AN INTERIM REPORT

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Bethlehem, PA 18015

PROJECT TITLE:

SOUND MONITOR SYSTEM WITH POWER OVER ETHERNET CAPABILITIES

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Advisor Signature

Date

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Problem Statement

Do Lehigh University students get enough sleep? No. The average student does not get enough sleep. According to a survey from the National College Health Assessment of Lehigh University undergraduate students about student health behavior in 2014, only 11.5% of undergraduates reported that they felt rested when they woke up in the morning on the last 7 out of 7 days. 60.3% of students said they felt rested only 3-5 days of the week. The other 10.6% reported that sleepiness during the day affected their daytime activities. How does correlate with our project?

Background Research

Very few college students get the eight hours of sleep they need daily or frequently put together their sleep hours in haphazard fashion. Difficulties due to sleep pose many great challenges to student's social and academic lives. Such lack of sleep certainly has costs. There is no easy cure for this other than to try to get adequate sleep and to figure out ways to fall asleep when the opportunity presents itself.

What might cause lack of sleep in college students? Among college students, some of the most common causes of daytime sleepiness are sleep deprivation, inadequate sleep hygiene, alcohol, caffeine and energy drinks, stimulants, technology or sleep disorders.

Sleep deprivation is when students get adequate sleep because they go to bed late and wake up early. Sleep deprivation can arise from poor sleep behaviors. Many students have inadequate sleep hygiene that encourages sleep deprivation. Approximately four out of five college students drink alcohol, with nearly 40% of men and women reporting "binge drinking" at least 4-5 drinks in a row within the last 14 days. [1] Alcohol shortens sleep latency, but then promotes fragmented sleep in the latter half of the night. Caffeine and energy drinks increases vigilance, alertness and decreases sleepiness. Stimulants increase concentration and increase sleep latency. Technology use prior to bed increases restful sleep. It increases sleep latency and heightens cognitive alertness. [2]

College is a time of intellectual growth and development as young adults. It can be proven that any number of reasons can cause a sleepiness of a student in college which can inturn cause a disruption in that student's academics; however why haven't noise levels been put under the microscope. When the landscapers are mowing the lawn at six thirty in the morning; when students are conversing in the hallways during quiet hours; when your neighbors next door are being too loud because the walls are paper thin; when you can hear the music a floor below you. Noise is coming from everywhere and can affect a student's sleeping behavior which can lead to poor sleep hygiene. This can ultimately affect a student's academic standing.

User Specifications

The user interface shall follow a Linux style and functionality conventions. The interface for the sound monitor system has a Raspbian interface loaded onto it.

The Linux environment runs on the Raspberry Pi hardware. The system must have at least 990 Megabytes of free disk space to install the program and 512MB-1GB of memory is required to load the application. The program write information directly to create the platform to the user's new computer, the Raspberry Pi. The user's computer transfers and receives data from a local

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[1] Task Force of the National Advisory Council on Alcohol Abuse and Alcoholism . A call to action: Changing the culture of drinking at US colleges. Bethesda, MD: National Institute on Alcohol Abuse and Alcoholism; 2002. [Accessed August 8, 2013]. (NIH Publication No 02-5010).

[2] Hershner, Shelley D, and Ronald D Chervin. "Causes and Consequences of Sleepiness among College Students." Nature and Science of Sleep 6 (2014): 73–84. PMC. Web. 5 Dec. 2015.

server using basic networking protocols using either an ethernet cable or a wifi dongle. All the system's information is stored in the server's' own database which stores the data on the server's disk.

All data transferred between the server and the individual computer shall use the TCP/IP networking protocol over an Ethernet connection as well as Wi-Fi. Our project is dealing with power over ethernet capabilities which will be attached to the Raspberry Pi as well as power the board. Power over ethernet is closed and is not accessible from the internet, which ensures unauthorized access is prohibited. Analog sound sensors are external microphone to enhance power and can be paired with a preamp for improvements of sound quality.

Hardware Design

As shown in Appendix C, our hardware design features a Raspberry Pi 2 Model B+ attached to a breadboard through a ribbon cable at its GPIO pins. The ribbon cable is then connected to a breakout board that allows us to use the input/output pins. Wired to the breakout board is an analog to digital converter, we chose MCP3008, that is necessary to convert the analog output of our sound sensor, the DFRobot Sound Sensor, to a digital input the Raspberry Pi can work with.

Software Design

To run the Raspberry Pi, it needed to have an operating system installed on it. The chosen operating system was the Raspbian Wheezy OS. To read input from the sound sensor, the project uses a python code that reads from the input pins every second. It calculates the average input every fifteen seconds and outputs that to a text document stored on the Raspberry Pi.

The Raspberry Pi also has node.js installed on it for future use.

