UNIVERSITY OF MISSOURI – COLUMBIA
DEPARTMENT OF ELECTRICAL ENGINEERING & COMPUTER SCIENCE

OUTDOOR ~~SOLAR~~ SOLAR-POWERED LIGHTING INSTALLATION AND ACOUSTIC MOSQUITO REPELLENT FOR UNPOWERED OUTDOOR STRUCTURES

ECE CAPSTONE PROJECT – PROPOSED IMPLEMENTATION

September 28, 2020

— Engineering Team —

Matt Soehngen, Electrical Engineering, Physics
Nicholas Erickson, Electrical and Computer Engineering
Sterling LaBarbera, Computer Engineering

Who is your faculty advisor?

— Course Instructor —

Mr. Jim Fischer

Cover sheet grade: A−

Table of Contents

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in the front matter, use lowercase Roman numbers for the page numbers.

Proposed Implementation

Ideation

By Nicholas Erickson

For our capstone design project, our group wanted to focus on utilizing a renewable energy source to help solve a problem or improve an existing product. We decided it would be an interesting idea to use solar energy to power an outdoor light-emitting diode (LED) strip to be used for social gatherings. When we were thinking of ways to implement our idea, we brainstormed that it would be a nice addition to attach a mosquito repellent tone to deter mosquitos while enjoying your time outside. When thinking about the practicality of our product, we wanted the user to have the ability to change the colors and have the lights pulse to outdoor music if desired. When thinking of a way to implement these ideas we decided we could develop an app for a smartphone to control the colors of the LEDs and the output mode for the user. This would allow the user the ability to fully remotely control the LED lights by changing the mode through their phone. In order to implement this idea we decided to connect the smartphone to a controller which would connect to the LED lights. When thinking about our products outdoor intended use, we brainstormed that it would be a nice addition to attach a mosquito repellent tone to deter mosquitoes from visiting while enjoying your time outside.

Proposed Implementation

Our proposed implementation for our capstone project is to power an outdoor LED strip with a solar charged battery. Our LED strip will be remotely controlled through a Bluetooth app with settings to change the colors and modulate to outdoor music. Additionally, our device will be attached with a mosquito repellent circuit.

Theory of Operation

Product Concept Diagrams

By Matt Soehngen

The concept diagram shown in Figure 1 indicates the intended locations of the solar panel, rechargeable battery pack, ultrasound-producing pest deterrent device, and lighting strip on a gazebo. The controller sending signals to the lighting strip will be connected between the battery and the lighting strip, while the ultrasonic buzzer module can be connected directly to the battery.

Commented [JDF5]: Formatting. Use double line spacing for all written prose.

Indent by 1/2 inch the first line of each paragraph.

Commented [JDF6]: Define each abbreviation, acronym, and initialism on first use.

Commented [JDF7]: "Bluetooth" is a proper noun (it's a trademarked name), so it should be capitalized. In general, use exactly the letter case that is defined for the trademarked name—e.g., eBay

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Each display element must be explicitly mentioned in the report via its caption number—e.g., Figure 9, Table 6, etc.

The first mention of a display element should come BEFORE you begin your discussion / description of that element. Don't write 1000 words about an illustration, for example, and at the end of that discussion say, "Oh by the way, all this time I've been talking about Figure 12."

Each figure should be located in the document as close as possible to its first mention. If the figure is too large to fit between its first mention in the text and the bottom of the page, it is okay to move the figure to the top of the next page (as was done here).

In the body of the report, use Arabic numbers for the page numbers, restarting at 1 (one).

Figure 1. <Place here a summary description of this figure.> (P.S. Good job on this figure…)

Functional Block Diagrams

By Sterling LaBarbera

The functional block diagram shown in Figure 2 shows the main functional elements that comprise the proposed project, and it shows how those functional elements interrelate. For the discussion that follows, see Figure 2.

Unit 1 – Solar Charged Outdoor Lighting

Our Lighting installation will provide up to 4 hours of lighting from the battery source. The battery will charge during the day via solar panels mounted to the roof of the structure. There will be app control for different light settings and intensities. This unit will also feature a mosquito repellent circuit that produces a high frequency audio tone.

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Unit 1 Solar Charged Outdoor Lighting

Solar Panel
1BT1

Lighting strip
1U1

Audio Sensor
1U2

Bluetooth Connector
1U3

MPPT
1U4

Repellant Tone Circuit
1A2

Controller
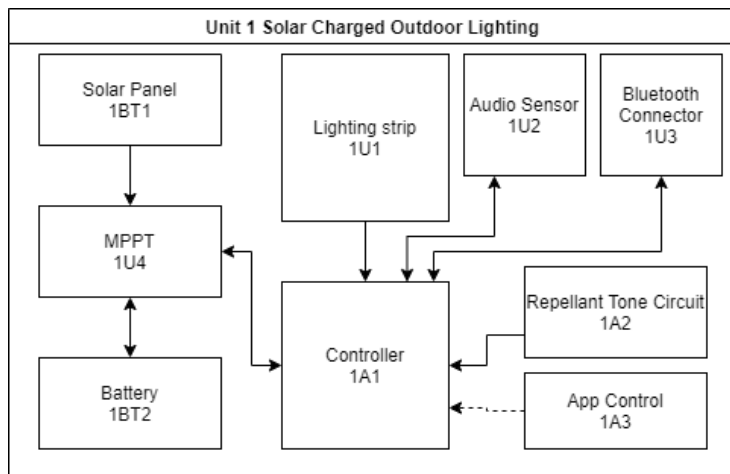1A1

Battery
1BT2

App Control
1A3

Figure 2. Functional block diagram for the proposed project.

