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Design and Implementation of Bag Security System

Aarchi Vijendra More (Student)

Sonopant Dandekar College, Palghar (W), Maharashtra, India

Abstract

The rising occurrence of theft in public areas like buses, trains has heightened the demand for low-cost, portable, and effective personal security devices. Bags, which tend to be used to hold valuable items, are particularly exposed to theft because they are easily accessible and heavily dependent on simple locking devices like padlocks and zippers. These conventional methods have only passive protection and can easily be broken or manipulated. To cope with this increasing issue, this paper proposes the design and implementation of an alarm-based Anti-Theft bag security system with active and real-time reaction to unauthorized entry. The new system incorporates hardware and software elements in order to guarantee real-time detection, deterrence, and control. It is constructed with an ESP32 microcontroller, magnetic door sensor, active buzzer, and rechargeable battery and remote monitoring and control through the Blynk IoT platform.

In a closed position of the bag, the magnetic sensor stays in contact, representing an authorized state. If an un-authorised opening is attempted on the bag, the sensor can sense the detaching of its magnetic contact and alert the ESP32 to activate the buzzer. The active buzzer generates an audible alarm that immediately alerts the owner and the people around, thus deterring theft. The alarm is persistent until the user turns it off manually through the Blynk mobile app, sending a "Stop" command remotely. This combination of hardware and IoT software offers an easy-to-use interface for both control and monitoring in real time. Use of a rechargeable battery by the system guarantees portability and seamless functionality, hence its application in mobile settings like public transport and travel scenarios.

The suggested system was field-tested in various real-life scenarios to assess its performance. Findings indicated an instantaneous response upon detection of intruder access. The system showed good deterrence power, with the alarm serving to draw attention and discourage attempts at stealing. Users could remotely switch off the alarm via the Blynk app, adding flexibility and ease of use. The magnet sensor proved to be dependable by reliably detecting when bags are opened without triggering false alarms during normal handling, thus verifying system stability. In addition, the design was energy-efficient and utilized little power in idle mode and only moderate power when alarm mode was on.

The combination of ESP32's Wi-Fi and Bluetooth support with IoT-based mobile control has turned an ordinary bag into a smart, interactive, and responsive security system. Hardware-software integration, real-

time generation of alerts, and human-centric control mechanisms are highlighted in this research, advancing portable security technology. The results confirm the Anticipated Anti-Theft bag as a viable, reliable, and cost-effective solution that complements personal safety in crowded places. Potential future enhancements could incorporate offline deactivate functionality. In general, the system effectively illustrates how IoT and embedded systems can be used to develop intelligent, proactive anti-theft devices that balance efficiency, usability, and portability for daily protection.

Introduction

Bags are widely used to carry essential items such as money, documents, laptops, and personal belongings. Most conventional bags rely on simple zippers, locks, or straps as security mechanisms. However, these passive methods can be easily tempered with or broken by thieves, especially in crowded places. Padlocks and zipper locks may also slow down a theft attempt but cannot fully prevent unauthorized access. Hence, there is a need for advenced, technology-driven solutions to secure bags against theft in real-world scenarios.

The problem becomes more critical in India, where the rapidly growing population and increasing crowd density in public transport, markets, and events, make theft more common. Crowded places often provide opportunities for thieves to disreetly accesspersonal belongings, making traditional security measures insufficient. This rising concern demands an active, portable, and reliable security system.

This paper presents the design and development of an alarm-based Anti-Theft bag security system to counteract the increasing rate of theft in public spaces. It has led to the efficient and portable security solution that alerts owner in case of unauthorized access. The system is implemented using ESP32 a powerful microcontroller with Wi-Fi and Bluetooth capabilities, as a central unit. A magnetic door sensor is employed to detect the bag's opening; once the magnetic contact is broken, the ESP32 activates an active alarm buzzer, producing a loud sound to deter theft. The alarm continues until turned off manually through the Blynk IoT mobile application, ehich provides a user-friendly interface for remote control monitoring. Blynk acts as a bridge between the hardware and the user, enabling real-time commands via the internet. The system is powered by a battery, ensuring portability and uninterrupted operation even in mobile conditions. Unauthorized access is identified when the sensor detects separation, triggering the alarm mechanism. This integration of microcontroller technology, IoT connectivity, and real-time alert generation provides a low-cost portable, and efficient solution for bag security.

