Project Proposal:
Easy Cooking Programmable Electric Stove

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1. Introduction

1.1 Title: "Easy Cooking Programmable Electric Stove"

Cooking is traditionally a manual process that often requires the cook to follow a set of instructions. This process is highly prone to fluctuations in execution. In the case of an inexperienced cook, this process is also daunting and prone to errors. As such, we decided to design a system that partially automates the cooking process to address these issues.

1.2 Objectives

The goal of this project is to create a simple and safe interface that guides a person through the process of cooking as well as make the cooking process more convenient.

The functions we hope to include in the finished product are as follows:

- Stove automatically adjusts heat settings.
- Screen that prompts the cook with cooking instructions.
- Interface to extract the electronic recipe into the stove.
- Shut off function when there is no cooking vessel present.
- Measure and display food temperature on the screen.

With these functions, we hope that our finished device will bring about the following benefits:

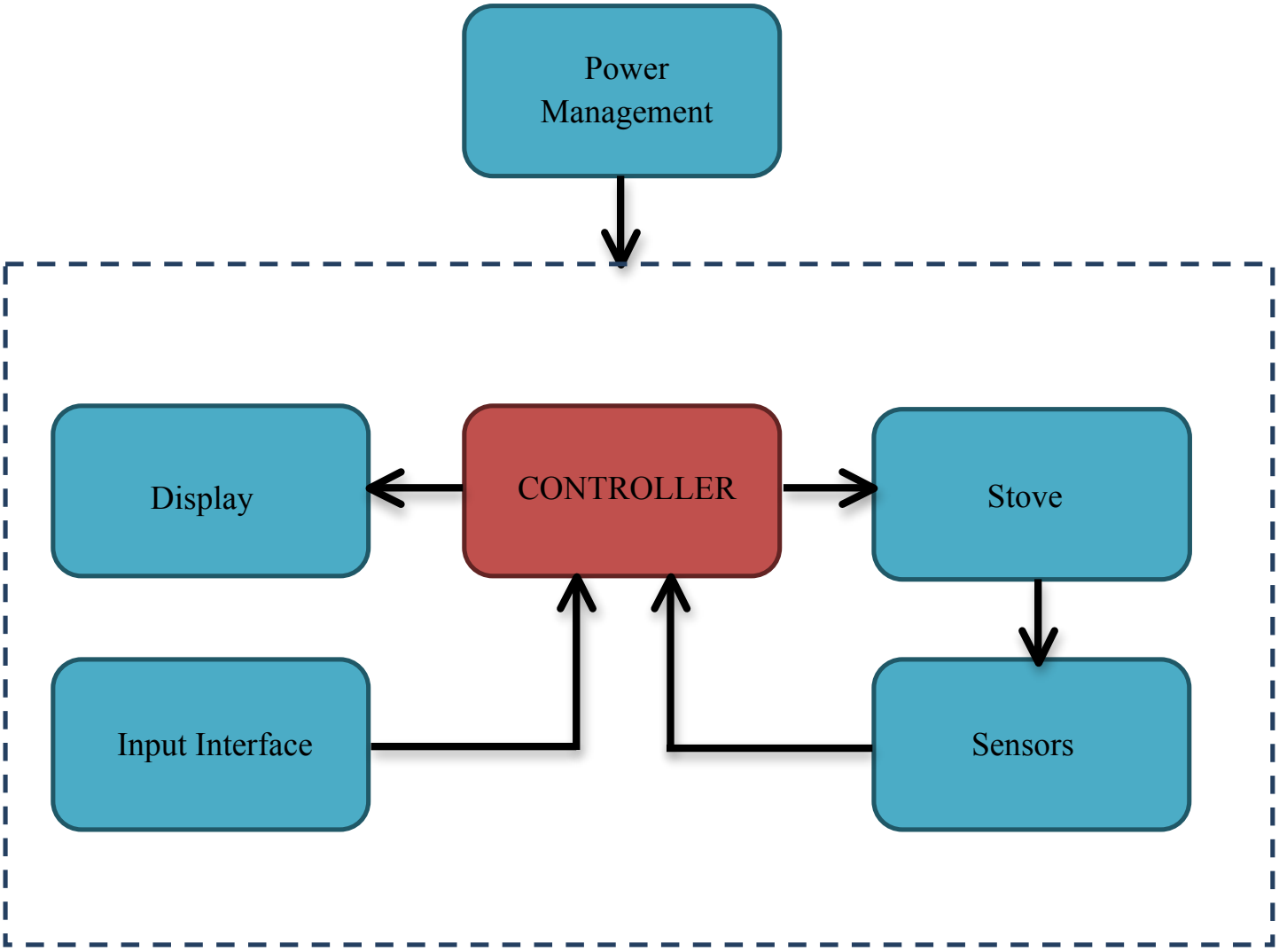
- Allows for more convenient cooking as the user does not have to change the heat level manually.
- Allows the cook to follow the recipe easily.
- Potentially increase the success rate of cooking a dish.

