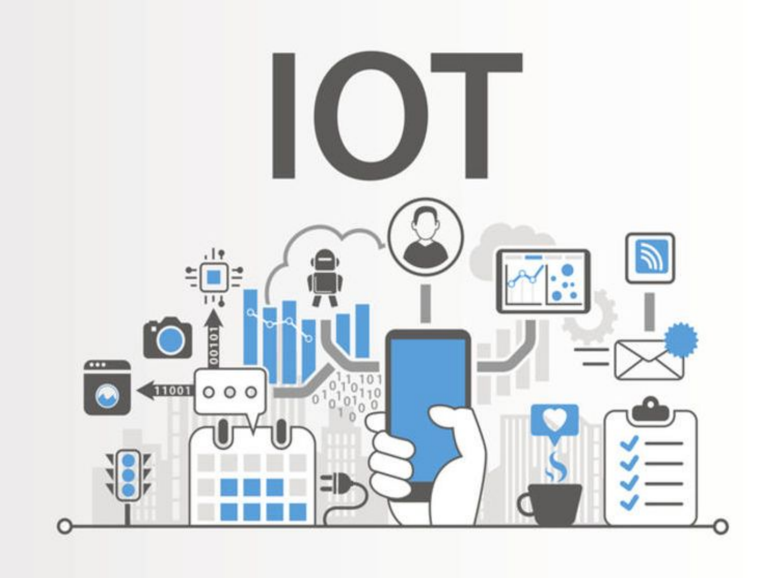

Small-Form-Factor Solar-Powered Self-Sustainable IoT Sensor with long-Range Wireless Communication

sdmay20-07

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Advisor/Client: Dr. Cheng Huang and Dr. Meng Lu

Problem Statement

Our project is Small-Form-Factor Solar-Powered Self-Sustainable IoT Sensors with Long-Range (LoRa) wireless communication. The device needs to measure light and temperature in a specified environment. Using the LoRa wireless communication module, we must transmit data to a separate LoRa module that acts as a gateway to an online source. After that, this data can be monitored by the users from a web browser or a smartphone app. The system is fully self- sustainable using solar energy and power optimization.

Purpose

The purpose of this project is to create a prototype for our client that can detect light emitted from organisms (bacteria) and measure the temperature from the environment around it. The use of the device will be purely for research purposes.

Concept Sketch

- The PCB Housing holds main PCB with the LoRa module and circuitry for power and sensors.
- The Sensor Housing holds the sensor PCB with the light sensors and temperature sensor. It is connected to the main PCB via ribbon cable.