Review of literature

1) **"IOT-Based Home Security Using Magnetic Sensor" (2020)**
   The objective of this study was designing the home door security system so that the users were able to find out the situation of home when they are away. If the door was forcibly opened, the magnetic sensors sent information to Node MCU. The Node MCU order the camera to take a picture and it was sent to the homeowner's smartphone through the Telegram application.

2) **"Robust light-weight magnetic-based door event detection with smartphones" (2018)**
This paper introduces light-weight magnetic-based door event detection, a system that uses smartphones' build-in magnetic sensors to detect door events without extra infrastructure. It achieves around 80% accuracy using only magnetic data, and up to 90% accuracy when fused with other build-in sensors.

3) **"Smart home monitoring system using esp32 microcontrollers" (2020)**
This outlines an Iot-based home security system build with ESP32. It detects intruders, triggers alarms, captures images, sends alert to smartphones, and also monitors temperature data via a web server.

4) **"A sensor based IoT monitoring system for electrical devices using Blynk framework" (2020)**
This paper discusses a remote electrical device monitoring system that uses sensors, the internet, and th Blynk server. It enables status tracking, remote control of applications, and reduces the need for physical verification, thereby improving energy efficiency.

5) **"A simple smart home based on IoT using NodeMCU and Blynk" (2019)**
This research explains a simple IoT-based smart home prototype that uses Wi-Fi and the Blynk app to control electrical loads. It highlights applications beyond homes, such as security and industry, and proposes an energy-saving solution by allowing remote control of building lights at low cost.

Methodology

Hardware Components:

1) ESP32 microcontroller

   Microcontroller receives input from the sensors, handles communication, and controls the alarm function, thus being the central unit of the system.

2) Magnetic door sensor

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Magnetic sensor detect the bag opening without authorization, which causes the alarm to sound and alert the user.

3) Active alarm buzzer

   It is audible buzzer, acts as an instant deterrer by provideng a loud signal when unauthorized opening is sensed, thus drawing the attention of user as well as sorrounding people towards the bag.

4) Battery

   Batteries allows continuous operation without constant recharging, enabling permanent security monitoring.

Software Components:

1) Arduino IDE

   It is used to program the microcontroller, ensuring proper functionality and integration of security features.

2) Programming language

   C/C++ is used for developing the microcontroller's firmware, enabling smooth communication between hardware components and the Blynk Iot interface.

3) Blynk IOT platform

   The Anti-Theft system is integrated with Blynk IoT templates, allowing users to monitor real-time system status and remotely control features such as arming/disarming the alarm via Blynk mobile application.

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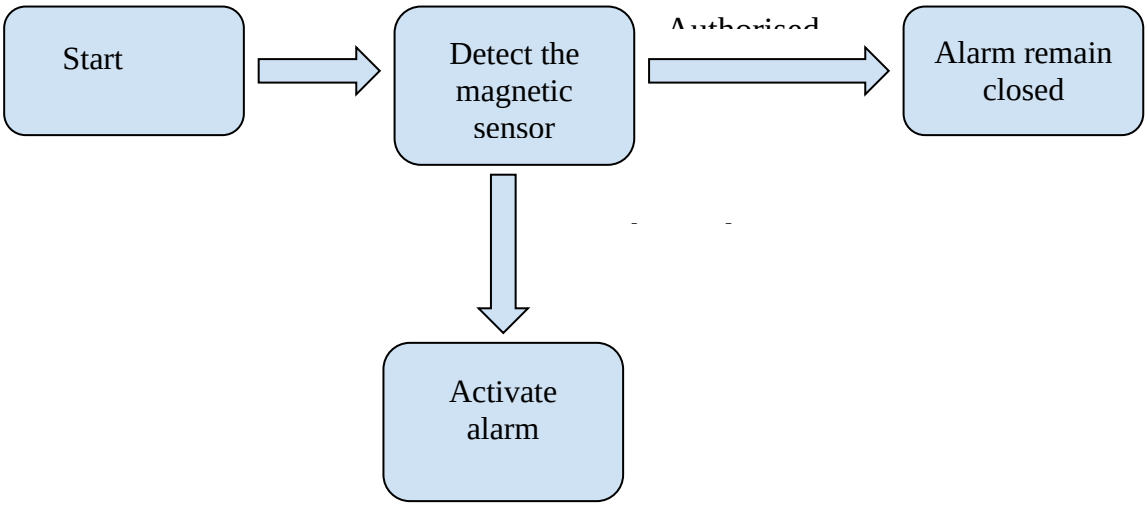
Working Principle:



