Microprocesadores

Engineering faculty

ESP32 ADC Single-Shot Moisture Sensor Calibration

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Practice Report

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1 Setup & Calibration

- **Hardware:** Soil-moisture sensor → analog output → ESP32 ADC1_CH5 (12 dB attenuation).
- **Acquisition:** Single-shot ADC with **factory/eFuse calibration** enabled to convert raw counts into millivolts (mV).
- **Procedure:**
  1. Collected readings across increasing water additions (spoonful steps).
  2. Converted ADC raw values to mV using ESP-IDF calibration.
  3. Computed relative humidity (%) from the best-fit exponential model:

$$RH(\%) = 3.0504\, e^{0.0012\, V_{\mathrm{mV}}}$$

  4. (Optional) Clamped RH into 0–100 % for reporting.

2 Calibration Curve

```
I (3587307) EXAMPLE: ADC2 Channel[0] Raw Data: 0
I (3587307) EXAMPLE: ADC2 Channel[0] Cali Voltage: 128 mV
I (3588307) EXAMPLE: ADC1 Channel[4] Raw Data: 0
I (3588307) EXAMPLE: ADC1 Channel[4] Cali Voltage: 142 mV
I (3589307) EXAMPLE: ADC1 Channel[5] Raw Data: 551
I (3589307) EXAMPLE: ADC1 Channel[5] Cali Voltage: 603 mV
I (3590307) EXAMPLE: ADC2 Channel[0] Raw Data: 0
I (3590307) EXAMPLE: ADC2 Channel[0] Cali Voltage: 128 mV
I (3591307) EXAMPLE: ADC1 Channel[4] Raw Data: 0
I (3591307) EXAMPLE: ADC1 Channel[4] Cali Voltage: 142 mV
I (3592307) EXAMPLE: ADC1 Channel[5] Raw Data: 557
I (3592307) EXAMPLE: ADC1 Channel[5] Cali Voltage: 608 mVS
I (3593307) EXAMPLE: ADC2 Channel[0] Raw Data: 0
I (3593307) EXAMPLE: ADC2 Channel[0] Cali Voltage: 128 mV
```

Figure 1: execution log

Figure 2 shows the exponential calibration curve with labeled axes, legend, and a reference point at 3000 mV.

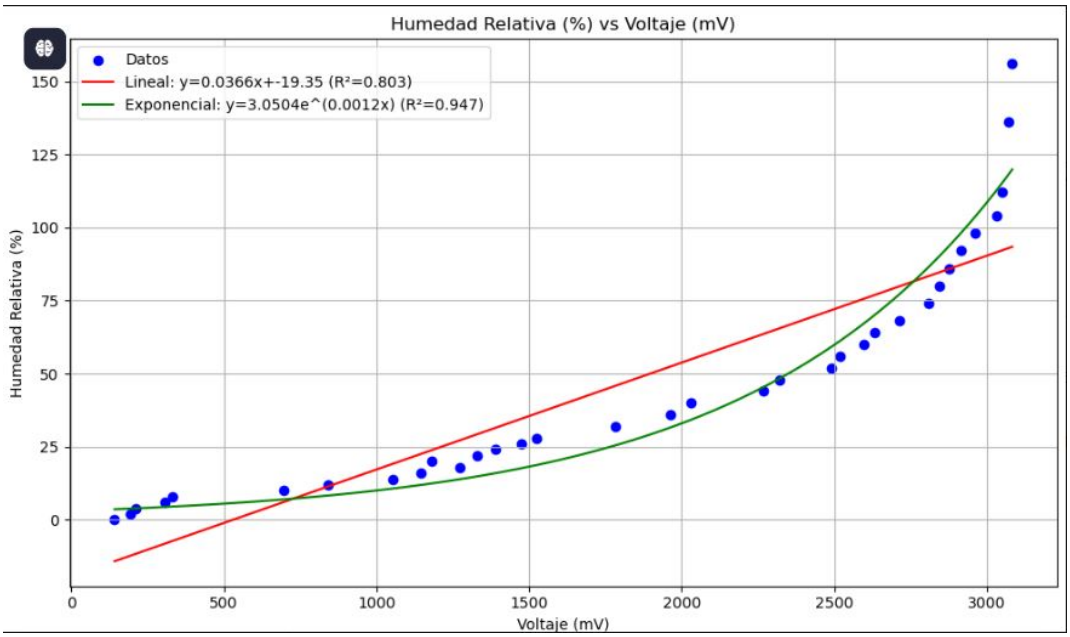

Figure 2: Calibration curve of Relative Humidity (%) vs Voltage (mV).

3 Sensor Behavior Discussion

- **Form:** The response is exponential, not linear—consistent with moisture sensors where conductivity increases nonlinearly with water content.
- **Goodness of fit:** Exponential fit ($R^2 \approx 0.947$) clearly outperforms the linear fit ($R^2 \approx 0.803$) from the original regression.
- **Implications:**
  - Low-voltage region shows gentle slope (coarse sensitivity).
  - Mid–high voltages show rapid RH increase (higher sensitivity), saturating near maximum moisture levels; results may be clamped to 100 %.
  - For control/monitoring, prefer the exponential model for converting mV to RH, and average multiple samples (e.g., median of 5–10 reads) to reduce noise.