We hope to build this device with the following features:

- Single burner electric stove, AC input.
- Power management unit which connects to wall outlet, controls power input to the stove, and powers controller and peripherals.
- Temperature IR sensors.
- Proximity IR sensors.
- Display for cooking instructions/status.
- Controller to process the state of the system and provide necessary outputs.
- Buttons to control the state of the system/advance to next cooking stage.
- Bluetooth connectivity to extract electronic recipe from external devices such as mobile phones or computers.

2. Design

2.1 Block Diagram



2.2 Block Descriptions

1) Controller

   This block is the brain of the whole device. It will perform the following main tasks:

   a. Receive and process signals from the sensor block to determine temperature of food and presence of a cooking vessel.
   b. Retrieve the recipe via Bluetooth.
   c. Output the cooking steps and temperature of the food to the display.
   d. Send signals to the power management block to allow for turning on/off of device
   e. Send pulse-width modulated signal to the stove to adjust heat settings according to the recipe.

2) Power Management

   This unit connects to the wall outlet and makes necessary conversions to provide power for the whole device. When sensors detect no cooking vessel on the stove, this block cuts off all power to the stove.

3) Stove

   Single coil heating element. The heat level will be adjusted by varying current into the coil with a pulse width modulator (PWM). Power will be provided by the power management block while the PWM input will be provided by the controller.

4) Display

   LCD to show instructions, status and food temperature.

5) Input Interface

   Interface that receives the recipe via Bluetooth from an external source and input from the user through start, reset and continue buttons.

6) Sensors

   a. Temperature Sensors

      - This will monitor the temperature of the food in the cooking vessel as well as the temperature of the heating element. These data will be sent to the controller.

   b. Proximity Sensor

      - To detect whether a cooking vessel is present on the stove and this information will be sent to the controller.

3. Requirements and Verification

3.1 Requirements

1. Controller
    - Receive and process input from sensors as well as input interface (recipe via Bluetooth, button presses) with 100% success rate.
    - Generate output signals to control stove and display.
    - Sends control signals to the power management block and the stove.
2. Power Management
    - Receive input from 120V wall outlet and converts it to rated voltages of devices.
    - No power is provided to the heating element if either the maximum operating temperature is reached or no cooking vessel is on the heating element.
    - Sufficiently isolated so as not to put user in danger of electric shock.
3. Stove
    - Normal single burner electric stove operation, with electronic heat control via pulse width modulation (PWM) and maximum operating temperature.
4. Display
    - Show cooking parameters (time elapsed, temperature, etc.).
    - Show recipe instructions.
    - Show state of the system.
5. Input Interface
    - Retrieve recipe from external source via Bluetooth with 100% success rate.
    - Respond to button presses with 100% success rate.
6. Sensors
    - Proximity sensor detects cooking vessel with 100% success rate.
    - Temperature of heating element is read with an accuracy of ±5%

3.2 Verification

1. Controller
   Generate inputs for the controller using LabVIEW while also monitoring the outputs, making sure that the outputs correspond correctly to the inputs.
2. Power Management
   - Verify that the output voltages correspond to the rated voltages of our devices.
   - Test over current protection (using fuse) by forcing high current.
3. Stove
   Verify correct operation of the pulse width modulator by measuring the rate of temperature increase at each heat setting, making sure that higher heat settings correspond to more rapidly increasing temperatures. The temperature data will be obtained using a thermocouple and processed using LabVIEW.
4. Display
   - Verify functionality of LCD by connecting it to a known source (such as a computer).
   - Verify that controller output corresponds to correctly displayed characters on the LCD.
5. Input Interface
   - Send text file to the controller and verify that it is shown accurately on the LCD.
   - Verify that button presses register correct signals and that buttons are correctly debounced by plotting signals of interest in LabVIEW.
6. Sensors
   - Verify functionality and sensitivity of proximity sensor by having a cooking vessel placed at various orientations and positions on the stove. The output will be fed into LabVIEW where a voltage vs. time graph will be plotted.
   - Verify functionality and accuracy of temperature sensor by simultaneously measuring the temperature of a test object using a thermocouple. Outputs from the temperature sensor and the thermocouple will be plotted and analyzed using LabVIEW.

3.3 Tolerance Analysis

The most important component of our design is the stove. In order to ensure the proper functionality of the stove, we need to verify its response to the modulated signal from the controller. As such, we need to ensure that higher heat settings (more current into stove) correspond to more rapidly increasing temperatures in order to model the normal operation of a traditional stove.

To obtain data about the normal behavior of a traditional electric stove, we plan to run tests on an unmodified control stove using a thermocouple and our temperature sensors. By comparing the differences in the temperature gradient vs. heat setting plots of the modified and unmodified stove, we can iterate on the pulse width modulation scheme. The data will allow us to either produce a response that is very similar to that of the control stove or one that is more linear.

