

Team #6

Expandable Computer Power Storage System

PREPROPOSAL

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Executive Summary

The sponsor currently has a problem keeping an Indian school's computer lab functioning correctly due to a constantly failing power system. By implementing an alternative power source/backup supply students and teachers alike will be able to make use of available technology on a more regular and dependable basis. We are proposing the implementation of a solar powered battery backup system as it will be able to supply the lab independently of the archaic power grid that currently powers it. Additionally, it would be easy to expand if there ever in the future became a need to add more computers.

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Introduction

The problem presented to our team lies with a school's computer lab in India that has an intermittent source of power. The power grid in India is very unreliable, and this results in blackouts for the computer lab frequently, sometimes for multiple hours a day. An estimated 27% of India's power is lost through transmission or theft^[1]. With no permanent fix in the foreseeable future, there is a need for a constant source of power. This requires the school to either turn on its diesel generator for power or to wait out the power outage. The erratic tendencies of the nation's power grid are detracting from the student's education by forcibly shutting down their computers, causing them to lose any unsaved data and by disconnecting them from the internet.

By implementing a more reliable power source the school would be able to make better use of existing technology and improve the student's overall educational experience. This power source will need to be able to power around ten low-power laptops for as long as the power is out, which may be up to five hours at a time. Ideally, the system will provide a custom power supply based on a specific laptop model to avoid power loss through transformers and inverters. This specific laptop model will be decided upon by the sponsor, after receiving suggestions from the team. The sponsor has also indicated that the design should be easily expandable; if in the future there is an opportunity to add more computers to the system, the design should be able to accommodate the larger load. To help out with the ease-of-use for this system, a micro-controller will be added to the circuit to monitor the remaining charge of the batteries and display the time and percent charge remaining for the batteries. There is some interest from the sponsor in utilizing solar panels to charge the batteries in order to prolong their life while the power is out.

This design must also be reasonably reliable. The end users of this power supply will not have the technical knowledge to repair any damage that is sustained, so the power supply must be resistant to power surges and other electrical hazards. Because the computer lab that this will be housed in services around 30 students at a time, the final design must also be resistant to physical stress, such as bumps or drops from low heights. Also, because the end users will not have the expertise to repair the design if something goes wrong, maintenance of the design will be limited to mostly swapping out the batteries if they start to lose their ability to charge.

As lead-acid car batteries are readily available in India, the sponsor has suggested this as a possible method to store energy. This design choice also presents its own set of safety hazards. Improper handling of the car batteries can result in either electrical shock or a battery acid spill. While the design cannot account for a leaking battery, it does need to be able to cover the terminals of the battery to keep the risk of electrical shock low. The design also needs to be able to keep the batteries mostly covered and physically stable to reduce the risk of any accidents.

Background

The idea for this improvement was brought about by the sponsor, Stephen Blosser, through his work with Asian Aid. Asian Aid is a program that serves by providing education to the needy, orphans, the blind and deaf. The main goal of their visit was to upgrade the existing school through a variety of different improvements. Currently, there is support for a program that scans textbooks and then using voice-reading software converts the scanned text into an audio file. This is very beneficial for both blind and illiterate students as they can now benefit from text books that were otherwise meaningless.

Even though the school has all of the technology necessary to continue this program, the problem lies with India's poorly maintained power grid. It is common for the school to lose power daily for at least a few hours at a time. During this time none of the students or faculty can use the existing computer lab, rendering the project much more ineffective. In addition, sudden power losses can be detrimental to the condition of purchased equipment while users also run the risk of losing open data. To avoid this problem, there needs to be a way to power the computers independently of the power grid.

There are a variety of products that charge a single laptop with portable solar cells, but none are designed to charge more than a single laptop battery at a time. In regards to the lead acid battery chargers, there are numerous products that allow these to be charged at different rates from wall voltages, but we ran into a similar issue with recharging multiple batteries at once. We have not had any success locating complete systems for sale that meet the requirements of the sponsor, though other organizations have accomplished similar designs for different applications.

