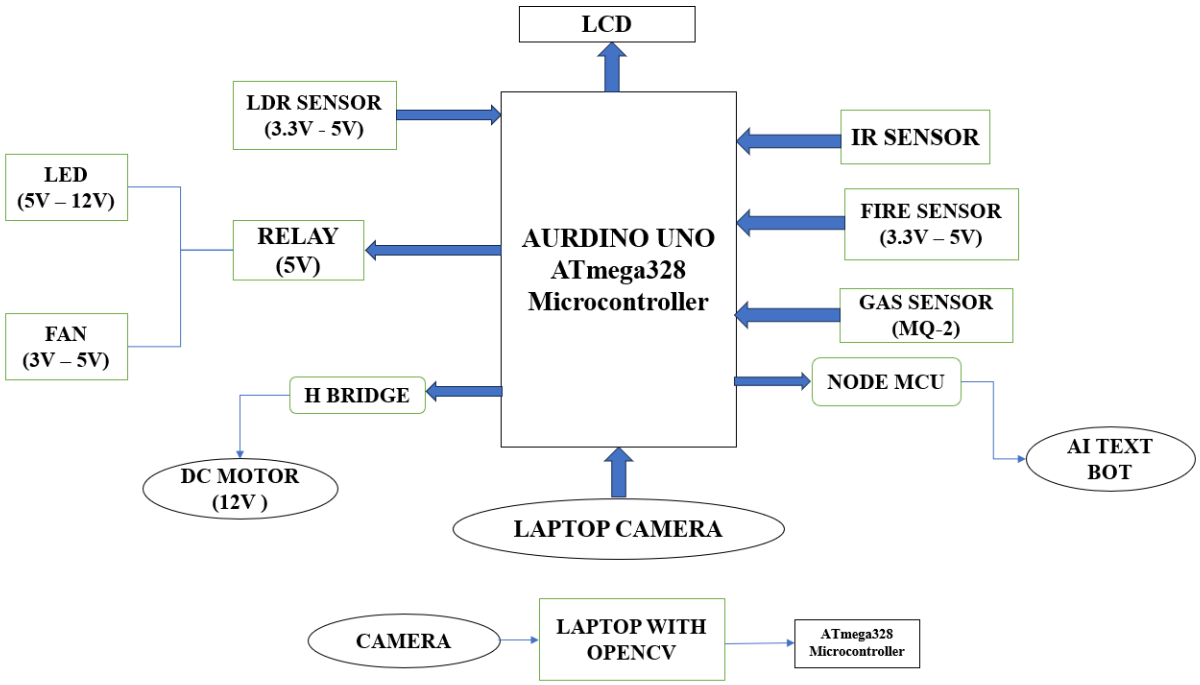

Fig 1 : BLOCK DIAGRAM

Anomaly Detection: Through continuous monitoring of the camera feed, the system establishes normal patterns of activity. Any deviations or anomalies trigger alerts. This involves the use of machine learning algorithms to classify and understand what constitutes regular activities. Automation Control: The Arduino UNO, acting as the central controller, receives signals from various sensors.

Based on programmed logic, it controls the DC motor via the H-Bridge for physical automation, manages the relay for appliance control, and communicates with Node MCU for remote access. Voice Commands: The voice module sensor allows residents to interact with the system verbally. The Arduino, equipped with voice recognition capabilities, interprets spoken commands and executes corresponding actions. Safety Measures: The fire and gas sensors continuously monitor environmental conditions. If a potential hazard is detected, the system triggers alarms, alerts residents, and may take preventive measures such as shutting down appliances.

1. Arduino UNO

Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 Analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

2. POWER SUPPLY

The transformer 230Volts will be stepped down to 12-0-12 one side of the 12V is given to the 7805 and Lm317. In this project the microcontroller requires +5V power supply. The design description of power supply is given below. A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled conductors without changing its frequency. A varying current in the first or primary winding creates a varying magnetic flux in the transformer's core, and thus a varying magnetic field through the secondary winding.