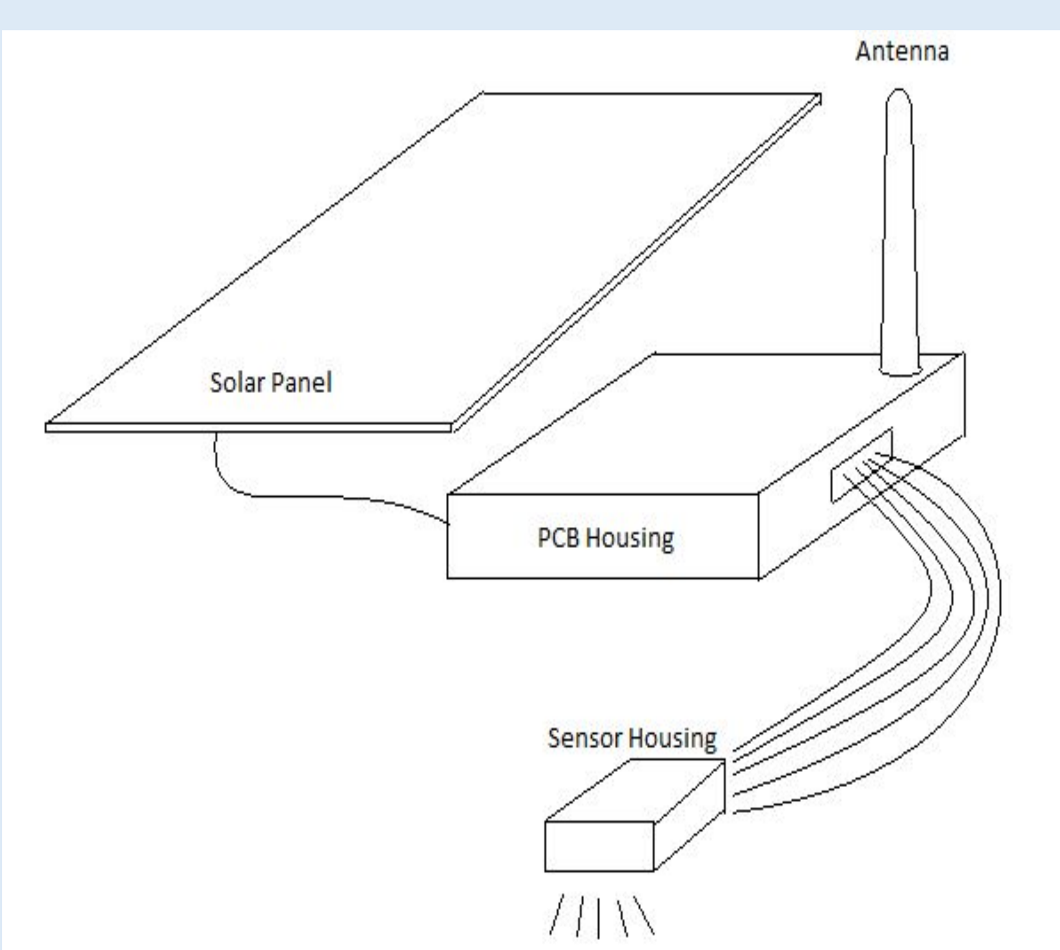

Figure 1.Conceptual Sketch

The original idea was for the device to be placed in an open field. In this case, the device would have to be able to operate in outdoor climates, most likely in Iowa. It would have to be waterproof and be able to withstand temperature ranges of 10-90 F. However, since our project will be a prototype it is being built to be used in a lab.

Functional Requirements

- Gather correct information from all sensors
- Use sensors that are sensitive enough to pick up small amounts of light
- Send data wirelessly over a long range
- Entire product must be self-sustainable (solar power)
- Power consumption must be very low

Non-Functional Requirements

- Pocket sized
- Left out in field for long time
- Waterproof/withstand general weather

Technical Details

- TMP36 Temperature Sensor
  - Low voltage
  - −40°C to +125°C temperature range
- TSL2591 Light Sensor
  - High luminosity range
  - High sensitivity/gain
- HC-12 LoRa module
  - Long range
  - Low power consumption
- Arduino Mini
  - Tiny size
  - Low power consumption
- Power management Chip
  - MCP73831
  - MCP1700

