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WIRELESS ELECTRONIC STETHOSCOPE USING ZIGBEE

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ABSTRACT
In medical field any disease can be primarily accessed using an acoustic medical device that is a Stethoscope. The wireless electronic stethoscope can be designed by using microcontroller and data is transferred through wireless transmission using zigbee module. In this to pick up the input signals from body of patient a microphone is used as a sensor. After receiving signals, these signals are further processed, amplified to increase their strength. These heart sounds are transferred wirelessly using zigbee module due to this multiple doctors can do auscultation. PC connectivity is provided to store these audio and video files for further analysis. These saved files can be made available using LANs and internet so another doctor can use them in their case, research. Here Heart beat signals are sensed, sent, displayed, monitored, stored, reviewed, and analyzed with ease. In this zigbee communication is used because it is low of cost, requires less energy, supports large number of nodes, reliable and can be used globally. Zigbee is developed by Zigbee alliance. Zigbee was standardized in 2003. The zigbee has IEEE standard as 802.15.4. Zigbee operates in the ISM radio bands 868MHz in Europe, 915MHz in U.S.A. & Australia and 2.4GHz in most jurisdictions worldwide. Data transmission rate varies from 20kbps in 868MHz frequency band and to 250kbps in 2.4GHz. Hence by using wireless stethoscope doctors can hear cardiac sounds clearly and multiple doctor can hear the cardiac sounds because of zigbee module, this will increase accuracy of diagnosis.

KEYWORDS:

INTRODUCTION
The stethoscope comes from the Greek language for scope means chest and stethos means inspection. It is a very vital transducer for many medical practitioners. And used for end user like doctors, nurses and physicians detect the abnormalities of the heart and lung such as sounds of heart, lung rhythm, and vibration of the intestines and blood flow (Geddes 2005). Diaphragm of head stethoscope is the metal end that is placed on the chest to listen to the lungs and heart sound with the tubing to tapered inner bores. This structure is able to provide a better sound transmission while listening is known as a vacuum tube. The most type of stethoscope used these days is the acoustic stethoscope (Myint & Dillard 2001). However, the problem with this acoustic stethoscope is the sound level is very low making it hard to analyze and diagnose the heart sound by a medical doctor. This is why several forms of digital electronic stethoscope have been developed to replace the conventional acoustic stethoscope. Basically, the purpose of digital stethoscope is to improve the sound resolution, allow variable amplification, minimize interference noise and simplify the output signal.

The digital stethoscope can enhance the auscultation problem of acoustic stethoscope which is easily affected by the movement and noise surrounding. Several techniques with the functions like stethoscope have been widely used such as SPO2,

RELATED WORK
R.Nivethika and N.Kirthika developed a digital stethoscope, and it presents real time heart defect monitoring and heart sound hearing system. The purpose of this work is to design and implement a digital stethoscope which acts as a platform to detect cardiac murmurs [1]. Ms. Kadam Patil D. D. and Mr. Shastri R. K. developed electronic stethoscope with the functions of wireless transmission is discussed. This electronic stethoscope based on embedded processor.
Initial research was conducted to determine the types of heartbeats that are routinely measured during a visit by a doctor in hospital. This is a respiration rate of breathing that can give a total of heartbeats in heart rate per minute.

One of the methods used to measure this heartbeat is by the auscultation method. These methods provide information about a variety of internal body sounds originated from the heart, lungs, bowel and vascular disorders (Khan et al. 2012). The ability to detect heart sounds may be influenced by a number of factors, including the presence of ambient noise or other sensory stimuli. This may result in inaccurate or insufficient information due to the inability of the user to discern certain complex, low-level, short duration or rarely encountered abnormal sounds (Jiang & Choi 2006). Therefore, only the skilled physician who is proficient in the skill of auscultation is likely to make accurate diagnoses upon cardiac auscultation. It is, thus, desirable to enhance the diagnostic ability by processing the auscultation signals electronically and providing a visual display and automatic analysis to the physician for a better comparison study.

PROPOSED ALGORITHM

BASIC INFORMATION OF STETHOSCOPE

INTRODUCTION:

The stethoscope is an acoustic medical device for auscultation, or listening to the internal sounds of an animal or human body. It is often used to listen to lung and heart sounds. It is also used to listen to intestines and blood flow in arteries and veins. “Stethoscope” came from the Greek words "stethos" (chest) and "skopein" (to look at).Some researches concluded that an abnormal heart-rate profile during exercise and recovery is a predictor of sudden death. Because he incidence of cardiovascular disease increased year by year, cardiovascular diseases relating to heart has become worldwide common and high prevalent disease.

