Construction of Wireless Stethoscope with Noise Reduction Feature using Zigbee Module

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Abstract: Stethoscope is the most generally employed tool in the health care. Sometimes hearing the patient's heart sound or murmurs which are low in amplitude may lead to false diagnoses and this project helps to overcome several problems. The physician will be able to monitor his patient's condition by the graph displayed using the MATLAB software in his laptop with the use of ZigBee module. MATLAB software is used for analyzing the heart sounds, so the doctor will be able to diagnoses the graph accurately. ZigBee module is employed for wireless transmission of data from the stethoscope to the doctors who are far away from the patients while the stethoscope is in contact with the patients. When immediate assistance is required i.e. when the readings cross the threshold level, a buzzer would alert the authorities for the immediate assistance. All the components could be built and controlled through the Arduino microcontroller which is easy and simple to implement. Thus our project aims at helping people and as well as doctors for easy and accurate diagnoses through the extensive use of embedded systems and wireless communication technology.

I. INTRODUCTION

Our goal is to develop biomedical technologies that will enhance the lives of people in this developed world and to support healthy living by improving the current methods of auscultation.

Diagnosis is done by listening to the sounds of the internal body parts. Every organ of the body is unique and each has a specific sound profile that can be used to determine the healthy functionality. When these sounds get changed they can uncover clues about what is happening in that specific part of the body. The ability to diagnose accurately comes with experience and it takes time to understand the specific sound profiles that separate healthy from unhealthy.

There are Different acoustic details to listen for. A full auscultation exam must assess these four different details - blood pressure, sounds of the heart, sounds of the lungs, and sounds of the bowels.

Specifically, for our project, we chose to focus on heart and lung sounds since many primary medical issues arise from these organs of the body. Wireless stethoscope is convenient for patient monitoring. The acoustic sound properties of the lung and heart are analyzed using a wireless stethoscope. Cardiac action parameters which are obtained from the recorded digitized heart sounds are analyzed. The insights of cardiac and breathing actions are provided by cardiac heart sound. Using zigbee technology, the recorded heart sounds are wirelessly received by a receiver module which is connected to a computer. The data is passed through a digital filter and normalized by amplitude scaling and the noises were reduced by using moving average algorithm.

Critical analysis can be done on the recorded sound signal in time and frequency domain using MATLAB and ARDUINO environment. Predominant information regarding the cardiovascular disorders is disclosed by software module. Therefore, we can solve the shortage of specialist doctors and help them in urban as well as rural clinics and hospitals.

II. PROBLEM STATEMENT

Due to cardio-vascular disease a large number of deaths occur between the age group of 25-69 years. There are many numbers of diagnostic tests which can be used to determine the heart diseases. Auscultations can be heard using the stethoscope.

Heart sound detection using traditional stethoscope is usually the main problem that physician's face. Mostly murmurs of heart go unnoticed during the routine check-ups as detection depends on the training of physicians and the quality of the equipments. Hence existing stethoscope should be replaced by digital wireless stethoscope.

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III EXISTING SYSTEM AND ITSDISADVANTAGES

The usual stethoscope has a chest piece which has a bell and a diaphragm in it. The bell detects sounds at a lower pitch while the diaphragm resonates at higher pitch. The sounds travel through the metal tubes and reach the ear piece. The human ear would receive the sound from the ear tips. In existing system, the doctors face a lot of problems and inaccuracies. There is a risk factor where the user might lose his or her hearing ability. The stethoscope's ability to magnify and amplify sound could backfire. Suppose one held the tool to a loud noise or something occurred that caused a loud noise, the physician's hearing would be seriously affected. The spreading of Germs could be another issue. Doctors are advised to clean the ear tips frequently and to sterilize the diaphragm. And also, these kinds of stethoscopes do not distinguish sounds too well.

IV. PROPOSED SYSTEMTECHNIQUE

The proposed system has the stethoscope which has the mike transducer and mike amplifier. This is in-turn connected to the ADC sampler. The digitized data is sent to the microcontroller for further measurements. The temperature sensor and buzzer, which would ring in case of emergencies, would be a supplement. The Zigbee module is used for transmitting the data in a wireless way. The Arduino microcontroller is used to control the functions of buzzer, temperature sensor and the zigbee module. The transmitter part of the zigbee module receives the data from the Arduino microcontroller and transmits it to the receiver module of the zigbee. The receiver module is connected to the doctor's laptop which is equipped with Mat lab software.

The PCG graph can be viewed through the Mat lab software.

Therefore, the physician who is physically away from the patient would receive the heart sound measurements in his laptop. It is also possible for the patient to view the PCG graph through the Arduino software which provides the options of serial monitor and serial plotter. Thus, this forms the skeletal system of wireless transmission of the stethoscope data. If the sound needs to be heard by a group of physicians, then a speaker can be connected externally to the microcontroller. This would be an additional feature, since a group of doctors would be able to hear the heart sound at the sometime.

