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"Smart ATM Security System"

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Abstract: The increasing frequency of ATM-related crimes, including theft, vandalism, and unauthorized access, necessitates the development of advanced security solutions. This paper proposes an IoT-enabled Smart ATM Security System that integrates an ESP32 microcontroller, GSM module, IR sensors, touch sensor, motor driver with DC motor, LCD display, buzzer, and battery backup. The system employs multi-layered security: IR sensors monitor human presence near the ATM entrance, the touch sensor detects tampering attempts, and the GSM module provides real-time SMS alerts to bank authorities. A motorized door mechanism ensures restricted access, while an LCD display communicates system status. The design was implemented using Arduino IDE and Embedded C programming. Experimental testing under various scenarios demonstrated rapid response time, high reliability, and uninterrupted operation during power failures. The proposed system offers a cost-effective, scalable, and efficient solution for ATM security.

Keyword: Smart ATM Security System, IoT, ESP32, GSM, IR Sensor, Touch Sensor, Motor Driver, Real-Time Alerts.

I. INTRODUCTION

Automated Teller Machines (ATMs) are essential components of modern banking systems, providing customers 24/7 access to financial services. However, ATMs are also common targets for crimes such as physical break-ins, theft, vandalism, and tampering with cash dispensers. Traditional methods of ATM security include CCTV surveillance, mechanical locks, and security guards. While these measures help monitor activities, they often lack the ability to respond proactively in real time. Recent advancements in the Internet of Things (IoT) have enabled the design of intelligent systems capable of monitoring, detecting, and responding automatically to suspicious activities. By integrating sensors, microcontrollers, and wireless communication modules, ATM security can be made more robust, responsive, and cost-effective. This paper presents a Smart ATM Security System using ESP32 as the main controller, combined with IR sensors, touch sensor, GSM module, motor driver, and buzzer. The proposed system improves security by detecting human presence, preventing tampering, and notifying authorities immediately through GSM communication.

II. OBJECTIVES

The objectives of the project:

- To design and implement a smart ATM security system using ESP32 microcontroller.
- To use a touch sensor for tamper detection.
- To employ a GSM module for real-time SMS alerting to bank officials.

III. METHODOLOGY

A. BLOCK DIAGRAM

The **ESP32 microcontroller** is the central unit that controls the system. The **IR sensor** detects human presence near the ATM, while the **touch sensor** identifies tampering attempts. A **power supply** provides stable operation. The ESP32 communicates with an **LCD display** (via I2C) to show system status, and it controls a **buzzer** for audible alerts. A **GSM module** sends SMS notifications to the bank in case of suspicious activity. The **DC motor** operates the ATM door, allowing or restricting access. Together, these components form a smart, IoT-based ATM security solution..

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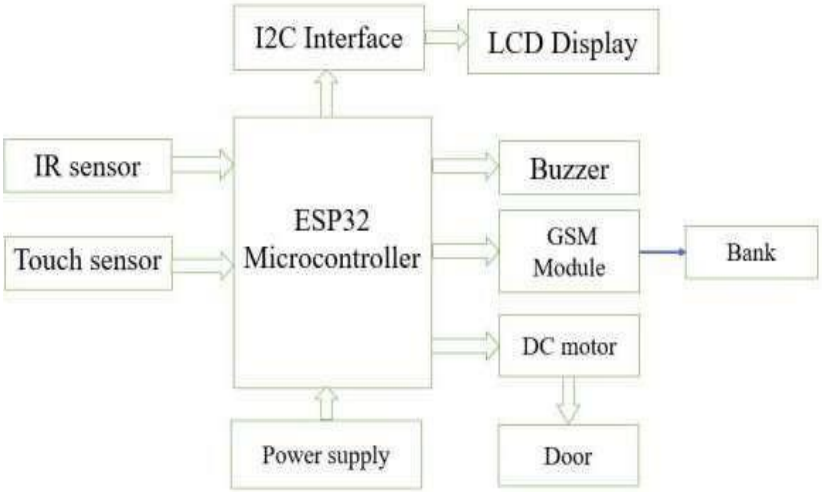