3. IR SENSORS

The IR sensor or infrared sensor is one kind of electronic component, used to detect specific characteristics in its surroundings through emitting or detecting IR radiation. These sensors can also be used to detect or measure the heat of a target and its motion. In many electronic devices, the IR sensor circuit is a very essential module. This kind of sensor is similar to human's visionary senses to detect obstacles.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2024

DOI: 10.17148/IJARCCE.2024.13559

4. METAL SENSORS

A metal detector is an instrument that detects the nearby presence of metal. Metal detectors are useful for finding metal objects on the surface, underground, and under water. The unit itself consists of a control box, and an adjustable shaft, which holds a pickup coil, which can vary in shape and size. If the pickup coil comes near a piece of metal, the control box will register its presence by a changing tone, a flashing light, and or by a needle moving on an indicator. Usually, the device gives some indication of distance; the closer the metal is, the higher the tone in the earphone or the higher the needle goes.

5. RELAY

The relay in the AI-Enabled Home Security and Automation system acts as a vital interface between the Arduino UNO microcontroller and high-power appliances, offering compatibility with 5V microcontrollers. With a rated through-current of 10A (NO) 5A (NC), it efficiently switches ON/OFF devices. This pivotal component enables automation of electrical systems, controlling doors, windows, or curtains based on security or automation triggers. Its ability to handle high-power loads enhances versatility, contributing to the system's intelligence and functionality. Additionally, it reinforces security measures by securing entry points and initiating safety protocols in response to anomalies, ensuring comprehensive control and safety.

6.NODE MCU

The Node MCU, based on the ESP8266 SoC, facilitates connectivity and communication in the AI-Enabled Home Security and Automation system. With embedded Wi-Fi capabilities, it links the local system to broader networks, enabling integration with external devices and online platforms. This microcontroller unit enables remote monitoring and control, enhancing security and automation functionalities. Through Wi-Fi connectivity, it ensures access to updates, databases for Facial Recognition, and alerts to user devices, showcasing the project's dedication to seamless, interconnected living.

7. DC MOTOR

The DC motor, with specifications including 45rpm RPM, 12V Operating Voltage, and 2 kg-cm Torque, serves as a crucial mechanical actuator in the AI-Enabled Home Security and Automation system. It enables automation of doors, windows, or curtains, enhancing security and convenience. Controlled by the Arduino UNO microcontroller via an H-Bridge, it offers precise speed and direction control, ensuring synchronized operation with other system components. In security scenarios, it automates entry points in response to AI-triggered alerts, fortifying home protection. By integrating the DC motor, the smart home becomes dynamic, responsive, and tailored to residents' needs, elevating the living experience.

8.LCD DISPLAY

LCD, short for liquid crystal display, features pins serving specific functions. Pin1: Ground/Source, connects to microcontroller or power source's GND. Pin2: VCC/Source, supplies voltage, connecting to power supply. Pin3: V0/VEE/Control, regulates display contrast with a changeable POT. Pin4: Register Select, toggles between command or data register. Pin5: Read/Write, switches between read/write operations. Pin6: Enable, held high for read/write execution. Pins 7-14: Data, transmit data to the display in 4 or 8-wire modes. Pins 15 and 16: +ve and -ve pins of the LED, connect to +5V and GND respectively.

9. DC FAN

The 12V DC fan is a versatile cooling device suited for various applications, including automotive, electronic, and industrial use. Its low voltage requirement makes it popular for DIY projects, computers, and solar-powered setups. Featuring durable housing and efficient blades, it ensures longevity and effective heat dissipation in compact spaces. Whether cooling electronics or providing personal comfort, its quiet operation and energy efficiency make it a reliable choice for professionals and hobbyists alike, delivering consistent performance wherever cooling is necessary.

10. LDR SENSOR

The LDR sensor module, also known as a Photoresistor sensor, detects light intensity using an onboard Light Dependent Resistor. Operating at 3.3V or 5V DC, with an LM393 comparator chip, it provides digital outputs (D0) and power LED indicators. With a compact PCB size of 3cm * 1.6cm and a fixed Hole Diameter of 3mm, it offers versatility in installation. In smart homes, it optimizes lighting based on ambient conditions, enhancing energy efficiency. Additionally, it aids in security by detecting sudden light changes, aligning with anomaly detection features for prompt alerts.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2024

DOI: 10.17148/IJARCCE.2024.13559

11. GAS SENSOR

The Gas Sensor detects gas presence or concentration by changing resistance, producing a corresponding output voltage. Integrated with comparators, it triggers digital pins when gas exceeds set thresholds. In home security, it identifies harmful gases like carbon monoxide or natural gas leaks, ensuring comprehensive safety measures. Upon detection, the system activates responses like ventilation, gas supply shutdowns, and resident alerts, safeguarding both premises and occupants. Real-time monitoring underscores the system's commitment to holistic security and resident well-being.