4. Cost and Schedule

4.1 Cost Analysis

Labor:

Name	Hourly Rate	Total Hours Invested	Total= Hourly Rate x 2.5 x Total Hours Invested
Chng, Xiong Kai Benjamin	$40.00	150	$15000.00
ArdyWinoto	$40.00	150	$15000.00
Cheng Han, Lee	$40.00	150	$15000.00
PCB	$35.00	4	$140.00
Mechanical Store	$50.00	10	$500.00
Total			**$45640.00**

Parts:

Item	Part Number	Quantity	Unit Price	Total Cost
Single Coil Cooking Range	Toastess THP-517	2	$30.00	$60.00
Arduino	Arduino UNO A000066	3	$27.20	$81.60
IR Proximity Sensor	Sharp GP2Y0A21YK	2	$15.00	$30.00
IR Temperature Sensor	Melexis MLX90614ESF-BCA-000-TU	2	$20.00	$40.00
LCD	---	1	$19.95	$19.95
Round Push Button	MSPS103C	4	$2.72	$10.88
Controller- FPGA board	544-1736-ND Cyclone II Starter Kit EP2C20N	1	$228.75	$228.75
Laser Pointer Module	---	1	$5.00	$5.00
Bluetooth Module	P14874CT-ND	1	$15.57	$15.57
Transformer	595-1165-ND	1	$8.69	$8.69
MOSFET	IRL630PBF-ND	10	$2.35	$23.50
Miscellaneous (Capacitors, Inductors and Resistors)	---	--	$20.00	$20.00
			TOTAL = $543.94	

GRAND TOTAL = LABOR + PARTS = $46,183.94

4.2 Schedule

Week	Benjamin	Ardy	Cheng Han
1/28 RFA due	• Project Topic Discussion • Submit RFA • Discuss project/proposal details	• Project Topic Discussion • Discuss project/proposal details	• Project Topic Discussion • Discuss project/proposal details
2/4 Proposal due(Wednesday 4pm)	• Final proposal	• Proposal Draft 2	• Proposal Draft 1
2/11	• Research power electronics circuits and come up with preliminary design	• Design state machines for micro-controller • Finalize parts	• Prepare documents for design review • Order parts and request for funding
2/18 Design Review sign up(Opens Monday closes Friday)	• Design schematics for PWM and converter • Work on design review document	• Design and implement temperature and proximity sensor units • Work on design review document	• Learn Android App programming for Bluetooth • Work on design review document
2/25 Design Review	• Implement power electronics and PWM for stove	• Implement state transition on controller based on button presses and sensor inputs	• Preliminary Android app that allows a user to input recipe manually
3/4	• Program controller to send PWM signal to the stove	• Perform reliability and accuracy testing of sensors • Obtain performance data of control stove	• Preliminary Android app that allows transmission of simple data to Bluetooth module
3/11 Individual Progress Reports due(Wednesday 4pm)	• Complete individual progress report • Program controller to display recipe on LCD	• Complete individual progress report • Submit 1st draft of power circuitry PCB	• Complete individual progress report • Implement Bluetooth connectivity for controller
3/18 Spring Break	• Prepare slides for mock up demo (power electronics	• Prepare slides for mock up demo (state	• Prepare slides for mock up demo (slides for Bluetooth

	and PWM)	transitions/algorithm)	transmission)
3/25 Mock-up Demos Presentation sign up(Opens Monday closes Friday)	• Perform testing on the reliability and accuracy of senors in affecting the stove • Prepare for mock up presentation	• Finish power circuitry PCB and submit 2nd draft if necessary • Prepare for mock up presentation	• Prepare for mock up presentation • Finish android app for recipe transmission via Bluetooth
4/1 Mock-up Presentations(Web sign-up, EL 159) Last day to request 1st revision PCB(Friday)	• Fix remaining issues with power electronics and display	• Fix remaining issues with control logic, sensors and buttons	• Ensure proper transmission of data from the Android device to the Bluetooth module
4/8 Last day to request final revision PCB(Friday)	• Start writing final report • Ensure completion of system including the house of power electronics and stove	• Start writing final report, debugging and fine-tuning	• Start writing final report, debugging and fine-tuning
4/15 Demo and Presentation sign up(Opens Monday closes Friday)	• Prepare final report with emphasis on project deliverables(power electronics, display)	• Prepare final report with emphasis on project deliverables (control logic, sensors)	• Prepare final report with emphasis on Bluetooth transmission of recipe
4/22 Demoes and Presentation	• Prepare for demonstration and presentation	• Prepare for demonstration and presentation	• Prepare for demonstration and presentation
4/29 Presentations Final Papers and lab notebook due(Wednesday 4pm	• Finish up final report • Last check on all equipment for check out	• Finish up final report • Last check on all equipment for check out	• Finish up final report • Last check on all equipment for check out