Figure 1. Block Diagram of Smart ATM Security System

B. FLOW CHART

The system begins with initialization. **IR Sensor 1** detects human presence to open the door and closes it once the user enters. Inside, the **touch sensor** checks for tampering. If tampering occurs, the **GSM module** sends alerts to the bank and police, and the **buzzer** activates. Otherwise, **IR Sensor 2** monitors the user's exit, opens the door, and closes it after the user leaves

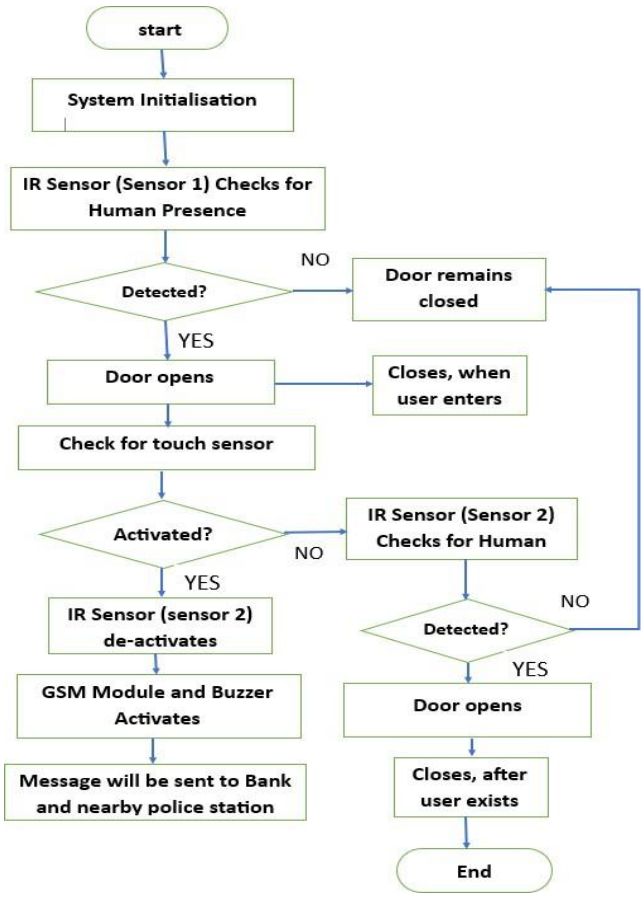

Figure 2 Flow Diagram of Smart ATM Security System

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IV. HARDWARE DESCRIPTION

4.1 ESP 32 Development Board

The ESP32 is a low-cost, low-power microcontroller with built-in Wi-Fi and Bluetooth. It acts as the central processing unit, receiving inputs from sensors and controlling outputs such as the motor, buzzer, and LCD display.

Figure 3 ESP32 Development Board

The device features a dual-core Xtensa LX6 microprocessor, built-in Wi-Fi and Bluetooth v4.2, with up to 34 GPIO pins, 520 KB SRAM and 4 MB Flash memory, operating voltage between 3.0V – 3.3V, and supports various protocols like UART, SPI, I2C, I2S, PWM, ADC, DAC, and CAN.

4.2 IR Sensor

IR sensors are used near the ATM entrance to detect human presence. They trigger the ESP32 to either allow access or keep the door locked.

Figure 4 IR Sensor

4.3 Touch Sensor

The touch sensor detects unauthorized tampering attempts with ATM hardware. When activated, it triggers the GSM module to send an SMS alert and activates the buzzer.

