Programmable Power Strip

Jesse Goodall
November 17, 2006

Abstract

With the increasing use of household electronics comes the increase in power consumption. This project is focused on the construction of a programmable power source in the form of a power strip directed towards consumer use. Benefits include reducing everyday power consumption, entertainment such as choreographed lighting or equipment, and home security. The project will be performed in three major steps: physical construction of a simple model involving relays controlled through a serial or parallel connection with a computer, software implementation and application development, and if possible the implementation of a remote physical connection and web interface. The project is projected to cost about $350 total. This includes about $200 for 6 relays, $100 for miscellaneous equipment, and roughly $50 for remote control equipment. In this price range the product would have to be considered specialty consumer equipment.

Introduction

The semester-long project to create a programmable power strip is developed in the following proposal. The proposal outlines the following:

- Technical Discussion demonstrating the value of the project
- Project Plan describing the tasks and their scheduling for timely completion
- Project Qualifications describing my qualifications to implement the project
- Project Cost based on equipment and technical assistance costs

Technical Discussion

The ability to control a conventional source of AC power as a function of time using automated means is not a new concept. Many consumer devices include electronics to perform this function for purposes of energy conservation or security.

Examples include computers which shutdown after lack of usage, monitors which sleep, or the lights on a car. Industrial appliances or institutional buildings use this functional ability extensively to conserve power after work hours. On a consumer level, the availability of a device to provide this functionality common to institutions for general purpose use rather than device specific use is not widely available. The proposed project intends to create a device to control a conventional source of AC power as a function of time using automated means for consumer usage.

The device is based on two conceptual parts with a modular interface. The first is a physical component supplying conventional 120 VAC power. The second is a programmable interface to control the 1st part as a function of time. The most common power supply device in homes today is probably the power strip. Adding programmability to a power strip ensures the features desirable in a power strip are inherent in the proposed device. Computer control will be the programmable interface. Interfaces could come in many forms including LCD or buttons, but a computer while more physically inconvenient provides much more functionality and ease of use than other options. Computers are common, can be mobile as laptops, provide the option of web control, and cater to more sophisticated control using visual or script based control. The interface between the computer and the device can come in numerous forms providing flexibility in design and project implementation. The simplest interface will be used for the initial part of the project to ensure a working solution within the timeframe of the project. The simple solution proposed is a serial or parallel interface. Both are direct physical connections. This can restrict the placement and use of the device but implementation is easy.

A solution to the direct connection problem is tackled in the final part of the project: creating a remote connection. This can come in many forms which need to be researched as part of the project. One proposal is to use an infrared transmitter and receiver like a TV remote. The problem with this is obstruction of the signal which restricts placement of the device. Another idea is to use an onboard chip to store program functionality and a few buttons to run or terminate the program. Data can be uploaded to the chip using the already implemented serial or parallel connection. A more involved solution uses a web interface for programmability from any internet connected computer.

There are at least two methods to implement this. One would use a computer permanently attached to the device using the usual serial or parallel direct connection. The computer would host a webpage and provide a web connection. The alternate solution is to use a pre-built chip acting as a standalone web server with Ethernet connection. The final idea is to make the device wireless using a wireless hub connected to the standalone web-serving chip or using a wireless transmitter built into the power strip device.

There are several advantages to implementing the proposed project. Advantages include modularity of design, cost, and application. Modularity of design is the product of the conceptual framework for the design of the device. As discussed above, the device can be divided into three components: a physical power strip, a human interface using a computer, and a physical connection. Physical construction of the power strip can be constructed independently of the interface and software deployment. The interface and software can be developed in stages of increasing complexity insuring completion of a functional device by the project deadline.

One of the objectives of the project is to create a cost effective design. Power strips are general in the fifty dollar or less price range. Therefore, a programmable power strip should not be much more expensive for common consumption. Because a computer is assumed to be available and software development should not require any expensive equipment that is not already available, the only primary cost of the project is the equipment for physical construction of the power strip and interface component. The estimated cost of equipment is $350. This is based on the use of 6 relays (the primary cost driver) at $200, $100 for logic, wiring, and a frame, and $50 for the additional interface such as the standalone web-serving chip or infrared TX/RX device. A summary of costs is provided below in the Project Cost section of this report.

Because of the general form of the device based on a simple power strip already in wide circulation, the device will be applicable to a wide range of uses. Applications include controlling lighting especially for when a house is vacant to simulate occupancy and avoid robbery of the house and controlling lighting for entertainment such as synchronizing it with music or switching a set of multicolored lights. The device could also be used to switch on power for electronic equipment at regular intervals such as radios, computers (for use with remote boot), speaker systems, battery chargers, fans or portable hvac equipment, dehumidifiers, or kitchen appliances. It could be used to save energy during the night when devices are not being used, for security to stop people from turning on equipment outside of business hours or when kids are around, or to control things remotely.