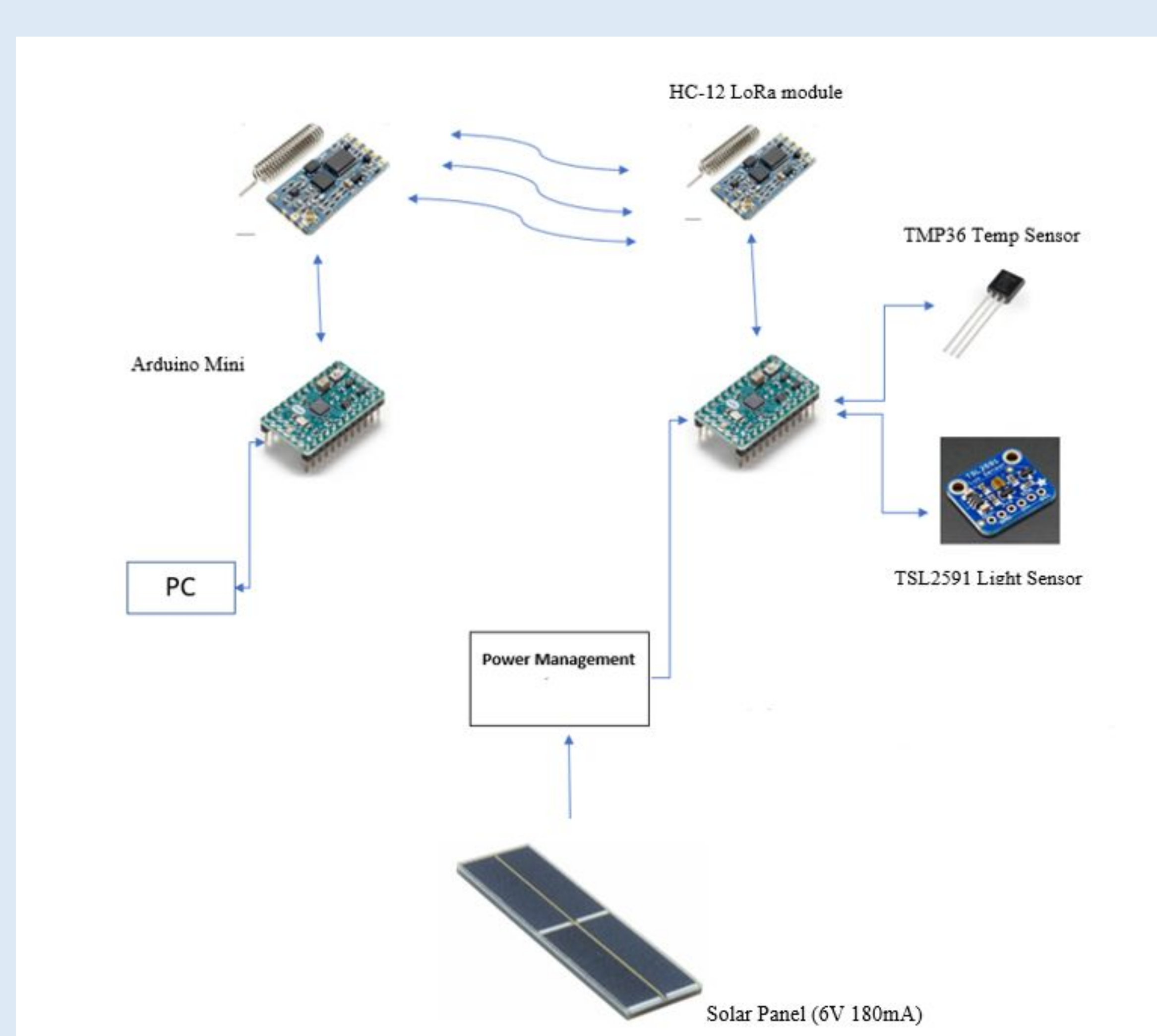

Figure 2 Design Diagram

Engineering Standards

- Readable and concise code
- Clean circuit design
- IEEE Code of Ethics
- IEEE 1680-2009