Figure 5 Touch Sensor

4.4 Motor and Motor Driver: The motor driver controls the DC motor for automated locking/unlocking of the ATM room door.

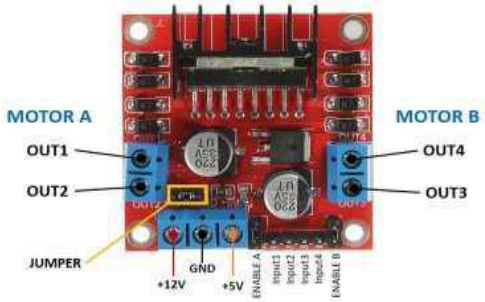

Figure 6 Motor Driver

Figure 7 DC Motor

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4.5 GSM Module: The GSM module provides real-time communication by sending SMS alerts to bank authorities when suspicious activity is detected.

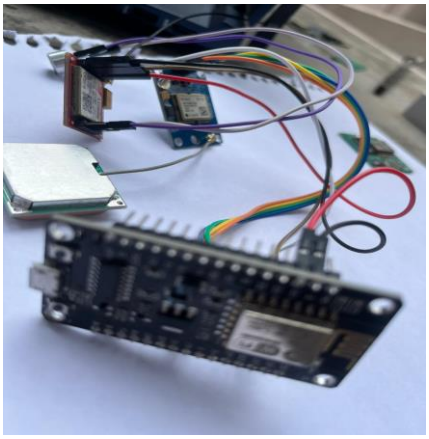

Figure 8 GSM Module

4.6 LCD Display: The LCD screen displays system status such as "Access Granted," "Access Denied," or "Tamper Detected.

Figure 9 LCD Display

4.7 Buzzer: The buzzer provides an audible alert in the case of tampering or unauthorized access.

Figure 10 Buzzer

4.8 Power Supply with Battery Backup: The system is powered by a regulated power supply with battery backup, ensuring continuous operation even during power failures.

Figure 11 Battery

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V. SCHEMATIC DIAGRAM

The schematic diagram illustrates the working of the Smart ATM Security System. The ESP32 microcontroller acts as the central unit, connected to IR sensors for human presence detection and a touch sensor for tamper detection. An LCD display, interfaced through I2C, shows the system status such as entry or occupancy. The GSM module is used to send SMS alerts to bank authorities in case of suspicious activity. A buzzer is connected to provide audible alarms, while a DC motor controlled by the L298N driver operates the ATM door locking and unlocking mechanism. The entire system is powered by a battery, ensuring smooth and uninterrupted operation even during power failures.