Experimental Results

Though the sound monitor system has not yet been implemented in a dorm or other academic building, the system has been tested in a home and the laboratory. It was found that the recording results are very low and only pick up loud sounds at a close range. This does not make for very accurate results and a new microphone will need to be installed to the system. In a addition to the microphone, a preamp is considered to enhance the power and sound quality of the sound sensor.

Ethical Consequences

Anytime you are monitoring your surrounding it is called into question about whether or not you are invading one's personal privacy. When looking into this project, confidentiality and privacy were brought into question. Monitoring only noise levels is the concern of our project. No conversations or video recordings will be taped. No one will be threatened or violated in the progression of this project. No ethical consequences will be crossed. This project is only beneficial to student health and students' academics life.

Intellectual Property Considerations

The project's future implementation will incorporate Power over Ethernet sound monitoring devices. It falls under the classification of Electrical and Audio Signal Processing Systems and Devices because a PoE sound monitoring device is an audio signal processing device. More specifically, it directly monitors sound levels.

Patent 8,194,866 is a sound monitoring, data collection and advisory system. It features one or more sound level indicators that are connected on a network server. Each of the sound level indicators measures the sound level at its specific location. The sound level indicators can also provide visual representation of the level of the sound. The visual representation can be a light that can be controlled through the system. The sound level indicators are monitors remotely on the network server they are connected to. The system provides an application to monitor multiple sound level indicators in real-time while also collecting the data to monitor its history.

The system is used to control noise traffic in the user's selected areas. This is important to guarantee desired noise levels at various locations such as office, a hospital, a school, a museum, various other buildings where noise control is essential to level of comfort. The system collects characteristic data of the noise levels and provides a representation of it.

The sound levels are measured in decibels (dB) which are a logarithmic unit of measurement that expressed the magnitude of a quantity relative to an implied level. The system provides graphical representation software to visualize sound level history for the user. The devices can feature power over ethernet technology to allow for flexible installation. It uses dynamic host configuration protocol to allow it to operate in an IP network.It features a multimedia card interface. It can work over a network server or on its own. If it is operating over the network server it sends and receives data via the server if it is operating in stand alone it collects the data and stores it.

This system relates to our senior design project because it is a sound sensor used to collect and monitor sound levels at various locations in order to improve the quality of life. Our senior project is a POE sound sensor that will monitor sound levels in various dorms around campus to try to confirm the idea that a specific dorm is getting less sleep because that dorm is nosier. The data will be used then to improve noise levels at certain hours of the day.

The system also allows for data to looked at remotely via a server and seen in a graphical form which is what we planned to do for our project. It can also view the data in real-time while also collecting it and compiling it which is what we will be doing with ours. The system can operate without connection to the server and store on a card installed in the sound level indicators. We will be putting an sd card in our raspberry pi to collect data while also sending it over the server.

The system also specified that it will allow for POE technology which is the basis for our project. Though we will make an implementation that does not run over ethernet, we expect our final outcome to be powered solely via power over ethernet.

US Patent 20140362999A1 is a system for generating an alarm for a certain level of work in a workspace. It has a threshold level that when passed can communicate with a system and send an alert to the users.

High levels of sound in one area can be disruptive to other areas of a workspace and can prevent people from working fully. This invention features at least one sound sensor connected to an outputting signal device. The output device features some kind of visual representation to show that the sound is at a certain level such as a light. Based on the lighting the individual can adjust their sound level to meet the needs of the workspace.

The system is to be mounted somewhere such as a wall. It is claimed that there is at least one sensor connected to an alert signaling device that is within a workspace. It is to detect when at least one aspect of sound exceeds a certain threshold and further indicate that to the user.

This is similar to the project of this report in that it is a sound monitoring device that can detect levels of sound. The project of this report is used to detect levels of sound in a dorm or workspace to further improve quality of life levels. This patent is intended for use in a office space where high levels of noise could be conducive for productive work. If the system is mounted in one room, it will detect and alert users when it has passed the threshold and could begin to interrupt users in the surrounding rooms so they can adjust their sound levels. The project of this report will do the same but in a dormitory. Sound monitors will be placed in hallways and detect sound levels to allow people to know if it will be too noisy for sleep.

This patent would be mounted somewhere in the room likely on the wall just as the sounds monitors of this report's will likely be when they are ready to be implemented.

Alternative Designs

Our first design originally involved an Arduino Uno. We both had background and familiarity in working with the Arduino. It is simple to code with, having its own platform and the main purpose of an Arduino board is to interface with sensors and devices. Another positive was that it is much easier to connect analog sensors to the Arduino. It can easily interpret and respond. The downfalls were that the Arduino is only a microcontroller, not a full computer. It can't run a full operating system. Also, the Arduino isn't built for network connectivity directly out of the box.

We moved onto the Raspberry Pi 1 Model B. A Raspberry Pi in general is a fully functional computer. It has a processor, memory, and graphics driver. It runs a version of Linux operating system. The Pi has built-in Ethernet port, allowing easy access to any network. This gave us more functionality, more reliability, and more speed. However, we quickly realized that with being a fully functionally computer that requires a mouse and keyboard. Another feature that we included was a Wi-Fi dongle to allow for access to the internet anywhere incase ethernet capabilities weren't available.

