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Wireless Stethoscope with Bluetooth Technology

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ABSTRACT –

Stethoscopes are used to listen to acoustic signals from the internal organs of the human body. Although stethoscopes play a very important role in the diagnosis process, the chest piece and the connecting cable are known to facilitate transmission of pathogens from patient to patient and from patient to the user. Replacing the connecting cable with a wireless system may help reduce the potential risk and further allow broadcasting of the signals to multi-users for examination. This work reports on the design of a two-piece Bluetooth-based wireless system that eliminates the connecting cables in electronic stethoscopes. The design consists of a Bluetooth based integrated chest-piece module for captured acoustic sound transmission and a microcontroller-based (MSP430) head-piece receiver module for decoding the data for the three operational modes of the stethoscope. The design was first tested using a chirp signal source with frequency of 10 Hz – 5 kHz. Results obtained for the three operational frequency bands of the stethoscope were consistent with the expected behaviour of the stethoscope.

INTRODUCTION

Stethoscopes are used regularly by medical personnel to listen to acoustic signals picked from the internal parts of the human body during diagnosis and treatment of patients. Typically, signals that are picked from the body for diagnosis include that of the heart, lungs, and bowels [1]. Although stethoscopes have become ubiquitous in healthcare delivery and are often used as a symbol of medicine in several media, their use may also serve as a threat to both patient and health personnel. For example, the diaphragm of the chest-piece and the connecting cable of the stethoscopes have been shown to harbor potentially pathogenic bacteria as these elements make the most contact with the patients and are also the parts mostly exposed to hospital wares

Several forms of digital electronic stethoscopes have been developed to replace the conventional acoustic stethoscope. Basically, the goal of the digital stethoscope is to improve sound resolution, allow variable amplification of the sound, minimize interference noise, and also provide data for visualization and storage. Although digital stethoscopes have introduced more flexibility in the use of the device as well as improved dataquality, incidentally, the modern electronic stethoscopes still conform to the look and feel of the conventional stethoscope with connecting cables. For example, wireless based electronics stethoscopes such as Littman 3200 and other Bluetooth enabled devices, still come equipped with connecting cables between the chest-piece and the head-piece with the chest-piece having a wireless module to transmit the signal to receivers such as phone, digital audio recorder or computers for recording and listening to the sounds. In a number of situations however, the length of the connecting cables of the stethoscope tends to restrict movement of the stethoscope users during examinations. Further to this is the constraints posed by the posture of patients (seated, reclining on couch, or stand upright) considered by the medical personnel as most suitable during auscultation. Replacing the connecting cable between the chest- piece and the head-piece with a wireless communication will introduce more flexibility in use of the device in addition to the minimization of the problem of transmission of pathogens. Furthermore, all the existing stethoscopes are limited to single users, which implies that details heard by one user within a specific period of examination cannot be confirmed by other members in a team unless the data is directly accessed from a third party device such as a computer. With the proposed wireless design, the signal captured from a patient can be broadcast to multiple users of the device within operational range with restricted access.

Fig: hearing heartbeat using Bluetooth headset

Bluetooth transmission and reception module has been incorporated Transmitter Receiver Module, Bluetooth version It is a dense and highly mobile design Bluetooth adapter which can be detached from the main board. For this system we have used a USB adapter, fitted into the board for ease of use of the transmitter module. The voltage regulators IC7805 and IC7905 are used on board provide the module with the necessary power supply of maximum 5V and hence eliminate the need to use an additional power source in the form of a 5V battery This Bluetooth module can wirelessly stream the filtered audio from the circuit to any compatible Bluetooth headset or speaker. The module is attached to a 3.5mm audio socket which enabled us to have an Audio Out Aux Port to connect this device. Bluetooth technology is a high-speed low powered wireless technology link that is designed to connect phones or other portable equipment together. It is a specification (IEEE 802.15.1) for the use of low-power radio communications to link phones, computers, and other network devices over short distances without wires. Wireless signals transmitted with Bluetooth cover short distances, typically up to 30 feet (10 meters).

It is achieved by embedded low-cost transceivers into the devices. It supports the frequency band of 2.45GHz and can support upto 721KBps along with three voice channels.

This frequency band has been set aside by international agreement for the use of industrial, scientific, and medical devices (ISM).rd-compatible with 1.0 devices.

DESIGN

System design description A typical stethoscope is made up of three components: the head-piece, chest-piece, and a connecting cable that serves as a communication link between the two main components. The chest- piece embodies the acoustic or electronic sensor which captures the analog signals or sounds from the body and transmits the data in the form of voltage signals over the communication link to the head-piece. The proposed wireless stethoscope design consists of two modules: an integrated chest- piece that serves as the transmitting system and integrated head-piece that serves as a receiver system. The chest-piece system consists of the data acquisition interface that is integrated with the wireless module whereas the head-piece system consists of an integrated wireless receiver unit and a microcontroller. Figure 1 shows the hardware architectural view of the wireless system and sub-systems interconnection and Figure 2 shows the conceptual view of the expected device.

