ESP32-CAM + LAPTOP AUDIO MODEL — COMPLETE PROJECT DOCUMENT

1. OVERVIEW

This document covers the setup where the ESP32-CAM captures images and the **laptop itself speaks the output** using server32.py.

✓ Laptop converts text → audio and plays it directly.
✓ No speaker amplifier or ESP32-S3 used.
✓ ESP32-CAM + Button + Ultrasonic alert system.

2. ESP32-CAM SYSTEM (freshhhcam.ino)

- Blind person presses button.
- ESP32-CAM captures high-resolution picture.
- Encodes to Base64.
- Sends to **server32.py**.
- Server processes and plays back through laptop speakers.

Button Wiring

Button	ESP32-CAM
GND	GND
VCC	3.3V
OUT	IO13

Flash LED Wiring

LED	ESP32-CAM
+	IO4
–	GND

3. ESP32-CAM Programming Setup

UPLOAD MODE (Important!)

Connect Arduino Uno → ESP32-CAM:

Arduino	ESP32-CAM
5V	5V

Arduino	ESP32-CAM
GND	GND
TX	U0R
RX	U0T
RESET → GND	(only during upload)
(only during upload)	IO0 → GND

After upload: - REMOVE IO0→GND - REMOVE RESET→GND - Leave **TX & RX connected** - Power CAM using Arduino's **5V**

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4. ESP32 BUZZER + ULTRASONIC SYSTEM (buzzer.ino)

A second ESP32 continuously detects obstacles.

Ultrasonic → ESP32

HC-SR04	ESP32
VCC	VIN
GND	GND
TRIG	D5
ECHO	D18

Buzzer → ESP32

Buzzer	ESP32
+	D15
–	GND

If obstacle < **100 cm** → buzzer rings for **2 seconds**. Blind user then presses camera button.

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5. PYTHON SERVER (server32.py – Laptop Audio)

This server:

✓ Receives Base64 image from ESP32-CAM
✓ Sends to OpenRouter Vision Model
✓ Extracts readable text + objects
✓ Cleans the text

✓ Converts to MP3 (gTTS)
✓ Converts MP3 → WAV using FFmpeg
✓ Plays WAV sound DIRECTLY on laptop speakers using pygame

HOW TO RUN

```
py -3.10 server32.py
```

Laptop begins speaking outputs.

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6. FULL WORKFLOW

1. Ultrasonic sensor detects obstacle.

2. Buzzer beeps → blind user presses button.

3. ESP32-CAM captures image.

4. Image sent to laptop server (server32).

5. Laptop: Vision analysis → OCR → Object detection.

6. Laptop generates speech.

7. Laptop plays audio automatically.

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7. FILES USED

- freshhhcam.ino → ESP32-CAM
- buzzer.ino → Ultrasonic + buzzer ESP32
- server32.py → Laptop audio server

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8. COMMAND SUMMARY

Purpose	Command
Run laptop audio server	`py -3.10 server32.py`
Upload camera code	Arduino IDE (IO0→GND)
Run ultrasonic buzzer	Upload buzzer.ino to 2nd ESP32

This document is for the **Laptop Audio Model (server32)** where all sound comes directly from the computer.