Using a mouse, keyboard, and Wi-Fi dongle this requires over 2 USB ports which the Raspberry Pi 1 Model B didn't support; however the Raspberry Pi 2 Model B supports 4 USB ports. This was the last big change to our big hardware design.

Cost Analysis

The project this semester remained under the budget of $500. In the Bill of Materials as shown in Appendix B, the total amount spent is less than $130 not including shipping and tax. The Bill of Materials shows all purchases including distributors and manufacturers. The hardware such as the Arduino Uno, Raspberry Pi 1, and Raspberry Pi 2 we had on hand. This cut a significant of the cost down. A future expense is upgrading the sound sensor (microphone) to include a preamp to enhance to power.

A benefit of our project is the knowledge base for our field. What we have been learning this semester and will be continuing to learn are the stepping stones of our future careers. Project development and management are in high demand and developing these skills well can really make a difference between a project coming in on time and on budget and it being a failure.

Governmental Regulation Impact Study

The International Standard 9614-1 is the standard for the determination of sound power levels of sources using sound intensity measurements. This relates to our project because our sensor gives the sound intensity measurements and we must take these and determine sound power levels. We need to determine sound power levels in order to make our sound intensity measurements useful to the user of our products. We should follow this standard because it sets forth the ideal for this conversion and will ensure we do it properly.

The ANSI s1.4.1983 is a standard on sound level meters. It states that a sound level meter will consist of a microphone to convert sound pressure signals to electrical signals, an amplifier to raise microphone outputs to a useable level, a level range control to shape the frequency response, and an indicating system to display sound levels. It may also contain a sensitivity control to allow adjustment of amplification. The standard provides frequency weightings and exponential-time-averaging-statistics.

This relates to our project because we are creating a power over ethernet sound sensor. We use everything discussed in the above standard. We have a microphone connected to amplifier and then a device to show us the levels produced. The microphone provides stats to us about the sensitivity and power of the microphone that allow us to convert the sound levels given to useful information for our project. We are able to convert our levels given to decibels because of many of these stats given. Our sound sensor meter, as far as I can tell, meets all the specifications set forth by this rule and make it a useful piece to our design project.

In the IECC/TR 62652 ED.1.0 EN:2010 standard, it sets the standard for connecting circuits via power over ethernet. It discusses safe ways to connect and disconnect connections. It discusses cabling for power over ethernet. This relates to our project because we intend to power our sound sensor system via power over ethernet. We should follow this standard because it sets the standard for how to connect things via power over ethernet. It also discusses the safe and right ways to power things via power over ethernet which is very important to our project.

Health and Safety Study

FCC Title 47 part 15 involves radiators, transmitting devices, and emissions. It states that all radiators must either be licensed or meet the guidelines set forth by the rest of the provision. It states that transmitting devices may not cause interference and instead must accept interference and prohibits the operation of the device if the operator is notified it is causing interference. It prohibits damped wave transmissions and prohibits operating a device for unlawful eavesdropping.

This regulation relates to our project because it regulates the use of transmitters. Our project, a power over ethernet sound sensing device using transmitters in multiple forms. Our device first uses a microphone and amplifier to receive sound levels. Many microphones and amplifiers are required to be licensed under this regulation. Because our microphone and amplifier were purchased from a large company, it is likely they were registered if they needed to be. Our project also submits information via a wireless network. Many wireless devices also require regulation under this title.

In an FDA regulations for laser products, manufacturers of electronic radiation emitting products are subject for regulation under the FDA. This rule defines and classifies both lasers and laser pointers. This limits the strength of both visible and invisible laser wavelengths. The FDA requires warning labels on certain classifications of lasers. The rule also defines appropriate and inappropriate use of different lasers and other technology.

This law does not apply to my senior design project as it regards lasers and similar technology. Our project does not use any kind of laser technology or any kind of LED. Our project uses simple power over ethernet connection, a sound sensor and sends information via a wireless connection. It does not do any of the following set forth by this regulation.

The IRB-Health and Human Services states that an institution must have an FWA in order to receive support from Health and Human Services for research on human subjects and each FWA must have at least one Institutional Review Board registered with the office of human research protections. Before an institution may obtain an FWA it must register with an Institutional Review Board.

These regulations do not relate to our project. Our project does not do any research on human subjects. Though it’s inception was thought up to monitor sound traffic levels in college dorms, our project will likely not be implemented. Even if it were implemented it would be measuring sound levels in dorm hallways and thus not be doing any research on human subjects. If we were to go further with our project, these regulations might be something that we would have to consider.

Environmental Impact

The raspberry pi has low energy usage, which leads it to have a very small environmental impact (if any environmental impact at all).

