Smart Stove

Senior Project Design

Joshua Andrews, Electrical Engineering
Riley McKay, Electrical Engineering

May 5, 2017

Abstract

A "smart stove top" project is proposed, where a temperature sensor is used to monitor the temperature of a hot plate and the duration of use while the hot plate is on. The project will be powered with a 5V DC source provided from the 120V AC hot plate source. The converter circuit will allow power to pass to the hot plate as long as the protection circuitry is not activated. The protection circuitry will not activate until the temperature sensor records a temperature above 120 degrees, the temperature at which it will take 5 minutes of direct contact to cause burns. If the hot plate is left on for more than a set amount of time, an alarm will sound and an LED will flash. If the alarm sounds for another 5 minutes without being reset, the power will be cut to the hotplate, therefore minimizing the risk of fire.

Contents

1 Feasibility

The proposed design initially encompassed a complete stove top and had the ability to cut the power if certain criteria were met. The idea was scaled down to a single hot plate burner, which eliminates potential problems that could be foreseen with a larger-scale project. The hot plate provides a more practical and economical approach to the same problem, without the challenges of a full size stove top or having to deal with 220V AC needed to power a standard electric range.

1.1 Design

A preliminary design has been developed for the smart stove top project as a block diagram and is shown in Figure 1 below.

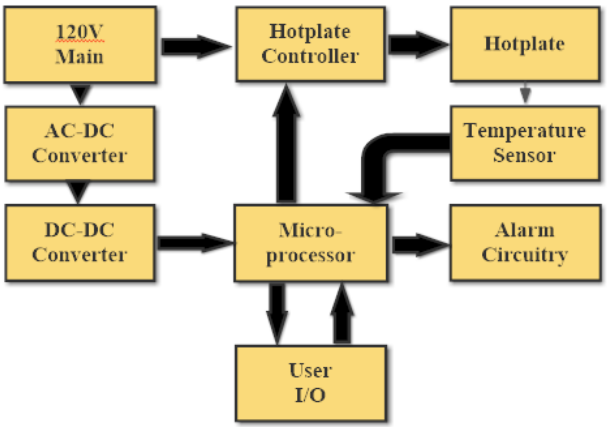

Figure 1: Block diagram of smart stove project

The schematics for the designed components have not yet been generated. The major components of the project that will be designed instead of purchased include a DC-DC converter, a hot plate controller, and a battery back-up system.

The project will have to operate around high temperatures with the temperature sensors connected to the hotplate and the relay will also be very close to the hot plate. The project will also have to be protected from messes, spills, and oil/water vapor emanating from cooking.

There are a couple products on the market that function with a similar premise, but many of these products are very expensive. The commercially available products are a plug and play solution to stove top safety that have several issues. The iGuardStove, at a retail price

of 400 dollars, uses a motion sensor to detect is the stove user is in front of the stove but can be activated by pets and children as well. It also shuts power off to the entire stove instead of just the burners. The designed smart stove project is intended to be a low cost option that stove manufacturers can incorporate into their designs. Power would not be shut off to the stove, allowing the clock and lights to continue functioning. The reset circuitry would also require a push of a button instead of a motion sensor, minimizing the risk of inadvertent resets and increasing safety.

To test through the design phase and for proper operation of the project an oscilloscope, digilent analog discovery 2, IR temperature sensor, voltmeter, and a dual voltage power supply will be used. These instruments are readily available in either Barrows Hall or at home.

The main standard for our design comes from CISPR13, EN55013 for consumer applications. It specifies how much EM interference the power supply will be able to produce while still conforming to the regulation. It specifies that the energy in all but the fundamental harmonic must be small in order to meet the standard. As the designed power supply will operate on DC, it is expected that the standard will be met.

1.2 Execution

A hotplate has already been acquired for a low price. The sensors, microcontroller, and various wiring and passive components should be easy to acquire. None of the parts required are difficult to obtain, so shipping costs and time shouldn't be a big factor. There is a possibility of additional funding as contact has been made with St. Joeseph's Hospital, but for the scope of this project, the funding provided by the department should suffice. If for some reason the project exceeded projected costs, both teammates are willing to spend a moderate amount of money to accomplish the goal, although the total cost should be well within budget. If things go wrong, all of the individual parts are cheap enough and easy enough to replace. In the event of a design failure, there may be several alternative designs that may be deemed acceptable. Simple testing devices such as oscilloscopes or the digilent analog discovery 2 should be adequate, and an Ardunio will be used to program the microcontroller and will then be removed and placed into the project's circuitry.