BLOCK DIAGRAM:

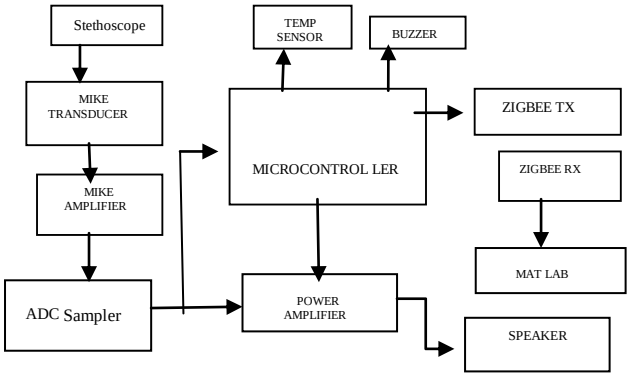
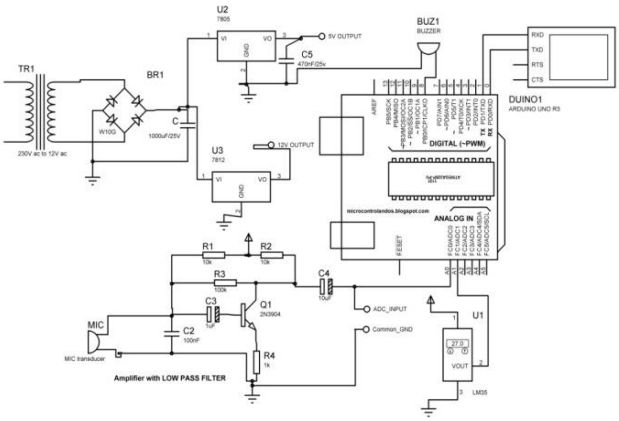


fig1. Block diagram of the project

V. CIRCUIT DIAGRAM

The voltage is reduced to 12V using step-down transformer. AC to DC voltage is converted by the bridge rectifier. By employing two regulators-, 12 V and 5V can be obtained. The 12V is given to Aurdino board and 5V is applied to amplifier with low pass filter circuit.



I. FIG.2 CIRCUIT DIAGRAM OF THE PROJECT

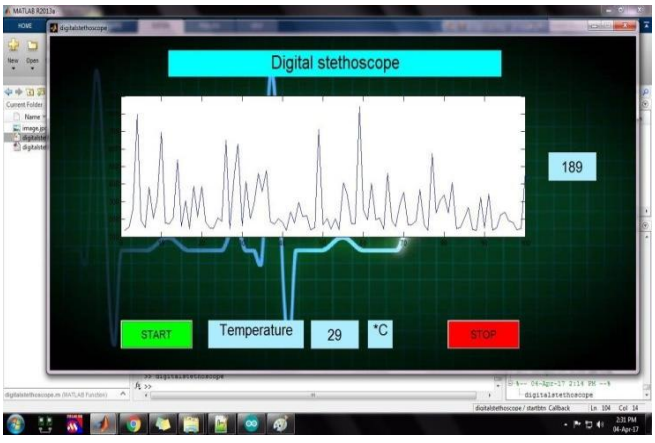
This circuit would eliminate the noise effectively. The noise from the mike can be minimized by the C2 capacitor. The resistors(R1, R2, R3, R4) capacitors(C3, C4) transistor Q1 with low pass filter forms the amplifier circuit . A threshold value can be set, in-case of emergencies, the buzzer would ring, calling for immediate assistance from medical department. The zigbee module can be connected to the Arduino and it would transmit the PCG wave readings to the doctor's monitor. Since mat lab software is used, the readings can be saved and viewed later for diagnosis. This can also be entered into patient's medical history, if needed. For the Patient's benefit, they could connect the hardware to their laptops and view the PCG graph through the Arduino software too. Thus, both the doctor and the patient would be benefited.

VI. ADVANTAGES OF PROPOSEDSYSTEM

1. Amplified sound output:
   Has it contained amplifier circuit and noise reduction circuit, the accuracy of the values is increased.
2. Intensified frequency range:
   By varying the frequency range in electronic stethoscope, a various medical issues can be detected.
3. Significant noise reduction:
   The external noise and internal circuit noise can be eliminated significantly through this setup.
4. Record &store functionality:
   By the ability of storing and replaying it, it can be entered into the patient's history.
5. Reduced time for accuracy:
   Its ability to amplify sounds and tune into specific frequencies at increased speed helps the medical professional to determine a patient's physical health.
6. Digital display:
   Here a digital display is used to see what the listen through their headphones.

VII. RESULTS ANDOUTPUT

Thus, the graph can be obtained in both Arduino software and also in mat lab software. The amplitude value can be obtained along with temperature in the mat lab software using a suitable code. The following are the outputs displayed in mat lab software and Arduino software respectively.