Project Management Study

At the beginning of the semester, planning out the entire semester was challenging. Not knowing and have extreme optimism made us plan our first Gantt Chart with completing our project first semester. As shown in Appendix E, we had no idea what to up on there. Most of it was research with skipping to creating a fully functional prototype by the end of the semester. We didn't factor in our heavy course load, break schedule, and problems we might have faced down the road.

Reevaluating our Gantt Chart at the end of the semester as show in Appendix F, it is clear that our values had changed. What we designated as milestones or deliverables of our projects were less frequent. What we were concentrating on, we considered more valuable to our project. We rid ourselves of useless things and focused on what we thought mattered to our project.

Conclusion

The idea of behind our project is to monitor the noise levels on campus, specifically in dorms, and then compare the expected results with the project results. It is expected that the sound monitor system of this project will be implemented by the end of next semester May 2016.

Although not yet available the capabilities of Power over Ethernet, we have been successful in familiarizing and working with the hardware and pulling together a working prototype for the first semester.

Both principal investigators had arranged a meeting with the Director of Health Advancement and Prevention Strategies Office. The exchange of ideas about the undergraduate student health survey in 2014 statistical results and possibility of testing dormitories. The visit left methodologies being developed and potential contacts in Residual Services when needed.

This semester was productive in that we set out to design our project, figure out what we wanted to do, and start to develop. Next semester we will work more on the power over ethernet, enhancing our sound monitoring system with a better microphone and work more on the backend database system by building and designing a server to start collecting and analyzing the noise levels.

APPENDICES

Appendix A: TECHNICAL SPECIFICATIONS

Sound Monitor System

Part	Functionality
Raspberry Pi 2 Model B+	Sound monitor system (mini-computer)
Analog Sound Sensor	Sound sensor
ADC Chip	Converts analogs to digital
Breakout board	Allows for the connection of GPIO pins
Preamp	Enhances sound sensor
Micro SD card	Loaded with Raspbian Linux environment
HDMI cable	Video cable connected to Raspberry Pi
Power cable	Powers Raspberry Pi
HDMI to VDI converter	Conversion allows us to plug into monitor
Monitor	Displaying Linux environment
Wi-Fi Dongle/Ethernet cable	Provides internet access via Ethernet or Wi-Fi access

