Experiment 11: The Project Proposal

Laboratory Outline

Finish Laboratory 10: Navigation

When finished, begin defining the project as described below.

The Project

Today, you need to submit your project proposal. You have already been informed of the expectations of the project proposal and below is an example to also help guide you on the style of the content and the formatting. If you have already started characterizing devices to be used in your final project, please include that data in your proposal as well.

Read through the example below, then spend time discussing project ideas with your TAs and classmates. The project is open-ended (meaning you can really do anything you want), but the TAs will define a default project (a task that any team could adopt as their final project). Brainstorming with others can help you define a practical and fun project and even enable to define a larger project that may have distinct components completed by different teams!

Thermo-luminescent Coffee Table

Project Proposal
ECE 110 Lab
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Introduction and Problem Statement

In many homes and offices, the display of visually impressive furniture does a great deal to impress guests and improve the morale of the viewers. The primary goal of this project is to produce a piece of furniture that would elicit the same effect upon viewing. While such a piece of equipment may be simple in design, the cost of purchase or availability from a manufacturer is often prohibited. The goal of this project is to produce a product that is affordable, easily shipped and somewhat customizable. In addition, the equipment must function as furniture and must be appropriately durable for everyday use in a household or office.

Proposed Solution Concept

The proposed design concept consists of a coffee table which is capable of reacting to the temperature of objects placed on top of it. The coffee table will be able to roughly sense where an object is placed on the table and determine the temperature of the object. Using that information, the table will be able to produce colored light that corresponds to both the temperature and location of the object(s) on the surface. In practice, this will mean that when a hot cup of coffee is placed on the table, a red glow will appear below the cup. If a cold beverage, such as ice water is placed on the table, a blue glow will appear. Temperatures within that range will produce colors that fall in between red and blue on the color spectrum accordingly.

In order to accomplish this goal, several aspects must be considered. First, the sensors and light sources must be considered chosen so that the table is reactive to the full range of temperatures and consumes a minimal amount of power. From there, a method of processing the sensor inputs and controlling light output must be designed so that the table behavior is reliable and possibly adjustable. In addition, the method of powering a potentially large number of light sources and other circuit components must be carefully considered so that the trade-off between table size and sensor/source density is mitigated. Lastly, the mechanical design of the table must be carefully considered so that the table is sturdy, within a reasonable weight range and protects the internal electronics from potential liquid spills.

In total the overarching project will be accomplished by a large team of students. Each design aspect listed will be accomplished by a smaller, two person “subteam”. This project proposal pertains to the design of the temperature sensitive, light emitting surface.

Solution Outline

The planned solution consists of a modular design. The electronic surface of the table will lie some small distance below the actual protective surface on which objects may be placed. Electronic surface will consist of an array of tiles. Each tile is planned to be a 5cm square containing a thermopile to be used as temperature sensor and 8 light emitting diodes (LEDs) and the relevant circuitry for utilizing these devices. A set of pins will be located on the surface of the each tile to act as an interface to the controller and power supply. An overview of the design concept is shown in Figure 1 below.

