IoT Based Security System For Bank Vaults

Mrs. D. Shanthi Chelliah[1], Mr. V. Parthiban[2], S. Bharathi[3], R. Naveen Kumar[4]
[1]HOD, Dept of Electronics and Communication Engineering
[2] Asst. Prof**,**Dept of Electronics and Communication Engineering
[3, 4]Dept of Electronics and Communication Engineering
[1, 2, 3, 4] Sri Muthukumaran Institute of Technology

Abstract- *Maintenance and Security System in banking Sectors plays a vital role in economic development. Hence a system is designed to support the banking sector and public for the safety of banks. The main goal of this paper is to design and implement a bank vault security system based on IOT technology. The proposed system is designed which implements a security system to handle the cash lockers by the authorized person. It is developed using Arduino Microcontroller which is interfaced to the RFID reader to read the code, keypad module for password authentication and camera module for face recognition. If unauthorized person tries to break or open the lock, it is automatically monitored and detected using embedded and IOT technology and information is sent immediately to the respective authorities and the person is trapped. The proposed system found to be cost effective with better performance.*

Keywords- Microcontroller, RFID, Keypad, Facial recognition.

I. INTRODUCTION

Bank is a financial institution which provides us financial services like issuing money, saving cards, protection to valuables etc. Earning money and saving it is very important part in man's life for a comfortable economic status and hence banking sector plays a vital role. Increase in threats against bank thefts is common now a days in spite of high security measures. Increasing crimes in banks has become a serious issue. The existing system contains only password authentication, keys, and finger print recognition to open lockers.

This system only open the lockers when a authentications are matched. If anyone tries to break or access the cash locker, there is only alarm which indicates the threat and the action is not taken immediately. Hence the proposed system is designed using embedded and IOT technology to ensure safe and secure access to a bank locker from a genuine authorized user by the following security check levels-

1.RFID authentication
2.Password authentication
3.Facial recognition

If any one of authentication is mismatched the person can't able to access the locker and if the person try to break the locker, immediately information will be sent to authorities and the unauthorized person made unconscious to hold that person. Hence the proposed system is more efficient to give safe and secure bank locker system.

II. LITERATURE SURVEY

[1] K. Ramesh, M. Vara prasad and Dr. K. Hemachandran (2018), "Design and implementation of advanced ARM7 based biometric security system using wireless communication", Proc. International Conference on Inventive Systems and Control (ICISC), IEEE Xplore, PP 543-546.

This project aims to enhance embedded protection applications by combining fingerprint and mobile number collection with locker access control. The system generates a unique four-digit code upon fingerprint authentication and sends it to the authorized customer's cell phone via GSM modem. The customer enters the code on the keypad for further access, which is validated by the microcontroller. The main controller used in this project is LPC2148, which belongs to the ARM7 architecture, and it interfaces with the biometric module and serial interface. A 7805 3-terminal voltage regulator and full wave bridge rectifier are used for power supply.

[2] Ashutosh Gupta, Prerna Medhi, Sujata Pandey, Pradeep Kumar, Saket Kumer and H.P.Singh(2016), "An Efficient Multistage Security System For User Authentication", International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT) , IEEE Xplore, pp. 3194-3197.

This paper proposes a multi-stage security system for identifying authorized persons using RFID, keypad password and finger print technology. The system uses a microcontroller based matrix keypad and GSM network in addition to RFID technology and finger print module. Verification is required

for access and unauthorized access attempts are notified to authorized persons. Related works include RFID-based security systems and microcontroller-based digital door lock security systems. Future implementation will use FPGA technology.

[3] Rupali R. Ragade (2017), "Embedded Home Surveillance System with Pyroelectric Infrared Sensor Using GSM", 1st International Conference on Intelligent Systems and Information Management (ICISIM), IEEE Xplore, pp. 321 – 324.

This embedded based home security system is designed using smart sensors such as the pyroelectric infrared sensor (PIR) and ultrasonic sensor to detect intruders in the home. The ultrasonic sensor detects the movement of objects, while the PIR detects changes in human temperature through infrared radiation. These sensors are built around a microcontroller. When the system detects an unauthorized person or intruder, it triggers a buzzer and sends an SMS. The microcontroller then sends a signal to an embedded system to capture an image using a web camera.

[4] Srinivatsan Sridharan (2014), "Authenticated Secure Bio-metric Based Access to the Bank Safety Lockers, Proc. **International Conference on Information Communication and Embedded Systems (ICICES2014),IEEE Xplore, pp. 387-393**

This paper proposes a biometric-based authentication mechanism for safe locker access, improving on the current model that relies on keys. The proposed system includes two-level authentication by the branch head and user, with secure individual authentication through biometrics and a password. Access is granted only to authorized individuals for their safety lockers. The branch head responsible for safety deposits is assigned by the central regional office of the bank on a daily basis, ensuring improved security and preventing unauthorized access.