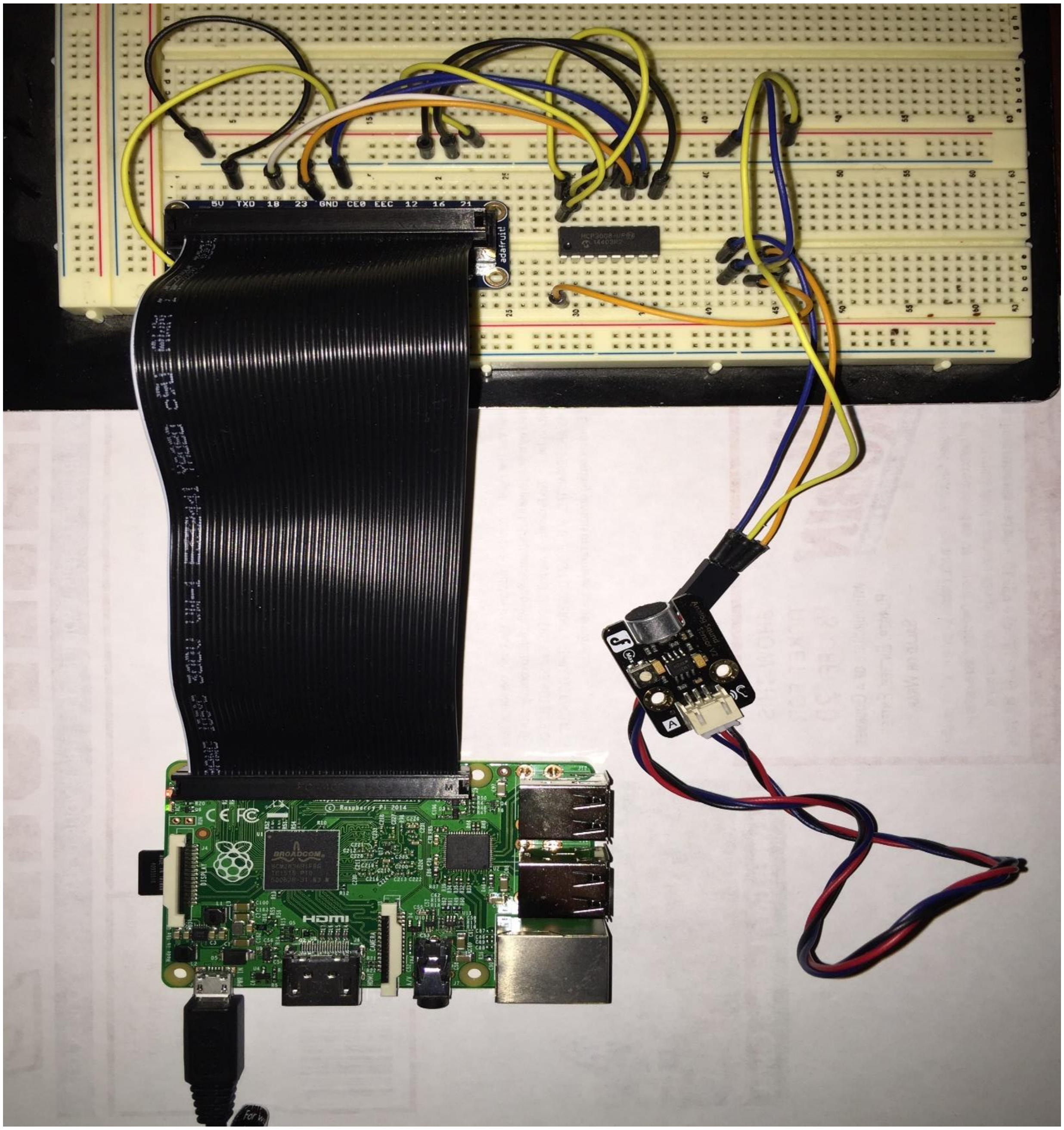
Raspberry Pi 2 Model B+

Processor Chipset	Broadcom BCM2836 ARMv7 Quad Core
RAM	1 GB SDRAM @ 450 MHz
USB 2.0	Four USB Ports
GPIO	40 pins
Ethernet Port	Yes
Input Voltage	5 V
Flash Memory Storage	Micro SD card
Operating System	Linux distributions (Raspbian)
IDE	Scratch (anything with Linux support)
HDMI	Yes

Appendix B: BILL OF MATERIALS

Item	Reference #	Description	Quantity	Manufacturer	Distributer	Manufacturer P/N	Distributer P/N	Price
1	Cobbler26	Assembled Pi 26 Pin Cobbler + Cable	1	Adafruit	Mouser Electronics	914	485-914	$6.50
2	A2D_Convert	MCP3008 - ADC interface	1	Adafruit	Mouser Electronics	865	485-865	$3.75
3	Cobbler40	Assembled Pi 40 Pin Cobbler + Cable	1	Amazon	Adafruit	B00Q1T07O8	NS-GPIO-P-01-A	$11.82
4	MicroSD	64GB MicroSD card and Adapter	1	Sandisk	Target	MD8832-D1G-V18-X-P	056-10-0274	$41.00
5	WifiDongle	Miniature Wifi Module, Raspberry Pi	1	Amazon	Adafruit	B00GSNBPXA	814	$18.57
6	Sound1	Analog Sound Sensor	2	DFRobot	RobotShop	RB-Dfr-38	DFR0034	$13.80
		Total Quantity	**7**				**Total Price**	**$95.44**

Appendix C: PROTOTYPED DESIGN



Appendix D: PATENTS

US 20090052677A1

(19) **United States**
(12) **Patent Application Publication**
Smith

(10) **Pub. No.: US 2009/0052677 A1**
(43) **Pub. Date: Feb. 26, 2009**

(54) **SOUND MONITORING, DATA COLLECTION AND ADVISORY SYSTEM**

(76) Inventor: **Christopher M. Smith**, New Palestine, IN (US)

Correspondence Address:
BOSE MCKINNEY & EVANS LLP
111 MONUMENT CIRCLE, SUITE 2700
INDIANAPOLIS, IN 46204 (US)

(21) Appl. No.: **12/195,366**

(22) Filed: **Aug. 20, 2008**

Related U.S. Application Data

(60) Provisional application No. 60/965,448, filed on Aug. 20, 2007.