II. FIG.3.OUTPUT OF MATLAB SOFTWARE BY USING ZIGBEE.

This is the output obtained through Arduino software.

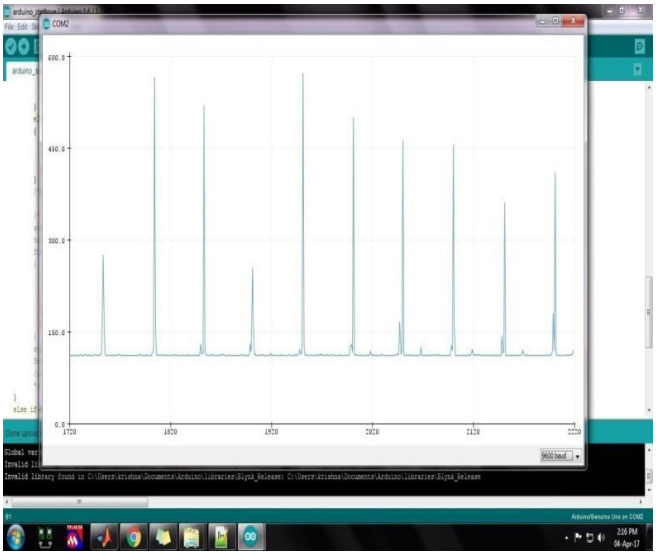


Fig.4: Arduino output graph

VIII CONCLUSION

Thus, we are able to construct a system where the PCG signals are transmitted wirelessly from stethoscope through the zigbee module. This would help the doctors to analyze the heart sounds irrespective of their work experience. The noises that usually occur due to environment and stethoscope components are drastically reduced by filter components and regulators. This is easy to implement and also cost effective. The mat lab software helps us to view the graph and also store it if needed. The Arduino software which is open source is been utilized, therefore, it is compatible to nearly all the systems. The buzzer would help the doctors to become aware of the emergency situations that require immediate assistance. Hence, it could be concluded that this project would be a benefit for both doctors' and patients.

REFERENCES

[1] Mariusz Kruk, Jacek Kadziela, Harmony R. Reynolds, Sandra A.Forman, Zygmunt Sadowski, Bruce A. Bartonetc, etc. Predictors of Outcome and the Lack of Effect of Percutaneous Coronary Intervention Across the Risk Strata in Patients With Persistent Total Occlusion After Myocardial Infarction: Results From the OAT (Occluded Artery Trial) Study, JACC: Cardiovascular Interventions, 2008,1(5):511-520

[2] Francesco Antonini-Canterin, Elisa Leiballi, Roxana Enache, Bogdan A. Popescu, Monica Roşca, Eugenio Cervesato, etc. Hydroxymethylglutaryl Coenzyme-A Reductase Inhibitors Delay the Progression of Rheumatic Aortic Valve Stenosis: A Long-Term Echocardiographic Study, Journal of the American College of Cardiology, 2009, 53(20):1874-1879

[3] Ashish Harsola, "Embedded Stethoscope for Heart Sounds", International Journal of Advanced Computer Research, Volume-2 Number-4 Issue-6 December-2012, pp151-155.

[4] Mariusz Kruk, Jacek Kadziela, Harmony R. Reynolds, Sandra A.Forman, Zygmunt Sadowski, Bruce A. Bartonetc, etc. Predictors of Outcome and the Lack of Effect of Percutaneous Coronary Intervention Across the Risk Strata in Patients With Persistent Total Occlusion After Myocardial Infarction: Results From the OAT (Occluded Artery Trial) Study, JACC: Cardiovascular Interventions, 2008,1(5):511-520

[5] Francesco Antonini-Canterin, Elisa Leiballi, Roxana Enache, Bogdan A. Popescu, Monica Roşca, Eugenio Cervesato, etc. Hydroxymethylglutaryl Coenzyme-A Reductase Inhibitors Delay the Progression of Rheumatic Aortic Valve Stenosis: A Long-Term Echocardiographic Study, Journal of the American College of Cardiology, 2009, 53(20):1874-1879
[6] Ashish Harsola, "Embedded Stethoscope for Heart Sounds", International Journal of Advanced Computer Research, Volume-2 Number-4 Issue-6 December-2012, pp151-155.
[7] Yang Tang, Guitao Cao, Hao Li, Kanjie Zhu, "The design of electronic heart sound stethoscope based on Bluetooth", 4th International Conference on Bioinformatics and Biomedical Technology, 2010, Loc: Chengdu, Vol:65,pages:1- 4DOI:10.1109 /ICBBE. 2010. 5516342.
[8] http://advan.physiology.org/content/36/4/360
[9] https://en.wikipedia.org/wiki/Heart_sounds
[10] H. B. Sprague, "History and present status of phonocardiography." IRE Trans. on Med. Electr. , pp. 2- 3,1957.
[11] S. M. Debbal, et al, "Computerized heart sounds analysis," Comp. in Biology and Medicine, pp. 263- 280,2008.

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