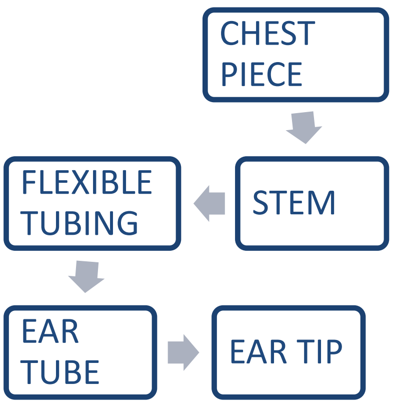

Figure: Block diagram of basic stethoscope

Working:

Although it is a very simple device the stethoscope is one of the most important diagnostic tools in medical world.

A stethoscope is very straight forward device .The chest piece consist of shallow ,bell shaped piece and a clear ,stiff diaphragm, which is then connected to the metal ear piece by a flexible tube.the bell is used to pick up lower frequency sounds, and the diaphragm is used for higher frequency sound. When the chest piece is placed on skin vibrations within in the body are amplified by either the bell or diaphragm. These acoustic pressure waves then travel up through the tubing, resonating to the ear piece and in to the listener’s ears.

HEART SOUNDS

The humans contain the myogenic heart located at the middle of thoracic cavity in a space called mediastinum, between two lungs. The heart acts as a pumping organ. The rhythmic contraction (systole) and relaxation (diastole) of heart is called **heart beats**. Acoustic heart sounds are produced when the heart muscles open valves to let blood flow from chamber to chamber. A normal heart will produce two heart sounds, S1 and S2 as shown in Figure 3.1 S1 symbolizes the start of systole. The sound is created when the mitral and tricuspid valves close after blood has returned from the body and lungs. S1 is primarily composed of energy in the 30Hz - 45 Hz range. S2 symbolizes the end of systole and the beginning of diastole. The sound is created when the aortic and pulmonic valves close as blood exits the heart to the body and lungs which lie with maximum energy in the 50 Hz - 70 Hz range with higher pitch. Typically, heart sounds and murmurs are of relatively low intensity and are band limited to about 100–1000 Hz. Meanwhile, Speech signal is perceptible to the human hearing. Therefore, auscultation with an acoustic stethoscope is quite difficult.

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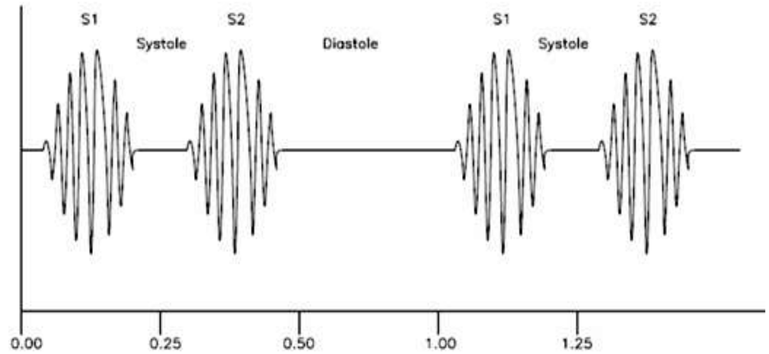


