E-PROCEEDINGS

INTERNATIONAL TINKER INNOVATION & ENTREPRENEURSHIP CHALLENGE (i-TIEC 2025)

"Fostering a Culture of Innovation and Entrepreneurial Excellence"

23 January 2025
PTDI, UiTM Cawangan Johor
Kampus Pasir Gudang

ORGANIZED BY:

Electrical Engineering Studies, College of Engineering
Universiti Teknologi MARA (UiTM) Cawangan Johor
Kampus Pasir Gudang
https://tiec-uitmpg.wixsite.com/tiec

e ISBN 978-967-0033-34-1

9 789670 033341

E-PROCEEDINGS
of International Tinker Innovation & Entrepreneurship Challenge (i-TIEC 2025)

"Fostering a Culture of Innovation and Entrepreneurial Excellence"

23rd JANUARY 2025
PTDI, UiTM Cawangan Johor, Kampus Pasir Gudang

Organized by

Electrical Engineering Studies, College of Engineering,

Universiti Teknologi MARA (UiTM) Cawangan Johor, Kampus Pasir Gudang.

https://tiec-uitmpg.wixsite.com/tiec

Editors

Aznilinda Zainuddin

Maisarah Noorezam

e ISBN: 978-967-0033-34-1

Published in Malaysia by
Universiti Teknologi MARA (UiTM) Cawangan Johor
Kampus Pasir Gudang, 81750 Masai

A-ST044: ENHANCED ANTI-THEFT SAFETY BOX SYSTEM FOR HOME APPLICATION

Muhammad Alif Azman, Nor Affida M.Zin, Nurul Nadia Mohamad,
and Fatimah Khairiah Abd. Hamid
Electrical Engineering Studies, College of Engineering, Universiti Teknologi MARA,
Johor Branch, Pasir Gudang Campus, Masai, Malaysia

Corresponding author: Nor Affida M.Zin, affida0253@uitm.edu.my

ABSTRACT

Conventional or traditional safe lock systems frequently have inadequate security and access control mechanisms. The lack of advanced components makes it more difficult to safeguard against modern burglary techniques and unauthorized access attempts. This could result in breaches and compromised security for valuable assets. The proposed solutions for the currently existing issues in safe lock systems include the use of IoT-based sensor systems to automate security and provide real-time monitoring, ensuring robust protection against unauthorized access. Hence, this technical report presents the design and implementation of an advanced electronic safe lock system utilizing a range of sensors and actuators for enhanced security. By integrating capacitive fingerprint sensors and numerical keypads, the system enhances authentication reliability and reduces false rejections and acceptances. Real-time monitoring with an ESP32 camera module and GPS tracking ensures continuous surveillance and immediate alerts in case of breaches. Visual and audible alerts through RGB LEDs and buzzers provide immediate feedback, while the incorporation of a WiFi module enables remote monitoring and control. These advanced techniques ensure consistent and accurate security measures, increasing efficiency and reducing the possibility of human error.

Keywords: Electronic safe lock system, Capacitive fingerprint sensor, Numerical keypad authentication

1. Product Description

The continuous evolution of security technologies has spurred advancements in the realm of personal and property protection, fostering innovative solutions for secure and intelligent access control. This technical report introduces a comprehensive project entitled "Enhanced Anti-Theft Safety Box System," designed to harness the power of integrated sensors and actuators. The project addresses the critical need for robust and intelligent management of safe access, where precision control is paramount for ensuring security and user convenience. In real-life security systems, maintaining the delicate balance between accessibility and protection is a complex task that greatly influences the effectiveness of the security measures. The report provides a detailed exploration of the design, implementation, and functionality of the system, emphasizing its adaptability and scalability to different security needs. The project's multifaceted approach extends beyond basic access control, incorporating intelligent features such as RGB LEDs for visual alerts, a buzzer for audible

notifications, and a GPS module for precise location tracking. These components collectively contribute to the system's goal of achieving an intelligently managed and secure access control ecosystem. As the project seeks to address key challenges in security through technological innovation, it promises to make a valuable contribution to the evolving landscape of smart security solutions, bridging the gap between technology and real-world security practices.

