FABRICATION OF A WIRELESS TEMPERATURE MONITORING SYSTEM FOR ART CONSERVATION

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Introduction

A variety of factors can cause damage to artwork, one of which is temperature. Inadequate temperatures can cause cracks, chipping, and color distortion.

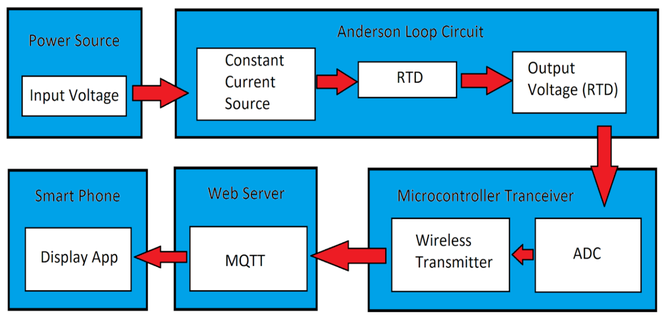
In this work, we present the design and fabrication of a RTD wireless temperature detecting system to monitor temperature in museums

71.124 The Walters Art Museum, Baltimore, Maryland, French, 14th c., Ivory Diptych with Crucifixion and Flagellation.

Objective

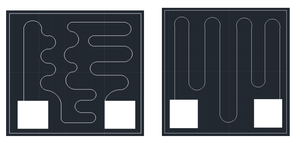
Design and fabricate an efficient wireless resistance temperature detector (RTD) network to monitor temperature in art museums

System Block Diagram

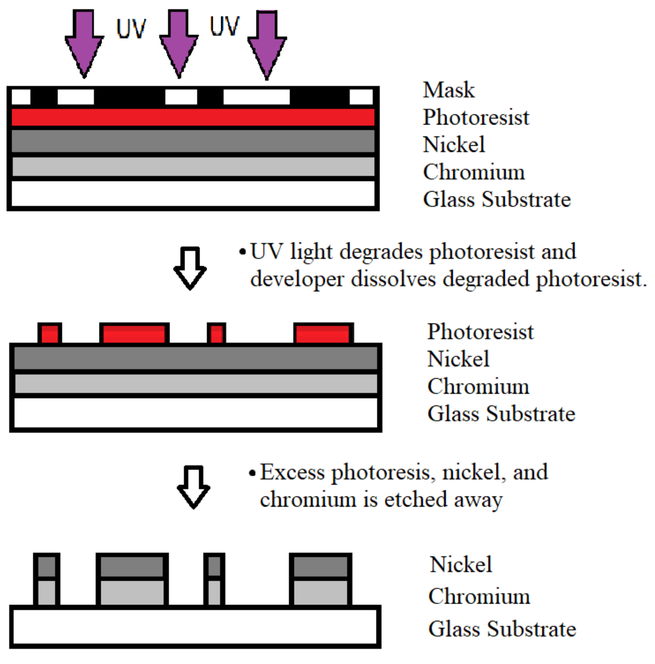


RTD Design

- **Parameters**:
  - Wire thickness = 200 nm
  - Minimum line width = 300 µm
  - Space between lines = 400 µm
  - Pattern Dimensions = 5 x 5 mm
- **Sample Designs:**

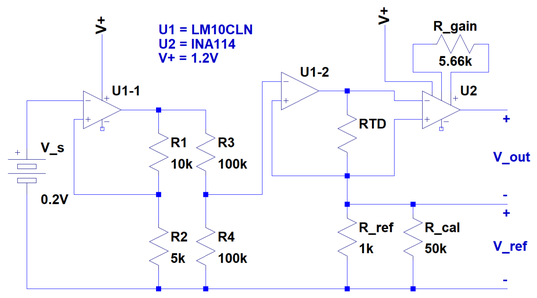


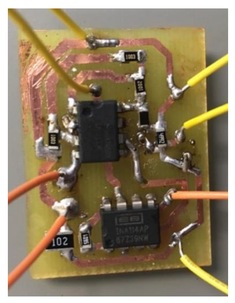
RTD Fabrication (Photolithography)



Anderson Loop Signal Conditioning[1]

- Provides a constant current to the RTD.
- Neglects bias voltage allowing for higher ADC resolution.
- Op-Amps induces voltage gain increasing voltage sensitivity.





