EE/MKT/FASC Collaborative Project

Spring 2013

Energy Conservation Controller

Product Overview

The product this semester is a device for use in a residential or commercial building to reduce energy consumption. In most structures there are numerous way that electrical energy is wasted. The goal is to build a product for eliminating electricity usage by devices that do not have to be consuming power at times when they are not being used. Two areas that should be addressed by the project team are electronic entertainment devices and lighting as shown in Fig. 1.

Most modern electronic devices such as audio and video equipment consume a small amount of power all the time even when they are turned off and nobody is using them. If a device is controlled by a remote control, then it needs to always be operating enough to see if the remote is signaling it to turn on. The project team should try to identify ways to reduce this wasting of electrical power by adding a smart controller that shuts off devices when there is no need to have them on. The product is programmable by the home or business owner so they can specify times of the day that power should be completely shut off to certain devices. For example, it might be programmed to turn off all power to a TV between 1:00 AM and 5:00 PM Monday through Friday. This would reduce by almost 50% the amount of time the the TV is consuming some amount of power.

The same concept of shutting off devices whenever possible can also be applied to reducing power usage by lights. In houses lights are often left on in rooms when nobody is around. Exterior lights are sometimes on at times when there is no need for them to be on. When people go on vacation they may leave a light on in their house so it won't appear completely dark at night. Homeowners can buy timers to control lights but these are often a hassle to set up and program, and each controller must be programmed individually.

Electrical power could be saved by a product that either controls the lights automatically or makes it possible for the homeowner to easily program the lights to turn on and off at selected time. For example, this could be used to control exterior lighting around a house by having the lights come on a hour after sunset and go off at 10:00 PM for example. It could also be used to control lights on the inside of the house while the owners are gone on vacation.

Individually none of these are major causes of energy usage, but taken together the amount of wasted energy can be significant.

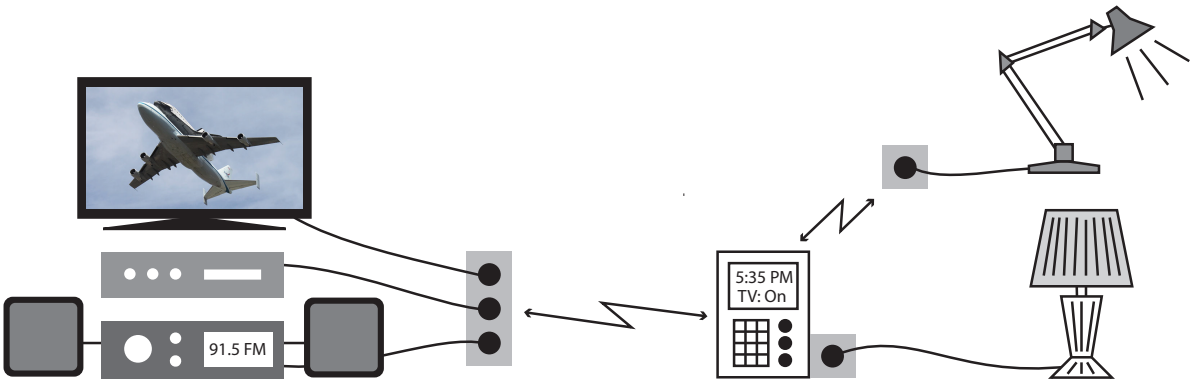

Figure 1: Energy controller connected to various devices

Product Features

The EE/MKT/FASC product teams are free to design the product in any way they choose that achieves the goal of reducing electricity usage as described above. The following is one possible implementation.

This product can be viewed as a sort of power strip with each outlet controlled by a user settable timer. Initially the user sets the product's clock to the time of day and day of the week. They can then set for each outlet a time and day to turn on and a time and day to turn off. There might be several on-off cycles each day depending on what the market research has determined the consumers want.

The product can be designed as a central control station that the user interfaces with in some manner, and it controls multiple outlets that electrical devices are plugged into. Some of the outlets can be local outlets that are incorporated into the controller unit. Other are remote outlets that are turned on and off by the controller by using a wireless link of some sort.