The system integrates a capacitive fingerprint sensor (R502), a numerical keypad, an ESP32 camera module, an RGB LED, an LCD display, a buzzer, a GPS module, and a solenoid lock. These components work together to create a multi-layered security mechanism. Users can authenticate using either the fingerprint sensor or the numerical keypad, with a maximum of three attempts allowed. Upon successful authentication, the system displays a "granted access" message on the LCD, turns the RGB LED green, emits a single three second beep from the buzzer, and unlocks the solenoid lock. If authentication fails after three attempts, the system enacts several security measures: displaying an error message and the remaining attempts on the LCD, turning the RGB LED yellow, sounding the buzzer continuously for one-minute, streaming video from the ESP32 camera module, and sending an alert notification with the safe's location via the GPS module. This integrated approach ensures both proactive and reactive security responses, making the electronic safe lock system highly reliable and secure.

2. Method Flow Chart and Product Model

The Enhanced Anti-Theft Safety Box System project involved a comprehensive and systematic approach to design, develop, and implement a sophisticated system for enhancing home security. Beginning with a thorough literature review, the project aimed to draw insights from existing research on modern security systems, ensuring a foundation grounded in established knowledge. The system design phase defined specific requirements and functionalities, culminating in a well-thought-out circuit design that integrated a capacitive fingerprint sensor (R502), a numerical keypad, an ESP32 camera module, an RGB LED, an LCD display, a buzzer, a GPS module, and a solenoid lock. Additionally, a Wi-Fi module was incorporated to enable IoT connectivity for remote monitoring and control.

Figure 1 shows a comprehensive array of components depicted, illustrating the intricate architecture proposed for the Enhanced Anti-Theft Safety Box System for Home Security project. Serving as primary inputs, a fingerprint sensor and numeric keypad stand as pivotal mechanisms for user authentication and access control, fortifying the system against unauthorized entry. Complementing these inputs, output functionalities are realized through a solenoid lock, LCD display, buzzer, and LED indicator, collectively ensuring intuitive operation and user engagement. Seamlessly integrated wireless connectivity with an ESP32 camera module augments the system's defensive capabilities through visual surveillance as well as enables communication with external devices. This combination of carefully chosen parts represents a synthesis of security, usability, and usefulness and is representative of the project's goal of redefining home security via technical innovation and complexity.

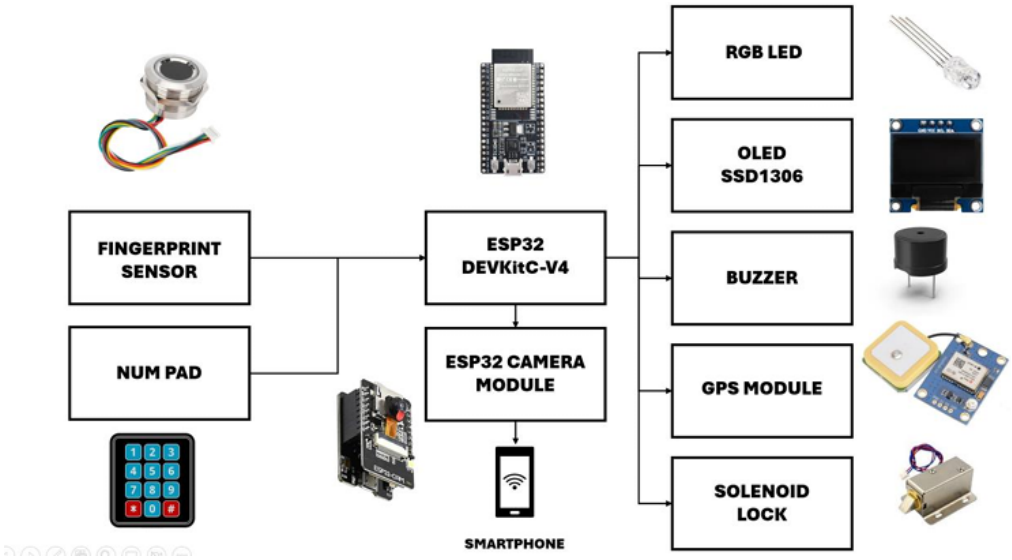


Figure 1. Block Diagram of Enhanced Anti-Theft Safety Box System.

