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# SMART TRASH MANAGEMENT SYSTEM USING STM32

Project based learning

Subject: Microcontroller and Programming

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## Introduction

Waste management is one of the key challenges in modern urban life. Overflowing and unattended dustbins not only cause unpleasant sights but also pose health hazards. To address this, we propose a **Smart Dustbin** system using **STM32**, **IR sensor**, **Ultrasonic sensor**, and **Servo motor**.

This smart dustbin automates the process of waste disposal. When a person approaches the bin, the IR sensor detects their presence and signals the STM32 microcontroller to open the lid using a servo motor. Simultaneously, an ultrasonic sensor monitors the bin's fill level. If the dustbin is full, the system prevents the lid from opening, thus avoiding overfilling and maintaining hygiene.

This project demonstrates the practical application of embedded systems in smart city infrastructure and promotes automation in daily life.



## Problem Statement

A smart dustbin using the STM32F407G-DISC1 enables hygienic, contactless waste disposal. An IR sensor detects user presence to trigger a servo motor, automatically opening and closing the lid. An ultrasonic sensor monitors bin fill levels to prevent overflow and improve waste collection efficiency. This system enhances sanitation, minimizes manual handling, and supports cleaner, smarter waste management.

External power supply is also given to ensure smooth operation of servo motor along with the sensors



# Objectives

- To design and implement a **smart dustbin** system using **STM32F407G** microcontroller.
- To **automatically open** the dustbin lid using a **servo motor** when a person is detected.
- To use an **IR sensor** to detect the presence of a person near the dustbin.
- To use an **ultrasonic sensor** to measure the **fill level** of the dustbin and **prevent lid opening when full**.
- To program the STM32F407G using **STM32CubeMX** and **HAL libraries** for peripheral configuration.
- To promote **hygienic, touchless waste disposal** and contribute to **smart city** infrastructure.



## Working Principle

The Smart Dustbin operates on the principle of automated control using sensor feedback and microcontroller logic. The system uses:

- An IR sensor to detect the presence of a person near the dustbin.
- An ultrasonic sensor to measure the distance to the top of the trash pile inside the bin, determining whether it is full.
- An STM32F407G microcontroller to process sensor inputs and control output devices.
- A servo motor to open or close the lid based on the sensor signals.



## Components Required

- **STM32F407G-DISC1** – Microcontroller board for processing and control
- **IR Sensor Module (LM393)** – For detecting the presence of a person
- **Ultrasonic Sensor (HC-SR04)** – For detecting the fill level of the dustbin
- **Servo Motor (SG90)** – For automated lid movement
- **Jumper Wires** – For connecting components
- **Breadboard** – For circuit prototyping
- **USB Cable** – For programming and power supply
- **Power Source (5V)** – To power servo motor



# Circuit Connections

## 1. IR Sensor

- **VCC** → 5V
- **GND** → GND
- **OUT** → **PA0** (GPIO Input on STM32)

## 2. Ultrasonic Sensor (HC-SR04)

- **VCC** → 5V
- **GND** → GND
- **Trigger** → **PC0** (GPIO Output on STM32)
- **Echo** → **PC1** (GPIO Input on STM32)

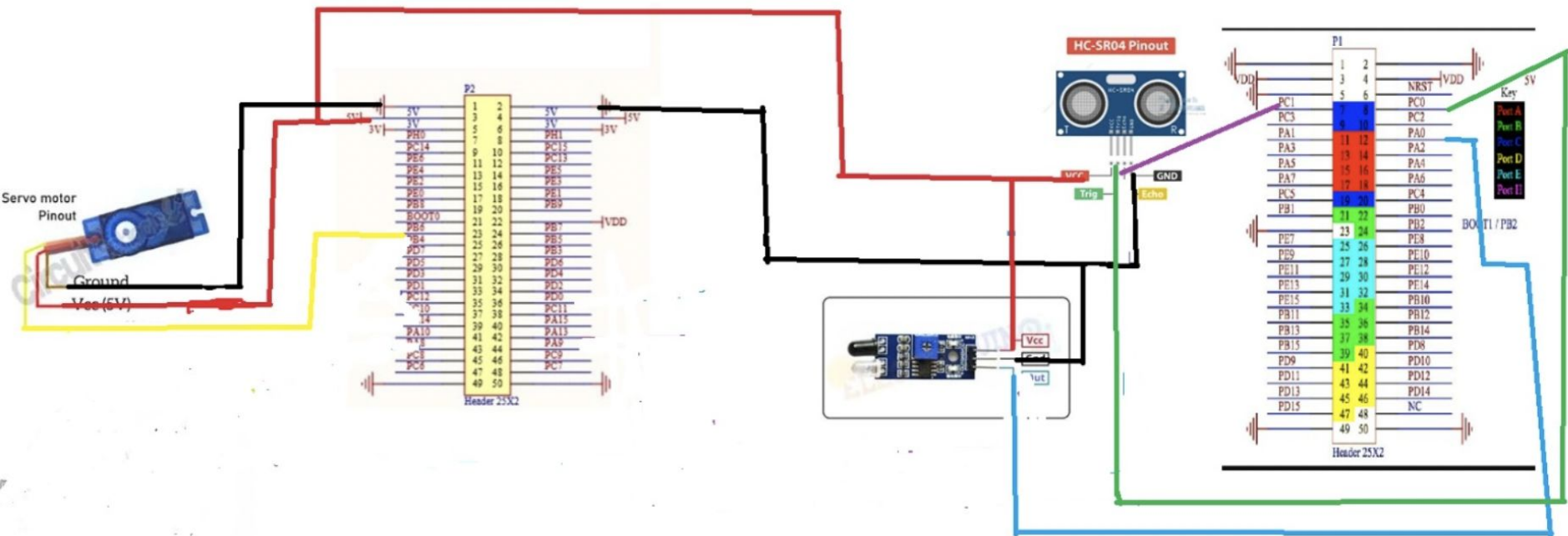


# Circuit Connections

## 3. Servo Motor (SG90)

- **VCC (Red wire)** → 5V (external source)
- **GND (Brown wire)** → GND
- **Signal (Orange/Yellow wire)** → **PB6** (TIM4 Channel 1, PWM Output)







# Algorithm

1. Start the STM32 HAL library.
2. Configure the system clock.
3. Initialize all GPIOs for IR sensor, ultrasonic sensor and servo motor PWM. Also Initialize Timer 4 for PWM generation (used by servo).
4. Start PWM on TIM4 Channel 1. Enable the DWT cycle counter for microsecond-level timing.
5. Read the IR sensor state (detects human presence).
6. Measure distance using the ultrasonic sensor
7. If IR sensor detects a person (IR = HIGH): Set servo angle to 90° (lid fully opens).
8. Else if ultrasonic distance < 15 cm: Set servo angle to 0° (lid stays closed).
9. Else Set servo angle to 45° (intermediate/idle position).
10. Wait for 200 milliseconds to prevent jitter or rapid servo movement.
11. Go back to Step 3 to continuously monitor sensors and control the servo.



## Conclusion

The Smart Dustbin system using the **STM32F407G microcontroller**, **IR sensor**, **ultrasonic sensor**, and **servo motor** effectively demonstrates an efficient, touchless waste disposal mechanism. It detects a person's presence and opens the lid automatically, improving hygiene and convenience. Additionally, it intelligently prevents lid operation when the bin is full, thus avoiding overflow and promoting better waste management.

This project showcases the practical use of embedded systems and sensor integration in creating smart city solutions, and serves as a strong example of how microcontrollers can be used to automate real-world applications.