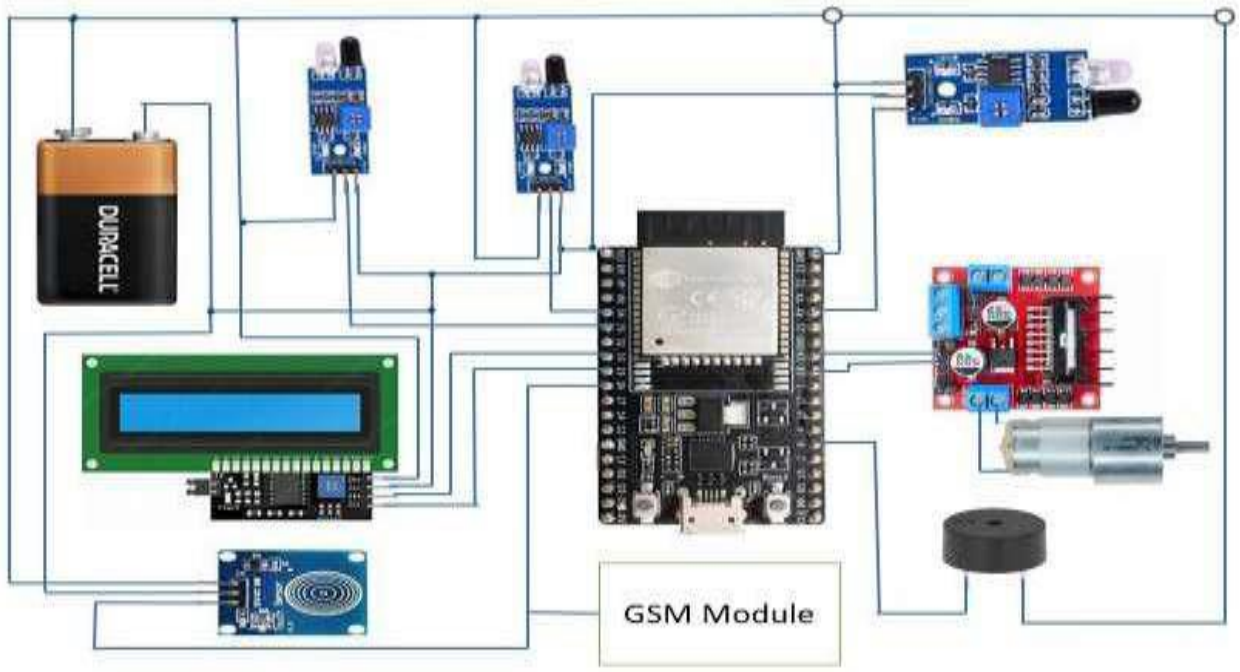

Figure 7 Schematic of Voice Assistant Home Automation

VI. SOFTWARE DESCRIPTION

6.1 ESP32 with Arduino IDE

For ESP32 Programming, we can use Arduino IDE. Open the Arduino IDE and go to File ► Preference as shown in the Figure 8 Then on the Preference window as shown in Figure 9, enter the below link in Additional Boards Manager URLs https://raw.githubusercontent.com/espressif/arduino-esp32/gh- pages/package_esp32_index.json.Then click on OK button.

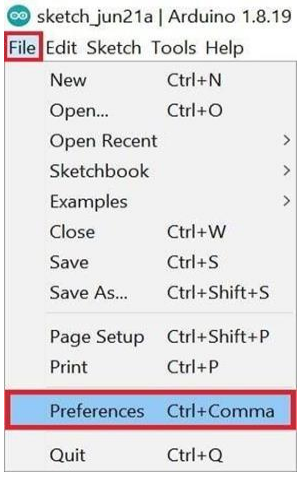

Figure 8 File bar

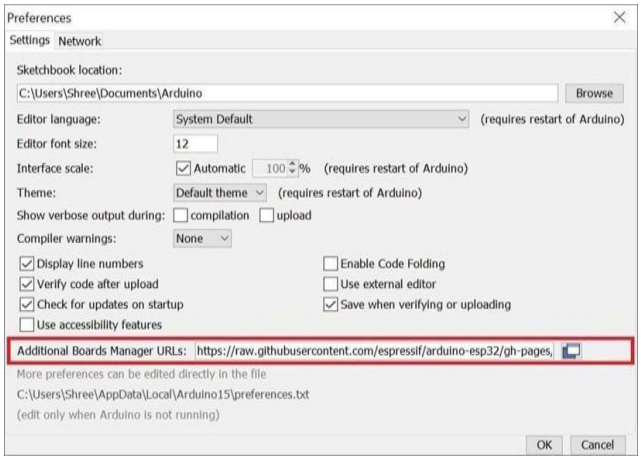

Figure 9 Preference window

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To add the ESP32 board, go to the path Tools ► Board ► Boards Manager in Figure 10(a). Then, type on esp32 on the search bar and click on the install button in Figure 10(b). Wait for installation window as shown in Figure 10(c)