12.FIRE SENSOR

The Flame Sensor, sensitive to light within 760 nm – 1100 nm range, is vital for flame alarms due to its high photosensitivity and fast response time. Operating at 3.3V to 5V, it offers adjustable sensitivity and accuracy, with output in analogy and digital forms. However, it's prone to damage from high temperatures. In smart homes, the Fire Sensor serves as a critical component for fire prevention, triggering automated responses like fire suppression and emergency alerts to ensure prompt evacuation, prioritizing life and property safety.

13. PYTHON

Python is a high-level, general-purpose programming language. Its design philosophy emphasizes code readability with the use of significant indentation. Python is dynamically typed and garbage collected. It supports multiple programming paradigms, including structured (particularly procedural), object-oriented and functional programming. It is often described as a "batteries included" language due to its comprehensive standard library. Guido van Rossum began working on Python in the late 1980s as a successor to the ABC programming language and first released it in 1991 as Python 0.9.0 Python 2.0 was released in 2000. Python 3.0, released in 2008, was a major revision not completely backward compatible with earlier versions. Python 2.7.18, released in 2020, was the last release of Python 2. Python consistently ranks as one of the most popular programming languages and has gained widespread use in the machine learning community.

14. OpenCV

OpenCV's functions in Python are the fundamental building blocks of the library, providing low-level operations for manipulating and processing images and matrices. These functions form the backbone of OpenCV and are used by many of the higher-level functions and algorithms in the library. OpenCV provides functions for reading and writing images and videos in various formats .OpenCV also provides a set of basic image processing functions, such as image arithmetic, pixel manipulation, and colour space conversion.

15. ARDUINO IDE

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

15. Embedded C

When designing software for a smaller embedded system with the 8051, it is very common place to develop the entire product using assembly code. With many projects, this is a feasible approach since the amount of code that must be generated typically less than 8 kilobytes and is relatively simple in nature. If a hardware engineer is tasked with designing both the hardware and the software, he or she will frequently be tempted to write the software in assembly language.

In an era where technology seamlessly integrates with daily life, the project on "AI-Enabled Home Security and Automation with Facial Recognition and Anomaly Detection" arises from the imperative to forge a safer and smarter living environment.

By innovatively combining facial authentication, real-time audio-video database creation of unauthorized individuals, and intelligent home automation using object detection, the project aims to redefine home security. With a vision to enhance safety through diverse sensors, including LDR, fire, gas, and temperature sensors, the project emerges as a proactive solution, harnessing the power of artificial intelligence to safeguard homes and elevate the quality of residential living.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2024