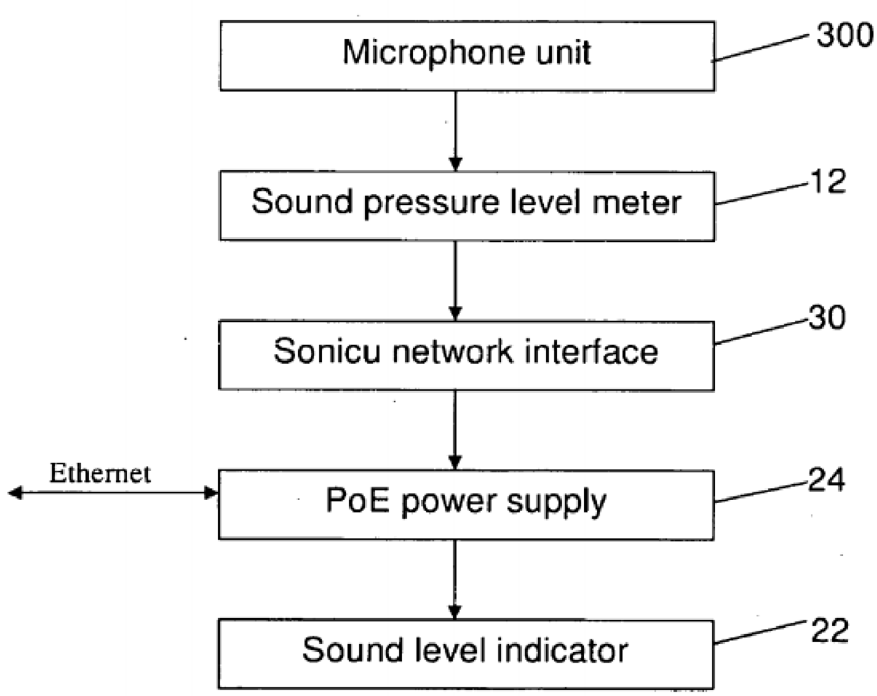
Publication Classification

(51) **Int. Cl.**
H04R 29/00 (2006.01)

(52) **U.S. Cl.** **381/56**

(57) **ABSTRACT**

A sound monitoring system and method. The system can include a plurality of sound pressure level meters, a plurality of sound level indicators and a server connected by a network. The sound pressure level meters measuring a sound level at their location, and the sound level indicators providing a visual indication of the sound level measured by at least one of the sound pressure level meters. The system devices can be powered, as well as monitored and controlled remotely over the network. A user interface enables constructing and monitoring multiple zones and groups in a monitored area, as well as reviewing real-time and historical sound data. The system can also control lighting in the monitored area, and use lighting as a visual indicator of noise level.



US 20140362999A1

(19) **United States**

(12) **Patent Application Publication**

Scheper et al.

(10) **Pub. No.: US 2014/0362999 A1**

(43) **Pub. Date: Dec. 11, 2014**

(54) **SOUND DETECTION AND VISUAL ALERT SYSTEM FOR A WORKSPACE**

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(72) Inventors: **Robert Scheper**, Grand Rapids, MI (US); **Matthew Warner**, East Grand Rapids, MI (US); **Karl J. Mead**, Grand Rapids, MI (US); **Brett Kincaid**, Ada, MI (US); **Kurt Heidmann**, Grand Rapids, MI (US)

(21) Appl. No.: **13/911,654**

(22) Filed: **Jun. 6, 2013**

Publication Classification

(51) **Int. Cl.**

G08B 21/18 (2006.01)

H04R 29/00 (2006.01)

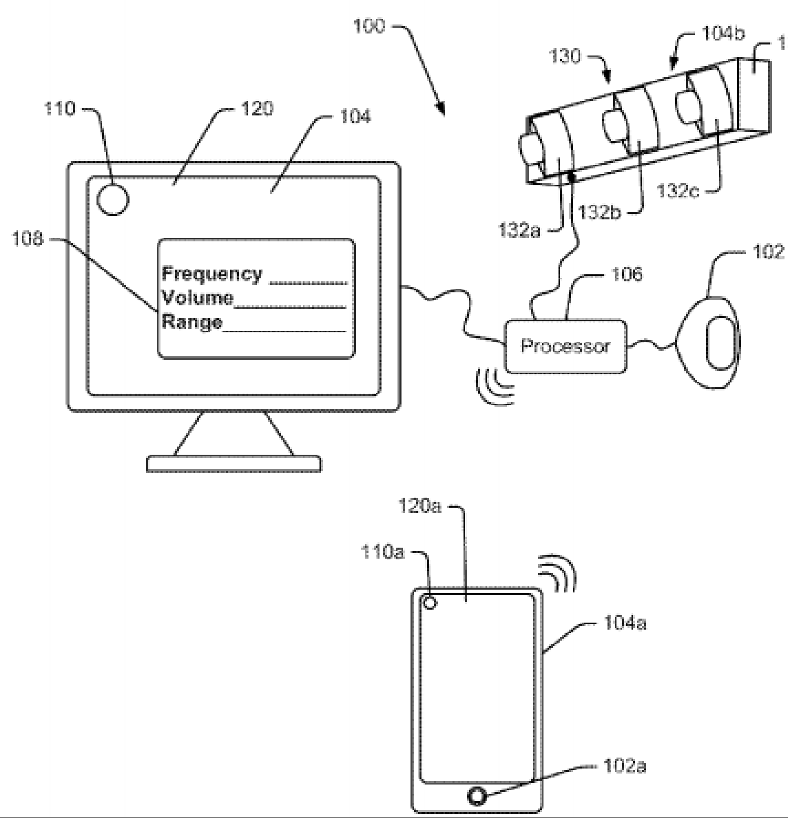
(52) **U.S. Cl.**

CPC *G08B 21/182* (2013.01); *H04R 29/00* (2013.01)