The working principle of the alarm-based anti-theft bag system begins with the continuous monitoring of the magnetic sensor attached to the bag's zipper. When the bag remains closed, the sensor detects an authorized condition, and the alarm stays inactive. However, if the bag is opened without permission, the sensor identifies it as an unauthorized access by detecting the separation of its magnetic contact. This triggers the ESP32 microcontroller to immediately active the buzzer alarm, producing a loud sound that alerts the owner and deters the thief. Thus, the system ensures real-time detection and response to any unauthorized attempt.

Result and Discussion

The Anti-Theft bag checked under different conditions:

- Immediate Response

  The system demonstrated an excellent immediate response time during testing. As soon as the magnetic door sensor detected unauthorized access, the ESP32 microcontroller processed the signal and activated the buzzer within one second. This quick reaction is crucial in preventing theft attempts, as it alerts the owner instantly and draws the attention of nearby individuals. Such responsiveness ensures that even minimal tampering with the bag triggers an alarm, making it difficult for the thief to act unnoticed.

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- High Deterring

  The alarm's sound level, measured between 88 to 90 decibels, proved highly effective in deterring potential thefts. The loud sound not only startles the intruder but also immediately attracts attention from people in the surrounding area, creating a psychological barrier for the thief. This feature plays a key role in prevention, as most theft attempts rely on stealth. The effectiveness of this audible alert ensures that the system serves as both a reactive and proactive deterrent.

- User Control

  One of the most significant advantages of the proposed system is its integration with the Blynk IoT mobile application, which allows the user to control the alarm remotely. The user can deactivate the buzzer simply by sending a "Stop" command through the Blynk interface. This remote functionality adds convenience, as the owner does not need to physically open the bag or manually reset the system. It also ensures flexibility and user-friendly operation, enhancing the overall practicality of the device.

- Reliability

  The magnetic door sensor used in the system exhibited consistent and stable performance throughout testing. It accurately detected the opening and closing of the bag without producing any false alarms during normal use, such as movement, vibration, or accidental touch. This reliability ensures that the system maintains credibility and does not cause unnecessary disturbances, which is essential for daily usability.

- Low Power Consumption

  The system's design emphasizes energy efficiency, making it suitable for portable, long-term use. Powered by a rechargeable battery, the circuit components—including the ESP32, buzzer, and sensor—consume minimal power during idle states and moderate power only when the alarm is active. This allows the device to operate for extended periods without frequent recharging, ensuring continuous protection and cost-effectiveness.

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Conclusion

The proposed alarm-based Anti-Theft bag effectively prevents unauthorized access by generating an immediate and loud audible alarm whenever a theft attempt is detected. The system, built using an ESP32 microcontroller, magnetic door sensor, and an active buzzer, is lightweight, affordable, and easy to operate, making it ideal for everyday use. The integration of the Blynk IoT platform further enhances the system's functionality by enabling remote control and real-time status monitoring through a mobile application. This connectivity allows users to deactivate the alarm conveniently and monitor the bag's security status from any location. The design focuses not only on ensuring safety but also on achieving user-friendliness, portability, and cost efficiency. Moreover, the system's low power consumption supports long-term use with minimal maintenance, making it suitable for individuals who travel frequently or commute through crowded public areas. The primary aim of this research is to continually enhance both security and usability, ensuring that the Anti-Theft bag serves as a reliable, practical, and empowering solution for protecting personal belongings in diverse environments such as mass transit systems, public spaces, educational institutions, and travel situations.

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