DOI: 10.17148/IJARCCE.2024.13559

III. RESULTS

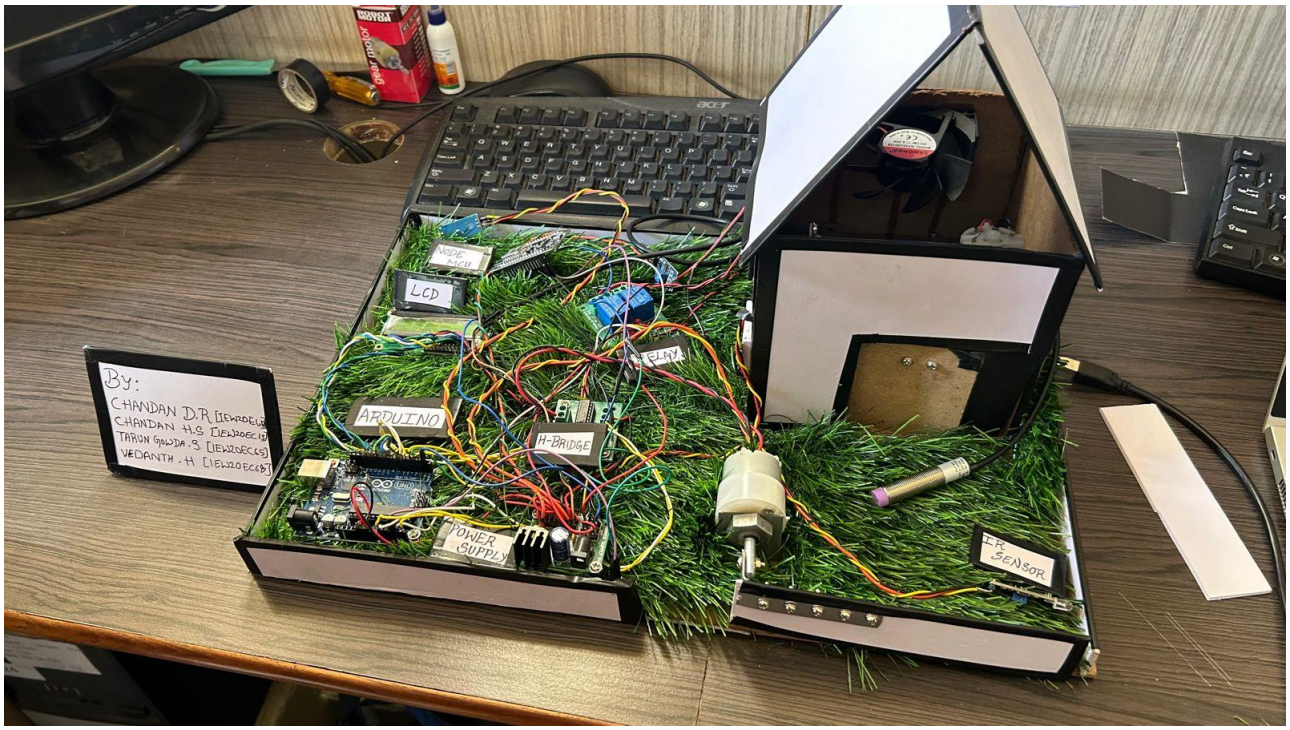

Fig:2 PROTOTYPE OF THE MODEL

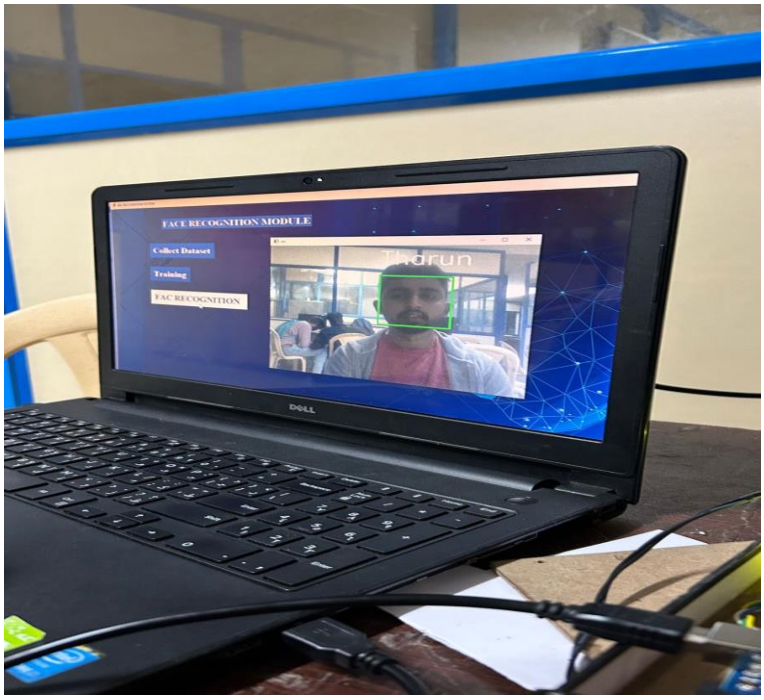

Fig 3: If known person is detected through laptop camera, gate and door is accessed and also all sensors are accessed

