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## Project Design Report:

# Intelligent HVAC System

*Team Buckyball*

## Project Abstract

The Intelligent HVAC System will control Heating, Ventilating, and Air Conditioning (HVAC) of a residence. The project will consist of two modules that can be easily added to a home's existing HVAC system. The Central Thermostat Unit (CTU) will control the general heat, air conditioning, and fan levels of the residence and communicate wirelessly to one or more Individual Room Controllers (IRC). Users can set their desired room temperatures with a simple user interface, and the Individual Room Controllers will adjust vent openings to meet the users' comfort levels. The project will be demonstrated by simulating temperature conditions (with compressed air and a hair dryer). LEDs will be used to display the CTU's operation and the IRC will control standard-sized vents.

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# Introduction

With current political and economic pressures, energy efficiency has become an important issue for home owners and renters. New HVAC systems have responded by producing energy efficient ways to heat and cool a home. However, for many of those who have older HVAC systems or cannot significantly modify their existing systems, energy efficient heating and cooling was not a realistic goal without sacrificing comfort. With the Intelligent HVAC System, significant improvements in energy efficiency can be obtained without major modifications to an existing heating and cooling system. The system is easy to install, operate, and remove, and is an attractive enhancement for an environmentally-friendly home.

A brief internet search was unable to easily find a similar product, but it is assumed there are competing systems currently available. Patent 4417687, issued in 1983, describes a similar product but the Intelligent HVAC System will include a “smart” wireless thermostat unit.

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## Project Features/Objectives

The Central Thermostat Unit and Individual Room Controllers will coordinate with each other so that the user can control room temperatures from both the IRC and CTU.

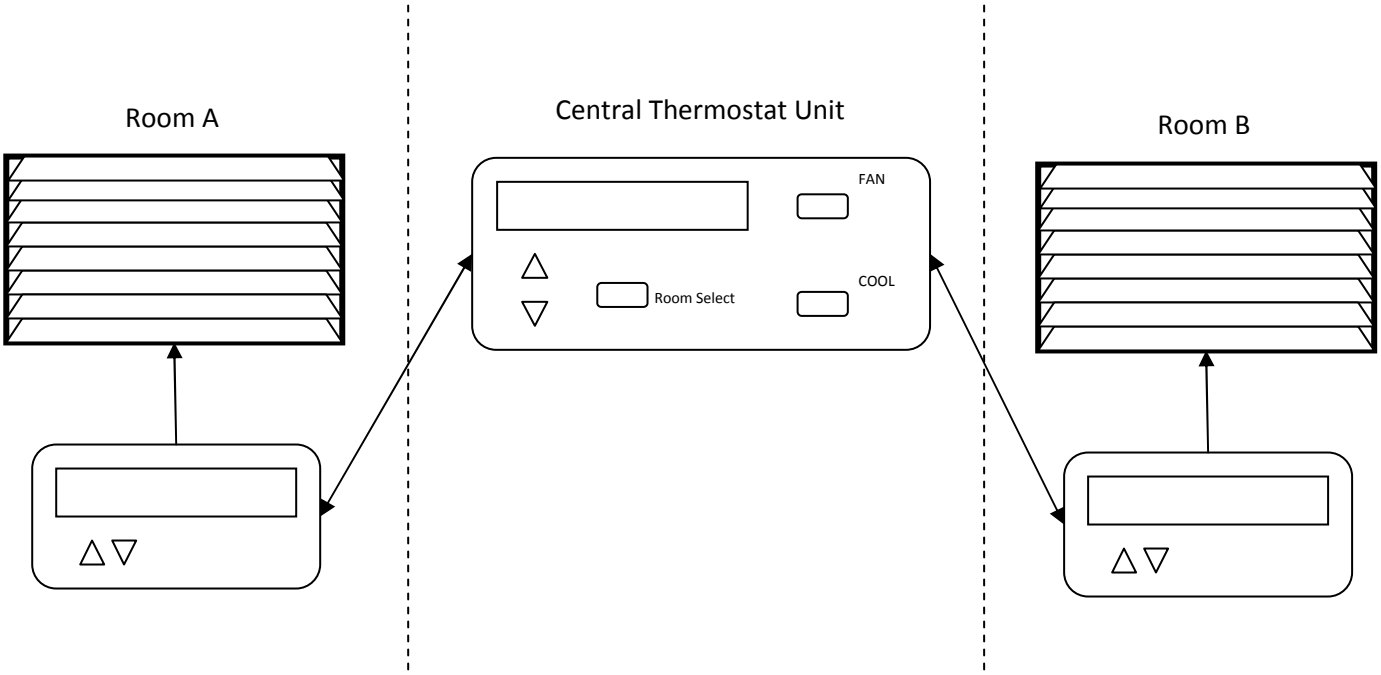


**Figure 1: Intelligent HVAC System**

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## *Central Thermostat Unit (CTU)*

The Central Thermostat Unit will control the main HVAC system. The CTU will feature a two-line, 20-character LCD and five pushbuttons. The LCD will display the current and desired temperatures for both rooms, as well as the fan and heat/cool status. The pushbuttons will be used to select the temperature settings for each room, HVAC fan setting, and heat/cool setting.

