Microcontroller Lab Project Report

Smart Tea Maker Machine

Using ESP32, Motors, Pump, Relay and Wi-Fi Control

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Abstract

This project presents a Smart Tea Maker Machine implemented using an ESP32 micro-controller. The system automates the tea preparation process using a DC motor for cup movement, an IR sensor for cup detection, a servo motor for dispensing tea powder, and a relay-controlled 5V water pump for water dispensing. In addition, Wi-Fi based control allows the user to start/stop the system and override the waiting period through a web interface. The project demonstrates practical applications of motor control, sensor interfacing, and IoT-based user interaction.

1. Introduction

Automation is a key aspect of modern embedded systems, particularly for repetitive household tasks. Conventional tea preparation requires continuous supervision and typically lacks flexibility, efficiency, and remote control.

This project presents a **Smart Tea Maker Machine** using an ESP32 microcontroller. The system automates tea preparation by integrating an IR sensor, motors, and a relay-controlled water pump, while also providing Wi-Fi based user interaction through a browser interface. The work demonstrates practical embedded systems and Internet of Things (IoT) concepts through a real-life application.

2. Objectives

- Design an automated tea-making system using a microcontroller

- Move tea cups using a DC motor and L298 motor driver

- Detect cup presence using an IR sensor

- Dispense tea powder using a servo motor

- Dispense water using a 5V pump controlled via relay

- Provide Wi-Fi based control (Machine ON/OFF and CONTINUE override)

3. Components Used

3.1 Hardware

- ESP32 Microcontroller

- L298 Motor Driver

- 6V DC Motor (cup movement)

- Servo Motor (tea powder dispensing)

- IR Sensor Module (cup detection)

- Relay Module

- 5V DC Water Pump

- 3.7V Battery and supporting wiring

3.2 Software

- Arduino IDE

- ESP32 Wi-Fi + WebServer libraries

- Embedded C/C++ programming

- HTML and JavaScript (web interface)

4. System Architecture

The ESP32 works as the main controller. The IR sensor detects cup presence and provides: (i) a signal to the ESP32 to stop the DC motor and trigger servo action, and (ii) a direct trigger to the relay to activate the water pump. Wi-Fi enables the user to start/stop the machine and override the waiting time using a web interface.
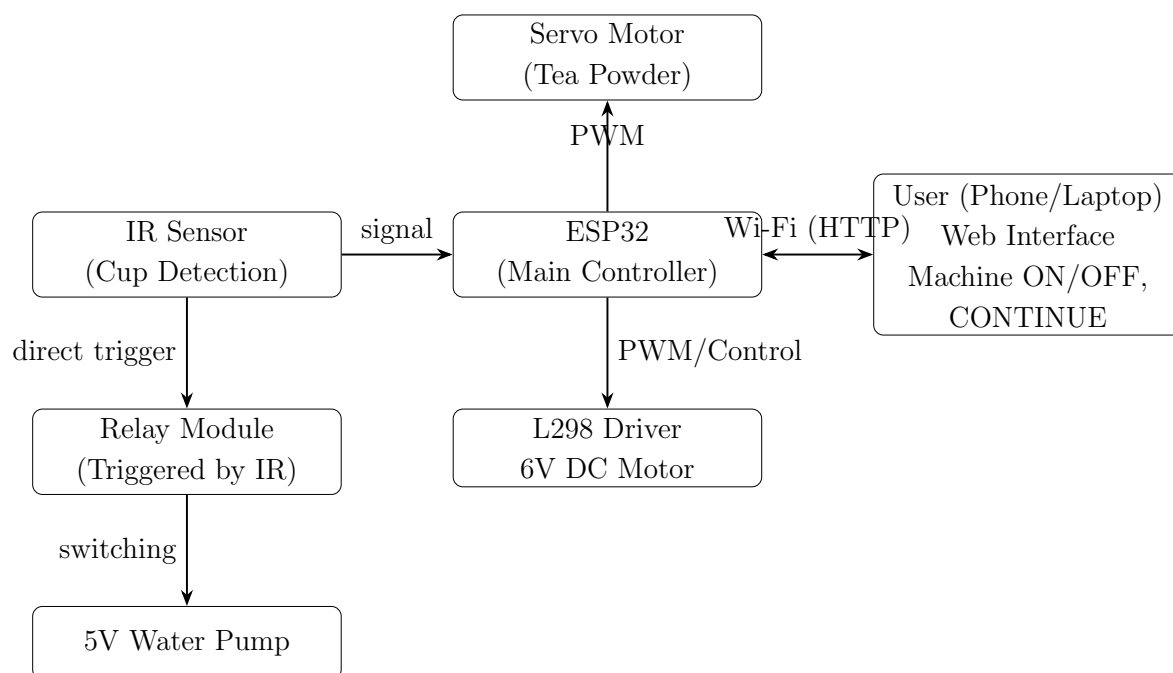
4.1 System Block Diagram