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2024

DOI: 10.17148/IJARCCE.2024.13559

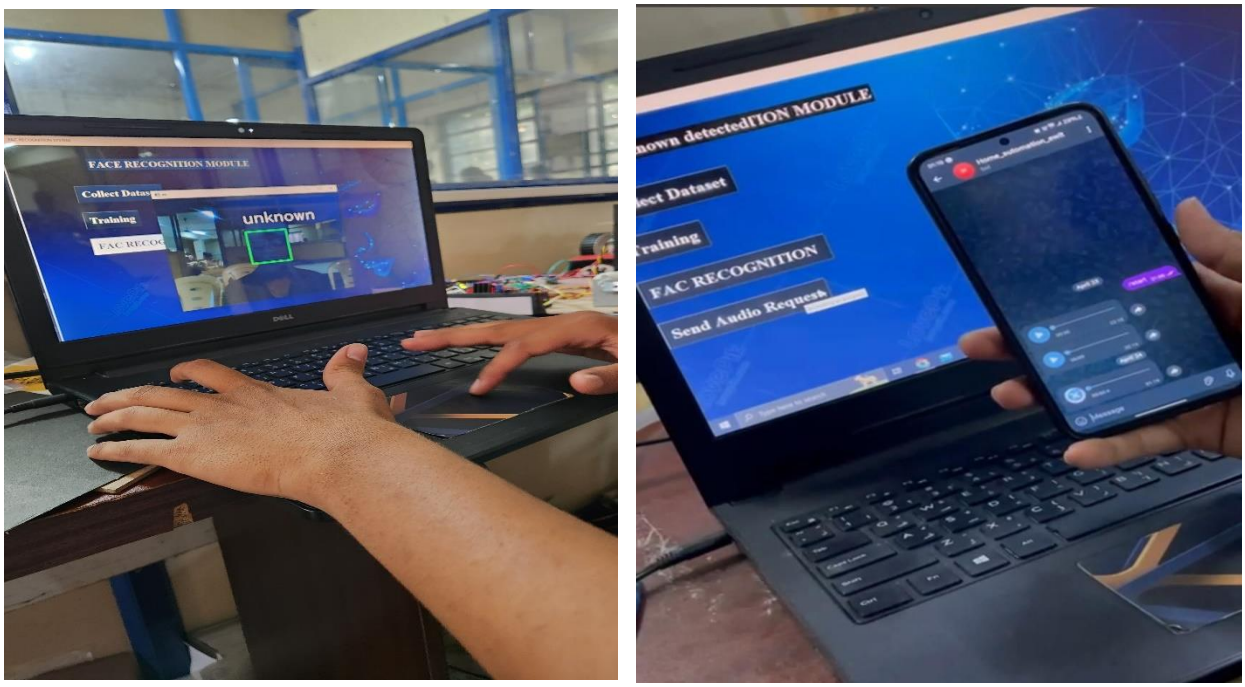

Fig 3: If unknown person is detected through laptop camera, gate and door is not accessed and A request for audio message is given, then sent to admin for OTP request and also checks for metal sensor. (If OTP entered correctly Gate and Door is accessed and all sensors are accessed if not NO).