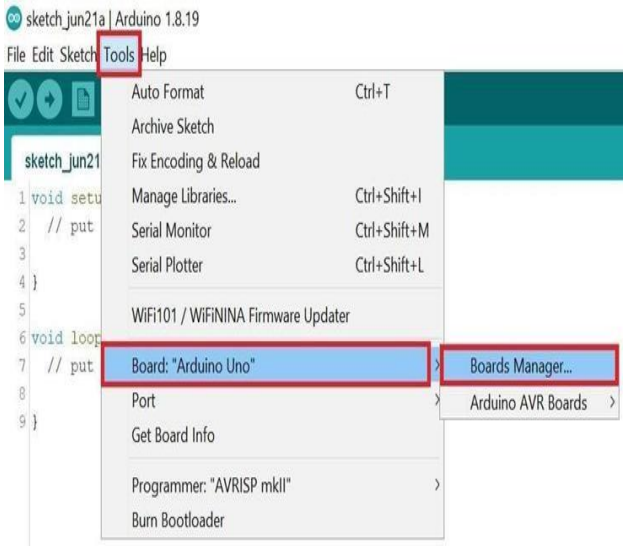

Figure 10(a)

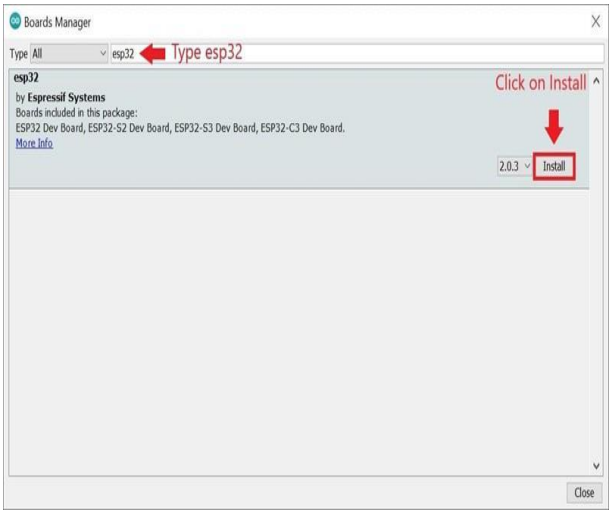

Figure 10(b)

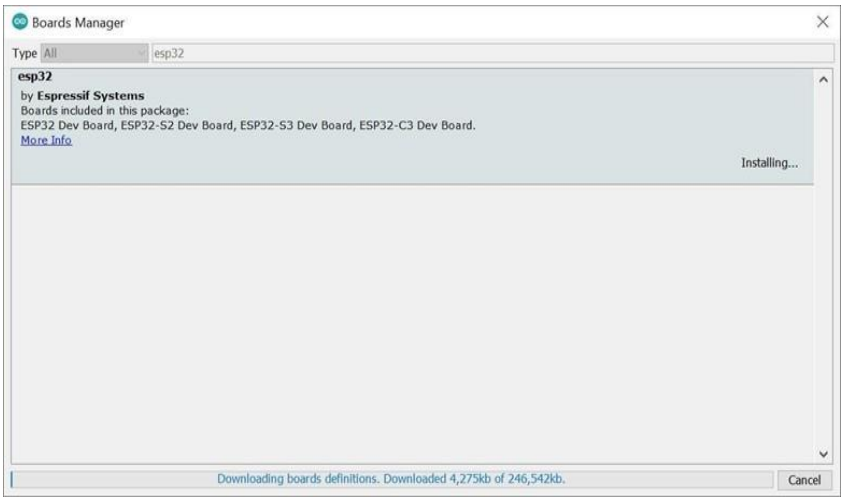

Figure 10 (c)

After board installation select the ESP32 board using the path Tools ► Board ► ESP32 Arduino ► DOIT ESP32 DEVKIT V1 as shown in Figure 11(a) and then Select the COM Port using Tools ► Port ► COM* path. In our computer, the ESP32's COM port shows COM5 as shown in Figure 11(b).

