<u>Wireless Breathing Monitor</u>

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I. Introduction

A common problem faced by surgeons and anesthesiologists in the medical field is that, during a surgery, their only recourse for confirming that their patient is still breathing is to use a stethoscope. The stethoscope is pressed up against the patient's neck and the doctor listens for the sound of air moving in and out of the throat. The problem with this process is that there is not a *continuous* method of determining whether or not a patient is breathing. Heart rate monitors stationed in the operating room do not detect breathing, so a patient could theoretically stop breathing for a period of time while the heart rate monitor still detects a pulse. By the time the heart rate monitor signals that the patient's heart has stopped, it may be too late, whereas a continuous breath monitor could sense a problem much sooner. Our proposed solution is to develop a technology that continuously monitors a patient's breathing throughout a surgery.

II. Problem Description

While in surgery, it sometimes becomes unclear whether the patient is breathing or not. It is usually a result of the patient's breathing becoming shallower, and thus it is harder to notice the rise and fall of the chest, and also harder to hear inhalation and exhalation. One method for checking to make sure a person is breathing is to hold a stethoscope to the neck and listen for the air rushing through the larynx. This common procedure is unnecessarily burdensome. There are two problems with it- first, this takes valuable time from the doctors- one of them must locate a good measurement spot and hold the stethoscope in place for a few seconds. Second, it is clumsy. In addition to the many cords and instruments surrounding the patient, now another person has to get close to the patient and manually place the stethoscope on the neck to listen closely.

We think the best way to solve this problem is to develop a device that attaches to the neck of the patient and wirelessly transmits the sound to a computer. We are then able to analyze the sound data and even display a visualization on screen. This way the information is readily available to all staff in the operating room.

III. Proposed Solution

Monitoring the status of the patient during surgery is crucial. We propose constructing a wireless breath monitor that will measure the strength of the patient's breath, and will signal whether the patient is breathing safely or if the patient's breathing has dropped to a dangerously low level. With the amount of medical equipment already present in the operating room, the ideal breath monitor will be wireless. This gives the surgeon more space with which to operate on the patient. The monitor will be able to be placed on either the patient's throat or chest, depending where on the body the surgery is being performed, and will sense how strongly the patient is breathing. The monitor will transmit this information to a receiver, which can record and display the information, and signal if the breathing level is safe or not. A general block diagram of how this breathing monitor will work is shown in Figure 1.

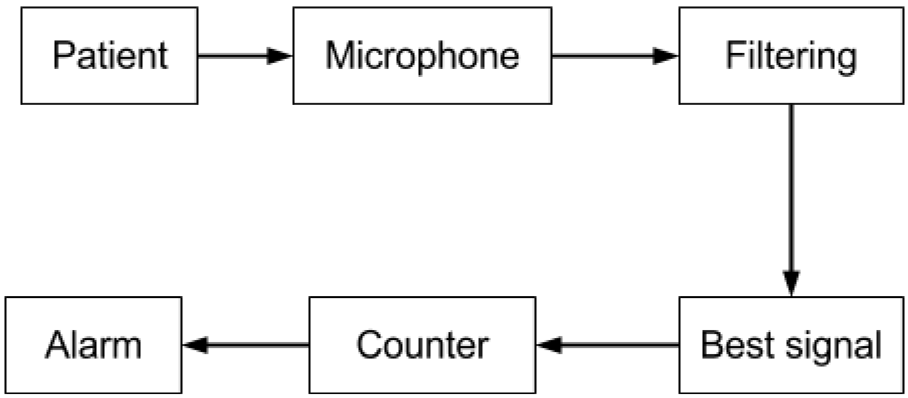

Figure 1. Block Diagram of the solution

IV. Demonstrated Features

Some of the required features that will attempt to address our problem include:

- A long-lasting, adhesive microphone for detecting respiration. The adhesive design will be similar to that of a Band-Aid. The microphone will also have a threshold of detection that is free from the influence of electrical noise or possible drafts or bursts of air that would cause a false positive detection. The microphone will also be capable of operating continuously over extended periods of time.
- The microphone will be compatible with wireless networks.
- A receiver capable of continuously reading the signal from the microphone via a wireless network and converting the signal to a digital readout that can be displayed on a monitor.
- A monitor for displaying the respiration as a signal.
- An alarm corresponding to the threshold in the microphone that will promptly notify those using the device when the patient has stopped breathing.
- An alarm notifying those using the device when the microphone is not functioning properly.

V. Available Technologies

Part	Use	Cost
Unidirectinal microphone (Uni-directional Lavalier Mic FOR SHURE Wireless Microphones)	We chose unidirectional microphone to preven sounds coming from other sources in the surgery room.	$30 (ebay)
PC sound card (PCI Audiophile Card - ASUS Xonar Essence ST)	Amplification and some filtering will be done automatically. According to compreviews.about.com, this particular produ has a built in headphone amplifier and it also gives the best signal to noise ratio and very lo harmonic distortion.	$205 (Amazon)
LEDs	We want the device to give some type of visu signal along with the alarm sound signal. Thu LEDs would be sufficient.	35 cents (Digikey)
Various microphone cables	Connect microphone to sound board.	$10
Personal computer	To run data analysis	Hopefully at least one of our group member uses PC.
Software programs (Matlab & Labview)	We have learned that the breathing frequency between 500 Hz and 1000 Hz. Thus, we will create 5 bandpass filters (100 Hz each) in orde to choose the best frequency range. We will use Matlab to obtain the frequency range to filter the signals. Hopefully we will have access to Labview, which will be used to get the average signal to noise ratio for each frequency range. We will then choose the best band and feed it to the counter.	Matlab is definitely available to us. However, it will be a problem if we don't have access to Labview; unless we can find a substitution.

VI. Engineering Content

There are several functions that need to occur for the breath monitor to operate successfully. The monitor must remain attached to the chest or neck throughout surgery without causing damage to the patient. The monitor must be designed to be unobtrusive and to use an adhesive that attaches without distorting the breath signal. The monitor must be able to sense whether or not the patient is breathing, and the relative strength of the breath. A patient's breathing is a continuous, analog signal, so an analog-to-digital conversion must be performed by the monitor before it transmits the information. The monitor must then wirelessly transmit the information to a receiver, which will record and display the information. The receiver will need to sound a signal if the breath goes below safe levels. The appropriately safe level must be able to be set by the doctor prior to the operation.

This project presents many engineering challenges. The monitor microcontroller must be designed, along with an ADC and a process for sensing breath and processing the information electronically. A wireless communication system must be built, as well as a user interface through which the doctor can set the level at which the alarm will sound.

VII. Conclusion

The development of an effective wireless breath monitor is something that will make operating on a patient easier for surgeons and potentially save lives. To accomplish this goal, our group will need to do extensive research in both the electrical engineering field as well as the medical field. From an engineering standpoint, we must develop a deep understanding of certain aspects of the project such as how a wireless microphone works, how to program an analog-to-digital converter, how to output a sound input visually, etc. From the medical perspective, we must make sure that the breath monitor is sterile and easily cleaned, does not interfere with other devices in the operating room, and works consistently throughout an operation. The breath monitor must also be easy to use, because the objective is to give doctors one less thing to worry about during a surgery. This means that microphone should attach to and detach from a patient's neck effortlessly and a simple, yet effective, user interface must be developed.