High efficient stand-alone Streetlamp

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ECE 445 Proposal - Fall 2017
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1 Introduction

1.1 Objective

Our goal is to design a stand alone streetlight that will power itself through sunlight (Solar Power) and store the energy for later use (at night). Lithium-ion batteries will power LED lights that can produce 3000+ lumen. Battery status and customization will be available through a mobile app on a bluetooth connected smartphone.

1.2 Background

In some area in the US/around the world it is difficult to have the access to the power grid. It would be inefficient to pull a power line across an entire region to power up a few street lights. Furthermore, during natural disasters, such as hurricanes, the power is often cut in a region, and essential streetlights will stop functioning at night. An independent, stand-alone streetlight that extracts and stores solar energy in a battery to power the light bulb will fix these problems.

1.3 High-level Requirements List

- Lithium-Ion Battery Capacity (>60Ah)
  - Needs to operate two consecutive nights without any input pow
- Average daily input power from power panel at least (400Wh, 33.3Ah)
- LED lights produce 3000+ lumens for minimum 2 days on a full charge
2 Design

2.1 Diagrams

Figure 2.1 Block Diagram
Figure 2.2 Physical Design Sketch

Chip No. Esp8266

Things on PCB: Microcontroller, Voltage Reg., Wi-Fi chip.
2.7 Requirements

2.7.1 WiFi-module

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Verifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Send messages up to 50 +/- 5 meters</td>
<td>1, 2</td>
</tr>
<tr>
<td>2. Receive messages up to 50 +/- 5 meters</td>
<td>A. Measure 50 meters with a tape measurer.</td>
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<td></td>
<td>B. Send a message to get battery charge status and</td>
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<td></td>
<td>see if a message is sent back with the data.</td>
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2.8 Schematics

![Figure 2.3 ESP8266 Wifi Module Schematic](image)

Figure 2.3 ESP8266 Wifi Module Schematic [4]
2.9 Calculations

2.9.1 Solar Panel Calculations

Solar Panel: 12v, 100 W, current = 8.33 A
LED: 12v, 33 W, current = 2.75A
With 33 W output and we want to operate 16 hours
The battery capacity should be 33 W * 16h = 528Wh
528Wh / 12v = 44Ah. The battery should be larger than 44Ah considering the motor needed for adjust solar panel.
2.9.2 Fuel Gauge Plot

![Graph showing voltage band of a 12V lead acid monoblock from fully discharged to fully charged.](image)

Figure 2.5 Voltage band of a 12V lead acid monoblock from fully discharged to fully charged [5]

This figure is a similar diagram, further detail needed to be corrected after doing the measurement using the battery.

3 Ethics and Safety

3.1 Ethics

“1. to accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment;”[1]

With our project, we are charging and discharging a battery. This introduces a potential danger of the battery explosion or expelling acid. For this reason, we will show warnings for any danger and accept responsibility for our choices.

“3. to be honest and realistic in stating claims or estimates based on available data;”[1]
We will not over promise on our light output or how long the light can stay on.

“4. to reject bribery in all its forms;”[1]
We will not accept bribery from other groups working on the same problem to allow their projects to be better than ours.

“7. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;”[1]
We will ask our TA for assistance whenever we are unsure to make sure we aren’t putting anyone at risk.

3.2 Safety
Our largest safety concern is with our battery. Batteries store large amount of chemical energy, especially in our project, a size of 60Ah can cause extreme heat which could cause fire if the battery is internally or externally shorted. We plan to use two series and multiple in parallel to achieve this capacity. Nominal voltage will be roughly 7.4 V, and shorting this voltage could generate a very high current.
Operational wise, we want to prevent damage to the battery and other potential hazards by stopping the charging or discharging of the battery when it is outside of the regulated temperatures. For lithium-ion batteries, this is between 0 - 45 degrees celsius for charging and -20 to 60 degrees celsius for discharge.[2]
User wise, our safety concern is making sure the final streetlight is bright enough to light up the ground as required and the ability to provide light throughout the night.
To prevent short circuits, we will keep the battery stored in a secure location with the terminals covered by insulating material and make sure no point in our circuit has a failure point that results in a short circuit, as stated in the General Battery Safety. We will also ensure our battery voltage does not decay below 3.0V/cell or exceed 4.2V/cell and any charge or discharge test performed with the battery inside a lithium safety bag after a TA approves our circuit.[3]

4 Citations and References


