جامعة الإسكندرية
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ESP32

Path Following Robot

User's Manual

• User's Manual

This manual Contains

• User's Manual

1. Introduction

This user manual provides detailed instructions for operating the **ESP32 Path Following Robot**. The robot features:

- **Line-following** capabilities using PID control.
- **Web-based control** via WiFi (Auto and Manual modes).
- **Real-time status tracking** (speed, PID values, history logs).
- **90-degree turn detection** for complex paths.
- **Adjustable speed and PID parameters**.

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2. System Overview

Hardware Components

- **ESP32 Microcontroller** (WiFi-enabled).
- **5x IR Sensors** (for line detection).
- **L298N Motor Driver** (controls two DC motors).
- **Buzzer** (audio feedback).
- **Push Button** (start/stop control).
- **LED Indicator** (status feedback).

Software Features

- **Web Server** (hosted on ESP32).
- **PID Control Algorithm** (for smooth line following).
- **Real-time Data Logging** (tracks run history).
- **Responsive Web Interface** (works on mobile/desktop).

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3. Setup Instructions

Step 1: Power On the Robot

- Connect the robot to a **5V power source** (ESP32 via Vin/ USB).
- Connect the robot to a **12V power source** (Motor Driver).
- Wait for the **WiFi AP** (Sonic) to appear.

Step 2: Connect to the Robot's WiFi

1. Open WiFi settings on your device.
2. Connect to **Sonic** (no password required).
3. Note the **IP address** (typically 192.168.4.1).

Step 3: Access the Web Interface

1. Open a browser (Chrome, Firefox, Edge).
2. Enter **http://192.168.4.1** in the address bar.
3. The **Control Panel** will load automatically.

4. Web Interface Guide

Auto Mode (Default)

Features:

- **Start/Stop Button**
  - ▶ **Start**: Begins line-following.
  - ■ **Stop**: Halts the robot.
- **Timer**
  - Displays elapsed time (mm:ss.ms).
- **Status Panel**
  - Shows **Ready**, **Running**, or **Finished**.
- **History Table**
  - Logs past runs (time, trigger mode, status).
- **Settings (⚙)**
  - Adjust **speed**, **PID values**, and **turn delay**.

How to Use:

1. Place the robot on a **black line track**.
2. Click ▶ **START** to begin autonomous navigation.
3. The robot stops automatically at the finish line or when interrupted.

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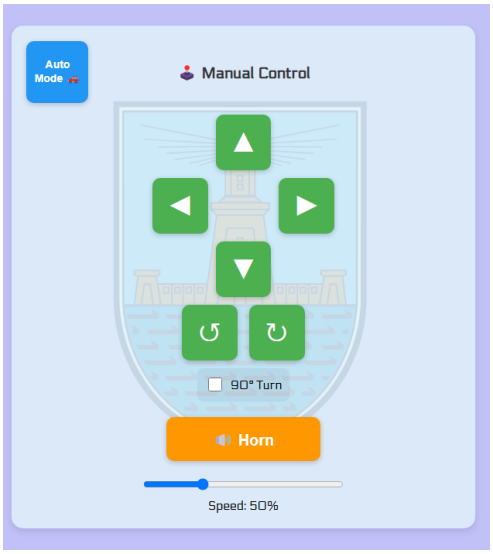


Manual Mode

Features:

- **Directional Controls**
  - ▲▼◄► for **forward**, **backward**, **left**, **right**.
  - ↻↺ for **clockwise/counter-clockwise rotation**.
- **90° Turn Toggle**
  - Enable/disable precise 90-degree turns.
- **Horn Button**
  - 🔊 Activates the buzzer while pressed.
- **Speed Slider**
  - Adjust motor speed (30%-100%).

How to Use:

1. Click 🕹️ **Manual Mode** in Auto Mode.
2. Use **buttons** or **arrow keys** (↑↓←→) to control movement.
3. Toggle **90° Turn** for sharp turns.
4. Press 🔊 **Horn** for audio feedback.

5. PID Tuning Guide

What is PID?

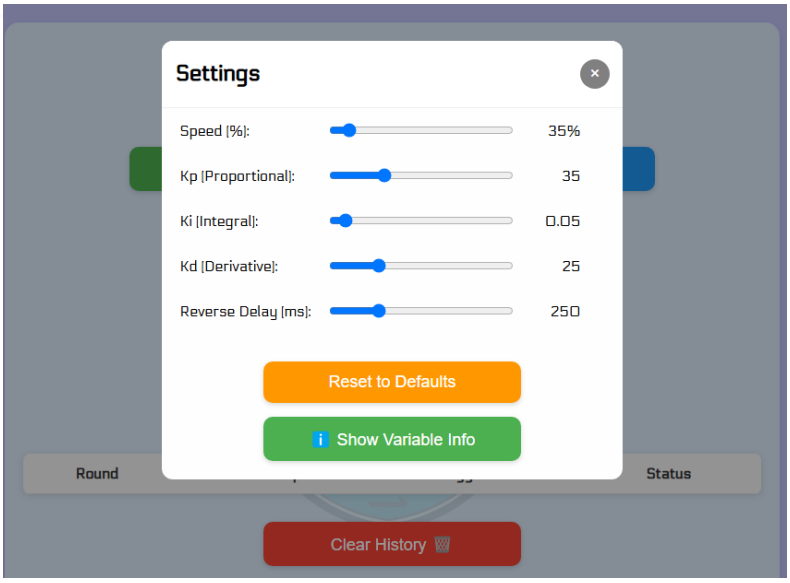
- **Proportional (Kp)**: Reacts to current error (higher = sharper turns).
- **Integral (Ki)**: Corrects accumulated error (higher = reduces drift).
- **Derivative (Kd)**: Dampens oscillations (higher = smoother motion).

Recommended Settings

Parameter	Default	Range	Effect
Kp	45	10–100	Increase for faster corrections.
Ki	0.05	0–1	Reduce if robot wobbles.
Kd	45	0–100	Increase for smoother motion.

How to Adjust:

1. Open **Settings** (⚙).
2. Drag sliders for **Kp**, **Ki**, **Kd**.
3. Click **Reset to Defaults** if needed.



6. Troubleshooting

Issue	Solution
Robot doesn't move	Check power, motor connections, and WiFi.
Poor line tracking	Adjust PID values or clean IR sensors.
Web interface not loading	Reconnect to Sonic WiFi.
Robot overshoots turns	Reduce **Kp** or increase **Kd**.

7. Safety Precautions

- Avoid **wet or uneven surfaces**.
- Keep fingers away from **moving parts**.
- Disconnect power before **maintenance**.
- Do not expose to **extreme temperatures**.

8. Maintenance

- **Clean IR sensors** regularly with a soft cloth.
- **Check battery levels** for consistent performance.
- **Inspect wheels** for debris or wear.

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9. FAQs

Q: Can I use this robot outdoors?
A: No, it's designed for **indoor use** on flat surfaces.

Q: How do I reset the robot?
A: Press the **physical button** or use the **web interface's stop button**.

Q: Why is the robot not detecting lines?
A: Ensure the track has **high contrast** (black line on white surface).

Q: Can I change the WiFi name?
A: Yes, modify the code
(WiFi.softAP("Sonic") in Control_Project_Final_Code_Less.ino).

Enjoy your ESP32 Path Following Robot! 🚀