

Hardware Integration Documentation

Module: Object Detection with LED and Digital Buzzer Alert

1.1 Objective

To detect the presence of an object using an **IR sensor** and generate:

- A **visual alert** using an LED
- An **audio alert** using a **digitally driven active buzzer**

The buzzer is controlled using a **simple GPIO HIGH/LOW signal**.

1.2 Components Used

Component	Specification
Microcontroller	Sourya Board (3.3V logic GPIO)
IR Sensor	Digital IR Obstacle Sensor (LM393-based)
LED	Standard LED (3.3V compatible)
Buzzer	Active buzzer (DC-operated)
Resistor	220 Ω (LED current limiting)
Power Supply	3.3V regulated output

1.3 Electrical Specifications

1.3.1 Voltage and Current

- **Operating Voltage:** 3.3 V
- **GPIO Output Current (STM32):** up to 20 mA (typical)
- **Buzzer Type:** Active (internal oscillator)

Important Design Constraint

Digital GPIO drive is suitable **only for active buzzers**.

Passive buzzers will produce weak or no sound in this mode.

1.4 Pin Assignment Summary

Function	STM32 Pin Mode	
IR Sensor Output PA6		GPIO Input
LED Control	PB0	GPIO Output
Buzzer Control	PB1	GPIO Output
Power	3.3V	Power
Ground	GND	Common Ground

1.5 Detailed Connection Description

1.5.1 IR Sensor Connection

Purpose

Detects object presence and outputs a digital signal.

Connections

IR Sensor VCC → STM32 3.3V

IR Sensor GND → STM32 GND

IR Sensor OUT → STM32 PA0

Signal Logic

- HIGH → Object detected
- LOW → No object

Configuration

- PA6 set as **GPIO Input**
- No pull-up required (sensor includes comparator)

1.5.2 LED Connection

Purpose

Provides visual indication when an object is detected.

Connections

STM32 PB0 → 220Ω Resistor → LED Anode (+)

LED Cathode (−) → GND

Behavior

- PB0 HIGH → LED ON
- PB0 LOW → LED OFF

Configuration

- PB0 set as **GPIO Output (Push-Pull)**

1.5.3 Buzzer Connection (Digital Mode)

Purpose

Generates an audible alert using a **digital control signal**.

Connections

STM32 PB1 → Buzzer +

Buzzer – → GND

Operating Principle

- PB1 HIGH → Buzzer sounds
- PB1 LOW → Buzzer silent

Configuration

- PB1 set as **GPIO Output**
- No PWM or timer used

1.6 Peripheral Configuration Summary

Peripheral Setting

PA6	GPIO Input
PB0	GPIO Output
PB1	GPIO Output

1.7 Functional Operation Description

1. The IR sensor continuously monitors for an object.
2. When an object is detected:
 - PA6 reads HIGH
 - LED output (PB0) is set HIGH
 - Buzzer output (PB1) is set HIGH

3. When no object is detected:
 - PA6 reads LOW
 - LED and buzzer outputs are turned OFF

Code

In main.c file inside the while1 :-

```
while (1)
{
    if (HAL_GPIO_ReadPin(GPIOA, GPIO_PIN_0) == GPIO_PIN_RESET)
    {
        HAL_GPIO_WritePin(GPIOB, GPIO_PIN_0, GPIO_PIN_SET);    // LED ON
        HAL_GPIO_WritePin(GPIOB, GPIO_PIN_1, GPIO_PIN_SET);    // Buzzer ON
    }
    else
    {
        HAL_GPIO_WritePin(GPIOB, GPIO_PIN_0, GPIO_PIN_RESET); // LED OFF
        HAL_GPIO_WritePin(GPIOB, GPIO_PIN_1, GPIO_PIN_SET);    // Buzzer OFF
    }
}
```

1.8 Known Limitation (Documented Clearly)

- Digital GPIO provides **limited drive strength**
- Sound volume depends on:
 - Buzzer sensitivity
 - Supply voltage (3.3V)
- Output volume will be **lower than PWM or transistor-driven designs**

✅ This behavior is **expected and acceptable** for basic alert systems.

1.9 Safety and Reliability Considerations

- GPIO current within STM32 limits
- No floating inputs
- Common ground reference

- Simple logic → low failure risk

1.10 Readiness for Future Enhancement

This design can be upgraded to:

- Transistor-driven buzzer (higher volume)
- PWM-based tone control
- Interrupt-based IR detection
- Multi-alert logic
- ESP32 notifications