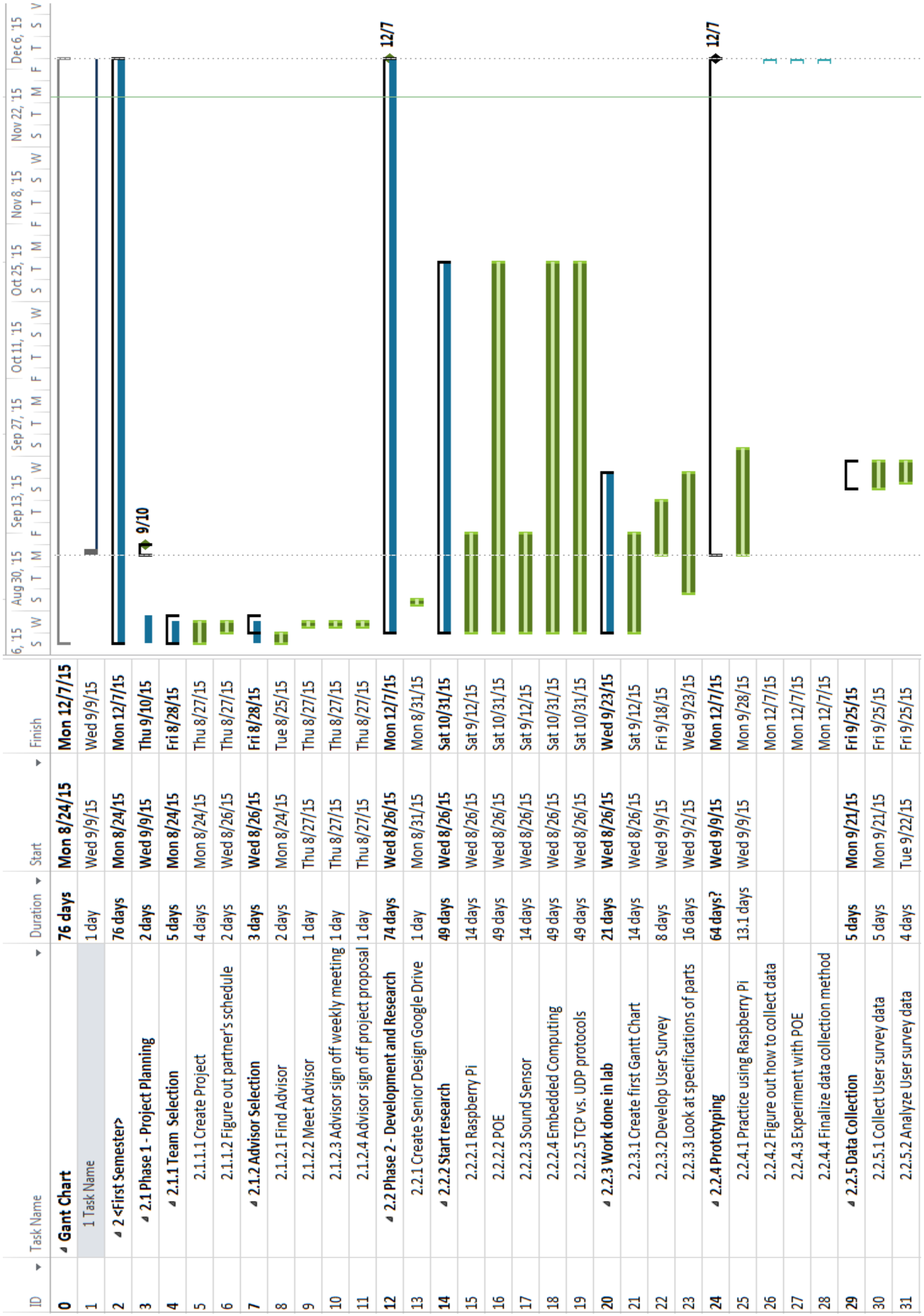
USPC **381/56**

(57) **ABSTRACT**

An alert system for generating a signal indicating at least one aspect of sound within a workspace environment, the system comprising at least a first sensor positioned one of within and proximate a workspace, the at least a first sensor sensing at least one aspect of sound generated within the workspace and generating a signal indicating the at least one aspect, a communication device located within the workspace, the communication device configured to generate a signal perceivable within the workspace and a processor receiving signals from the at least a first sensor and linked to the communication device, the processor programmed to perform the steps of identifying when the at least one aspect exceeds a threshold value and driving the communication device to indicate that the at least one aspect exceeds the threshold value.