Objectives

Our design will be capable of providing an uninterrupted, alternative energy source for multiple laptops using lead-acid car batteries as a storage device. The system will need to be expandable in order to meet a variable energy demand. The primary goal for the system is to

supply the computers for up to five hours. In order to meet this there will have to be an easy way to add more battery cells based on the growth of the computer lab, as the sponsor has indicated that there could be up to 30 computers in the future.

Since the existing power grid is unreliable at best, there needs to be some external supply of energy in order to make the system completely independent. Solar would be an excellent choice due to its ease of installation and availability.

The system should also have a display for the users to provide current status of the system. It is necessary to keep track of the usage and the status of the batteries, so that no battery will be overcharged or discharged to prevent damage as well as providing important information to the users.

FAST Diagram

The FAST diagram will be included in the final proposal.

Proposed Design Solution

Since 12 V lead-acid batteries are readily available in India (and the rest of the world) we have decided to incorporate these into our design. If in the future the power bank does need to be expanded, it could be more easily done using common car batteries. They were designed to be charged and discharged frequently so they seem to be an intelligent choice.

The primary source we plan to use when charging these batteries are to be solar panels. Though they do not have the largest amount of power readily available, the pro to using these is that the system could be completely independent of the existing grid. This will be a major advantage because, even if the grid is out for days, the system will be able to charge the computers for some amount of time. The major drawback to this source is price and cost of installation. The sponsor has assured us that solar panels have become much more attainable in recent years to third world countries.

To make use of all energy sources present, we are also planning to incorporate the intermittent power grid as a secondary source to charge the batteries. The idea is that harnessing the power grid will help ensure that the batteries will charge as quickly as possible while the power is on to help ensure the students will have computer access even if the power does go out. This cannot be the main source of energy due to its erratic behavior, but it will suffice as a good backup.

In order to keep track of the system status, a microcontroller will be used to control the power distribution of the solar panel and display the battery status to show whether they are fully charged or empty, since overcharging and discharging a battery will damage the battery.

Therefore, the microcontroller will help to decide which batteries need to charge and which batteries are available for using. Furthermore, with the microcontroller, it is also possible to direct the power from the solar panel to either the battery or the computers. In other words, the system can charge the computers when all the batteries are fully charged.

Testing the design will consist of ensuring multiple car batteries can be charged from the wall outlet and a solar panel, monitoring battery life using a microcontroller, and making sure that multiple laptops can be charged from the car batteries. First the circuit designed to charge the batteries from the wall outlet will be tested to ensure that the batteries are charging correctly. Then the circuit will be tested by using a solar panel to charge the batteries. Then the circuit that is used to charge the laptops from the batteries will be tested by connecting multiple laptops to the circuit to ensure that they are charging correctly. Throughout all of this, the microcontroller will be tested by having it connected to the batteries and monitoring their life. If all of these functions are considered working after they have been thoroughly tested, the design will be considered a success.