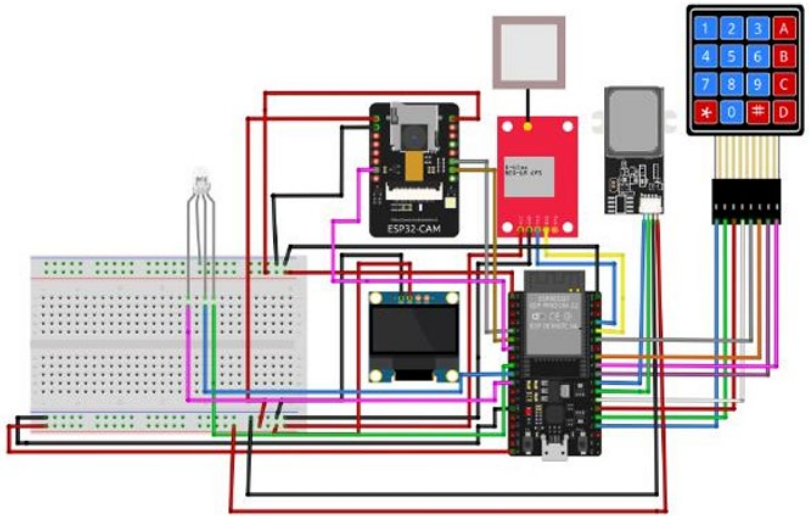
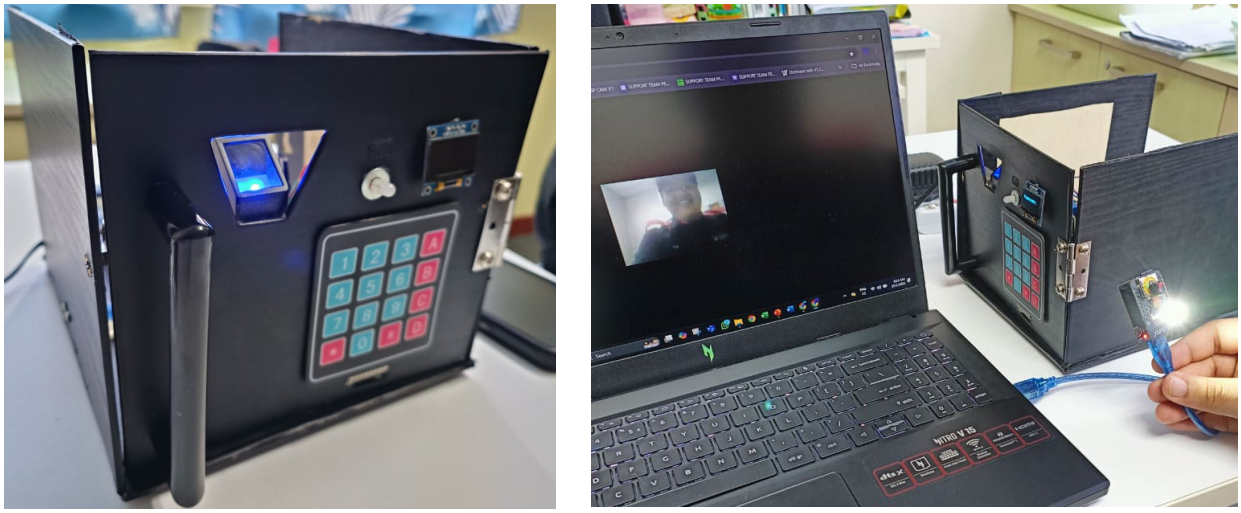


Figure 2. Schematic Diagram of Enhanced Anti-Theft Safety Box System.

Based on **Figure 2**, the schematic diagram for the Enhanced Anti-theft Safe Lock for Home Security vividly illustrates the strategic connections of each component to the ESP32 DevKitC-v4 microcontroller. Each sensor and actuator are meticulously interfaced with the corresponding pins on the ESP32 DevKitC-v4, ensuring a well-defined and organized system. The Capacitive Fingerprint Sensor R502 is intricately linked to the RX and TX pins, facilitating precise fingerprint authentication. The Keypad is connected to digital pins D2 through D9, allowing for accurate input readings. The ESP32 Camera Module is appropriately connected to the corresponding pins for camera functionality, including

VSYNC, HREF, PCLK, XCLK, D0-D7, and SDA/SCL for I2C communication. The RGB LED, indicating various statuses, is tied to digital pin 5 (rgbLedPin). Furthermore, the Buzzer, responding to different alerts, is linked to digital pin 6 (buzzerPin). The GPS Module, providing location data, is connected via UART pins RX and TX (gpsRxPin and gpsTxPin). The Solenoid Lock, a crucial security component, is connected to digital pin 7 (lockControlPin). The SSD1306 OLED display, a crucial output display, is connected via the I2C interface, ensuring efficient data presentation. This meticulous arrangement not only highlights the precise connections of each component to the ESP32 but also underscores the systematic integration that forms the foundation of the Enhanced Anti-Theft Safety Box System.