[5] Jiango Hu, Deming Wang, Yanyu Ding, Jun Zhang and Hongzhou Tan (2010), "Design and Implementation of Intelligent RFID Security Authentication System", IEEE International Conference on RFID-Technology and Applications, IEEE Xplore, pp. 286-290.

This paper presents a low-power and high-security RFID authentication system to address the security challenges in RFID communication. A random number generator is designed to enhance authentication security by preventing attackers from predicting the transmitted data. The triple DES algorithm is optimized for improved RFID encryption

capabilities. The hardware implementation of this system has a small area of 4597 gate equivalents and low power consumption of 6.8uW at 100KHZ clock frequency, based on 180nm CMOS process.

III. METHODOLOGY

The authentication follows three stages in which first stage the RFID reader reads the RFID ID card provided to the user by authorities if the RFID number matched with the RFID numbers stored in the database in Microcontroller then RFID authentication is successful and it moves to next stage of authentication that is password. In this the user enters the password through the provided keypad if the password matches with the password stored in the database in Microcontroller then password authentication is successful and it moves to next stage face recognition. In this camera reads the face and compare it with database and if the face matched then face recognition is successful and locker can be accessed by the use. If any one of authentication failed then the process will be stopped in that stage itself.

If any unauthorized person tries to access the locker by breaking it then vibration sensors sense the vibration then alarm is turned on and it sends the message to nearby police station and authorities to alert them that some unauthorized person is trying to access the locker. Simultaniously it closes the locker room with iron grid and release Anesthetic gas which make the person to be unconscious for some time. And this locker can be monitored through IOT.

Block Diagram
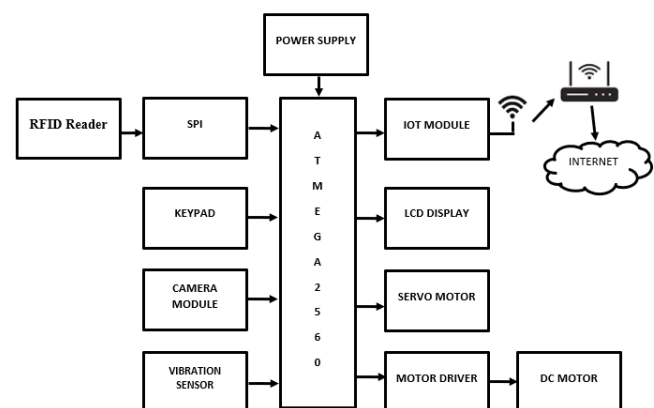
IV. HARDWARE DESCRIPTION

1.ESP32 Microcontroller

The ESP32 is a highly capable microcontroller based on the Xtensa LX6 architecture. It features dual-core 32-bit processors that can run at up to 240 MHz and built-in Wi-Fi and Bluetooth connectivity. The microcontroller includes a variety of peripheral interfaces, such as SPI, I2C, UART, and SDIO, making it easy to connect to external devices. It also includes a USB interface, analog and digital peripherals, and up to 4 MB of external flash memory for program storage. The ESP32 features advanced security features, such as hardware-based AES encryption and flash encryption, to protect against unauthorized access and data theft. It also supports low power consumption with multiple sleep modes, making it ideal for battery-powered applications. The microcontroller is highly programmable, with support for multiple development environments such as the Arduino IDE and ESP-IDF.

2.RFID Reader
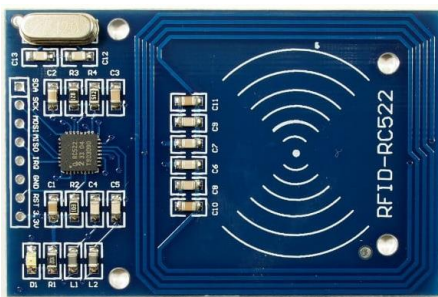
The MFRC522 is a highly integrated reader/writer IC for contactless communication at 13.56 MHz. It is based on an advanced modulation and demodulation concept called the "Phillips MIFARE" protocol. The MFRC522 includes an internal voltage regulator and a low-power mode to reduce power consumption during standby. It also features an integrated transmitter and receiver with an adjustable power level of up to 10 dBm.The MFRC522 includes a digital signal processing unit for fast and accurate demodulation and decoding of signals. It also includes a built-in anti-collision feature, which allows multiple cards to be read

simultaneously. The IC has a typical operating distance of up to 50 mm, depending on the antenna design and operating conditions. The MFRC522 supports several communication protocols, including SPI, I2C, and UART, making it easy to integrate with various microcontrollers.

