Small-Form-Factor Solar-Powered Self-Sustainable IoT Sensors with Long-Range Wireless Communication

DESIGN DOCUMENT

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Revised: Version 1

Executive Summary

Development Standards & Practices Used

- Concise & commented code
- Well-Documented & Labelled circuit boards
- Clean PCB layout

Summary of Requirements

- Sensors will be programed to work with MCU and achieve measurement in a very low frequency
- Long-range wireless communication module will be programed to work with MCU and can transmit data 1 mile away
- Fully sustainable
- Lower power consumption

Applicable Courses from Iowa State University Curriculum

- EE 330 Integrated electronics
- EE 321 Communication system
- TBD

New Skills/Knowledge acquired that was not taught in courses

- TBD

Table of Contents

List of figures/tables/symbols/definitions (This should be the similar to the project plan)

1 Introduction

1.1 Acknowledgement

We would like to thank Dr. Lu and Dr. Huang for helping us in this project. They gave us a very detailed guide for the whole design process and provided helpful suggestions.

1.2 Problem and Project Statement

Our project is Small-Form-Factor Solar-Powered Self-Sustainable IoT Sensors with Long-Range(LoRa) Wireless Communication. This project needs us to detect the light, humidity and temperature in an open field. Then, using long-range wireless communication module to transmit data to a LoRa gateway(approximately 1 mile away). After that, these data can be monitored by the users from web browser or smart phone apps. The overall system is fully self-sustainable using solar power energy and with power optimization.

This project will help people to detect

1.3Operational Environment

This project will be using in an open field, so it should be waterproof and can work under temperature ranges from 10~90 F.

1.4Requirements

- The sensors can collect data correctly
- The data can be transmitted through internet
- The entire system needs to be fully self-sustainable
- The power consumption needs to be very low
- The end product needs to be waterproof
- The end product needs to work under cold and hot temperature

1.5Intended Users and Uses

Our intended user should be farmer or scientists who plans to track the environmental data of an open field.

1.6Assumptions and Limitations

Assumptions

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Limitations

- The end product should be pocket size
- Lower power consumption

1.7 Expected End Product and Deliverables

At the end of this semester, we will produce a prototype that comprised with all the sensors and LoRa wireless communication module. We will then evaluate the power consumption of our device.

In the second semester, we will be working on the power optimization of the entire system and try to find a low-power MCU other than Arduinoi.

At the end, prototyping hardware with all the sensors, LoRa wireless module and power management circuits in the PCB level. The final product will be in pocket size , with fully self-sustainable by solar energy and can work under specific weather conditions.

2. Specifications and Analysis

2.1 Proposed Design

So far, we have researched several sensors and LoRa module that meet our requirements and we ordered them. We will then test each of them when delivered. We decided to divide into small groups, so each group will do their own tests.

2.2 Design Analysis

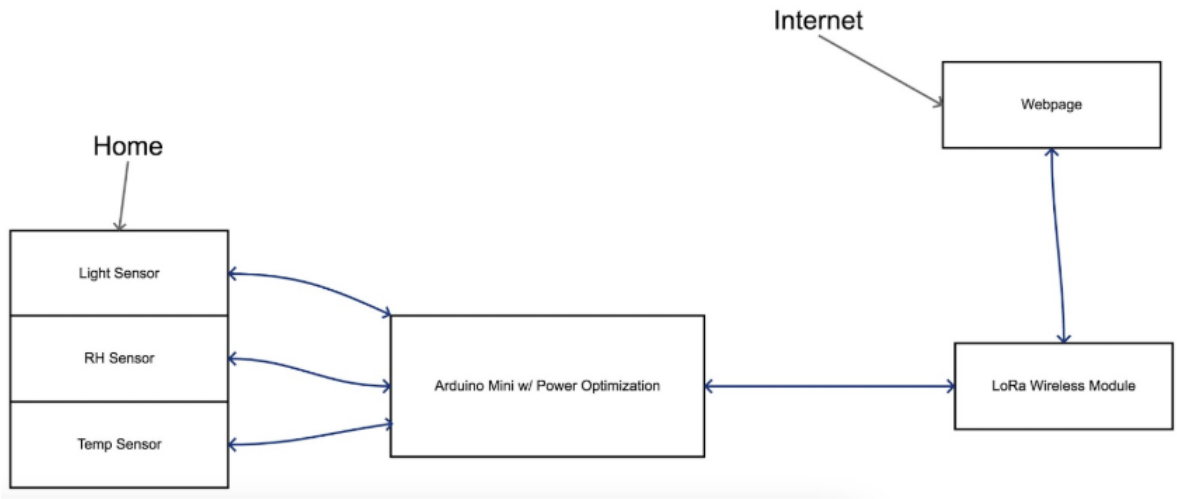
Our group was separated into three sub-groups, and each group has its own task. We have done the research on the required components for our project, and the order for the components has been placed. We think it is really efficient that we work for different parts of the project, and finally we can combine our work together. Since we didn't get our components yet, we don't have too much hands-on experience yet.

2.3 Development Process

Our team are following with the waterfall model, first we find out the requirements for the project, and second, we design a plan on how to achieve the goal. Third, we start working on the project followed by our plan. Finally we will test the outcome from our project to make sure it fits the project goals.