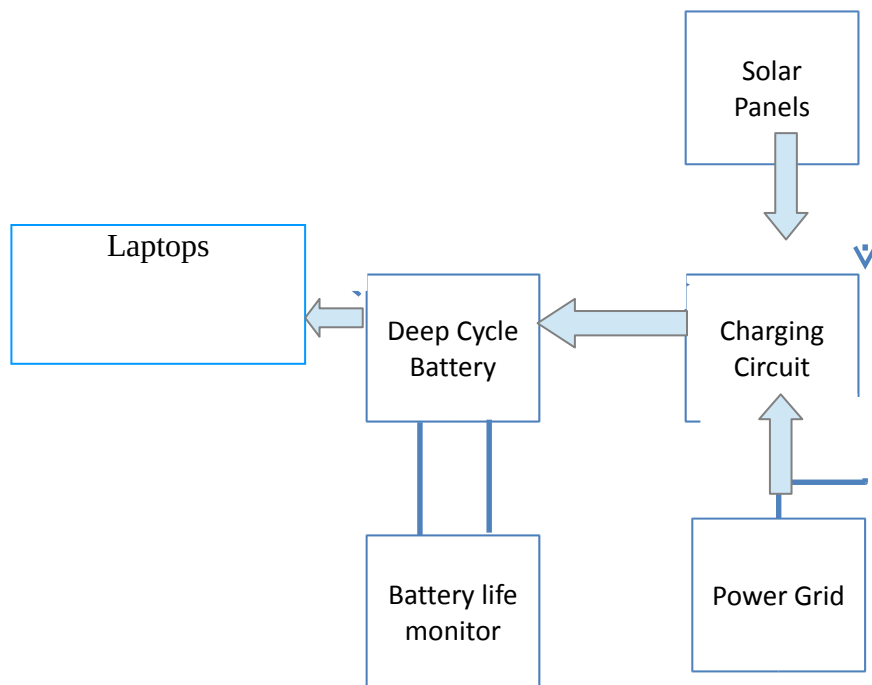


Figure 1. Block diagram for the proposed design

Risk Analysis

Project Management Plan

ID	Task Name	Duration	Start	Finish	Predecessors
1	Website Start	58 days?	Mon 9/16/13	Wed 12/4/13	
2	Proposal Stage	20 days?	Mon 9/16/13	Fri 10/11/13	
3	Pre-Proposal	5 days?	Mon 9/16/13	Fri 9/20/13	
4	Gantt Chart Due	1 day?	Wed 9/18/13	Wed 9/18/13	
5	Circuit Specification Determination	13 days?	Wed 9/18/13	Fri 10/4/13	
6	Design Layout	5 days?	Mon 9/30/13	Fri 10/4/13	
7	Prep for Presentation	2 days?	Mon 10/7/13	Tue 10/8/13	
8	Oral Presentation - Team 6	1 day?	Wed 10/9/13	Wed 10/9/13	7
9	Final Proposal Due	1 day?	Fri 10/11/13	Fri 10/11/13	8
10					
11	Hardware Stage	24 days?	Wed 10/9/13	Mon 11/11/13	
12	Battery life Monitor	16 days?	Wed 10/9/13	Wed 10/30/13	
13	Solar Power Feeding Design	16 days?	Wed 10/9/13	Wed 10/30/13	
14	Transformer for Power Grid	16 days?	Wed 10/9/13	Wed 10/30/13	
15	Prep for Technical Lecture	2 days?	Mon 11/4/13	Tue 11/5/13	14
16	Team Technical Lecture	1 day?	Wed 11/6/13	Wed 11/6/13	15
17	Component Combined	8 days?	Thu 10/31/13	Mon 11/11/13	14
18					
19	Testing Stage	7 days?	Tue 11/12/13	Wed 11/20/13	
20	Troubleshooting	7 days?	Tue 11/12/13	Wed 11/20/13	17
21					
22	Final Stage	15 days?	Mon 11/18/13	Fri 12/6/13	
23	Poster and Report Prep	12 days?	Mon 11/18/13	Tue 12/3/13	
24	Final Presentation/Report due	1 day?	Wed 12/4/13	Wed 12/4/13	23
25	Design Day	1 day?	Fri 12/6/13	Fri 12/6/13	24

Figure 2 Gantt Chart Schedule

Personnel and Tasks

Alan Everdeen – Webmaster, Document Prep. Research on the best type of laptop for the design to power. Installation and programming of microcontroller and related circuit.

Siyang (Leon) Liang – Presentation Prep. Solar panel research and design of the circuit that charges the batteries from the solar panel.

Danny Macbeth – Lab Coordinator. Design and implementation of circuit that charges the batteries from the power grid.

Tim Wang – Manager. Involved with the design and implementation of the circuits that deal with both the solar panel, power grid, and charging of the laptops.

Budget

2 x Lead-Acid Car Batteries @ \$40 each = \$80

Printed Circuit Board and components \$30

Solar Panels \$200

Laptop \$400 (Will be covered by sponsor)

Total = \$710

References

[1] R. Singh & R. Katakey, “Worst India Outage Highlights 60 Years of Missed Targets,” August 1, 2012. [Online]. Available: <http://www.bloomberg.com/news/2012-08-01/worst-india-outage-highlights-60-years-of-missed-targets-energy.html>