RTD Characterization

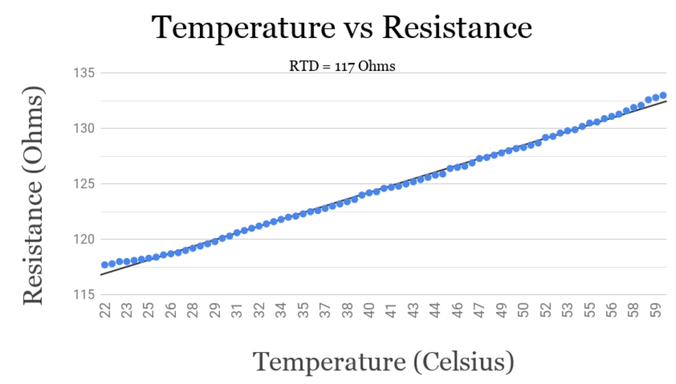
- With a linear relationship between temperature and resistance of the RTD, we can develop a linear equation of the behavior.

Water Bath Testing

- Liquid electrical tape coats sensor allowing submersion in water.
- Measured resistance across RTD with temperature increasing at 0.5°C increments.

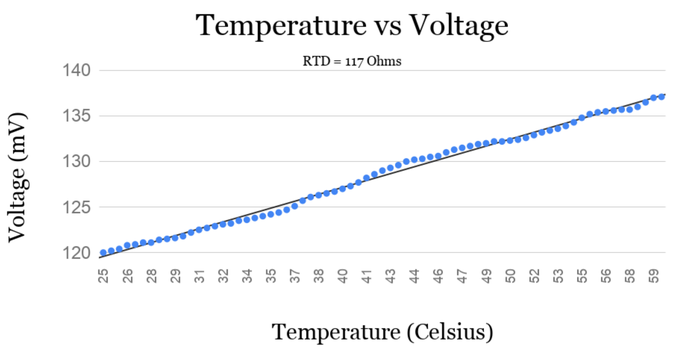
Results

- R = 0.203T + 117
  - R = Resistance
  - T = Temperature
- R^2 = 0.997
  - Close to perfect linear relationship

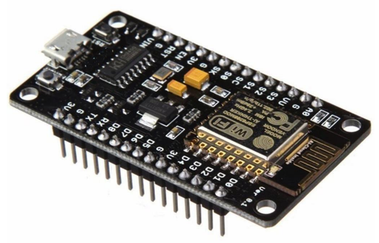


RTD with Anderson Loop Characterization

- V = 0.252T + 120
  - V = Voltage
  - T = Temperature
- R^2 = 0.994



ESP8266 Arduino Microcontroller[2]

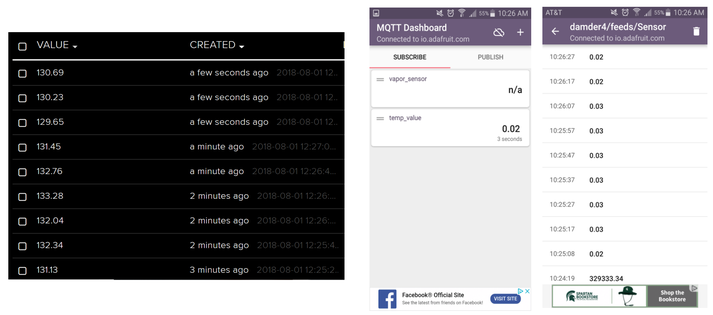


Features:

- 10-bit ADC
- Low-power modes
- Built in Wi-Fi
- Low-cost
- ±3 mV accuracy
- Ability to designate ID number to each sensor node.
- Connects to MQTT web-server
- Successfully transmitted relevant data to web-server.
- Ability to map temperature using linear function.

MQTT Web-Server and App

- Save data for up to 30 days and have 10 different feeds.
- Connect smartphone to web-server to read values through downloadable application
- View real-time data readings.



Next Steps

- Increase our output voltage from our Anderson Loop to increase our measurement precision.
- Testing battery lifespan in sensor
- Implement power saving modes
- Test sensor in a museum setting over long period of time.
- Integrate different sensor types

References

[1] NASA's "High Accuracy Temperature Measurements Using RTD's With Current Loop Conditioning"

[2] ESP8266 Datasheet

Acknowledgements

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