



# SMART HVAC

Energy-efficient A/C knows when you're in the room. By Dave Mabe

When I began working from home, I converted a shed in the backyard into an office. The shed wasn't heated or cooled, and summer was bearing down, so I needed to find an HVAC solution quickly. I didn't want to extend my home's HVAC system because this would have been a lot of trouble, quite costly, and wasteful; I knew the office would remain unoccupied much of the time. Being a home automation enthusiast, I saw this as a perfect opportunity, and I came up with a cheap, efficient solution that sets the temperature to different levels depending on whether I'm in the office.

My office is about 20 feet square, so all I needed for cooling was one energy-efficient window-unit air conditioner. As with the main house, I decided to use X10 home automation, which transmits through home electrical wiring. X10 hardware is easy to install: you just plug the controller modules

into the wall and then plug your appliances' power cords into the modules.

The peripheral components in my system were the X10 appliance module on the A/C unit, an X10-readable thermometer, and an X10 motion sensor. The thermometer I used was part of a multi-function weather station that takes indoor temperature as one of its readings, but you just need any cheap digital thermometer that can communicate over X10. To control the system, I used the excellent home automation program MisterHouse and a serial adapter that translates between MisterHouse messages on the computer and X10 signals on the power lines. (My weather station connects to a different computer in my network from the one that runs MisterHouse, but you can also plug the thermometer directly into the MisterHouse computer if it has a spare port.)

Photograph by Dave Mabe

## MATERIALS

**Air conditioning unit** Or fan, heater, or other HVAC appliance

**X10 appliance module** (model A466) One for each appliance, from [x10wirelesshome.com](http://x10wirelesshome.com), or just click on the company's notoriously ubiquitous pop-up window

**Digital thermometer** that's readable via X10 I took readings from my Oregon Scientific WM918 weather station via HomeSeer software, but the MisterHouse project site reports that you can also use an iButton DS1920-F5 sensor in a DS1402D reader [ibutton.com](http://ibutton.com) with an iButtonLink Link12 serial adapter [ibuttonlink.com](http://ibuttonlink.com).

**X10 motion sensor** (model MS14A) [x10wirelesshome.com](http://x10wirelesshome.com)

**Wireless transceiver** (model TM751) [x10wirelesshome.com](http://x10wirelesshome.com)

**X10 serial computer interface** Such as an X10 Activehome kit, [smarhome.com/1140.html](http://smarhome.com/1140.html)  
**MisterHouse software** Open source project [misterhouse.com](http://misterhouse.com)

I plugged the A/C unit into power through the X10 appliance module and set it to a lowest temperature of 60°F, since my MisterHouse virtual thermostat would be turning it on and off anyway. Once this was set up, the rest of the “thermostat” was some simple Perl code executed by MisterHouse:

```
$office_ac = new X10_Appliance('C1');
# C1 is the X10 code I set on the appliance module
$desired_temperature = 75;
$wiggle_room = 1.5;

if ($Weather(TempIndoor) > ($desired_temperature +
$wiggle_room)) {
    set $office_ac ON;
}

if ($Weather(TempIndoor) < ($desired_temperature
- $wiggle_room)) {
    set $office_ac OFF;
}
```

I placed this code in a file and saved it to the MisterHouse code directory, where it would be executed continuously, several times a second. In the code, \$Weather is a special variable that MisterHouse sets automatically when it checks for a weather station, and \$wiggle\_room defines some

leeway in maintaining the desired temperature. Increasing \$wiggle\_room saves energy by causing the A/C to switch on and off less frequently.

To add an occupancy check, I used a battery-powered X10 motion detector near my desk chair, which talks to an X10 wireless transceiver plugged into the wall. When the office is unoccupied in the summer, the desired temperature gets set higher (for winter, with a heater, it would be the opposite). To accomplish this I added the following code to the same file:

```
$desired_temp_unoccupied = 85;
$desired_temp_occupied = 75;
$office_occupancy_timer = new Timer;
$office_occupancy_timeout = 10;
$office_movement = new X10_Item('N9'); # this is the
motion detector

if (state_now $office_movement eq ON) {
    # motion detected in office!
    $desired_temperature = $desired_temp_occupied;
    set $office_occupancy_timer ($office_occupancy_timeout
* 60);
}

if (expired $office_occupancy_timer) {
    # no motion for 10 minutes
    $desired_temperature = $desired_temp_unoccupied;
}
```

MisterHouse's Timer variable type is perfect for this. When the motion detector senses movement, the code sets a timer for 10 minutes and sets the virtual thermostat to 75°F. If no motion is detected after 10 minutes, the timer expires and sets the thermostat to 85°, because I'm not in the office anymore (or maybe I'm just asleep!).

Because all this control is in software, there are limitless opportunities to customize your setup. For example, you could change the desired temperature remotely via MisterHouse's built-in web interface. You could track and determine your A/C's cooling rate at different outdoor temperatures. Even the fanciest “programmable thermostat” hardware would be put to shame by the flexibility you have with this system.

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