Figure : Hearts Sounds Block diagram of wireless electronic stethoscope

Transmitter section

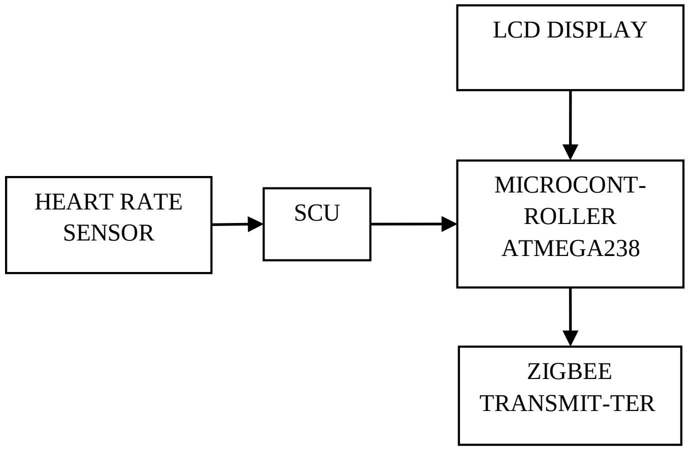
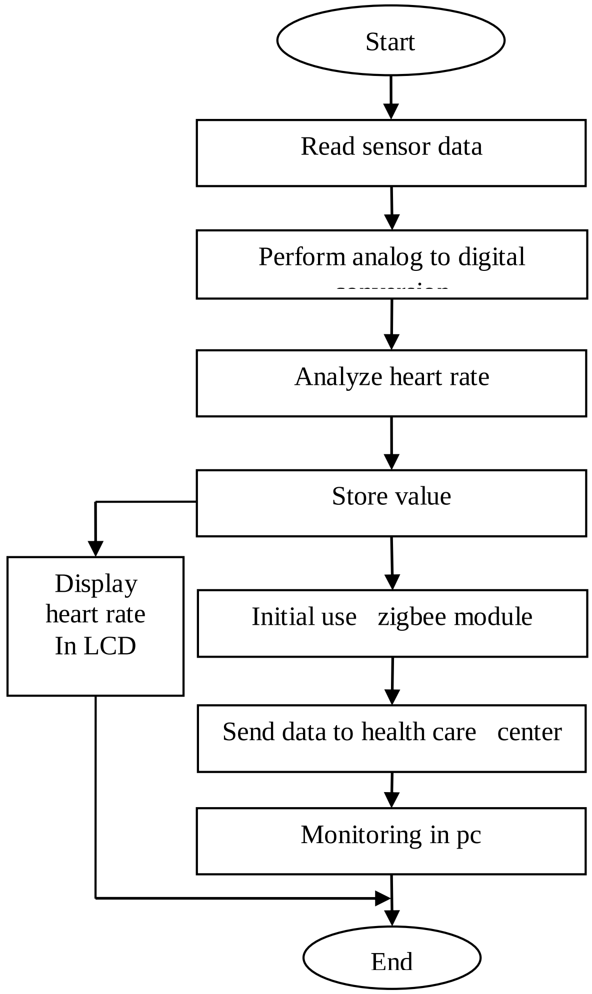


Figure :Block diagram of Transmitter section

Heart rate measurement module consists of following components:
1. Heart beat sensor
2. Signal conditioning unit
3. Atmega328 microcontroller
4. LCD display
5.XBEE transmitter

FLOWCHART



SENSOR: A sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. For example, mercury converts the measured temperature into expansion and contraction of a liquid which can be read on a calibrated glass tube. At thermocouple converts temperature to an output voltage which can be read by a voltmeter. For accuracy, most sensors are calibrated against known standards.

Heart rate Sensor

Heart rate is the number of heartbeats per unit of time and is usually expressed in beats per minute (bpm). In adults, a normal heart beats about 60 to 100 times a minute during resting condition. The resting heart rate is directly related to the health and fitness of a person and hence is important to know. You can measure heart rate at any spot on the body where you can feel a pulse with your fingers. The most common places are wrist and neck. You can count the number of pulses within a certain interval (say 15 sec), and easily determine the heart rate in bpm.

This project describes a microcontroller based heart rate measurement system that uses optical sensors to measure the alteration in blood volume at fingertip with each heart beat. The sensor unit consists of an infrared light-emitting-diode (IR LED) and a photodiode, placed side by side as shown below. The IR diode transmits an infrared light into the fingertip (placed over the sensor unit), and the photodiode senses the portion of the light that is reflected back. The intensity of reflected light depends upon the blood volume inside the fingertip. So, each heart beat slightly alters the amount of reflected infrared light that can be detected by the photodiode. With a proper signal conditioning, this little change in the amplitude of the reflected light can be converted into a pulse. The pulses can be later counted by the microcontroller to determine the heart rate.

The Easy Pulse sensor is based on the principle of photoplethysmography (PPG) which is a non-invasive method of measuring the variation in blood volume in tissues using a light source and a detector. Since the change in blood volume is synchronous to the heart beat, this technique can be used to calculate the heart rate. Transmittance and reflectance are two basic types of photoplethysmography. For the transmittance PPG, a light source is emitted in to the tissue and a light detector is placed in the opposite side of the tissue to measure the resultant light. Because of the limited penetration depth of the light through organ tissue, the transmittance PPG is applicable to a restricted body part, such as the finger or the ear lobe. However, in the reflectance PPG, the light source and the light detector are both placed on the same side of a body part. The light is emitted into the tissue and the reflected light is measured by the detector. As the light doesn't have to penetrate the body, the reflectance PPG can be applied to any parts of human body. In either case, the detected light reflected from or transmitted through the body part will fluctuate according to the pulsatile blood flow caused by the beating of the heart.

