A Different Kind of “Bar”-O-Meter

Project Proposal

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I. Introduction

Statement of Purpose: Most of the time people find themselves torn between several options, especially when trying to decide on the places to have a fun night. Knowing the number of people at the bars and the atmosphere there would certainly be helpful. Thus, we aim to develop a system that can indirectly estimate those information by installing weight sensors underneath the floors and making those data readily available online. We are excited to see how this system would benefit bars and their customers and call it "A Different Kind of 'Bar'-O-Meter."

Objectives:

While we aim for our system to enhance the communication between businesses and their customers, we have outlined certain specific objectives to be accomplished over the course of the semester.

Project Goals:

- Develop weight sensors with less than $\pm 10\%$ error and cost less than $50/sensor
- Realize data transmission from sensors (analogue) to PC (digital)
- Establish online portal (social website) to display information to public
- Power entire system with minimum cost

Intended Functions:

- Convert wall power to desired voltage needed for sensing pads
- Estimate weight on the tile using pressure sensors
- Send analogue signal from sensors to data transmitter through wire
- Convert analogue to digital signal and aggregate data for processing
- Parse/analyze data on computer and provide live update online

Benefits to Customer:

- Affordable cost for bars/clubs to install and setup
- Long-term investment in marketing effort for bar owners
- Easily accessible live information online on bars to customers

Product Features:

- Sensing pads powered by external battery to lower cost
- Data transmitter/receiver powered by wall power to avoid sudden power outage
- Present estimate for number of people at a bar online in the form of an interactive map
- Interpret bar atmosphere based on data collected and display online

II. Design

Block Diagram:

Our system consists of mainly four modules: Power Supply, Snesor Module, Transmitter/Receiver Module, and Computer/PC. The functionality of each module and the relationship between the modules are presented in Figure 1.

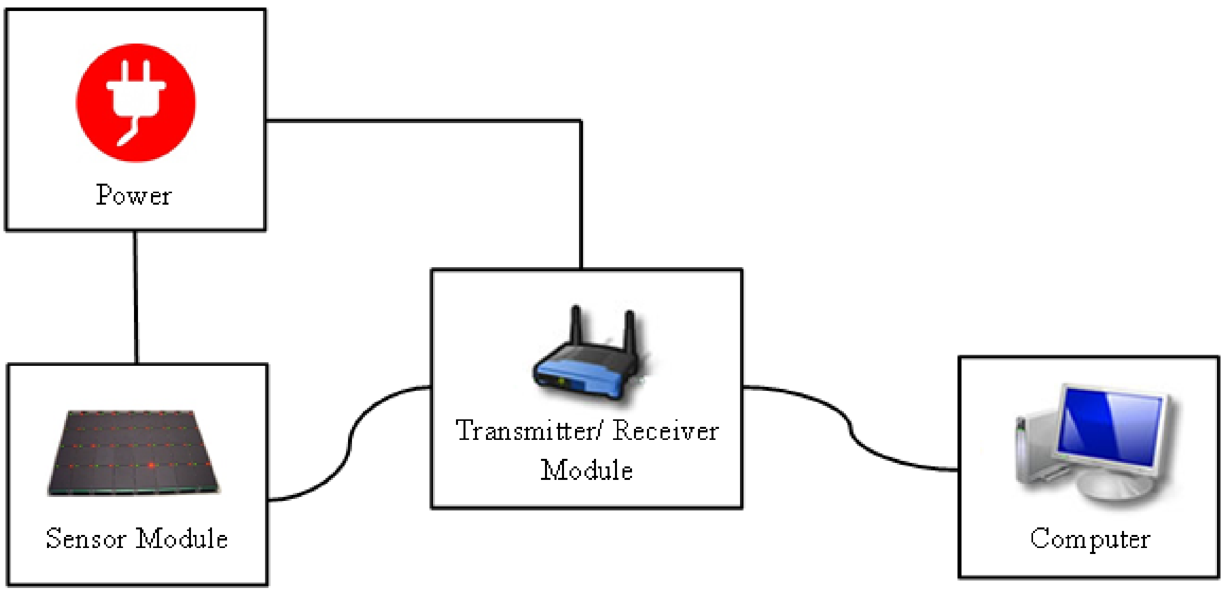

Figure 1

Block Descriptions:

1. Power Supply

The Power module intends to supply electricity to both the Sensor Module and the Transmitter/Receiver module using wall power. Since computers usually already have their own power supply, we have excluded the consideration of powering computers. We will use external batteries to provide 12V DC to each sensor pad. For the transmitter and the receiver, we plan to use 110V AC wall power directly. If after testing, we find external battery insufficient to power the sensing pads, we would consider the feasibility of using wall power for sensing pads as well. Using 110V AC to power sensing pads entails need to include a voltage transformer within the module to generate desired power range and ultimately ensure functionality of the system.

