EE/MKT/ITP Collaborative Project

Spring 2018

Sensor/Controller Device for a "Smart" Home

Product Overview

This semester teams are asked to develop some type of "smart" device for use in a residence or small business. A homeowner or business owner can install this device to sense various conditions and then control something based on the input conditions. It is up to the product development team to decide what type of smart device they wish to build. Some examples could be:

- Thermostat for controlling heating and cooling with various sensors to try and make it more efficient than a traditional thermostat that only senses the temperature in one location.
- Irrigation controller for determining when to operate sprinklers. This could include a number of sensors to try and reduce water usage when irrigation is not needed such as during rain or when rain is predicted.
- Lighting control. Turns lights (or other electrical devices) on and off according to predicted usage, and could also replace simple light timers that people use to make the lights go on and off when on vacation.
- Alarm system for detecting intrusion, smoke, water leaks, etc. This can also include safety devices such as a system for monitoring a swimming pool to watch for unexpected entries perhaps by a child that has fallen in.

It is likely that all of the functions provided by any of these devices are already available in some form as smoke alarms, light timers, thermometers, burglar alarms and many others. The goal of this product is to improve on these simpler devices that many home or business owner may already have by adding some intelligence to the device, and if possible have the device perform multiple functions. The results of the market research performed by the Marketing students should provide data as to what features consumers find attractive in the product.

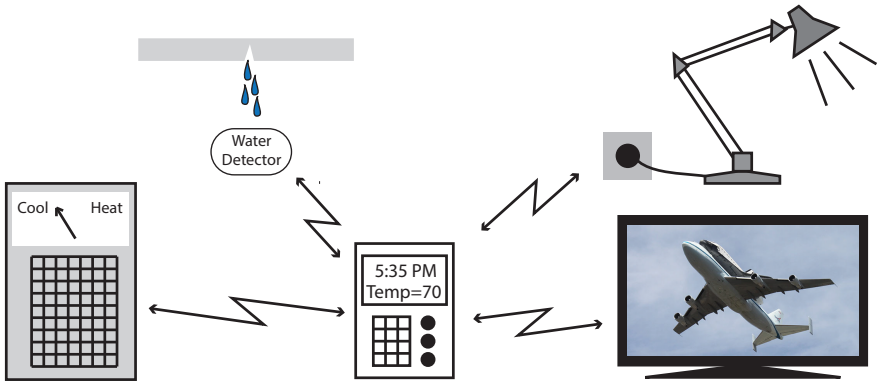

Figure 1: Smart system with various sensors/controllers

Product Features

Regardless of what function your product is designed to do, some basic guidelines should be followed.

- This product is intended for installation in existing homes or small businesses, not for installation in new homes during their construction. This may affect your design decisions since your customers may be less willing to run wires between devices if it means ripping walls apart to install the wiring.
- Ease-of-use. You are developing a product that will probably be installed and used by non-technical people. It should be easy to set up and use and not require the user to call in an expert every time they want to make a small change in the configuration.
- Expandable. The user should be able to add more sensors or controllers to their system in the future without having to reinstall or reconfigure the entire system. Your company plans on introducing additional components for the system in the future but should do so in a way that does not require their past consumers to scrap their existing system in order to incorporate them.
- Reliability. The product should be designed with the idea that once it is installed it may operate for many years without the owner making changes to it. What can be done during the design stage to produce a product that has a longer useful life than many consumer electronics devices?

The product development teams are free to design the product in any way they choose that achieves the goal of producing a system that meets the project requirements. The product teams are encouraged to explore any 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.

Product Requirements

The requirements for your product are heavily dependent on what type of project your team chooses to design so the requirements listed below are meant as rough guidelines. Once you have settled on a product, the more specific requirements will be discussed with the instructors at weekly meetings early in the semester. Regardless of what is eventually required for your product, teams are encouraged to go beyond these requirements in terms of both additional features and the quantity of each feature.

It is not required that every single feature that is claimed for the product be implemented in the prototype. Teams should plan to implement in their prototype about 80% of the 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, size, etc. 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, if your product claims to be able to control 20 devices of some type, it is not required that the prototype be able to control all 20. Showing that it can control two or three, and is expandable to more, is sufficient. The cost analysis of the final product should reflect any claims made for it, not just what was implemented in the prototype

In the description below of the project, the terms “inputs” and “outputs” refers to whatever devices the product includes that senses conditions (the inputs) or does something to cause some action to happen (the outputs).

- The product must be based around one or more pieces of dedicated hardware using embedded microcontrollers. **It it not a phone app.** You may choose to use a phone app as one possible way to communicate with the system but the end user must also be able to operate the system using controls attached to the device.
- If the device consists of multiple units (a main controller unit and one or more remote units) it is up to the product development team to determine what type of connection to use (wired or wireless) between the various devices. In the actual product the connection between the controller and the remote units can be some type of wireless link, however experience in past semesters has shown the the wireless links can be difficult and expensive for the teams to work with so teams may be allowed to simulate a wireless link by using a wired connection. This will be discussed in more detail in EE459 class meetings.

- The system must include at least three inputs of different types (temperature, moisture, noise, motion, buttons, light, etc.) If your product consists of multiple units (a main unit and one or more remote devices) at least one of the inputs must be incorporated into one of the remote devices and communicate information to the main unit. Other can be part of the main controller if that is the optimum place for it.

- The system must include at least three outputs of different types that do something as a result of the information provided by the inputs devices. These can be alarms, servo motors that move something, electrical outlets that are turned on or off, etc. If your product consists of multiple units (a main unit and one or more remote devices) at least one of the outputs must be incorporated into one of the remote devices and receive information from the main unit. Other outputs can be part of the main controller if that is the optimum place for it.

- At least one of the input or output components of the system must be new to the market in that it can not be found in competing products that are currently on the market.

- For products with multiple devices, the main controller must be able to detect and notify the user when it can no longer communicate with a remote input or output device. This might be due to a broken communications link, a dead battery, or the remote unit itself may have become defective. A user should not think that all is well with his system when in fact an input or output unit is no longer working.

- If the product is designed to include wireless links between the controller and the remote units, the design must address the issue of how to prevent inadvertent interference with or from a neighbor's similar unit. The product should only communicate with wireless devices that it is supposed to be associated with.

- 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. For example if the controller has a internal time-of-day clock, then the 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 configuration data for the various inputs and outputs should also be retained through power outages. It is not required that the various outputs continue to operate if the controller loses power, however once power is restored everything should resume normal operation without operator intervention.

- The devices may not use the home's 120V AC power wiring for communication like some devices that have been on the market for many years. This requirement is primarily for safety reasons since we don't want students to have their prototypes connected to high voltages while working on them.

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. Teams should always be aware of how additional features will affect the cost of their product and be prepared to justify the added cost. For example, a team may decide to add a module to their product to give it a wireless connection to the Internet, and then plan to use this to send messages to the user about various conditions. The cost of this module must then be factored into the cost of the product. Saying that you have added a $80 module to a project that is suppose to sell for $60 is not a good idea if you plan to make a profit.