Appendix E: ORIGINAL GANTT CHART



ID	Task Name	Duration	Start	Finish
0	Gant Chart	76 days	Mon 8/24/15	Mon 12/7/15
1	1 Task Name	1 day	Wed 9/9/15	Wed 9/9/15
2	2 <First Semester>	76 days	Mon 8/24/15	Mon 12/7/15
3	2.1 Phase 1 - Project Planning	2 days	Wed 9/9/15	Thu 9/10/15
4	2.1.1 Team Selection	5 days	Mon 8/24/15	Fri 8/28/15
5	2.1.1.1 Create Project	4 days	Mon 8/24/15	Thu 8/27/15
6	2.1.1.2 Figure out partner's schedule	2 days	Wed 8/26/15	Thu 8/27/15
7	2.1.2 Advisor Selection	3 days	Wed 8/26/15	Fri 8/28/15
8	2.1.2.1 Find Advisor	2 days	Mon 8/24/15	Tue 8/25/15
9	2.1.2.2 Meet Advisor	1 day	Thu 8/27/15	Thu 8/27/15
10	2.1.2.3 Advisor sign off weekly meeting	1 day	Thu 8/27/15	Thu 8/27/15
11	2.1.2.4 Advisor sign off project proposal	1 day	Thu 8/27/15	Thu 8/27/15
12	2.2 Phase 2 - Development and Research	74 days	Wed 8/26/15	Mon 12/7/15
13	2.2.1 Create Senior Design Google Drive	1 day	Mon 8/31/15	Mon 8/31/15
14	2.2.2 Start research	49 days	Wed 8/26/15	Sat 10/31/15
15	2.2.2.1 Raspberry Pi	14 days	Wed 8/26/15	Sat 9/12/15
16	2.2.2.2 POE	49 days	Wed 8/26/15	Sat 10/31/15
17	2.2.2.3 Sound Sensor	14 days	Wed 8/26/15	Sat 9/12/15
18	2.2.2.4 Embedded Computing	49 days	Wed 8/26/15	Sat 10/31/15
19	2.2.2.5 TCP vs. UDP protocols	49 days	Wed 8/26/15	Sat 10/31/15
20	2.2.3 Work done in lab	21 days	Wed 8/26/15	Wed 9/23/15
21	2.2.3.1 Create first Gantt Chart	14 days	Wed 8/26/15	Sat 9/12/15
22	2.2.3.2 Develop User Survey	8 days	Wed 9/9/15	Fri 9/18/15
23	2.2.3.3 Look at specifications of parts	16 days	Wed 9/2/15	Wed 9/23/15
24	2.2.4 Prototyping	64 days?	Wed 9/9/15	Mon 12/7/15
25	2.2.4.1 Practice using Raspberry Pi	13.1 days	Wed 9/9/15	Mon 9/28/15
26	2.2.4.2 Figure out how to collect data			Mon 12/7/15
27	2.2.4.3 Experiment with POE			Mon 12/7/15
28	2.2.4.4 Finalize data collection method			Mon 12/7/15
29	2.2.5 Data Collection	5 days	Mon 9/21/15	Fri 9/25/15
30	2.2.5.1 Collect User survey data	5 days	Mon 9/21/15	Fri 9/25/15
31	2.2.5.2 Analyze User survey data	4 days	Tue 9/22/15	Fri 9/25/15

Appendix F: REVISED GANTT CHART

ID	Task Name	Duration	Start	Finish
1	<First Semester>	76 days	Mon 8/24/15	Mon 12/7/15
2	Acquire Raspberry Pi 1	4 days	Tue 9/1/15	Fri 9/4/15
3	Make Gantt Chart	5 days	Mon 9/7/15	Fri 9/11/15
4	Purchase Sound Sensor	2 days	Fri 9/11/15	Mon 9/14/15
5	Design starter code with sensor	6 days	Mon 9/14/15	Sun 9/20/15
6	Re-familiarize selves with hardware	6 days	Fri 9/18/15	Fri 9/25/15
7	Complete User Specification	5 days	Mon 9/28/15	Fri 10/2/15
8	Purchase 26 pin cobbler and ADC chip	4 days	Thu 10/1/15	Tue 10/6/15
9	Patent search	5 days	Fri 10/2/15	Thu 10/8/15
10	Install linux OS on personal laptop	3 days	Wed 10/14/15	Fri 10/16/15
11	Acquire Raspberry Pi 2	3 days	Thu 10/15/15	Sat 10/17/15
12	Setup of Raspberry Pi(s)	74 days	Wed 8/26/15	Mon 12/7/15
13	Load linux onto Raspberry Pi(s)	11 days	Fri 10/23/15	Fri 11/6/15
14	Install Node.js on Raspberry Pi(s)	3 days	Fri 11/6/15	Tue 11/10/15
15	Complete Standards and Regulations	6 days	Sun 11/1/15	Fri 11/6/15
16	Purchase 40 pin cobbler and USB wifi	13 days	Thu 11/12/15	Mon 11/30/15
17	Work on Interim Presentation	14 days	Sun 11/15/15	Wed 12/2/15
18	Work on Interim Report	17 days	Sun 11/15/15	Mon 12/7/15
19	Other	70 days	Tue 9/1/15	Mon 12/7/15
20	Research	70 days	Tue 9/1/15	Mon 12/7/15
21	Title Change	46 days	Mon 10/5/15	Mon 12/7/15