Interactive LED Staircase Modules

Mike Udelhofen

TA: Mustafa Mir

Team #38

ECE 445

Interactive LED Staircase Modules – Mike Udelhofen

Introduction:

I have selected this project as a means to motivate pedestrians to engage in more physically active transit while reducing energy normally used in electronic devices. Additionally, the result will serve as a visually and sonically pleasing installation that can be placed in otherwise less attractive areas. I am excited to be employing Electrical Engineering skills and concepts in a way that will benefit human health, energy conservation, and the arts.

Objectives:

The project will serve to motivate pedestrians to use staircases instead of escalators and elevators in an initiative to conserve energy and promote a more active lifestyle, all the while making the place of installation more pleasant. It will consist of semi-transparent panels that can be easily installed onto a staircase. The interactive nature of the panels, with a series of LEDs and sensors that will respond with different illuminative patterns when stepped on, will attract passerby to use the stairs on which they are installed. Multiple modules can be connected together and will interact with each other to create ripple effects, create color gradients, and more. Additionally, ambient sounds will be incorporated in the response, with effects such as playing a different note for each stair step, thus creating an ascending musical scale as the user travels upward.

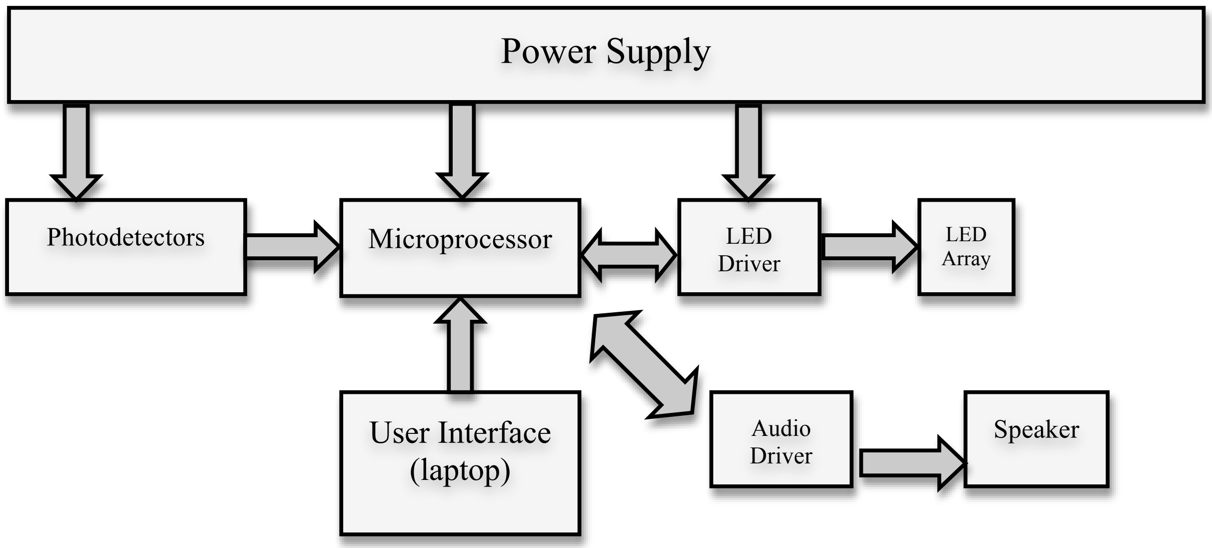
Benefits:

- Promotes pedestrian fitness
- Saves energy by diverting traffic from motorized lift systems
- Serves as a visually and sonically pleasing experience

Features:

- Multicolor LED array
- Detector array to relay step signal
- Speaker to play ambient sound responses
- Modular – multiple panels can be connected together easily and will interact

Design:



Block Description:

Photodetectors: These will detect changes in light over points on the staircase panel to determine where the user is stepping and, thus, which LEDs will light up. This signal is sent to the microprocessor.