2. Sensor Module

The Sensor Module measures the instantaneous pressure on a sensing pad. A pressure sensing pad has an area of around $0.25m^2$. A “Bar-O-Meter” system contains a set of sensing pads which can cover the entire to-be-measured area. Each pad performs the measurement synchronously, but independently, with relatively small time interval (~0.1s). The pressure level of a pad reflects the active level of people on top of it. A read of zero pressure means the area is empty, a pressure in the range of a normal person's weight means someone is standing on the area. Also, a stable pressure tells a low activity, and an unstable pressure shows that the area measured is active. While each individual sensing pad in the system corresponds to a specific area on the map, sending data directly from each pad is costly. Therefore, the pressure data are collected via wires from all pressure sensing pads in the form of analogue signals and compile them one into one digital signal. The data collection step is essential to prepare for the data transmission step.

3. Transmitter/Receiver Module

The Transmitter/Receiver Module takes the analog signal from sensors and produces a digital signal without loss of information, then transmits it through a bluetooth transmitter. This block is needed to communicate between the pressure sensing pads and the display terminal. It translates analog signals to digital signals, and sends out the signal. After receiving the data, the data is then ready for the Computer to process and display.

4. Computer

A computer analyzes the data, maps the data onto the map instantaneously, and creates an interactive map. The interactive map will be displayed on an existing social website. This block will mostly be implemented through software algorithms. A map of the bar (or any measured area) will be displayed on the terminal. The map is divided into subareas, each corresponds to pressure sensing pad placed. The level of activeness will be realized through color coding or change in patterns. The color/pattern on the map corresponds simultaneously with the intensity of the activities in the area.

III. Requirements and Verification

Requirements:

1. Power Supply

There are two parts for the power supplies, one for weight sensor circuit and the other for bluetooth devices and DSP boards, i.e. the data transmitter/receivers. For the weight sensor circuit power supplies, we use the SL power 12V DC power supplies. Because the circuit does not need too much power. we consider this 12V DC power supply can be used at least one year. And for the bluetooth devices and DSP boards we will just simply use the 110V AC power plugs.

2. Sensor Module

For each unit of the sensing pad, we will use one weight sensor, one amplifier and several resistors. The proposed circuit is displayed in Figure 2.

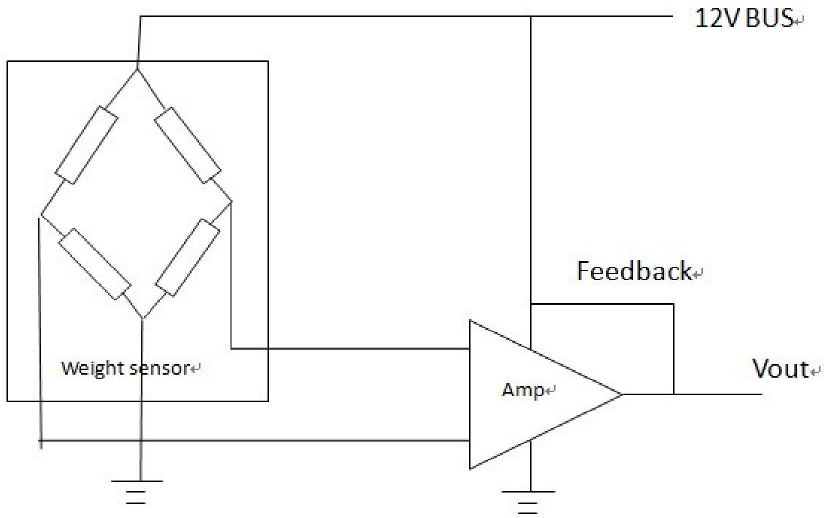

Figure 2

While this circuit is subject for further improvements, we plan to add more resistors to get the maximum gain of our amplifier depending on the type of amplifier we use. Pressure sensors are used for measuring the weight on sensing pads, also they can provide the changing of weight on sensing pads. Amplifiers are used to amplify the signals generated by weight sensors. We plan to use TI INA114 amplifier. It can provide us 10000 gain with 5 ohms resistor.

3. Transmitter/Receiver Module

For the receiver, we plan to use the Texas Instruments TMS320C5510A-200 digital signal processor chip mounted on a Spectrum Digital TMS320VC5510 evaluation board, which is used in ECE 420. We can use this Digital Signal Processing (DSP) board to convert analog signal that we get from the sensing pads to the digital signal that we can program on our computers. Furthermore, we will install the bluetooth devices on both of our receiver and computer. We use such means to transmit the data wirelessly from the receiver (the DSP board) to computer/PC.

4. Computer

Here, we are going to program C or C++ to analyze our data from the DSP board. Additionally, we plan to show our analyzed data in a heat map form online, so we need to connect to the internet and programing the web page.

5. Consistency in interconnectedness components

The only thing we need to concern during the transmission is that the maximum sample rate is 48kHz for the DSP board which we are going to use, so the maximum input should be less than 24kHz for avoiding aliasing. If it is not fast enough for the purpose of our system, we need to add source coding and channel coding for our data transmission.

Verification:

1. Power

For the simplicity of this system, we would use multimeters to measure the voltage provided by the SL Power Supply. If we decide to use power supply to provide electricity to the sensing pads as well, we would measure the input and output of our transformer to ensure that we are providing the correct level of voltage (12V DC).