2.4 Design Plan

Diagram:



3. Statement of Work

3.1 Previous Work And Literature

Include relevant background/literature review for the project

– If similar products exist in the market, describe what has already been done

– If you are following previous work, cite that and discuss the **advantages/shortcomings**

– Note that while you are not expected to "compete" with other existing products / research groups, you should be able to differentiate your project from what is available

Detail any similar products or research done on this topic previously. Please cite your sources and include them in your references. All figures must be captioned and referenced in your text.

3.2 Technology Considerations

Highlight the strengths, weakness, and trade-offs made in technology available.

Discuss possible solutions and design alternatives

3.3 Task Decomposition

In order to solve the problem at hand, it helps to decompose it into multiple tasks and to understand interdependence among tasks.

3.4 Possible Risks And Risk Management

Include any concerns or details that may slow or hinder your plan as it is now. These may include anything to do with costs, materials, equipment, knowledge of area, accuracy issues, etc.

3.5 Project Proposed Milestones and Evaluation Criteria

What are some key milestones in your proposed project? Consider developing task-wise milestones. What tests will your group perform to confirm it works?

3.6 Project Tracking Procedures

What will your group use to track progress throughout the course of this and next semester?

3.7 Expected Results and Validation

What is the desired outcome?

How will you confirm that your solutions work at a **High level**?

4. Project Timeline, Estimated Resources, and Challenges

4.1 Project Timeline

• A realistic, well-planned schedule is an essential component of every well-planned project

• Most scheduling errors occur as the result of either not properly identifying all of the necessary activities (tasks and/or subtasks) or not properly estimating the amount of effort required to correctly complete the activity

• A detailed schedule is needed as a part of the plan:

– Start with a Gantt chart showing the tasks (that you developed in 3.3) and associated subtasks versus the proposed project calendar. The Gantt chart shall be referenced and summarized in the text.

– Annotate the Gantt chart with when each project deliverable will be delivered

• Completely compatible with an Agile development cycle if that's your thing

How would you plan for the project to be completed in two semesters? Represent with appropriate charts and tables or other means.

Make sure to include at least a couple paragraphs discussing the timeline and why it is being proposed. Include details that distinguish between design details for present project version and later stages of project.

4.2 Feasibility Assessment

Realistic projection of what the project will be. State foreseen challenges of the project.

4.3 Personnel Effort Requirements

Include a detailed estimate in the form of a table accompanied by a textual reference and explanation. This estimate shall be done on a task-by-task basis and should be based on the projected effort required to perform the task correctly and not just "X" hours per week for the number of weeks that the task is active

4.4 Other Resource Requirements

Identify the other resources aside from financial, such as parts and materials that are required to conduct the project.

4.5 Financial Requirements

If relevant, include the total financial resources required to conduct the project.

5. Testing and Implementation

Testing is an **extremely** important component of most projects, whether it involves a circuit, a process, or a software library

Although the tooling is usually significantly different, the testing process is typically quite similar regardless of CprE, EE, or SE themed project:

1. Define the needed types of tests (unit testing for modules, integrity testing for interfaces, user-study for functional and non-functional requirements)

2. Define the individual items to be tested
3. Define, design, and develop the actual test cases
4. Determine the anticipated test results for each test case 5. Perform the actual tests
6. Evaluate the actual test results
7. Make the necessary changes to the product being tested 8. Perform any necessary retesting
9. Document the entire testing process and its results

Include Functional and Non-Functional Testing, Modeling and Simulations, challenges you've determined.

5.1 Interface Specifications

– Discuss any hardware/software interfacing that you are working on for testing your project

5.2 Hardware and software

– Indicate any hardware and/or software used in the testing phase

– Provide brief, simple introductions for each to explain the usefulness of each

5.3 Functional Testing

Examples include unit, integration, system, acceptance testing

5.4 Non-Functional Testing

Testing for performance, security, usability, compatibility

5.5 Process

– Explain how each method indicated in Section 2 was tested

– Flow diagram of the process if applicable (should be for most projects)

5.6 Results

– List and explain any and all results obtained so far during the testing phase

- – Include failures and successes
- – Explain what you learned and how you are planning to change it as you progress with your project
- – If you are including figures, please include captions and cite it in the text

  • This part will likely need to be refined in your 492 semester where the majority of the implementation and testing work will take place

-**Modeling and Simulation**: This could be logic analyzation, waveform outputs, block testing. 3D model renders, modeling graphs.

-List the **implementation Issues and Challenges**.

6. Closing Material

6.1 Conclusion

Summarize the work you have done so far. Briefly re-iterate your goals. Then, re-iterate the best plan of action (or solution) to achieving your goals and indicate why this surpasses all other possible solutions tested.

6.2 References

This will likely be different than in project plan, since these will be technical references versus related work / market survey references. Do professional citation style(ex. IEEE).

6.3 Appendices

Any additional information that would be helpful to the evaluation of your design document.

If you have any large graphs, tables, or similar that does not directly pertain to the problem but helps support it, include that here. This would also be a good area to include hardware/software manuals used. May include CAD files, circuit schematics, layout etc. PCB testing issues etc. Software bugs etc.