Smart Stove

Senior Project Design

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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.

Specifications

DC-DC 5V$\pm$1% with $\leq$50mV ripple supplying 500mA or greater
SSR 5V DC input controlling 120V AC, $\geq$5A
Reset/Alarm circuitry enabled when temperature exceeds 120 degrees

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. 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 solid state relay, 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 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.

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 implements such as oscilloscopes or the digilent analog discovery 2 should be adequate, and an ardunio will be used to program the microcontroller which 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.

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 implement 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, which 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 which should be conducive to a productive working environment over the three semester period.

2 Expense Report

Table 1: Component Costs

Component	Price/Unit	Quantity	Overall Price
12 V step-down transformer	$13.99	1	$13.99
Hot plate	$15.00	1	$15.00
Solid-State Relay	$20.17	1	$20.17
Ceramic Capacitors	$0.24750	20	$4.48
1/4W Resistor	$0.00475	20	$.015
Atmel ATmega328P microcontroller	$3.95	1	$3.95
LCD Display	$4.00	1	$4.00
Arduino Uno R3	$14.99	1	$14.99
Temperature Sensor	$4.99	1	$4.99
PCB Board	$1.20	1	$1.20

Cost of Components	$82.92
Shipping Cost	$15.00
Sales Tax	$4.97
Number of Circuits to be Built	1

TOTAL COMPONENT COSTS	$102.89

The component pricing was pulled from Digi-Key and Mouser. The information in Table 1 shows that the total component costs were $102.89. This is a rough estimate and expected to rise as more parts are added or problems arise with the design. The solid-state relay won't appear in the circuit, but could prove useful when testing the circuit and programming the board.

Table 2: NRE Costs

NRE Factors	Price per Hour
Salary	$40.00
Health Cost	$8.00
Social Security/Medicaid	$3.00
Sick Leave/Holidays	$4.00
401k Contribution	$5.00
Overhead Per Employee	$60.00
Total per Hour	$120.00
# Hours Worked on Project	225
# Employees on Project	2
TOTAL NRE COSTS	$86400.00

Table 2 depicts the non-recurring engineering (NRE) costs associated with building this circuit. This is based on industry standards for a 15 week period appropriating 24 hours per week as a team for this project.