This product should eliminate to some extent the problems that homeowners have with lighting timers. These are normally installed and programmed individually at each outlet. Any change to the programming must be done by physically accessing each timer. This product would allow the user to program all the lights from a single controller and possibly to have an array of stored programs available. For example, when going on vacation the user would only have to go to the controller and select "Out of Town" and all the required outlets would then follow the predetermined program. In addition it might also turn off all the outlets that electronic entertainment devices are plugged into to eliminate their power usage completely.

The product teams are encouraged to explore any other possible designs that they can dream up. Keep in mind the overall goal is to develop a commercially viable product which may or may not look like anything ever seen before on the market.

Design Requirements

The following are requirements for the product prototype that all teams must include in their design. Teams are free to go beyond these requirements in terms of both additional features and the quantity of each feature. Teams should plan to implement in their prototype about 80% of the additional features they claim for their product but should not make claims for product features that can not be implemented due to limitations on the available technology. Teams are not required to implement every product feature to the same extent or quantity as would be required in the final product. For example, one requirement is to control four outlets, however teams may state that their product controls up to 20 outlets. The cost analysis of the final product should reflect any claims made for it, not just what was implemented in the prototype

- The product prototype must be able to control a minimum of four outlets. At least two of the outlets must be in separate remote units that the controller communicates with over a wireless link of some sort. The other two can be physically part of the controller. The implementation of the wireless link must consider the issue of how to prevent inadvertent interference with or from a neighbor's similar unit. The product should only control wireless devices that it is supposed to be associated with.

- At a minimum each outlet must be able to be programmed for at least one turn-on and one turn-off time for each day of the week. More flexible scheduling can be implemented if the team wishes to do so.

- Each outlet must have some sort of override control that allows a user to turn the device on or off regardless of the current programmed settings.

- The controller must be immune to power outages in that the user should not have to take any action to put the product back into service after a power outage. The controller's internal clock must be able to continue to function during power outages so that it will know the correct time when the power is restored. All programming data for when each outlet should go on or off should also be retained through power outages. It is not required that devices turn or or off at the desired times if the controller loses power, however once power is restored to the controller it should set all controlled devices on or off as the program specifies.

All teams are encouraged to go beyond these minimum requirements in order to make their product more attractive to consumers. Whenever possible, additional features selected for inclusion in the product should be included in the prototypes sufficiently to show that they can be implemented and would work as planned.

Design Elements

Inputs

The controller needs some sort of input device to allow the user to program it. The decision of what type of user interface to use will have a major impact on its ease-of-use and should be carefully considered by all members of the product team. The market research should provide valuable information on what type of user interface is preferred by potential consumers. Some options based on past projects might be:

- Buttons or keypad
- Dials
- LDC touchscreens
- Remote control device such as used with a TV

Besides considering the consumer preferences, the design teams should examine the relative merits (cost, physical size, compatibility with the rest of the hardware, difficulty in implementing, etc.) of the different types of input devices to determine which is the best one to use.

Outputs

The controller needs to have some sort of output in order to communicate its status and conditions to the user. The output also needs to provide the user with any pertinent information when the device is being programmed. The design team must decide what information needs to be displayed and how to present it in a way that makes it easy for the user to understand it.

The local and remote units that actually control the power to devices must have a way to turn the outlet's power on and off. This can be implemented by triacs or relays or some other device that can switch higher voltages and current.

Wireless Link

In order for the controller and the remote units to communicate, both need some sort of compatible wireless link. The controller uses it to tell the remote unit to turn the outlet on or off. Base on the design decisions made by the team, there also may be reasons for the remote unit to send data to the controller in order to implement desired features.

Memory

The controller must have the ability to retain the programming information if power is lost. The user should not have to re-enter all the programming data if power is lost for some reason. The settings can be stored in some sort of non-volatile memory such as an FLASH or EEPROM or the device can be provided with long-term battery backup. When waking up after a power outage, the controller should be able to confirm that the contents of its memory is valid and has not been corrupted in some way. Once that is done it should set all the outlets on or off according to the stored schedule.

Timing

For the purposes of this prototype, accuracy of the internal clock is not very important so any method that makes the clock run with less than about a 5% error is acceptable. It is recommended that all teams implement a way to make the clock run faster than normal to help with the debugging. For example, make the clock run at a speed where one second of real time is one minute of time for the controller.