Project Plan

Activities List

- Research – physical implementation, software implementation, remote connection
- Purchase parts for physical implementation and remote connection
- Physical implementation using simple parallel connection – serial connection is alternative as you can get usb to com port adapters for laptops that don't have serial or parallel. Can also use php to serial (or parallel).
- Testing and software implementation – sync to music using simple DSP, create or find and implement simple user interface for direct control. Create sample programs, scripting interface, or timeline driven interface for animated effects
- Create remote interface using 2nd physical copy or with new connection to bread board
    - Keeping parallel port and providing web access from connected computer
    - Keep parallel port but provide chip to store program memory and buttons to run program
    - Using a different hardware interface
        - Standalone server chip and Ethernet interface – could serve webpage or allow device to act as independent network device
            - wireless by connecting from Ethernet interface to wireless hub
        - Infrared controller and receiver (tv remote for example would be cool) – easier than Ethernet I would guess but usually you would want to be able to put the power strip in corners behind objects
        - Direct Ethernet connection – not as useful as standalone implementation but allows a longer cable than parallel. Note this

may not be feasible unless using parallel connection at either end with Ethernet as the medium in between. (not included in CPM)

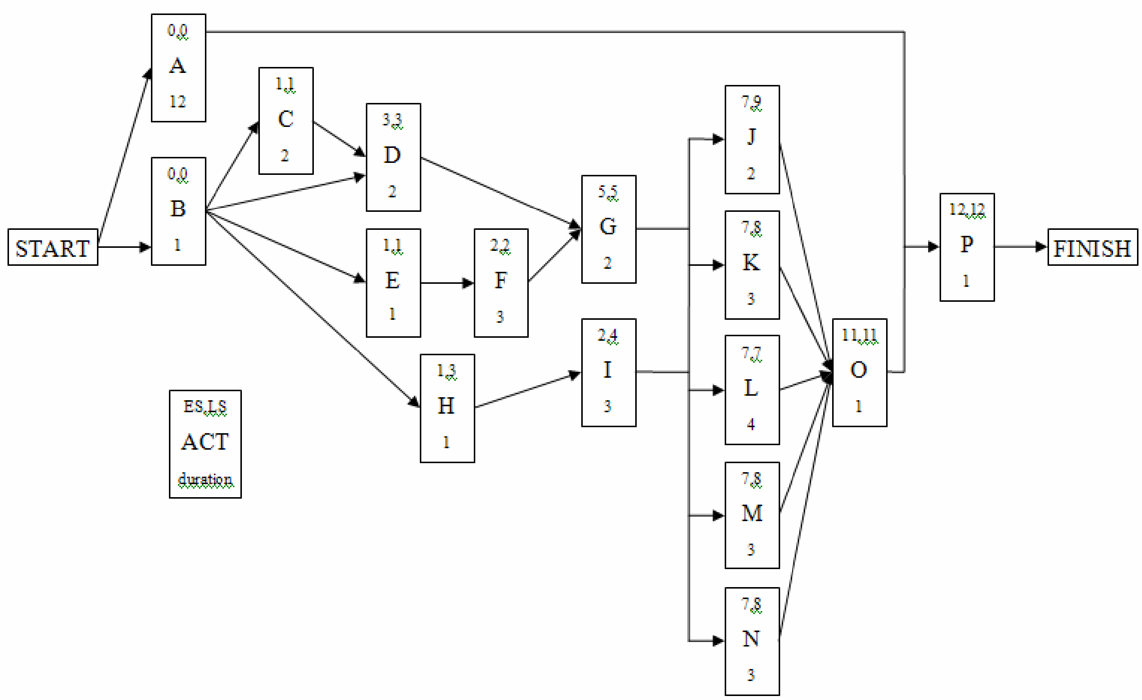
- Wireless using radio RX/TX from computer to power strip.