Schematic View

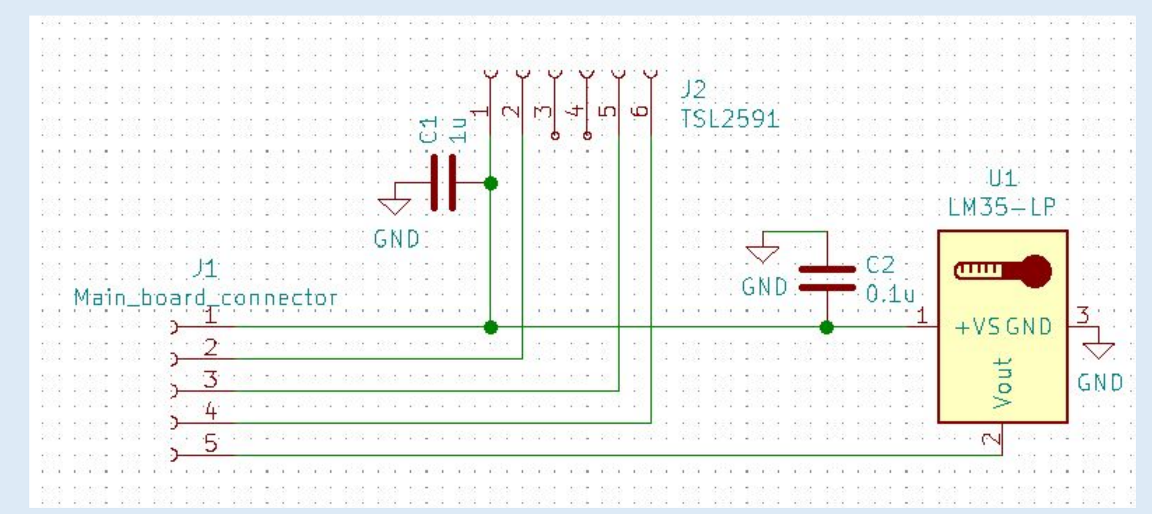

Figure 3 *Schematic view of sensor board*

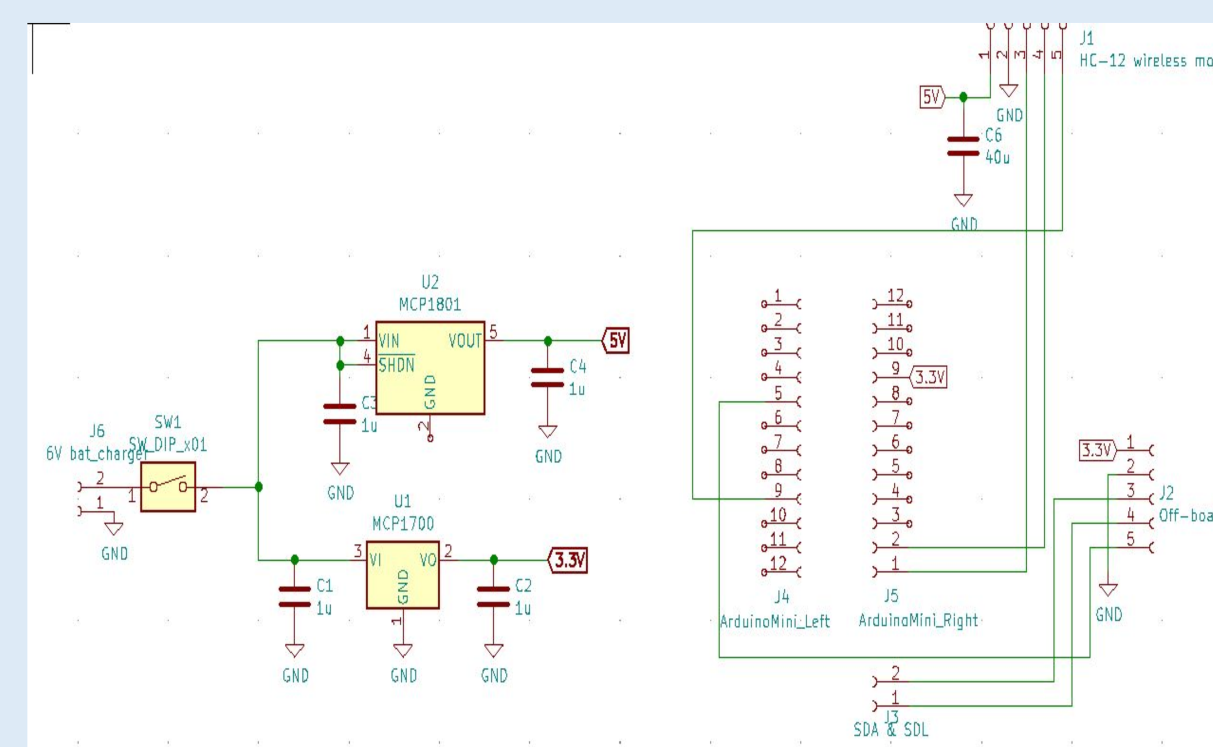

Figure 4. Schematic view of main board

Testing Strategy

- Component testing
  - Sensor testing
    - Arduino Coding
    - Analyze output reading
  - LoRa testing
    - Coding for transmitter and receiver
    - Basic communication testing
    - Range testing
- System testing
  - Integrate sensors on the transmitter.
  - Test the functionality of transmitter and receiver in lab
  - Test the system in open field