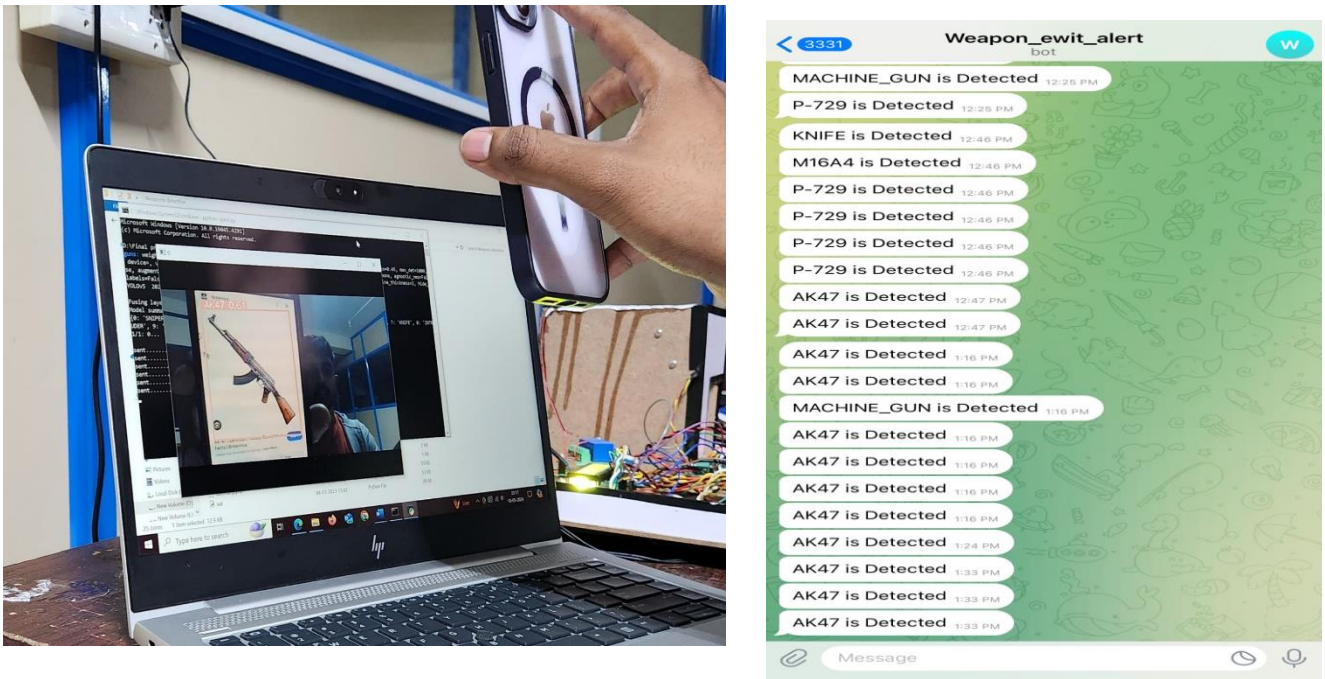

Fig 4: metal detection, if any guns, bombs, knifes are detected through laptop camera alert message is sent and immediate buzzer will be on.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2024