The sensor body is built with flexible Silicone rubber material that helps to keep the sensor tightly hold to the finger. Inside the sensor case, an IR LED and a photo detector are placed on two opposite sides and are facing each other. When a fingertip is plugged into the sensor, it is illuminated by the IR light coming from the LED. The photo detector diode receives the transmitted light through the tissue on other side. More or less light is transmitted depending on the tissue blood volume. Consequently, the transmitted light intensity varies with the pulsing of the blood with heart beat. A plot for this variation against time is referred to be a photoplethysmographic or PPG signal. The following picture shows a basic transmittance PPG probe setup to extract the pulse signal from the fingertip.

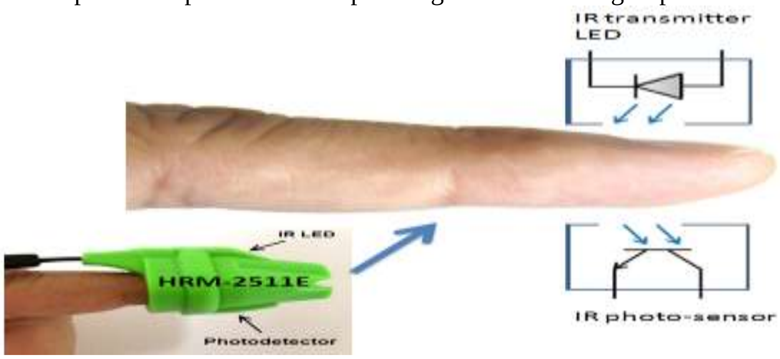
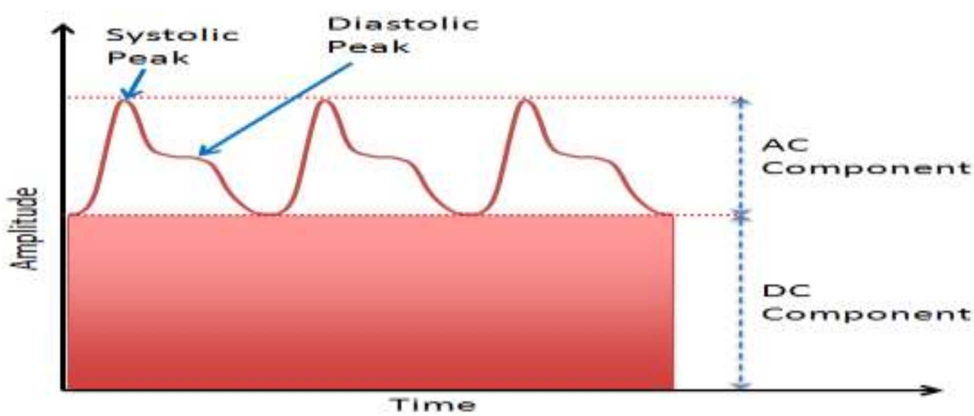


Figure: fingertip heart rate sensor

The PPG signal consists of a large DC component, which is attributed to the total blood volume of the examined tissue, and a pulsatile (AC) component, which is synchronous to the pumping action of the heart. The AC component, which carries vital information including the heart rate, is much smaller in magnitude than the DC component. A typical PPG waveform is shown in the Figure below



Circuit diagrams

The following circuit shows the ON/OFF control scheme for the infra-red light source inside HRM-2511E. Note that the Enable signal must be pulled high in order to turn on the IR LED. The photo detector output SENSOR) contains the PPG signal that goes to a two-stage filter and amplifier circuit for further processing.

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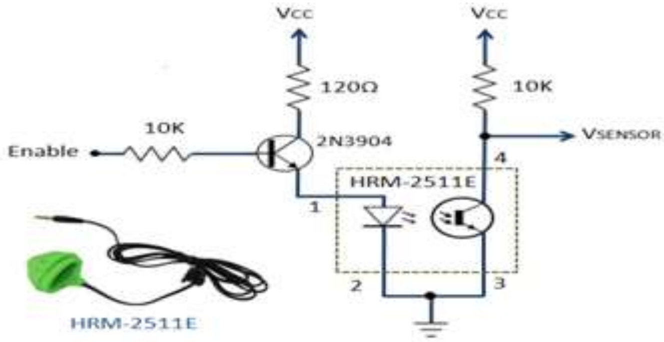
Signal conditioning unit

The reflected IR signal detected by the photo diode is fed to a signal conditioning circuit that filters the unwanted signals and boost the desired pulse signal. Signal conditioning unit consists of two stage operational amplifiers that are configureured as active low pass filters. The cut-off frequencies of both the filters are set to about 2.5 Hz, and so it can measure the pulse rate up to 2.5*60 = 150 bpm. The gain of each filter is about 100, which gives the total 2-stage amplification of 10000.



Results

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