1. To listen to heartbeats for any uneven rate of beating.
2. To verify the function of the lungs to know if there is liquid built
3 To test the blood pressure running throughout the veins.
4. To find out the course of digestion in the stomach.
5. It is also used for prenatal concern throughout pregnancy and labor

Inter Connectivity

Information sent via Bluetooth can be wirelessly received directly from the computer, so it can be recorded directly on the patient's electronic chart. It can later be heard for comparison, remotely, and can also be automatically read through a variety of automated reading software (see Background Art 13). During patient's surgery (mainly local anesthesia), if the stethoscope is attached near the heart area, the operator can perform the procedure while listening to the patient's tension with earphones or speakers. In other words, by using a stethoscope rather than using an expensive monitor, it serves as a monitor for listening to the patient's condition in light surgery.If you use two stethoscopes at the same time, you can hear two sounds at the same time. For example, with two stethoscopes close to the heart, one stethoscope is the atrium and the other is the ventricle, which, when heard, accurately identifies the patient's heart condition

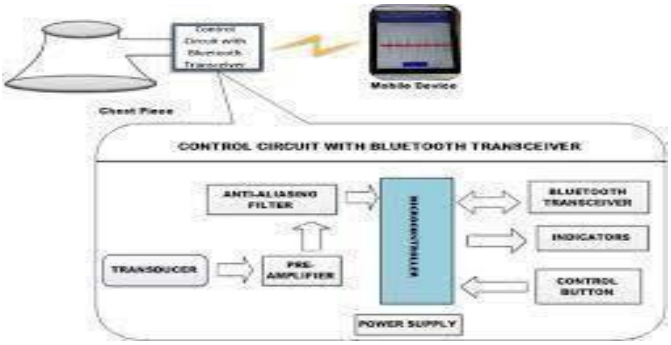

Fig: inter connectivity

Turn on your Bluetooth device and make it discoverable. The way you make it discoverable depends on the device. Check the device or visit the manufacturer's website to learn how.

- On your stethoscope, select Start > Settings > Bluetooth &devices > Add device > Bluetooth.
- Choose the Bluetooth device, follow additional instructions if they appear, then select Done.

Your Bluetooth device will usually automatically connect anytime the two devices are in range of each other with Bluetooth turned on. Since the rubber tube of the stethoscope is missing, there is no loss of sound which is important for diagnosing the patient.Because of the Bluetooth wireless communication, the body of the stethoscope and the ear tip (earphones) are separated. The size of the stethoscope is dramatically reduced and it is easier

for doctors to use. By using Bluetooth communication, it is possible to listen wirelessly at a long distance (within 10m).All Bluetooth earphones and headphones on the market can be used, so users can choose their own earphones and replace the earphone at any time when the earphone fails.Since the original sound is listened to directly after the thin film plate by the microphone, thecollected noise is reduced as much as possible, and theacoustic data converted into the electric signal throughthe microphone is used to remove noise, frequency filter (select the desired frequency), amplification, etc.After that, the sound of the area the doctorwants is veryclean.

Implementation

Advancements in Bluetooth technology has made it possiblefor stethoscopes to go wireless so clinicians can auscultatepatients without listening through traditional stethoscope earpieces. There are important advantages to wireless auscultation that help clinicians in different settings:

- To help protect healthcare providers from infectious pathogens, wireless stethoscopes enable clinicians to evaluate patients from a greater distance and keep the stethoscope components behind personal protective equipment (PPE) to help protect themselves.
- Clinicians with hearing loss can use wireless stethoscopes to pair with their Bluetooth enabled hearing aids, cochlear implants, or other listening devices.
- Wireless stethoscopes support telemedicine live streaming, where clinicians can share auscultations anywhere in the world in real-time.

Advantages

1. This provides for better noise cancellation so a better signal is obtained.
2. It is very easy to be implemented both in terms of software and hardware. It is rather compact and portable.
3. It is very cost effective.
4. A heart beat can be recorded and analyzed later on.
5. Real time monitoring can be done using LabVIEW.

Applications

1. A stethoscope with a built-in Bluetooth radio that aims to enable physicians to detect heart murmurs and other afflictions by sending the data recorded by the device sending it to a PC and amplifying the sound.
2. Medical advancements and applications in cardiac and pulmonary auscultation.
3. A device that interprets sounds and offers diagnoses on its own, which would require extensive clinical data to get past the Food and Drug Administration (FDA).
4. The development and commercialization of real-time computer based HS analysis system will be a major area for future research approaches.

Conclusion

Idea of integrating wireless bluetooth technology into a two-piece electronic stethoscope has been presented. Bluetooth protocol is known for its effectiveness in short range peer-to-peer communication and can therefore offer short range high efficiency data transfer in a simple device. To demonstrate the operational capability of the proposed device, a numerical model of the system was created. Results showed that it is possible for wireless data to be broadcast to multi head-piece sets and the various operational modes selected for evaluation with the aid of a microcontroller. Preliminary implementation of aspects of the system in hardware produced results that show that it is possible to realize the wireless electronic stethoscope in hardware and commercialized. A full two-piece wireless electronic stethoscope will eliminate the connecting cables of the conventional stethoscope and offer easy movement of the device users around patients during auscultation, minimize the spread of infections, and contribute to teamwork, especially in auscultation training of healthcare practitioners, where data is broadcast simultaneously to the members in the team for evaluation. Hardware implementation of a prototype system is currently ongoing using donated development boards from Texas Instruments Inc.

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