Shop Anti-theft Device – Project Write-up

1. Introduction

Retail theft is a major challenge for shops and supermarkets, often leading to significant financial losses. Traditional CCTV systems require constant monitoring, while advanced electronic tagging systems are costly. This project introduces a **low-cost, portable, and smart anti-theft device** that combines **proximity sensing, alarm notification, and wireless communication** to help shop owners detect suspicious movements around products or exits.

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2. Objectives

- To design a **portable, rechargeable anti-theft alarm system**.
- To use a **proximity sensor** for detecting unusual movement near shelves or items.
- To provide **instant alerts** through a loud buzzer and potential wireless notifications.
- To make the system **affordable and easy to deploy** without complicated wiring.

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3. System Components

a) Microcontroller (ESP32-WROOM-32)

- Acts as the **brain of the system**.
- Provides **Wi-Fi and Bluetooth connectivity** for optional remote alerts.
- Handles sensor data processing and alarm control.

b) Sensor Module (VL53L0X / VL53L1X ToF Sensor)

- A **laser-based time-of-flight proximity sensor**.
- Detects hand movements, object removal, or unauthorized activity near products.

c) Alert Mechanism (Buzzer + Driver)

- A **PAM8302 amplifier IC** drives a buzzer.
- Produces a **loud alarm** to notify shop staff immediately.

d) Power Supply

- **USB-C input with TP4057 charger IC** for Li-ion battery charging.
- **Boost/step-down regulator (MP1584/LM2576HVS)** supplies stable 3.3 V to ESP32 and sensors.
- Ensures **rechargeable, portable operation** without dependency on mains supply.

e) External Programming / Debugging Header

- **UART + I^2C header** for firmware uploading and testing.
- Allows easy debugging and calibration of the system.

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4. System Operation

1. **Monitoring Mode** – The ESP32 continuously reads data from the VL53L0X sensor.
2. **Detection** – If a sudden change in distance/motion is detected (e.g., a hand reaching to grab something or movement near the exit), the system flags it as suspicious.
3. **Alarm Trigger** – The buzzer is activated, producing a loud sound to alert staff.
4. **Wireless Alert (optional)** – ESP32 can send notifications via **Wi-Fi or Bluetooth** to a central system, smartphone, or dashboard.
5. **Rechargeable Operation** – The device runs on a battery and can be placed anywhere in the shop.

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5. Features

✅ Portable and battery-powered.
✅ Loud alarm for instant response.
✅ Wireless communication capability (expandable).
✅ Low power consumption with USB-C charging.
✅ Easy installation and repositioning.

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6. Applications

- Retail shops and supermarkets.
- Bookstores, pharmacies, and electronics stores.

- Kiosks and small businesses without CCTV systems.
- Temporary setups such as exhibitions or pop-up stores.

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7. Conclusion

The **Shop Anti-theft Device** provides an affordable and efficient solution for small to medium retail stores. By combining **proximity sensing, alarm activation, and IoT capabilities**, it enhances security while remaining easy to deploy. This project demonstrates how embedded systems and modern sensors can help solve real-world problems in retail environments.