ECE445

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Senior Design Project Proposal

Power Budget Automation System

Team 40

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I. Introduction

1. Statement of Purpose

This project is to build a home power budget control system to save energy for the user. Energy is invisible to us, but we were using it every single day. We might be aware of the money we overspend each month. However, the energy we wasted daily might not be as obvious. This project can help the users to understand their power usage behavior and decide a power budget plan that fit for them.

2. Objectives

2.1 Goals

- User interface with the system through the controller
- Wireless communication between sensors unit and controller unit
- Home electricity automation
- Power budget saving
- Notification helps alerting user if user reach the power usage limit setting

2.2 Functions

- Sensor system can turn light on/off depend on room's occupation
- IR sensor detecting room's occupancy
- Automatically turn off the power when the electric devices aren't used
- LCD display current power consumption, alert user, and allow remote control.

2.3 Benefits

- Reduce wasted energy
- Enable remote control to power outlet
- Save money by reducing power usage
- Allow user to manage home power usage

2.4 Features

- User remotely control through the controller system
- Learning ability on controlling
- User-friendly display and notification
- Easy and safe installation process

II. Design

1. Block Diagrams

The system will be the controller unit and sensor unit. The communication is wireless and bidirectional as indicated by the arrows. Figure 1 shows this top level of the system layout.