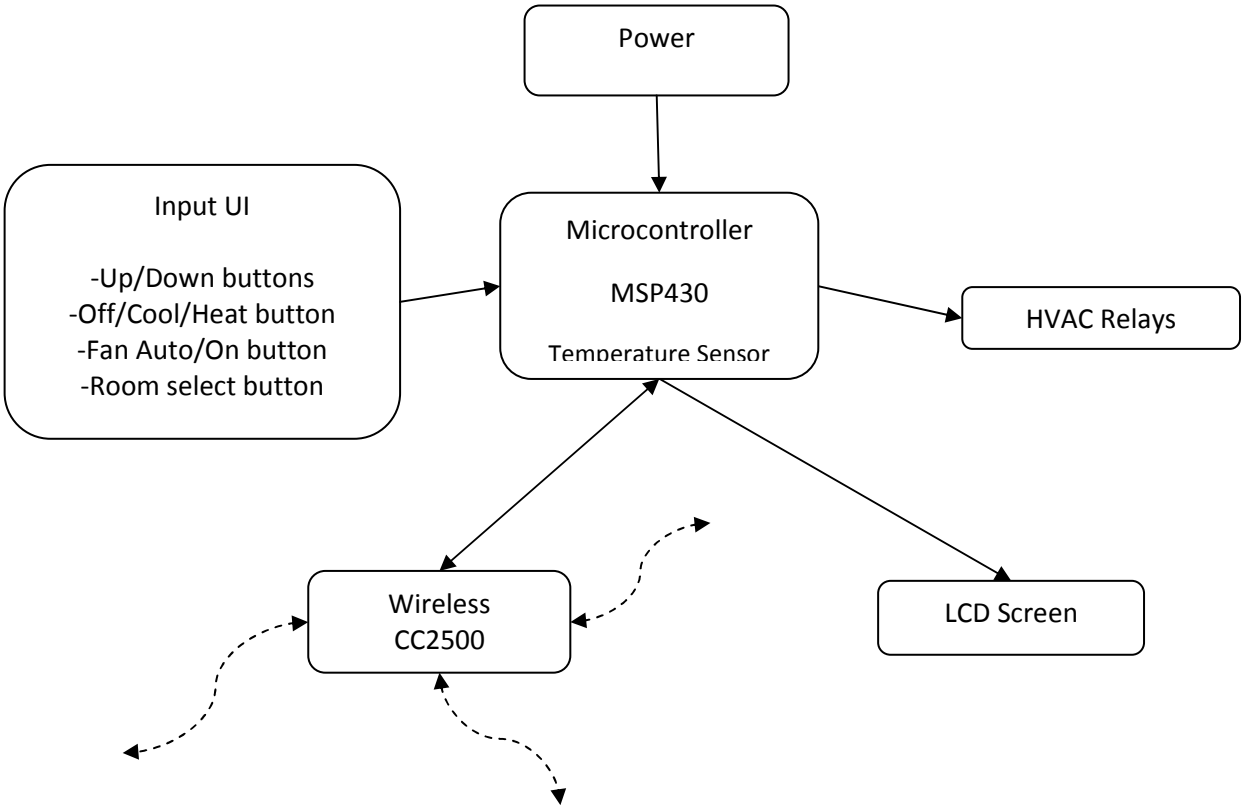


**Figure 2: CTU Design**

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## *Individual Room Controller (IRC)*

The Individual Room Controller will be able to control the desired temperature in the room by adjusting the HVAC register vent. The IRC will feature an LCD, two pushbuttons, and a HVAC register vent with servo motor and control hardware. The LCD will display the current and desired temperature for its room. The IRC will coordinate with the CTU for proper operation.