:: GRADER'S COMMENTS ::

- Is the "Bluetooth Connector" assembly (1U3) a Bluetooth radio? If so, relabel this block as "Bluetooth Radio". Also, if 1U3 is a Bluetooth radio, this implies there is another Bluetooth-enabled device that communicates with Unit 1 via 1U3. What is that "other" Bluetooth-enabled device? If it's a smartphone, for example, provide a box outside of Unit 1 labeled "Smartphone" or "Bluetooth enabled smart device" or similar (no reference designation is needed), and draw a dashed line to indicate the radio signal path between 1U3 and that external Bluetooth device.

- Each signal path requires a short label that indicates the information that is conveyed via that signal path. These signal paths are not labeled.

- For most MPPTs, the output signal is DC power with regulated voltage and adjustable current—e.g., 9 VDC. In other words, the MPPT is essentially a DC power supply. As a general rule, do not show power supply signal paths on your functional block diagram. In your case, remove the dual-direction signal path between 1U4 and 1A1 (I'm guessing this is a DC power signal; the signal paths aren't labeled). Instead, redraw 1U4's output as shown below, which only shows the MPPTs regulated output voltage. (NB: Keep the existing signal paths between 1BT1 and 1U4, and also between 1BT2 and 1U4; those signal paths are correct as shown.) And for what it's worth, if you wanted to, you could define a separate unit for 1BT1, 1U4, and 1BT2; they meet the definition of a "unit".

1BT1 – Solar Panel

This will be a purchased solar panel attached to 1U3 via its provided wiring.

1U3 – Maximum Power Point Tracker (MPPT)

The MPPT will also be purchased due to complexity. It provides regulated output from the unregulated Solar panel. It also functions with the battery as a charger.

1BT2 – Battery

The battery is purchased and stores ~~solar power~~ electrical energy for nighttime operation.

1U1 – Lighting Strip

We will be purchasing LED strip ~~L~~lighting with color/intensity control to allow our software features to function.

1A1 – Controller

The controller will consist of an Arduino running custom software that can modify the lighting with various audio from the environment via the sensor.

1U2 – Audio Sensor

A simple audio sensor will provide input for the visualization software to modulate the lighting   with music. This will be a purchased sensor compatible with the Arduino.

1U3 – Bluetooth Connector

A purchased Bluetooth adapter for the Arduino. Our ~~A~~app will connect via Bluetooth.

1A2 – Mosquito Repellent Tone Circuit

We will build and attach a circuit that emits a ~~high~~ high-pitched tone known to repel mosquitos. It will be controlled via the app software as well, but is only an on/off element.

1A3 – App Control

This app will have various controls for intensity, color, audio synchronization, and power for the full system and separately for the repellent circuit and the lighting. It will connect via Bluetooth.

Software Architecture

Nicholas Erickson

For our project, we will develop an android app that will be used to send signals to the bluetooth receiver. The app will contain an interface to change the color of the leds, flash the lights, and turn on and off the music mode to have the lights strobe to the music. Our arduino controller will be connected to an audio sensor in order to receive and react to various frequencies. Based on the signals that are received by our controller, the arduino will turn off the output voltage when the sensor detects a loud audio signal.

Light Signal API	
Audio sensor	Bluetooth receiver

Work Assignments

By Matt Soehngen

Table 1.   Group member assignments: unit assemblies.

Assembly Reference Designation	Assembly Name	COTS?	Assigned To
1A2	Repellant Tone Circuit	N	Matt Soehngen
1U3	Smartphone Bluetooth App Connection	N	Nicholas Erickson
1U1	Lighting Strip	Y	Matt Soehngen
1U2	Audio Sensor	Y	Sterling Labarbera
1U4	Maximum Power Point Tracker	N	Sterling Labarbera
1A1	Controller	N	Nicholas Erickson
1BT1	Solar Panel	Y	Sterling Labarbera
1BT2	Rechargeable Battery	Y	Sterling Labarbera

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Commented [JDF18]: LEDs

Commented [JDF19]: This figure is missing its caption: Figure 2. <Summary description of figure>.

Commented [JDF20]: In the functional block diagram figure, assembly 1A1 has six signal inputs. Where are the software elements for those six signals? As a general rule, each input signal and each output signal on 1A1 should have dedicated software (a device driver) that manages each signal—i.e., six I/O signals == six device driver blocks on the software architecture figure.

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Commented [JDF22]: Text within a table should have 1x or 1.15x line spacing; it should not be formatted with double line spacing. Double line spacing is reserved for written prose.

Commented [JDF24]: What is COTS? (i.e., Don't assume the reader knows what "COTS" means.) Define each abbreviation, acronym, and initialism on first use.

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Commented [JDF23]: Sort these rows by the values in the "Assembly Reference Designation" column: 1A1, 1A2, 1BT1, 1BT2, 1U1, 1U2, …

Table 2. Group member assignments – Software

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