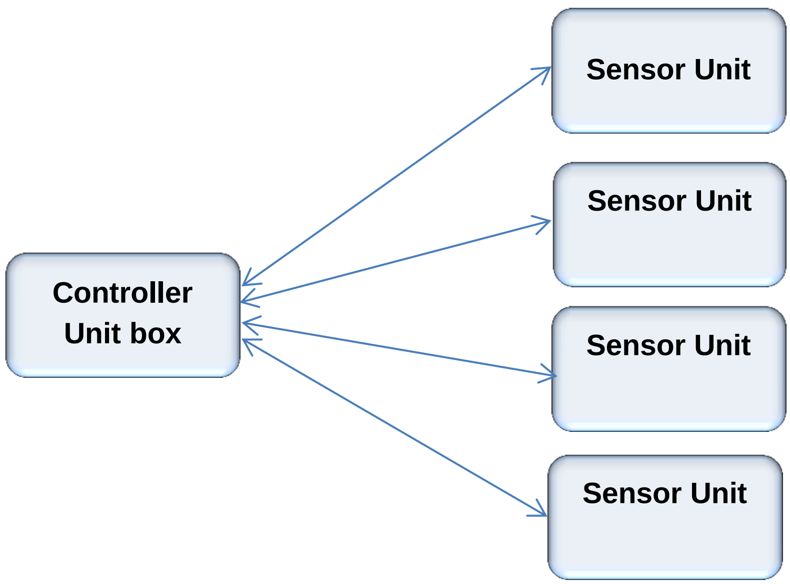

Figure 1. Top level system layout

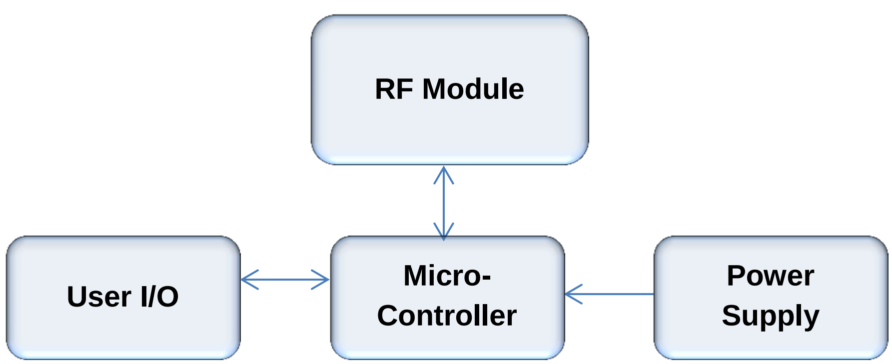

Figure 2. Block Diagram of Controller Unit

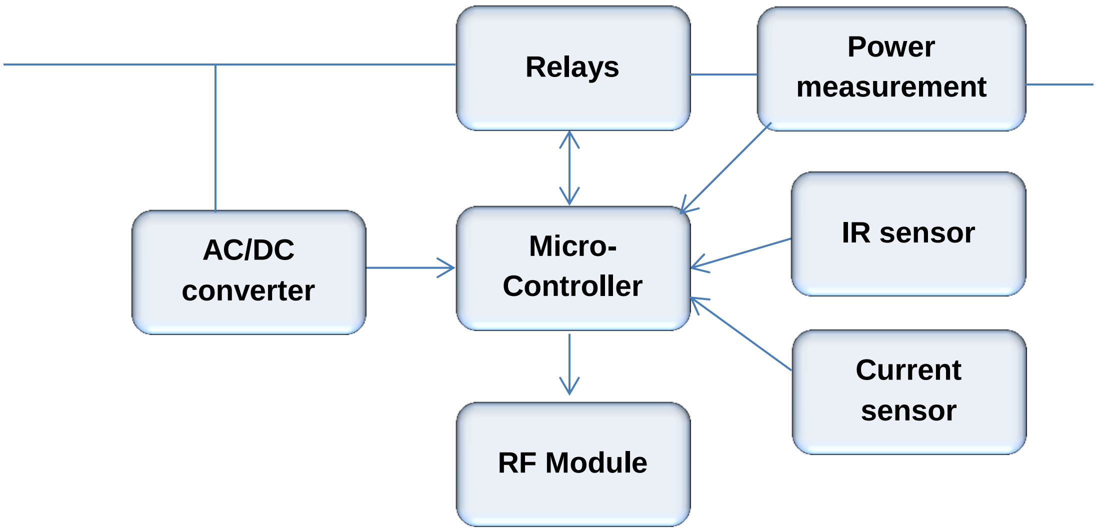

Figure 3. Block Diagram for Sensor Units

2. Block Descriptions

2.1 Controller Unit

The unit will consist of a microcontroller, RF module, power supply, and user I/O. Microcontroller in the big box will process all the data receive from small box and also commanding small box from user's input. RF module enables wireless communication between microcontroller and sensors. Power supply will be the energy source for Microcontroller's operation. User I/O display information of power usage and allow user to control the power.

Case Design

The case will be designed to be small and portable. It's intended to let the user to bring it with him around the house. The body should also be insulator to prevent electrical shock.

User I/O

A basic character LCD will be used for display and buttons for user input. Information such as power usage will be display on the LCD and user can interact with the system through the buttons. The LCD and buttons will connect with the microcontroller through a serial connection.

Microcontroller

The microcontroller receives input signal through RF transceivers and store data. When motion has been detected from the sensor system, the microcontroller will send signal to give command to start the power for particular areas. It also analyzes the users 'setting to generate a power budget management. The implemented microcontroller will be TI MSP 430. Furthermore, the MSP430 connects to the LCD through a serial connection.

Power supply

The power supply will be a small power circuit that provides a stable constant 3V to the MSP 430. Small batteries will be used as the initial energy source.

RF Module:

The transceivers transmit and receive radio signal for communication between controller and sensor system. These RFM12B-S2 modules operate in the 434 MHZ which is comply with an TI MSP 430 microcontroller. They are an inexpensive option for high performance and price ratio of wireless transceivers implemented with PLL.

2.2 Sensor Units

Microcontroller

MSP 430 microcontroller will be used to control the unit. This device is powered by the AC/DC converter, which provides a constant 3V. The microcontroller will receive input data from IR sensors/ Current sensors to output control signals to relays. Moreover, it will analysis data, which collects from power measurement, to send to controller unit via RF transmission. The main reason for using this sort of microcontroller is the low power consumption and low cost of this device.

RF Module:

We use the same wireless transceiver for each unit. They will transmits the data of power usage and receive the command from the controller for the relay.

IR Sensor:

The sensor module will detect motion and occupation. It is able to provide consistent and reliable reading. The sensor output an analog voltage will give signal to RF module as activation for starting power.

Current Sensor:

The main reason for using this current sensor is giving wide range current measurement for AC/DC signal; which is also good for metering and measuring overall power consumption of system. The current sensor will detect the current through electric device and then send the data to the microcontroller. This sensor will connect with the microcontroller through a serial connection.

Relay

It is used for relay module due to this relay can be controlled by DC voltage. The primary reason for using this device is high rate current adoption at 120VAC. This relay is connected to microcontroller via serial data port.