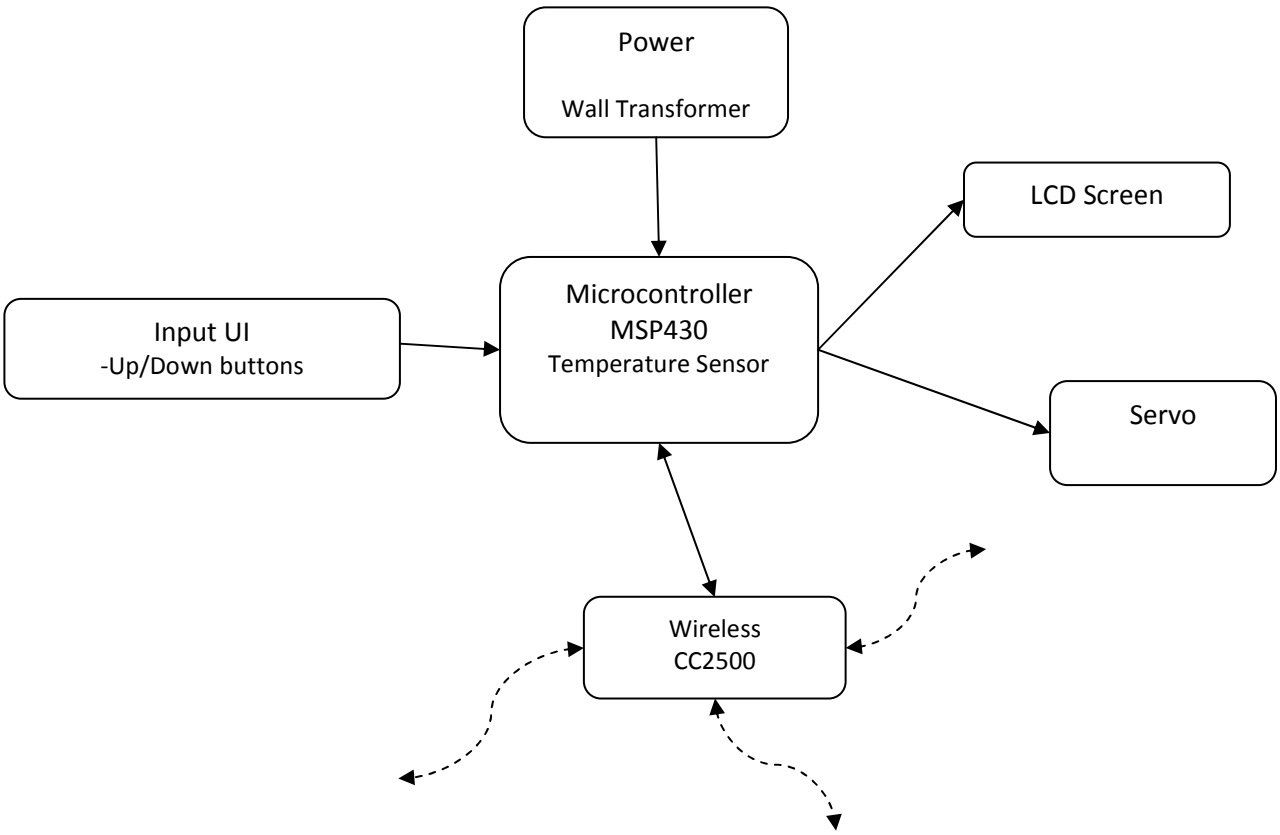


**Figure 3: IRC Design**

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## Concept/Technology

Power consumption, device costs, and ease-of-use were the primary considerations during technology selection. The Texas Instruments MSP430 microcontroller will allow the hardware to meet all three considerations. The MSP430 platform of ultra-low-power 16-bit RISC mixed-signal processors from TI provides the ultimate solution for battery-powered measurement applications[1] and includes an on-board temperature sensor. The Texas Instruments CC2500 radio frequency transceiver is a low-power, low-cost, 2.4 GHz chip that is ideal for implantation with the Intelligent HVAC System. The Texas Instruments ez430-rf2500 development board pairs the MSP430F2274 microcontroller with the CC2500 with an easy-to-use USB powered programmer. Servo motors will be used to control the AC register vent openings because pulse code modulation can be used to adjust the vents.

## Technical Objectives

The Intelligent HVAC System will have a CTU that is connected to the HVAC system with relays to turn on the fan, compressor and heat strip. The user interface will consist of an LCD screen (to display the set and current temperatures and HVAC settings) and a pushbutton to turn the HVAC system to cool, heat or off. There will also be a pushbutton that will allow the user to set the fan to auto or always on, and two pushbuttons to control the thermostat temperature. If the thermostat is set to cool, the compressor will turn on when the temperature is two degrees Fahrenheit above the set temperature and cool the house till it is one degree below the set temperature. For the heat setting, the thermostat will turn on

[1] www.ti.com/msp430

the heat strip when the temperature is two degrees below the set temperature and turn off when it is one degree above it. A pushbutton will be used to select whether the user wants to adjust the temperature for Room A or Room B from the CTU.

In the IRC there will also be an LCD screen to display the set and current temperatures and two pushbuttons to control the thermostat temperature. When the user would like to have the room set to a higher temperature a servo will close the register when it is two degrees Fahrenheit below the set temperature and open the register when it is two degrees below the set temperature. When the room is set to a cooler temperature than the rest of the house, servos will close all of the other registers in the house and turn the compressor on till it is two degrees below the set temperature, and then open all the register back open.