There are a variety of temperature sensors, speakers, and LEDs available online, from multiple reputable vendors that could be used in the project and should be easy to obtain. The selection process will be based on cost versus performance as the project is desired to remain as inexpensive as possible while still meeting specifications.

Many parts have already be acquired for the project and of the remaining parts required, most of them can be found in the the school store. All of the parts are common and available through many retailers. There is no expectation of running into an issue of being able to

acquire parts on time for this project. If last minute parts are required, both team members are willing to pay out of pocket for expedient delivery.

1.3 Teamwork

In order to accomplish this task, both teammates must work together successfully. It is expected that the project will take approximately 24 hours a week to complete, split between each teammate. Both teammates have an electrical engineering background, with one teammate having a double major in electrical and computer engineering.

The major design components of the project will require some research in order to successfully design and construct especially the design of the solid state relay. The required information should be available through various instructors and online references.

The project features mainly electrical components with the possibility of some coding, that should be in the scope of the team's skill set. Both teammates are willing to work equally on the project, and both have a peaceful attitude that should be conducive to a productive working environment over the three semester period.

The complete project is based on both team members completing senior year. If one member were not to be present for the the design, the specifications of the project could still be met by one team member. Having the temperature sensor already completed is a large step in being able to complete the project on time even with a single team member.

Both team members have a varying range of skills that will be useful in building the project. One team member is better with code while the other has taken ECE 323 which will be useful in the power supply design. One aspect that both team members are uncertain is the design of the hot-plate controller. Information on this topic will need to be acquired through instructors as well as looking at previous senior projects. Some of the current senior projects included specifications for no relays and the team members will talk with them about the design.

1.4 Description

The goal of this project is to create a product which uses a temperature sensor to monitor and control a hot plate burner. The product will ideally feature time and temperature settings, where the user will be able to control the temperature of the hot plate within a certain extent. Also featured would be a setting that turns the power to the burner off if the burner was left on for a set period of time. The goal will also include the exclusion of relays, instead opting to use discrete components to control the hot plate. The project will also be

comprised of a micro-controller and alarm circuitry. The main components will be powered by 5 V, which will be obtained by utilizing an AC-DC and DC-DC converter. Throughout the entire process discrete components will be used whenever possible.

The project contains a variety of individual parts, but all of them should be relatively easy to attain. All of the passive components should be easily found through a reputable dealer. The more important parts like the micro-controller, temperature sensor, hot plate, and step-down transformer should not present any difficulties either. All of the parts are relatively inexpensive and duplicates could be ordered. Both teammates are willing to provide additional funding if unforeseen expenses arise.

There are a few possible problems that need to be addressed throughout the course of the project. The project will be controlling a heat source with varying temperature. The change in temperature could cause problems as some electronics characteristics vary with temperature. Possible solutions to this would be some sort of heat shielding, or careful placement of the key components. Another problem not yet addressed is the sensitivity range of the relay circuitry and hot plate unit. One of the main specifications was to design this project without using relays, so the range of control may be questionable. Although these projects may pose potential setbacks, neither pose a significant threat to the overall feasibility of the project.

This project was designed to be used as a relatively low cost solution to the potential fire hazards posed by prolonged or unregulated use of a cooking surface, particularly aimed at the elderly, forgetful youth, or any other populace subject to improper use of a stove top. The project should be able to be developed at a low cost and provide a reliable alternative to existing higher-end items. Since this project is designed to be used for at-risk people, there is even a greater importance on the final product being dependable and reliable. Since this product could be producing a high temperature for an extended period of time, any malfunction could pose serious safety risks.

As designers it is important to minimize risks from an ethical standpoint. These points should factor into the design process when choosing the standards that are adhered to when doing the wiring, circuit layout, and components chosen. Harsh or improper use must also be considered when the designed project is constructed. The project is created for a specific purpose, but has to be able the myriad of potential hazards posed towards a household product, such as spillage from boiling over, poor power supplies, being disconnected when in use, ect. Therefore, the product must be as durable as possible. This shouldn't be a problem considering the design doesn't contain any overly-sensitive parts, with the only possible exception being the micro-controller circuitry.