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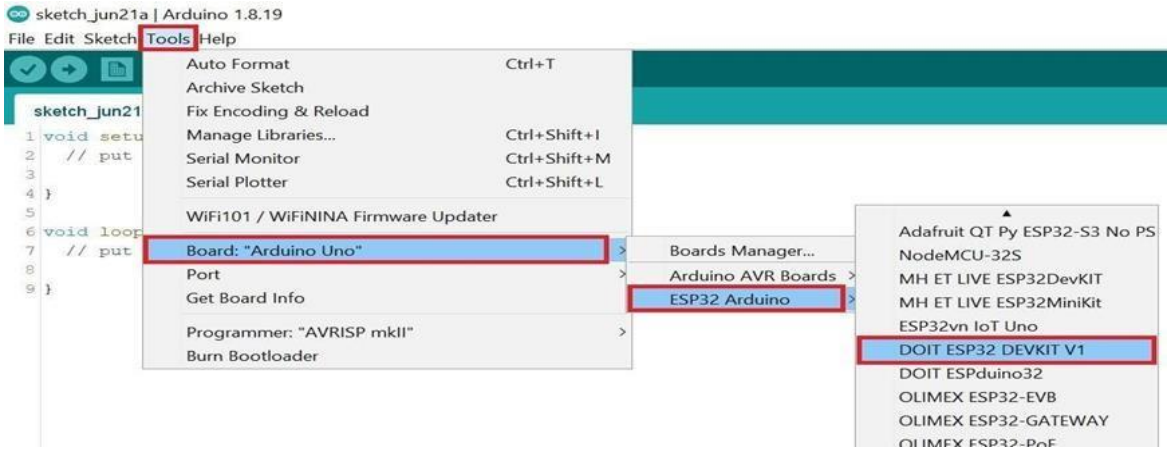

Figure 11 (a)

Figure 11(b)

6.2 Arduino IDE for Software Development

In Arduino IDE, navigate the mouse cursor to the Tools bar. Then click on Tool bar menu then select in Arduino then we need to use ESP – 32. Among the list shown in figure select the Which ESP board you going to use. Then go to Preferences. Select the Path and use the link which is given ashttps://dl.espressif.com/dl/package_esp32_index.json Double click the Boards Manager. Type ESP32 select 2nd one over there and install them.

VII. ESULTS AND DISCUSSION

The system reliably detected human presence using IR and PIR sensors, enabling controlled ATM access. The LCD displayed *"Enter ATM"* when vacant and *"ATM Busy"* when occupied. The touch sensor effectively identified tampering, triggering the buzzer for local alert and the GSM module for remote SMS notification. The DC motor with L298N driver accurately handled door locking/unlocking, and the entire system functioned smoothly even under battery backup, ensuring uninterrupted security

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Figure 13 Smart ATM Security System Model

VIII. APPLICATIONS

Some of the applications are:

1. Bank ATMs in urban and remote areas.
2. Mobile ATMs (e.g., vans).
3. ATMs in malls, railway stations, and airports.
4. High-security financial premises.

IX. ADVANTAGES

Main advantages of our project are:

1. Real-time alerts to bank officials via GSM.
2. Multi-layered security with sensors and door automation.
3. Low-cost and scalable system.
4. Battery backup ensures continuous operation.
5. Easy integration with existing ATM infrastructure.

X. LIMITATIONS

Some of the limitations are:

1. GSM-based alerting depends on network coverage.
2. Does not authenticate users (no biometric/facial recognition).
3. Limited to sensor-based detection; advanced threats may bypass.

XI. FUTURE SCOPE

1. Integration with biometric or facial recognition systems for access control.
2. Development of a mobile app for real-time monitoring.
3. Cloud storage of activity logs.
4. AI/ML-based threat prediction and anomaly detection.

XII. CONCLUSION

The proposed IoT-based Smart ATM Security System provides an effective and reliable solution to enhance ATM security. By integrating ESP32, IR sensors, touch sensor, GSM alerts, motorized door control, LCD display, and buzzer, the system ensures proactive detection and immediate response. The system is cost-effective, scalable, and suitable for deployment in both rural and urban banking environments. With future enhancements, it can be expanded into a comprehensive smart security solution for financial institutions.

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