Figure 1: System block diagram including Wi-Fi control and direct relay triggering

5. Working Principle

1. The DC motor runs and moves the tea cup along the path.

2. When the cup reaches the IR sensor, the sensor detects it.

3. The ESP32 stops the DC motor immediately after detection.

4. The servo rotates from $0° \rightarrow 60° \rightarrow 0°$ to dispense tea powder.

5. Simultaneously, the IR sensor directly triggers the relay, turning ON the water pump.

6. The pump runs for 0.5 seconds and then turns OFF.

7. The DC motor restarts and runs for 0.65 seconds to move the cup forward.

8. The system stops for 5 seconds for the next cup placement.

9. The cycle repeats automatically.

10. Using Wi-Fi, the user can stop/start the system anytime and override the 5-second waiting using `CONTINUE`.
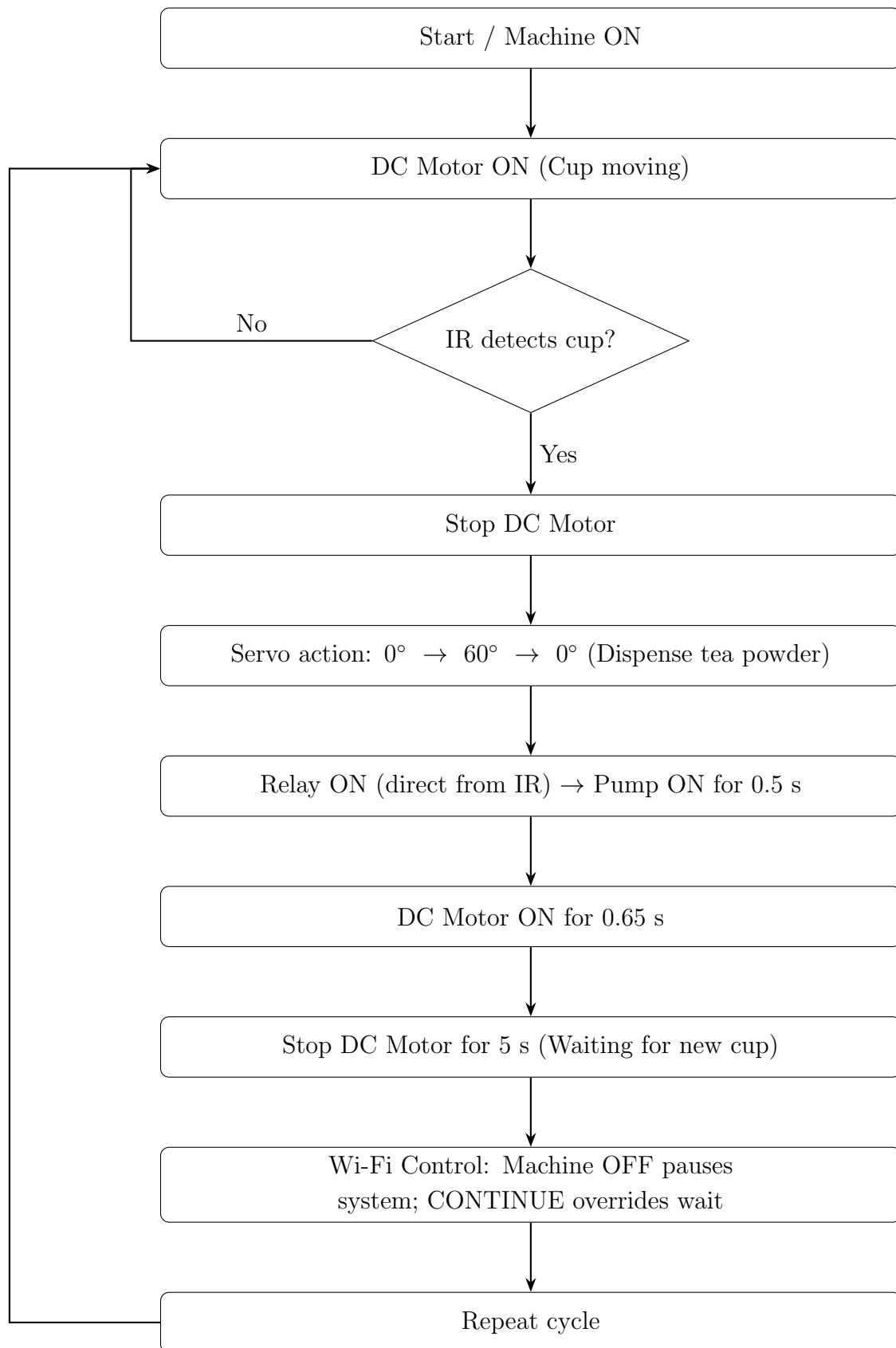
6. System Flowchart