(a) (b)

Figure 3. (a) the prototype and **(b)** The testing of the camera functionality of the Enhanced Anti-Theft Safety Box System.

Figure 3 (a) shows the successfully developed prototype of the Enhanced Anti-Theft Safety Box System with the fingerprint sensor, keypad and OLED screen at the door of the box. The captured video image from the camera also can be monitored remotely using the online platform as shown in **Figure 3 (b)** indicates the high reliability of the product.

3. Novelty and uniqueness

It's evident that the development of the Enhanced Anti-theft Safe Lock system holds significant promise in addressing the pressing concerns surrounding home security. By integrating advanced hardware components such as the ESP32 microcontrollers, along with sophisticated software solutions, the prototype demonstrates the potential to enhance residential protection against burglary and theft. By incorporating a suite of components, including a capacitive fingerprint sensor (R502), a numerical keypad, and an ESP32 camera module, the system enables real-time data collection essential for informed decision-making. The ability to monitor and control access closely mirrors the intricacies of actual security setups, providing a valuable tool for both security enthusiasts and professionals. Moreover,

the integration of a Wi-Fi module transforms the safe lock system into a connected Internet of Things (IoT) device, enabling remote monitoring and control. This connectivity not only enhances accessibility but also facilitates prompt responses to security breaches or unauthorized access attempts.

4. Benefit to mankind

By incorporating elements of both hardware and software innovation, along with IoT connectivity, our prototype represents a holistic approach towards enhancing residential security. Additionally, the integration of advanced features such as fingerprint recognition and impact sensing add a layer of sophistication that aligns with the evolving landscape of security technologies.

5. Innovation and Entrepreneurial Impact

Overall, our study not only demonstrates the feasibility of developing an Enhanced Anti-theft Safe Lock system but also highlights its potential to redefine the standards of home security. By leveraging cutting-edge technologies and innovative design principles, our prototype serves as a testament to the continuous evolution of security solutions in safeguarding the sanctity of residential spaces.

6. Potential commercialization

The proposed Enhanced Anti-theft Safe Lock for Home Security System holds significant potential for commercialization within the security sector. By partnering with home security manufacturers or companies, this solution can be marketed as an add-on feature or integrated service for home security systems. Residents would benefit from reduced theft cases, loss of personal belongings and enhanced life in peace, making them as ideal clients for the proposed solution.

7. Acknowledgment

Authors wish to acknowledge the support provided by the Electrical Engineering Studies, College of Engineering, Universiti Teknologi MARA Johor Branch, Pasir Gudang Campus, Masai, Malaysia in terms of financial, consultations and facilities.

8. Authors' Biography

Muhammad Alif Azman is currently pursuing a Diploma in Electrical Engineering (Electronic) at the UiTM Pasir Gudang Campus. He has demonstrated outstanding performance in both academic and extracurricular activities, having earned a place on the Dean's List for two consecutive semesters. Apart of his expert skills in electronic project, he is also talented and has involved in numerous graphic design projects.

Dr. Nor Affida M. Zin is a Senior Lecturer at UiTM Pasir Gudang Campus. She holds a Ph.D in Advanced Optical Networking, focusing on deterministic and time-sensitive services in Passive Optical Network. She has authored numerous high-impact journal articles and conference papers on PON technology. She is actively collaborating with academia and industry to enhance PON frameworks and developments in Malaysia.

Dr. Nurul Nadia Mohamad is a Senior Lecturer at UiTM Pasir Gudang Campus. She holds a Ph.D in Hydro Distillation Process, focusing on Self-tuning Fuzzy PID Controller System. She has authored numerous high-impact journal articles and conference papers on control technology. She is actively collaborating with academia and industry to enhance fuzzy distillation process control frameworks and developments in Malaysia.

Dr. Fatimah Khairiah Abd. Hamid is a Senior Lecturer at UiTM Pasir Gudang Campus. She holds a Ph.D in Advanced Semiconductor technology, focusing on high performance semiconductor material. She has authored numerous high-impact journal articles and conference papers on semiconductor technology. She is actively collaborating with academia and industry to enhance electronic devices and developments in Malaysia.