- Final Test using remote connection if successful
- Final Presentation

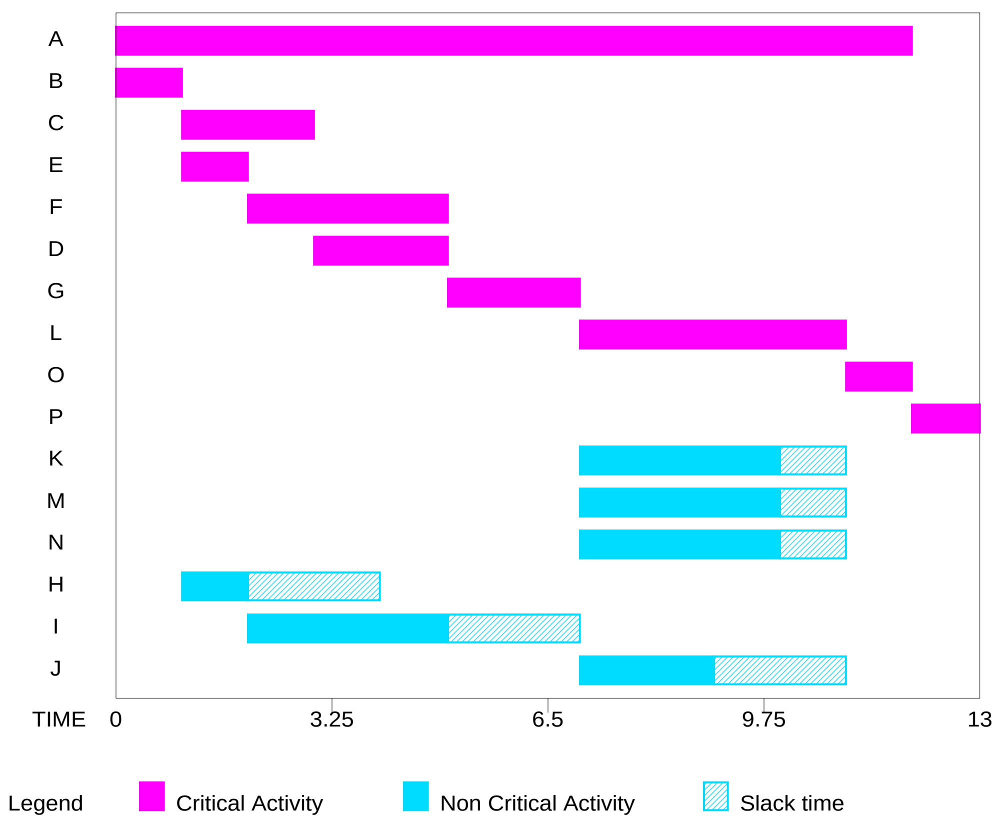
Table of Activities

Activity	Needs	Feeds	Duration (wks)	Effort (hrs/wk)	Action
A	-	P	15	1	Weekly reports
B	-	B,D,E,H	1	5	Research physical implementation
C	B	D	2	4	Purchase parts and wait for arrival
D	B,C	G	2	7	Physical implementation (phase 1)
E	B	F	1	7	Research software implementation
F	E	G	3	7	software implementation (phase 2)
G	D,F	J,K,L,M,N	2	7	testing
H	B	H	1	5	choose remote interface design option
I	H	J,K,L,M,N	3	6	research remote interface
J	G,I	O	2	6	directly connected computer
K	G,I	O	3	7	chip to store program
L	G,I	O	4	8	standalone server chip - Ethernet and wireless
M	G,I	O	3	6	infrared
N	G,I	O	3	7	wireless RX/TX
O	J,K,L,M,N	P	1	5	final testing
P	A,O		1	8	final presentation

Critical Path Method Network Diagram



GANTT



Equipment List

See Project Cost section of the report below.

Project Qualifications

As a senior in Swarthmore College majoring in an ABET accredited general engineering program, I am technically qualified to conduct the research and development necessary for the successful completion of this project. Having focused on electrical and computer engineering, the creation of an electrical device with a computer software development component is an appropriate notion. Hicks engineering building is an appropriate facility for development of an electrical device. For the physical construction, the labs in Hicks contain all necessary equipment especially since most construction is small scale and centers on a bread board. Software development can be performed in any computer lab. Testing the software can also be performed in any computer lab once the device has been safety tested. Manpower and technical assistance for these two phases should be relatively minimal. One person should be able to complete both tasks given adequate time. The final phase developing a remote interface will likely involve both a physical and software component and thus should be performed in an electronics lab in Hicks. This phase can also be completed by one person but time required will vary depending on the implementation chosen. Technical assistance needed is projected to be greatest in the third stage especially in the case of some of the more ambitious ideas.

Project Cost

Equipment List (for stage 1: physical implementation using simple parallel connection)

- 120 VAC solid state relays (3.3-5v input range) – control AC output using logic ($30 each x 6 http://smart.sager.com/smart/srchrsult.asp?mfr=CRYDOM%20COMPANY&nbr=D1225)
- Terminal block - to organize wiring from relays to output plugs (<$5)

- Grounded extension cords or power cables – cut the ends off and wire through terminal block to relays. One cord could be used to power the relays and provide ground plus one cord per relay (to provide output plugs). (<$7 x 5 (1 ft cords) + $30 (6ft) (note can save more money with female-female) http://www.apc.com/products/family/index.cfm?id=122&tsk=i244x)
- Bread board – for logic and input ($10 http://www.alliedelec.com/Search/ProductDetail.asp?SKU=761-0059&SEARCH=&MPN=QT%2D59S&DESC=QT%2D59S&R=761%2D0059&sid=455A588040A5E17F)
- LEDs – for status ($3 http://www.alliedelec.com)
- Resistors and logic elements (<$5 http://www.alliedelec.com)
- Parallel connection: DIP connection from breadboard to D-sub connector for PC (25 wire flat ribbon cable) ($10)
- Cable ties etc ($2 http://www.alliedelec.com)
- Screws and Plexiglas or Acrylic for cover ($5 http://www.onlinemetals.com/merchant.cfm?pid=7451&step=4&showunits=inches)
- Plastic or wood board for base on which to screw everything else into ($5 home depot)
- Wire for logic (AC wire in power cables). (<$5 http://www.alliedelec.com)

Total Cost of Materials

Total cost: ~$300 (note 6 relays account for 2/3 of this cost. Reduce # relays to 3 if necessary)
Add $50 for remote physical interface (used instead of serial/parallel).

Technical Assistance Requirements

- Phase 1 physical implementation: 1 hour/wk
- Phase 2 software development and testing: 1 hour/wk
- Phase 3: remote interface: 2 hours/wk