2. Sensor Module

Sensing pads will be tested by applying weight on the board to check the output against theoretical data. To ensure that the sensing pads will work under all conditions, we would generate a range of input from 0kg to 300kg. The first step is to check whether the output of sensing pads vary linearly with input. Then, we wanted to ensure that inputs within the range can be interpreted without loss of information. To test the fluctuation of output due to immense activity, we would apply intermittent weights on the pads, i.e. a person jumping up and down. The sensing pad would be considered working properly if the output varies linearly with input and exhibits fluctuation when input is sporadic.

3. Transmitter/Receiver Module

Since this module converts analogue signal to digital signal, we would test the functionality of this module by connecting the input to a function generator and the output to a hex display. The function generator would generate analog signals to simulate the information sent from the sensing pads. Then, we will check whether the hex display can produce the information we desired. Furthermore, we need to perform a series of testing because we want to ensure that this module can receive information from multiple sensing pads at the same time without mixing the data. Thus, we would construct a table of results.

4. Computer

Since the information sent from the previous module contains a lump of data that includes information on both the specific sensing pad and the weight on it, we would test whether the information is preserved after parsing. Also, since the data represents the voltage from each sensing pads, we would first need to confirm that the algorithm we developed could correctly correspond to the weight actually applied on the sensing pad. Hence, we would check the information on the location of the sensing pad, the voltage output, and the weight applied. Ultimately, we need to test whether the interactive heat map would display the information correctly by generating graphs to show the result.

Tolerance Analysis:

The most important and significant component in this project, as we all considered, is the weight sensor that we will use for measuring the weight on a sensing pad. Because it measures the original data and its accuracy affects our final result directly.

We plan to make the range of our weight sensor from 0kg to 300kg. For testing this, we can simply put something around 300kg on the sensing pad and see if it can measure its weight or we can let one person stand on the sensing pad and jump for 5 seconds to see if the weight sensing can afford that strength and also check the accuracy of the measurement. We allow at most $\pm 10\%$ of error between estimated value and measured value.

IV. Cost and Schedule

Cost Analysis:

Labor:

Name	Hourly Rate	Hours Invested/Week	Total Weeks	Total Labor Cost*
Chen Hu	$30.00	10	15	**$11,250.00**
Tuo Liu	$30.00	10	15	**$11,250.00**
Yiming Song	$30.00	10	15	**$11,250.00**
Grand Total				**$33,750.00**

Parts:

Item	Quantity	Unit Cost	Cost
12V DC Power Supply	1	130	**$130.00**
PCB's **	10	11	**$110.00**
GE Infrastructure sensing Pressure Sensor **	10	20	**$200.00**
TI INA114 Amplifier **	10	5	**$50.00**
Resistors **			**$50.00**
BNC Cables	2	12	**$25.00**
Texas Instruments TMS320C5510A DSP Board	1	395	**$395.00**
Bluetooth Device	1	150	**$150.00**
Software Tools	1	50	**$50.00**
Grand Total			**$1160.00**

*Total Labor Cost = Hourly Rate x Hours Invested/Week x Total Weeks x 2.5

** Assuming the system contains 10 sensor pads

GRAND TOTAL = Labor + Parts = $33,750 + $1160 = **$34,910**

Schedule:

Task	Assigned Resource	2/4	2/11	2/18	2/25	3/4	3/11	3/18	3/25	4/1	4/8	4/15	4/22	4/29
Complete proposal for submission	Chen Hu	X						Spring Break						
Design preliminary weight sensor circuit	Yiming Song	X	X											
Design data transmission circuit	Tuo Liu	X	X											
Order parts for system	Chen Hu		X											
Design transformer for AC to DC	Chen Hu		X											
Assemble weight sensor using amplifiers	Yiming Song		X											
Prepare mock design review	Chen Hu		X	X										
Design data transmission via Bluetooth	Tuo Liu		X	X										
Assemble data transmitter/receiver	Chen Hu			X										
Refine design review	Yiming Song			X										
Assemble sensing pads for testing	Tuo Liu			X	X									
Refine data transmission circuit	Tuo Liu				X									
Refine weight sensor circuit	Yiming Song				X									
Design PCB and send for fabrication	Chen Hu				X	X								
Develop PC-end data analyzer	Chen Hu					X								
Test data transmission module	Tuo Liu					X	X							
Test weight sensor module	Yiming Song					X	X							
Prepare for mock-up demo	Chen Hu						X		X					
Integrate modules for mock-up	Yiming Song						X							
Finalize power supply plan	Tuo Liu						X							
Test bluetooth communication	Yiming Song								X					
Verify requirements	Tuo Liu								X					
Finalize PCB and send for fabrication	Tuo Liu								X					
Fix remaining issues	Chen Hu								X	X				
Integrated testing	Tuo Liu									X				
Perform tolerance analysis	Yiming Song									X				
Integrate all parts for completion	Chen Hu									X	X			
Final testing for all modules / fixing	Yiming Song										X	X		
Prepare for presentation	Tuo Liu										X	X		
Prepare for demo	Chen Hu										X	X		
Demo	Yiming Song												X	
Presentation	Tuo Liu												X	X
Final Paper	Chen Hu												X	X