3.Keypad
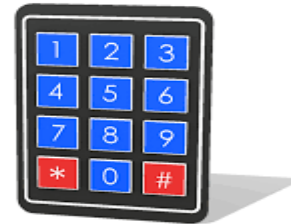
The 4x3 keypad is a matrix-type keypad that includes 12 pushbutton switches arranged in 4 rows and 3 columns. It is a low-cost input device that is widely used in various electronic applications. The keypad includes a tactile switch that provides a click feedback when a button is pressed. It also features a lightweight and compact design, making it easy to integrate into various projects. The 4x3 keypad has a simple and straightforward interface, with each button connected to a specific row and column. The keypad can be interfaced with microcontrollers using digital I/O pins, allowing for easy integration into various projects. The keypad has a typical operating voltage of 5V and can handle a maximum current of 10mA per button.

4.WiFi Camera

The ESP32-CAM is a low-cost development board that combines an ESP32-S module, camera module, and microSD card slot. It features a powerful dual-core 32-bit processor that can run up to 240 MHz and built-in Wi-Fi and Bluetooth connectivity. The board includes a variety of peripheral interfaces, such as SPI, I2C, UART, and PWM, making it easy to connect to external devices. The camera module included on the ESP32-CAM is a OV2640 camera

module with a resolution of 2MP. It supports various image formats, such as JPEG, BMP, and GIF, and can capture up to 1600x1200 pixels. The camera module features automatic gain control, white balance, and exposure control, allowing for high-quality images in various lighting conditions. It also includes a 10 cm FPC cable for flexible connectivity. The microSD card slot allows for up to 4 GB of external storage for image and video recording.

5.Vibration sensor

The SW820p vibration sensor uses a spring mechanism to trigger the contact when the applied vibration force exceeds a certain threshold. It has two legs that are normally insulated by a high resistance value, which creates a momentary short circuit between the two terminals when a vibratory force is applied. The sensor is highly sensitive and can detect even small vibrations, making it ideal for various applications such as security systems, motion detection, and alarms. It operates within a wide voltage range of 3V to 12V DC, and its low power consumption makes it ideal for battery-powered applications. Its small size and easy installation make it a popular choice among hobbyists and professionals, providing a cost-effective and reliable solution for vibration detection.

6.LCD Display

The LCD display with I2C interface is a popular output device that uses the I2C protocol for easy integration with microcontrollers. It features a high contrast ratio, adjustable brightness, and a programmable character generator for custom characters and symbols. The display typically includes a 16x2 or 20x4 character matrix and consumes only a few milliamps of current during operation. It can operate over a wide temperature range and has a long lifespan of up to 50,000 hours. The LCD display with I2C interface is highly reliable and cost-effective, making it ideal for various applications including industrial automation and consumer electronics.

7.Servo Motor

The TowerPro SG90 is a micro servo motor that is widely used in various robotic and automation projects. It is a small and lightweight motor that features a plastic gearbox and a coreless motor design. The motor can rotate up to 180 degrees and has a torque rating of up to 2.5 kg/cm. It operates at a voltage range of 4.8V to 6V and consumes a maximum current of 250mA under load. The SG90 servo motor includes a three-wire interface, with one wire for power, one for ground, and one for the control signal. The motor's control signal can be modulated using a pulse width modulation (PWM) signal, allowing for precise and accurate control of the motor's position. The motor's response time is fast, with a maximum delay of 0.1 seconds.The motor's compact size and lightweight design make it ideal for small-scale robotic projects. With its high torque rating, accurate position control, and low cost, the TowerPro SG90 servo motor is a popular choice for various hobbyist and industrial applications.

8.Motor Driver

The L298N is a dual H-bridge motor driver IC designed to control the speed and direction of DC motors. It can handle a maximum current of up to 2A per channel and can operate at a voltage range of 5V to 35V. The L298N includes built-in protection features such as thermal shutdown and overcurrent protection to prevent damage to the IC and the connected motor.The L298N features two H-bridge circuits, each consisting of four transistors. The H-bridge circuits allow the direction of the motor to be controlled by changing the polarity of the voltage applied to the motor. The motor speed can be controlled by varying the pulse width modulation (PWM) signal applied to the enable pin of the driver. The L298N is also easy to use, with a simple interface and flexible control options.

9.DC Motor

The 5V DC motor is a small-sized, low-cost motor that operates on a voltage of 5V DC. It is widely used in various electronic applications, such as toys, robots, and small appliances. The motor includes a shaft that rotates when power is applied to it, allowing it to perform various mechanical tasks. The motor also includes two wire leads for power and ground connection. The 5V DC motor typically operates at a speed of 10000-15000 RPM, depending on the load and voltage. It has a rated torque of up to 0.2 Nm and can handle a maximum current of up to 1A. The motor features a compact design and is easy to install and integrate into various projects. The 5V DC motor is highly efficient and reliable, with a lifespan of up to 1000 hours. It can operate over a wide temperature range, from -10°C to +60°C. The motor's low voltage and current requirements make it ideal for battery-powered applications. With its simple design, low cost, and easy integration, the 5V DC motor is a popular choice for various applications, including robotics, automation, and small appliances.