Figure 2: Flowchart of Smart Tea Maker Machine operation with Wi-Fi override

7. Connection Summary

This section summarizes the functional connections used in the prototype. Actual GPIO numbers may vary depending on implementation.

- **IR Sensor OUT** → ESP32 GPIO (for detection logic)

- **IR Sensor OUT** → Relay IN (direct trigger)

- **ESP32 GPIOs** → L298 IN1/IN2 and ENA (DC motor control)

- **ESP32 PWM GPIO** → Servo signal pin

- **Relay COM/NO** → Water pump supply line (switching)

- **Common Ground** shared between ESP32, L298, sensor, and relay (as required)

8. Wi-Fi Control System

The ESP32 operates as a Wi-Fi access point and hosts a simple web interface. Users can control the system using a browser.

- **Machine ON / Machine OFF:** Starts or stops the complete tea-making cycle

- **CONTINUE:** Overrides the 5-second waiting period when the motor is stopped

9. Advantages

- Fully automated tea preparation cycle

- Reduces manual effort and supervision

- Provides user flexibility through Wi-Fi control

- Safe pump operation using relay isolation

- Low-cost and extendable design

10. Limitations

- No temperature sensing or boiling control is implemented

- Water level detection is not included

- Performance depends on stable power supply and wiring quality

11. Future Improvements

- Add temperature sensor and feedback-based control

- Add water level sensor for safety and automation

- Improve the web interface with real-time status display

- Add multiple tea modes (e.g., strong/light) and logging features

12. Conclusion

This project demonstrates a practical embedded systems and IoT solution by automating tea preparation using an ESP32, IR sensor, DC motor, servo motor, and a relay-controlled water pump, with Wi-Fi based control for user interaction. The system reduces manual supervision and provides flexibility through remote start/stop and wait-time override, fulfilling the objectives of the Microcontroller Lab.

13. References

1. ESP32 Technical Reference Manual

2. Arduino ESP32 Documentation

3. L298 Motor Driver Datasheet

4. Relay Module Datasheet