Analog Line Follower Robot

User Manual

EN2091: Laboratory Practice and Projects

Team Neural Nexus

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1. User Input Controls

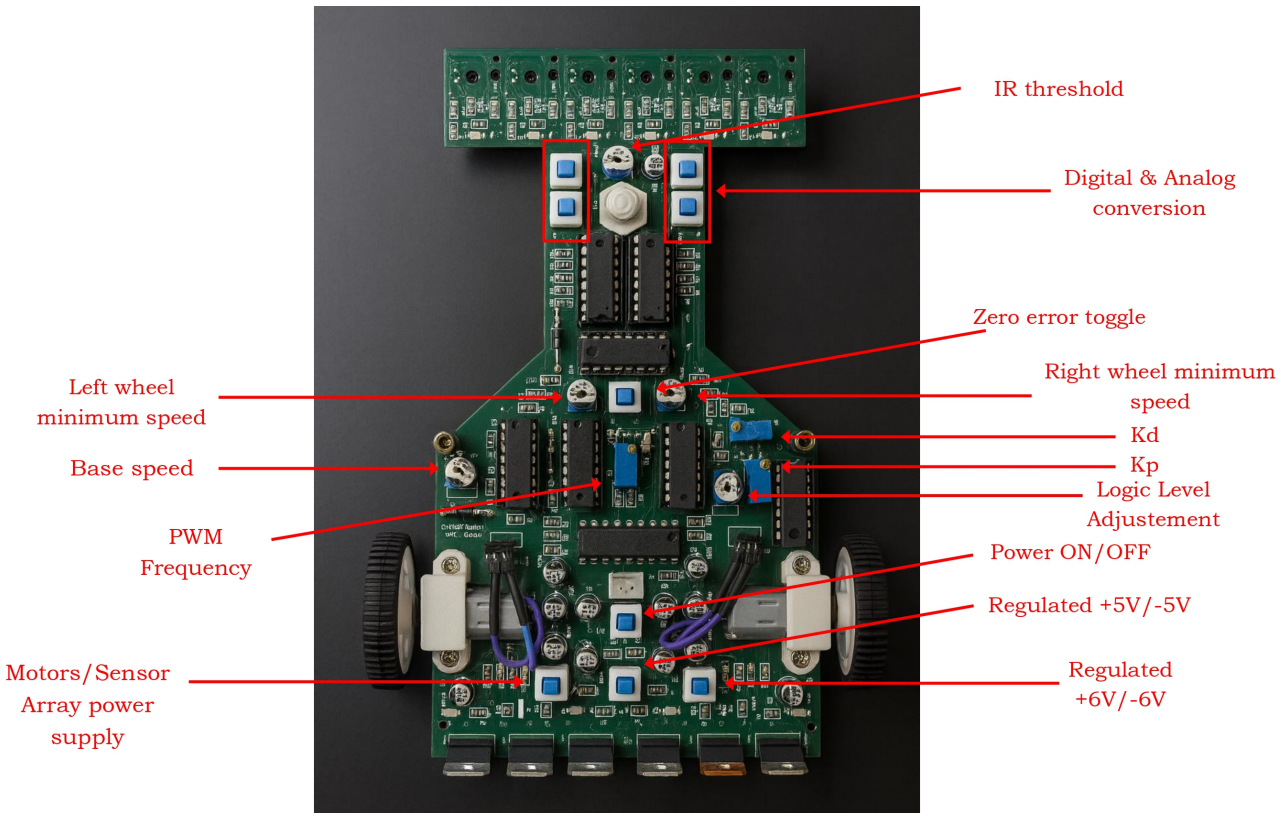

Figure 1: User Input Controls

- **Digital/Analog IR Output (Switches):**
  - This block contains four switches, each corresponding to a pair of TCRT5000 IR sensors in the front sensor array. Each switch selects whether its sensor pair outputs the raw analog voltage directly to the controller, or a processed digital signal obtained by comparing the analog value to the IR threshold setting. Analog mode provides continuous reflectance information, while digital mode outputs a binary indication of line presence based on the configured threshold.
- **IR Threshold (Potentiometer):**
  - Defines the reference voltage used when the sensor array operates in digital mode. Each sensor's analog output is compared against this threshold to determine whether the surface is reflective or non-reflective. This setting also drives the indicator LEDs, providing a visual sense of sensor activation relative to the chosen threshold.
- **Zero Error Switch (Switch):**
  - Temporarily forces the controller to ignore the IR sensor readings and assume a tracking error of zero. This is mainly used during base-speed tuning so the motors can run at the desired reference speed without correction from the line-following control loop.