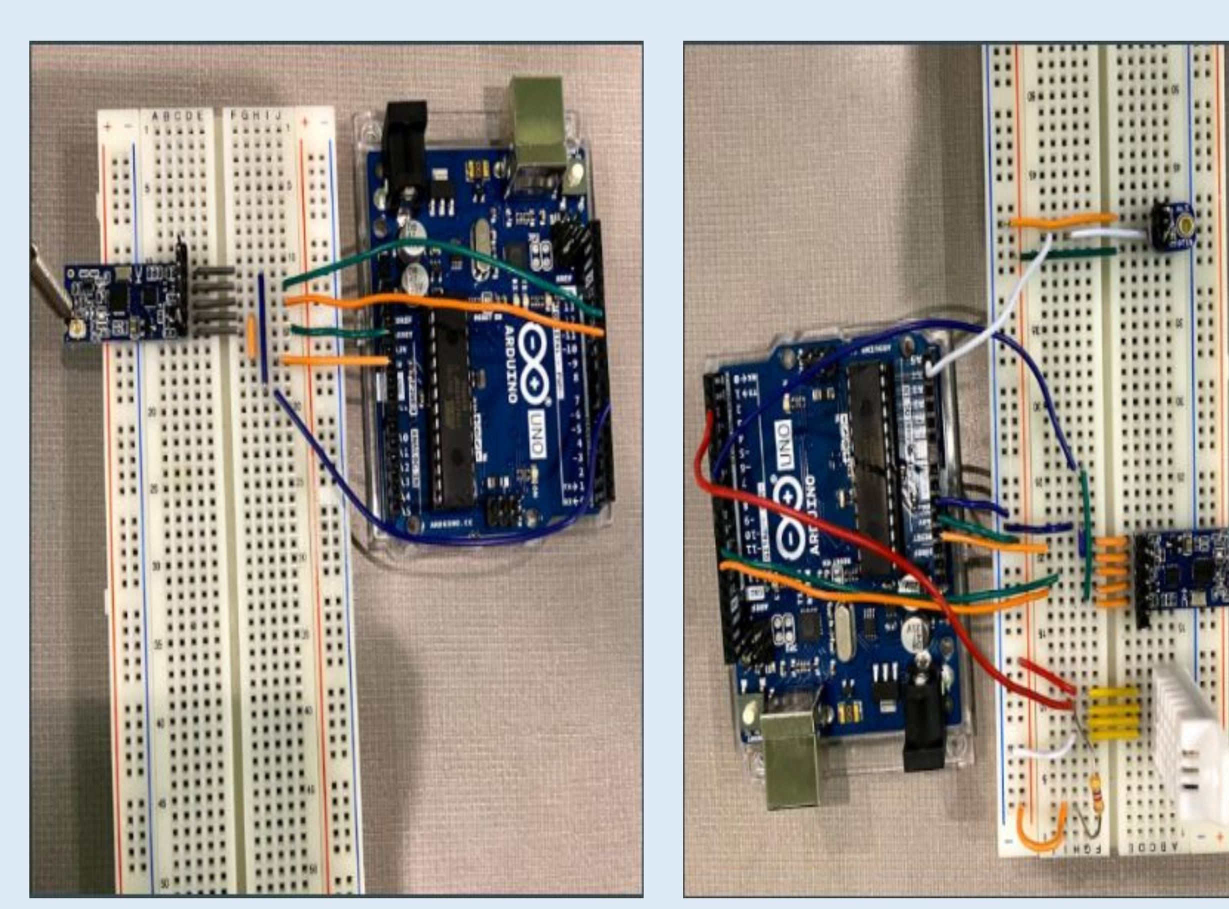

Figure 5 Protype of Receiver (Left) and Transmitter (Right).

Testing Environment

We did the indoor test in Coover Hall 2048, which is under room standard temperature. The outdoor testing was in November 2019 in Ames, since we want to test our device is fully functional in Winter.