Microcontroller ESP32

by Ruben Mercade Prieto

[Weather Station] [PI Controller]

PI Control - Photoresistor + LED

by Ruben Mercade Prieto - June 2021

Watch explanation Video.

This is an example of a PI control using a photoresistor as a sensor and LED(s) as the controller. You can choose between a Red, Green or Blue LED, or a combination thereof. Obviously, the more LED selected, the more light - which may be a problem to control low light conditions. The ESP32 is currently used in several commercial industrial control solutions, e.g.: [1], [2], [3].

The minimum value of the photoresistor is measured from the enviromental conditions at the startup of the ESP32; the maximum value is found similarly with all the 3 LEDs at maximum power.

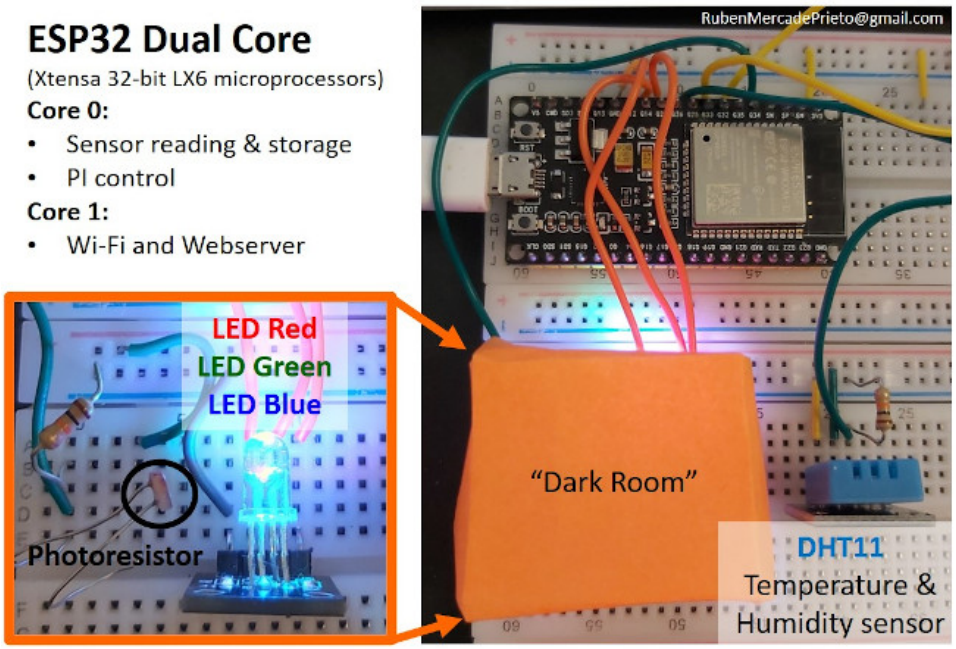
Let us revisit the key equation in a PI control. $Led(t)$ is the controlled variable, an 8bit PWM signal from the ESP32, and Led_{bias} is the initial value, often zero. P_{SP} and P_{PV} are the set point and process variable, respectively, which in this case corresponds to the 12bit (0-4096) value from the photoresistor. Their difference is the key error to calculate, $e(t)$. The tunable parameters are K_P, the proportional constant, and τ_I, the integral time constant

$$Led(t) = Led_{bias} + K_P(P_{SP} - P_{PV}) + \frac{K_P}{\tau_I}\int_0^t (P_{SP} - P_{PV})dt$$

$$= Led_{bias} + K_P e(t) + \frac{K_P}{\tau_I}\int_0^t e(t)dt$$

$$Led(t) \approx Led_{bias} + K_P e(t) + \frac{K_P}{\tau_I}\sum_{i=1}^{n_t} e_i(t)\Delta t$$

where in this ESP32 example, it has been selected $\Delta t = 0.5s$.



Photoresistor target value P_{SP} (1378-4139): **1988.00**

K_P value (0.005-0.1): **0.015**

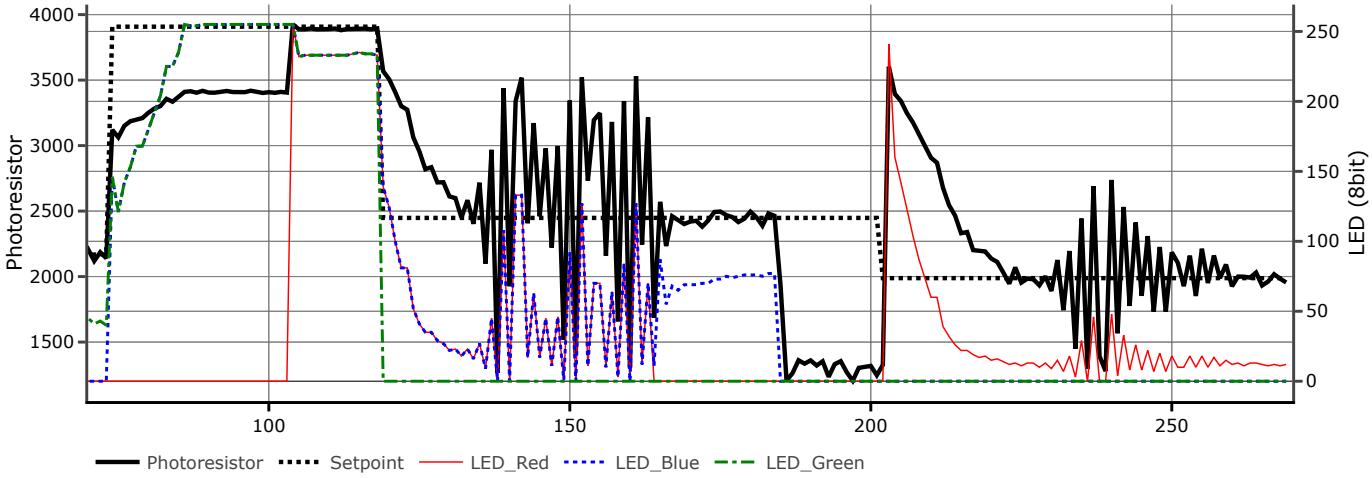
τ_I value (0.1-5): **0.80**

Actuator(s): ☑ LED Red ☐ LED Green ☐ LED Blue

Activate PI control

Existing control paremeters in the ESP32 are refreshed in this form every 15 s.

Send information to ESP32



The code files, explanations, and references used in this project are given in my GitHub repository at https://github.com/RubenMercadePrieto/ESP32_PIControl_DHT11