- **Base Speed (Potentiometer):**
  - Sets the nominal forward speed of the line-follower robot.
- **Right Wheel Minimum Speed (Potentiometer):**
  - Defines the minimum PWM or motor speed required for the right wheel to overcome stall torque and rotate reliably.
- **Left Wheel Minimum Speed (Potentiometer):**
  - Defines the corresponding minimum speed for the left wheel to maintain symmetry and prevent drift.
- K_p **Adjustment (Potentiometer):**
  - Controls the proportional gain of the PD controller, determining the primary correction strength applied based on tracking error.
- K_d **Adjustment (Potentiometer):**
  - Controls the derivative gain of the PD controller, improving responsiveness to rapid changes in tracking error and reducing overshoot.
- **PWM Frequency (Potentiometer):**
  - Sets the switching frequency of the generated PWM signal. Higher frequencies typically result in smoother and quieter motor operation.
- **Logic-Level Adjustment (Potentiometer):**
  - Adjusts the reference logic level used by the motor driver to ensure that signals from the analog/digital circuitry meet the driver's required voltage thresholds for reliable operation.
- **Power ON/OFF (Switch):**
  - Enables or disables the main system power supply.
- **Regulated +5 V / –5 V Supply (Switch):**
  - Turns the ±5 V regulated supply for op-amps on or off. (Included primarily for debugging.)
- **Regulated +6 V / –6 V Supply (Switch):**
  - Turns the ±6 V regulated supply for op-amps on or off. (Included primarily for debugging.)
- **Motor / Sensor Array Power Supply (Switch):**
  - Enables or disables power to the motors and front sensor array. (Included primarily for debugging.)

2. Battery Pack (4 × LiPo Cells)

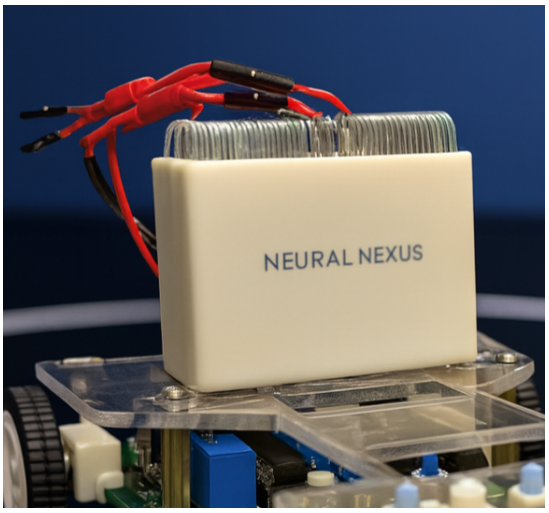

Figure 2: Battery Holder

- The robot uses four individual 3.7V LiPo cells powering motors, sensors, and regulated analog rails.
- **Charging:** Remove all batteries from the holder. Charge individually using a LiPo balance charger (4.20V max).
- **Operation Time:** Approximately **1 hour** of continuous use.
- **Usage Precautions:**
  - Do not discharge below 3.2V per cell.
  - Stop using if swollen or overheated.
  - Avoid short circuits.
  - Store at 3.8V per cell (storage mode).

3. General Safety Precautions

- Do not touch the robot while running.
- Keep fingers away from wheels and moving parts.
- Operate on a clean, flat surface.
- Do not place the robot near edges.
- Switch off power before making adjustments.
- Avoid short circuits.
- Keep away from moisture.
- Use only recommended batteries and chargers.
- Do not leave unattended while powered on.
- Allow electronics to cool after long use.

4. Advised Age Range

- Recommended for users aged **12 years and above**.
- Adult supervision suggested for younger users.
- Users should know basic electronics and LiPo safety.