DOI: 10.17148/IJARCCE.2024.13559

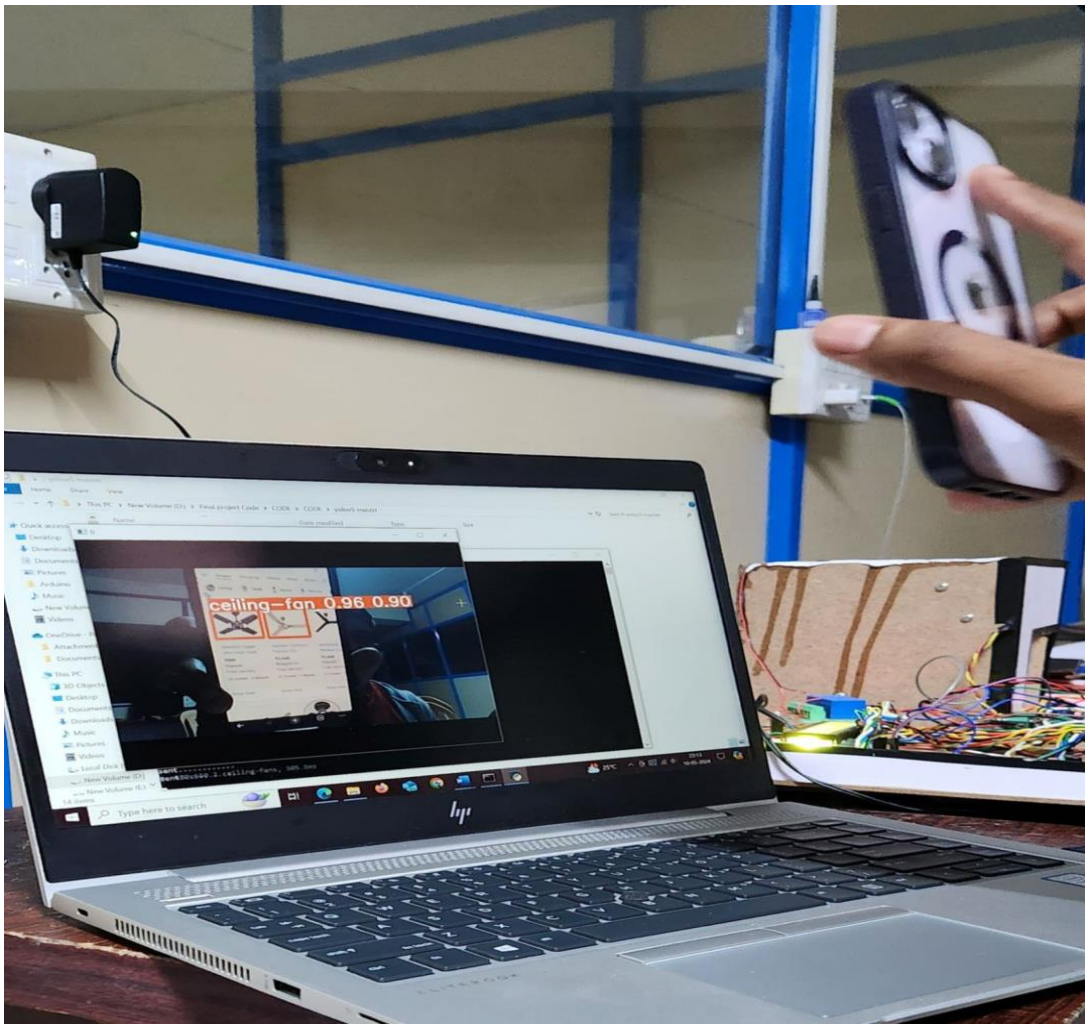

Fig 6 : if a fan image detected through laptop camera fan is On and to turn off again show fan image to camera

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2024
DOI: 10.17148/IJARCCE.2024.13559

IV. CONCLUSION AND FUTURE SCOPE

CONCLUSION:

The Home Security and Automation project represents a significant advancement in residential living, blending cutting-edge technology with proactive safety measures. Through the integration of AI, facial recognition, and anomaly detection, it offers a comprehensive solution to modern security challenges. By prioritizing safety, convenience, and efficiency, this system sets a new standard for home automation, promising residents a safer and smarter living environment that adapts to their needs with precision and intelligence.

FUTURE SCOPE

1. Advanced AI Integration Future iterations could leverage deep learning and natural language processing to enhance the system's intelligence, allowing for more intuitive interactions and predictive security measures.
2. IoT Expansion Integration with a broader range of Internet of Things (IoT) devices, such as smart locks, cameras, and environmental sensors, will enable seamless communication and coordination for comprehensive home automation and security.

REFERENCES

[1]. Gaurav Verma.; Smart Home Automation with Smart Security System over the Cloud" This article outlines a comprehensive smarthome automation system that utilizes ESP32 and ESP32-CAM modules, along with IoT cloud text bot integration, to provide a secureautomation experience. IEEE access 2023.;
[2]. Gajewski. M.; Anomaly traffic detection and correlation in smart home automation IoT systems." If something unusual pops up, likeexcessive data or strange patterns, we raise a flag—this is anomaly detection. IEEE access 2022.; .10, 28–36. [Google Scholar]
[3]. Crisan, C.; Smart Home Automation with Smart Security System over the Cloud., IEEE access 2021;p. 1097. [Google Scholar]
[4]. Rahim . Ahmad .T.., A Deep Learning-Based Intelligent Face Recognition Method in the Internet of Home Things for SecurityApplications." IEEE access 2020.;
[5]. Lwin, H.H., Automatic door access system using face recognition." IEEE access 2019;.pp. 1049–1057. [Google Scholar]
[6]. Kartik, J.S., Kumar, K.R., Srimadhavan, V.S.: Security system with face recognition, SMSalert and embedded network videomonitoring terminal. Int. J. Secur. Priv. Trust Manag.(IJSPTM) 2,15–17 (2013)
[7]. Lwin, H.H., Khaing, A.S., Tun, H.M.: Automatic door access system using face recognition.Int. J. Sci. Technol. Res. 4(6), 210–221(2016)
[8]. WILL BERGER (2018). http://www.willberger.org/cascade-haar-explained/
[9].Open.,//Source.Computer.Vision. https://docs.opencv.org/3.2.0/d7/d8b/tutorial_py_face_detection.html
[10]. Ubidots (2019). http://www.ubidots.com/education/