Microprocessor: Receives all inputs from the photodetector array to determine where LEDs should activate. It will also process data regarding which patterns and responses to execute within the LED arrays. For example, the microprocessor will activate and control the ripple effect response. It will also control the data sent to the audio driver, again as a function of photodetector signal, to produce stored sounds. Since the panels are modular, others will also connect and their I/O will operate from the main microprocessor.

User interface: The user interface will connect to the microprocessor via USB. It will be allowed to change and upload code to the microprocessor to change the functionality of the system or select between different display modes.

LED Driver: Converts signals from the microprocessor into usable signals to activate the designated LEDs within the array.

LED Array: Each module is defined by "pixels" and will be controlled as such. Each module will be 2 pixels x 6 pixels. Each pixel contains 4 LED triplets, with each triplet containing one red, one blue, and one green LED. Thus, the array is a total of 8 x 24 LED triplets for a total of 144 LEDs per module between R, G, and B.

Audio Driver: Receives a signal from the microprocessor and turns it into a usable audio output which is heard at the speaker. Also controls speaker volume.

Speaker: Receives audio input from the Audio Driver.

Performance Requirements:

- Detects a footstep on 95% of instances
- Latency from detection to output within .3 seconds
- Consumes less power than an escalator (standardized per each stair)
- Each module withstands at least 250 pounds

Testing Procedures:

1.) The microprocessor is the main electronic unit of the system. Thus, it must be able to process all data and must do so within a timely manner (e.g. minimal latency). Since it will be receiving signals from the detector arrays, processing the information, and turning it into usable signals for the LED drivers and audio driver, we will test the speed of this process from input in the photodetector circuit to output in both LED and audio segments.

2.) Sensor accuracy will be tested and adjusted appropriately. This will be done by placing a sensor under the plexiglass at the proper height and using several different room lighting conditions and different colored materials on the other side of the plexiglass, compiling data on different output voltages for different conditions.

3.) The system will be tested for power consumption. By checking the power consumption over the power input to the system, it will be determined whether or not this summed consumption is within design specifications. It will be compared to a calculated value for the average escalator power consumption per standardized height.
4.) Modularity is an important feature of the system. Thus, tests will be performed to make sure that:
    a. The microprocessor can handle the operation of three modules at once.
    b. Modules communicate with each other properly.

Using analysis of the system's latency.

Cost Analysis:

Cost of Labor = $80/hour x 2.5 x 144 hours = $28,800

Cost of Parts:

Part	Price	Quantity	Total Price
Plexiglass panels	-	3 panels x 1ft x 3ft = 9 sq ft	$50
RGB LEDs	$0.30	3 x 48 = 144	$43.20
Photodetectors	$.30	12	$3.60
Microprocessor	$5.00	1	$5.00
LED driver	$2.00	3	$6.00
Audio driver	$4.00	1	$4.00
Speaker	$5.00	1	$5.00
PCB	Free	1	$0
Miscellaneous	$10.00	-	$10.00
		TOTAL	**$126.80**

Total Cost = Cost of Labor + Cost of Parts = **$28,926.80**

Schedule:

Week	Task
1/16-1/30	Choose project idea, search for partners, submit RFA.
2/6	Work on and submit project proposal, search for parts.
2/13	Research microcontrollers and their specifications, begin electronics design, search for parts.
2/20	Finish electronics design, place parts orders, begin assembly of first module plexiglass box.
2/27	Assemble first module, ensure response of sensors and LED array.
3/5	Assemble first module, ensure interaction with microprocessor.
3/12	Finish assembly of first module, ensure operation of sensors, LED array, and audio in conjunction with microprocessor, begin writing code to control response behavior of first module.
3/19	SPRING BREAK
3/26	Finish writing code to control response behavior of first module, begin assembly of other two modules.
4/2	Assembly of other two modules.
4/9	Finish building other two modules, implement code for full system.
4/16	Finish writing and testing code on full system.
4/23	Final demo, presentation.
4/30	Finish final paper, presentation.