2.3 Performance Requirement

- Detector : the sensors need an accurate reading in home temperature condition
- Transceiver: Our system should have a transmitting range of 20 meters to ensure that the signal could be sent and receive from controller consistently.
- Power Supply: The efficiency of power supply which uses AC/DC converter should be over 70%.The power supply which uses battery should be over 90% due to ensure battery lifetime for controller .
- Microcontroller: The microcontroller is programmed to store and analyze data signal to communicate with sensor system and control power

III. Verification

1. Testing Procedures

- We check if the power supply gives the expected voltage and the circuit stays powered on DC output voltage waveforms of AC/DC converter has to be tested on oscilloscope prior to connect to microcontroller. We measure the power output on the sensor units and controller unit.
- We want to make sure the voltage supply from the AC/DC converter or the battery is within the tolerance of the microcontroller all the time. The MSP 430 wants a constant 3 volt supply and min/max it can take is 1.8V/3.6V. That will be the tolerance we have to meet for the power supply block
- To test motion detector, we will supply the unit with a 120/60Hz AC input , and place sensor at the output. If motion is detected, the output should be close to 120V/60Hz input. After a certain amount of time (approximate 30s) if there is no motion detected, the output is close to 0V. The accuracy of the current sensor for our power measurement will be tested. We will measure the current in separate channel with oscilloscope using the current sensor in the lab and in our project and make sure the current sensor used in our circuit can sense current within ±1%. Output signal of IR/Current sensors are tested via oscilloscope. Then connect these outputs to the microcontroller and use it to control relay.
- In terms of RF transmission, the packet transmission between 2 transceivers will be tested first. Then a transmission network between 2 more than transceivers will be set up base on the one to one transmission.
- User I/O module, LCD screen is used to test output information. Moreover, the output of LCD will be timed to ensure correct functionality of the full system.

2. Tolerance Analysis

The most essential part of our design is to be able to measure the power consumption. The current sensor's accuracy will be essential for correct power measurements which lead to an accurate power budget plan. The current sensor will need to detect the current through a wire with error no more than ±1%

IV. Cost and Schedule

1. Cost Analysis

1.1 Labor

Member	Hour Rate	Total Hours Invested	Total = Rate *hour *2.5
Hai Vo	$35/hour	180	$15,750
Vi Tran	$35/hour	180	$15,750
Benny Tsang	$35/hour	180	$15,750
		540	$47,250

Table 1: Labor Cost approximate

1.2 Part

Description of item	Quantity	Cost / Unit	Total cost
LCD display	1	$20	$20.00
Microcontroller TI MSP 430f2272	4	$5.00	$20.00
RFM12B Transceiver	4	$6.95	$27.80
IR sensor	3	$1.95	$5.85
Current sensor module	3	$9.95	$29.85
Relay	3	$2.28	$6.84
Misc Circuit Parts	1	$12	$12.00
Switches	4	$0.50	$2.00
Controller buttons	4	$0.50	$2.00
Case	4	$2.00	$8.00
			$134.34

Table 2: Parts cost approximate

1.3 Grand Total

Section	Total
Labor	$47,250.00
Parts	$134.34
Total	$47384.34

2. Schedule

Week	Description Task	Team Member
1/14	Initial Post Finding partners	 Hai Vo, Vi Tran , Benny Tsang
1/21	Finding partners	Hai Vo, Vi Tran , Benny Tsang
1/28	Project Page Update Work on RFA Working on proposal paper	Hai Vo Benny Tsang Vi Tran
2/4	Proposal Data mining on transceivers, Sensors Data mining on microcontroller, sensor, replay Data mining on AC/DC converter, power supply	 Hai Vo Vi Tran Benny Tsang
2/11	Mock Design review, investigate LabView Research and order parts Start design sensor	Vi Tran Benny Tsang Hai Vo
2/18	Write simple detector for microcontroller Testing &Debugging hardware Prepare for Design Review	Vi Tran Hai Vo Benny Tsang
2/25	Design Review Write code to communicate with sensors Testing controller system Research and implement power supply	 Hai Vo Vi Tran Benny Tsang
3/4	Build sensor system circuit Research on programing processor Testing & Debugging RF transceiver circuit	Vi Tran Hai Vo Benny Tsang
3/11	Individual Progress Report Improve UI interface Testing & Debugging Sensor circuit	Vi Tran Hai Vo Benny Tsang
3/18	Spring break Preparation for Presentation Final integration Programing on memory function for controller	 Vi Tran Hai Vo Benny Tsang
3/25	Preparation for Demos Working on final report	Hai Vo Vi Tran
4/1	Preparation for Mock-up Presentation Preparation for final report Testing sensor system	Benny Tsang Hai Vo Vi Tran
4/8	Testing & Debugging Microcontroller Preparation for final report Preparation for demo	Vi Tran Benny Tsang Hai Vo
4/15	Testing & Debugging power supply Preparation for final report	Hai Vo Vi Tran

	Preparation for final demo	Benny Tsang
4/22	Demo Preparation for presentation Preparation for final report	Benny Tsang Vi Tran Hai Vo
4/29	Presentation Final Paper Check in Supplies	Hai Vo Benny Tsang Vi Tran