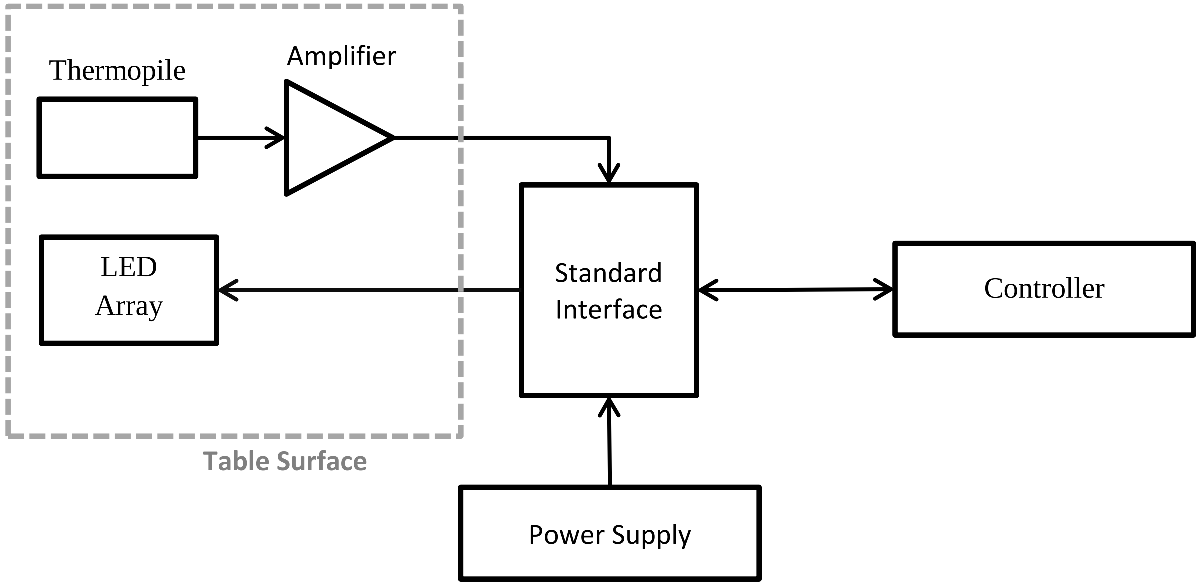

Figure 1: Project structure

The first stage of the design process will require the construction and testing of a single prototype tile. Once this first prototype has been successfully built, a set of 9 additional prototypes (10 in total) will be built and tested with prototype controller and power supply. Lastly a 50cm by 100cm coffee table will be built using a total of 200 tiles. This proposal will only focus on the initial 10 tile prototype.

Thermopile Integration

Since the thermopile is a low voltage device, an amplifier circuit must be designed that will map the thermopile voltage into a more useful range. In order to achieve a sufficient degree of temperature sensitivity, the amplifier must induce a minimal amount of noise. Under these considerations, an operational amplifier (OPAMP) will be employed. The output of the OPAMP circuit will be sent to the standard interface, through which it will be received by the central controller.

There will be many aspects about utilizing the thermopile sensor that must be characterized before the sensor can be properly integrated into the circuit. First, the sensitivity of the sensor must be tested to determine to what level of detail we may detect temperature. While the datasheet should contain this information, the amplifier circuit may have an effect. Additionally, the effect of distance and between the object being measured and the sensor will need to be characterized so that an appropriate distance be the table surface and sensor can be chosen.

LED Integration

Since a range of colors is desired in the table surface, a set of tricolor LEDs will be employed for each tile. The array of LEDs will be powered and switched on and off using a bank of shift registers connected in serial. The bank of shift registers will be controlled by the central controller in the table. By using shift registers to control the LEDs, the number of inputs necessary for each tile is reduced significantly reduced.

Standard Interface

The interface on each tile will consist of a 2 pin power source header and a 4 pin data header. The power source header will connect with the power supply circuit directly and be designed to accept 5V with a range of acceptable voltages and currents dependent upon the components and layout of the tile. Data header will consist of three input pins that will be used to control the shift register bank and one output pin that will come from the thermopile amplifier circuit. The inputs will operate at a standard digital voltage of 0V to 5V. The output voltages will also range from 0V to 5V but will vary in a continuous fashion within than range.

Necessary Components

1. RL5-RGB-D Diffused Tricolor LEDs (80)
    - A set of 8 tricolor LEDs will be used for each tile.
2. 74HC595 Shift Registers (30)
    - 3 Shift registers will be used on each tile.
3. OPA2234 OPAMP (10)
    - A minimum of one OPAMP will be necessary for each amplifier circuit.
4. TS118-3 Non-contact Infrared Thermopile Sensor (10)
    - 1 thermopile sensor for each board.
5. Arduino Uno
    - A simple controller to simulate the behavior and constraints of the table controller.
    - Note that the Arduino operates in the same voltage ranges of our standard interface.
6. Basic circuit components
    - Protoboard and wires- for testing and prototyping the initial circuit designs
    - Resistors - LED driver and OPAMP circuits
    - Capacitors - OPAMP circuit
    - Printed circuit board (PCB) - final prototypes

Projected Timeline

- Week 11
  - Design and prototype the thermopile circuit on a breadboard
  - Design and prototype the LED driver circuit on a breadboard
- Week 12
  - Test the integration of both the thermopile and LED circuits with the Arduino
  - Design PCB layout for each tile and optimize sensor/LED placement based on field of view of the sensor and smoothness of the LED lighting.
- Week 13
  - Solder the 10 prototype tiles and test each using the Arduino Uno
  - Integrate the array of tiles into the power supply and central controller
- Week 14
  - Debug and fine tune the prototype
  - Demonstrate the awesomeness