Hardware Connection Documentation

Overview

This document details the connections between the ESP32-CAM and Arduino UNO for the smart recycling system. The system uses serial communication between the devices and controls various components including a servo motor, relay, TFT display, and a button.

ESP32-CAM Connections

Power

- VCC → 5V
- GND → GND

Communication with Arduino UNO

- GPIO 12 (RX) → Arduino Pin 9 (TX)
- GPIO 13 (TX) → Arduino Pin 8 (RX)

Button

- GPIO 4 → Button Pin
- Button GND → GND

Relay Control for Arduino Power

- GPIO 14 → Relay Control Signal
- Base of PN2222A Transistor → GPIO 14 via 1kΩ Resistor
- Base of PN2222A Transistor → GND via 20kΩ Resistor
- Emitter of PN2222A → GND
- Collector of PN2222A → Relay Module IN Pin

Camera Module

The camera module is directly integrated into the ESP32-CAM board.

Arduino UNO Connections

Power

- Vin → ESP32 Relay NC 1
- GND → ESP32 Relay NC 2

TFT Display

- CS → A5
- CD → A3
- RST → A4
- LED → A0
- VCC → 5V
- GND → GND

Servo Motor

- Signal → Pin 7
- VCC → 5V
- GND → GND

Relay

- Control → Pin 6
- VCC → 5V
- GND → GND

Charger

- 5v positive → Relay NC
- GND → GND

Communication with ESP32-CAM

- Pin 8 (RX) → ESP32-CAM GPIO 13 (TX)
- Pin 9 (TX) → ESP32-CAM GPIO 12 (RX)

Communication Protocol

- Baud Rate: 9600
- Data Format: 8N1 (8 data bits, no parity, 1 stop bit)

System Operation Flow

1. **Initial State**
    - ESP32-CAM waits for button press
    - Arduino displays welcome message on TFT
2. **When Button Pressed**
    - ESP32-CAM captures image
    - Processes image through Edge Impulse model
    - Sends classification result to Arduino
3. **Arduino Response**
    - If plastic bottle detected:
        - Servo moves to accept position
        - Activates charging relay
        - Displays charging status
    - If non-plastic item detected:
        - Servo moves to reject position
        - Displays rejection message
4. **Charging Cycle**
    - 15-minute timer starts
    - TFT displays countdown
    - System returns to initial state after completion

Important Notes

1. **Power Supply**
    - Both devices need stable 5V power supply
    - Consider separate power supply for servo if using larger model
2. **Ground Connection**
    - All grounds (GND) should be connected together
    - This ensures proper communication and operation
3. **Serial Communication**
    - Communication is bidirectional
    - ESP32-CAM sends classification results
    - Arduino sends charging status updates
4. **Safety Considerations**
    - Double-check all connections before powering on
    - Ensure proper insulation of all connections
    - Monitor system temperature during operation
5. **Serial Communication Conflict**
    - The ESP32-Cam must boot first before the Arduino to avoid conflict in Serial Communication
    - Relay is added to power the Adrduino so that it won’t boot while ESP32-Cam is booting or else it cause error to the ESP32-Cam

Troubleshooting Tips

1. **If Communication Fails**
    - Verify TX/RX connections are correct
    - Confirm baud rate settings match (9600)
    - Check ground connections
2. **If Servo Doesn’t Respond**
    - Verify 5V power is sufficient
    - Check signal wire connection
    - Confirm servo library is properly initialized
3. **If TFT Display Issues**
    - Verify SPI connections
    - Check power supply voltage
    - Confirm library configuration matches connections
4. **If Camera Doesn’t Work**
    - Check camera module connection
    - Verify ESP32-CAM initialization
    - Confirm proper power supply