The CTU and the IRCs will talk to each other using wireless communication. The Individual Room Controllers will use wall power and the Central Thermostat Unit will be battery powered. The servos will be moved back and forth using pulse code modulation. Temperature sensors will be used to monitor the temperature of the different rooms. The processors do not need to be run at a high clock speed because of the low process load.

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## Division of Labor

The work separation will be in accordance to the table below:

| Greg Slovin | Robert Gravois |
|---|---|
| **MCU Port Expansion** | **Preliminary Delay, LCD, and Initialization Subroutines** |
| **Wireless Communciation** | **Temperature Acquisition** |
| **AC Register Mechanics** | **Servo Motor Control** |
| **PCB Design** | **PCB Design** |
| **PCB Population/Board Integration** | **PCB Population/Board Integration** |

**Table 1: Division of Labor**

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## Gantt Chart

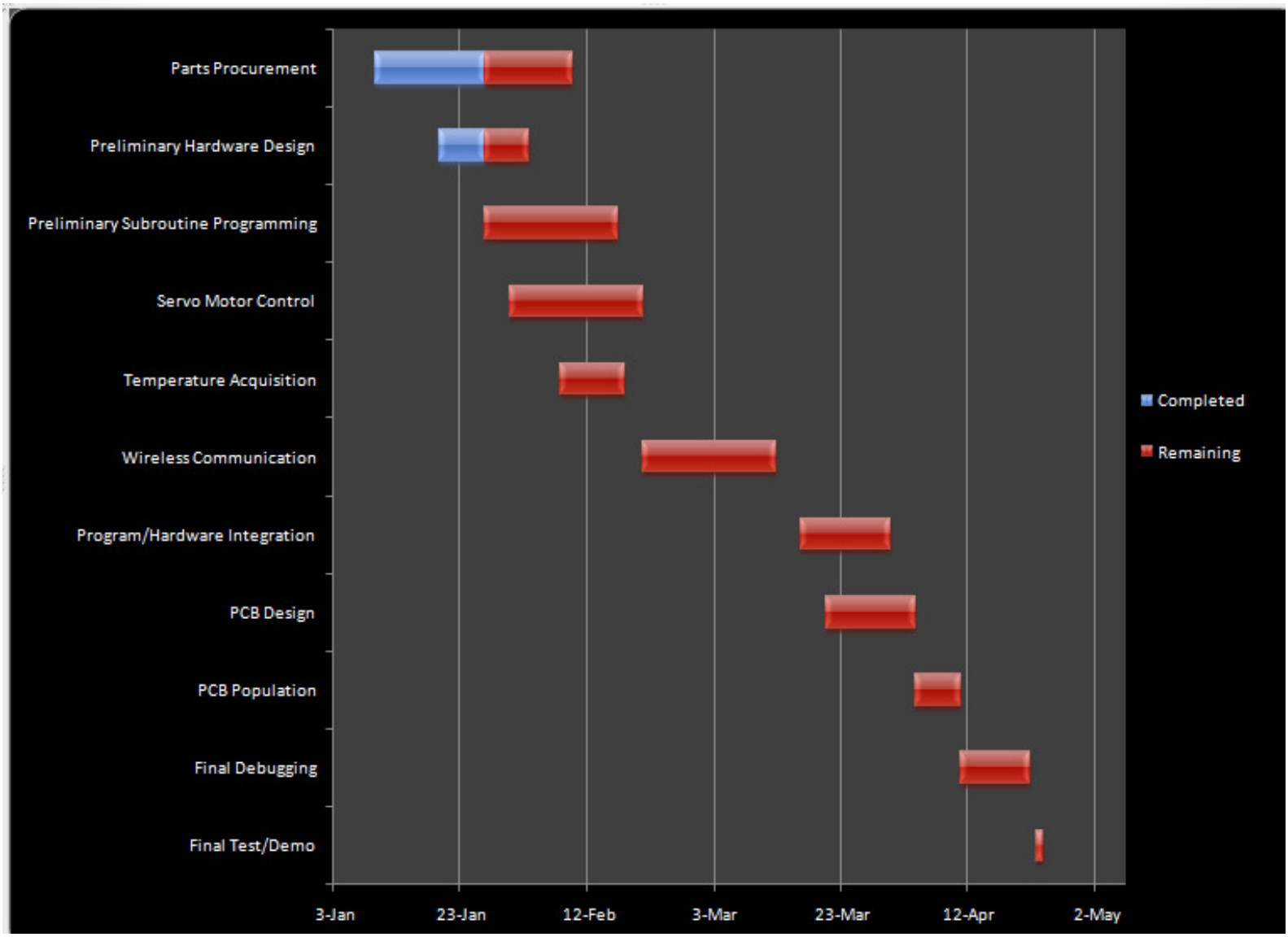


**Figure 4: Gannt Chart**