10.Power Supply

The 12V to 3V/5V converting power supply module is a small, compact device that converts a 12V input voltage into a regulated 3V or 5V DC output voltage. It includes a voltage regulator that maintains a constant output voltage even when the input voltage fluctuates. The power supply module also features a lightweight and compact design, making it easy to integrate into various electronic projects. It also features a high efficiency of up to 95%, which means that it converts the input power into output power with minimal losses. The power supply module has a maximum output current of 1A, which is sufficient for powering most microcontrollers and sensors.

V. SOFTWARE DESCRIPTION

1.Arduino IDE
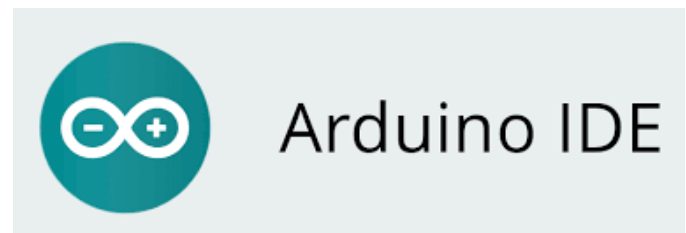
The Arduino Integrated Development Environment (IDE) is an open-source software that provides a simple and easy-to-use platform for programming Arduino boards. The IDE includes a code editor with features such as syntax highlighting, code completion, and error checking to help users write and debug code. It also includes a library manager that makes it easy to install and manage libraries, which are pre-written code that can be used to add additional functionality to an Arduino project. The Arduino IDE supports a variety of programming languages, including C and C++, and allows users to upload their code to Arduino boards using a USB cable. The IDE also includes a serial monitor that allows users to send and receive data from the board, making it easy to debug and test their projects. Additionally, the IDE supports third-party hardware and libraries, allowing users to expand their projects beyond Arduino boards.

2.Python

Python is a high-level, interpreted programming language that is widely used for a variety of applications, including web development, data analysis, artificial intelligence, and scientific computing. The language is easy to learn and use, with a simple syntax that emphasizes readability and reduces the cost of program maintenance. Python is available on a variety of platforms, including Windows, macOS, and Linux, and can be run on a variety of hardware architectures, including desktop computers, servers, and embedded devices. The language is regularly updated with new features and bug fixes, ensuring that it remains relevant and useful for a variety of applications. With its simplicity, versatility, and active community support, Python is an essential tool for developers and data scientists.

VI. VERIFICATION AND RESULTS

Prototype
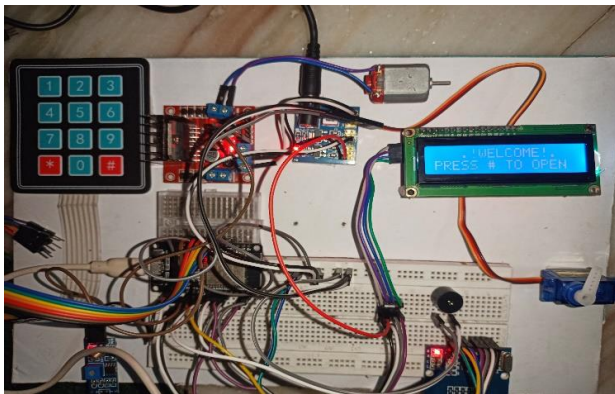
Facial Recognition
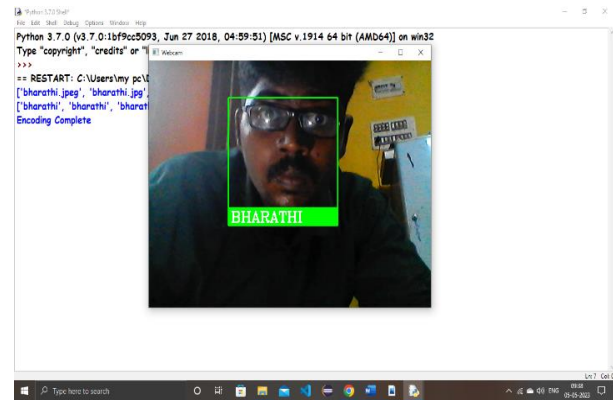
VII. CONCLUION AND FUTURE ENHANCEMENT

By using this RFID system, password authentication, face recognition, GSM technology and IOT technology an authorized person can only open the locker and collect the money. Here we used Arduino Microcontroller hence it is a low cost equipment, low in power consumption, compact in size, wide operating range, highly secured and reliable stand-alone unique system. In future the system can be enhanced to improve security in handling ATM by unauthorized persons and mishandling. Also technology can be improved to increase the reliability and performance against crimes in handling bank lockers.

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