

## **Remote controlled bioacoustics analyzer as a teaching and diagnostic tool in auscultation studies in clinical practice**

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### **Abstract**

*Bioacoustics methods are very useful in diagnosis of various diseases. Auscultation of lungs, heart and foetal sounds are very important among them. It is, however, a difficult skill to acquire and develop due to lack of proper teaching methods involved in auscultation. In this investigation we developed a program to remove these barriers and improve auscultation teaching methods in clinical teaching. The transmitter attached to the bioacoustic analyzer extract the sound through low-noise microphone preamp, filters unwanted sounds and amplifies only the required low frequency sounds obtained from auscultator areas of the body and transmit the signal to the computer via waves. The software that we have developed converts binary input from the sound card to wave pattern and analyzes to interpret probable diagnosis. The diagnosis could be achieved by side by side comparison of standard normal heartbeat pattern and abnormal heartbeat pattern in different diseases. With this analyzer, it is possible for the student to understand what exactly teacher has interpreted on the acoustic pattern in clinical teaching with the help of amplified sound from speakers and concomitant wave pattern displayed visually on the screen.*

**Key words :-** Auscultation, bioacoustics, medical education.

### **Introduction**

Bioacoustics methods of diagnosis had been used in ancient clinical practice of medicine and continued to be used even in modern medicine without considerable improvements to the bioacoustics measuring instruments such as stethoscope, foetoscope, transducers, blood pressure & pulses measuring instruments. These are the most commonly used techniques in screening and diagnosis in primary health care. Heart and lung auscultation are such methods used in clinical practice and perhaps the only method available in rural areas in primary health care issues. In addition to the interpretation of heart and lung sounds bioacoustics also includes the study of bowel sounds, laryngeal sounds, phonations, vascular sounds like carotid and femoral bruits and acoustic emissions from intracranial arteriovenous malformation or aneurysms (John Doyle *et al.*, 2000). This is a largely unexplored area with great potential for research. Interpretations of bioacoustics emission from any auscultator site of the body through available methods are difficult to teach in an organized manner (Todd *et al*, 2001). In clinical teaching the teacher and medical students are unable to hear the sounds through stethoscope or foetoscope simultaneously from the patient and interpret them for diagnostic purposes. It is uncertain whether the student can understand what exactly the teacher has interpreted on acoustic pattern due to limitation of hearing acoustic pattern from the patient, which is restricted to one person at a time. Sometimes the teacher uses pre recorded audio tape for these purpose. However, the interpretation of bioacoustic emissions through a stethoscope or foetoscope is a skill that can take years to build up and refined, that is unique to a person. In this investigation we removed these barriers by filtering unwanted sounds, amplifying low frequency bioacoustics using hardware and converting them into digital waves, visualized in computer screen with probable diagnostic information using new software.

### **Method**

The whole process is a noninvasive method consisting of different combinations of techniques in signal acquisition, processing and visualization.

### **Hardware Bioacousticscope**

TL072 low-noise, dual opamp IC was used to filter the unwanted sounds from the input signals which operate as a low-noise microphone preamp. Its gain is only about 3.9 because the high output impedance of the microphone. The sound extracted from auscultator areas are converted to frequency modulated waves and send to the computer.

## Software

Fast Furrier Transform algorithm with the help of visual basic 6 libraries kernel32, gdi32, avifil32, winmm, MSVFW32, multimedia MCI control in the modules and class modules, and windows API call methods were used according to architecture shown in Fig.1 in the development of this software. Also attempt was made to interpret the probable diagnosis through bioacoustics interpreter which needs more clinical investigations.

## Results and Discussion

The low-noise microphone preamp filters and amplifies the low frequency sounds obtained from condenser microphone of any bioacoustics instruments like stethoscope, feotoscope, transducers. It transfers sounds from any auscultator site of the body and transfer to receiver in the computer via waves. Bioacoustics recorder (Fig.2) convert binary input again to wave pattern by Fast Fourier Transform (FFT) logarithm. The resultant frequency data were plotted as time versus amplitude to show a characteristic wave pattern. The real time waves displayed, in the oscilloscope were then recorded as a wave form. The resultant pattern is viewed through Bioacoustics viewer (Fig.3) and any sample could be enlarged, played, analyzed and interpreted through a bioacoustics interpreter (Fig.4). It is obvious that a student can understand what exactly the teacher has interpreted on the acoustic pattern in clinical teaching with the help of amplified sound from speakers and concomitant wave pattern displayed visually on the screen. Probable diagnosis could be achieved by side by side comparison of wave pattern of the patient with the wave pattern stored in the data base obtained from patients with various known diseases.

### Characteristics of wave pattern of normal heartbeat

Normal heartbeat sounds are generated from, the tricuspid valve area, mitral area, aortic area and the pulmonary area of the heart. In the present investigation bioacoustics analyzer was used to analyze and interpret normal heartbeat sounds and heart murmurs. Normal heartbeat is heard like "luub- duub" which correspond to S1 and S2 visualized as two major peak. S1 peak is best heard at apex and S2 is heard at cardiac base. S1, the first sound is due to closure of mitral valve and the tricuspid valve and heard at early stage of contraction (Fig.4). S2, the second sound is mainly caused by the aortic valve closure (A2) and pulmonic valve closure (Donald, *et.al.*, 2003) (P2) and visualized within peak corresponding to the S2 (Fig.4). The time gap between S1 and S2 is heard during ventricular contraction and time gap between S2-S1 is heard during expiration. Usually, time gap between S1 and S2 is shorter than time gap between S2 and S1. In addition to the S1,S2 other sound waves like S3, S4 (4) and other characteristic sound waves (Gregory, *et al.* , 2005) also were visualized in our spectrum which may be useful in diagnosis various heart diseases conditions. An attempt has been made to classify various disease conditions according to the characteristic properties of their wave pattern using bioacoustics Interpreter. Same technique was applied with the foetoscope andndtransducers.

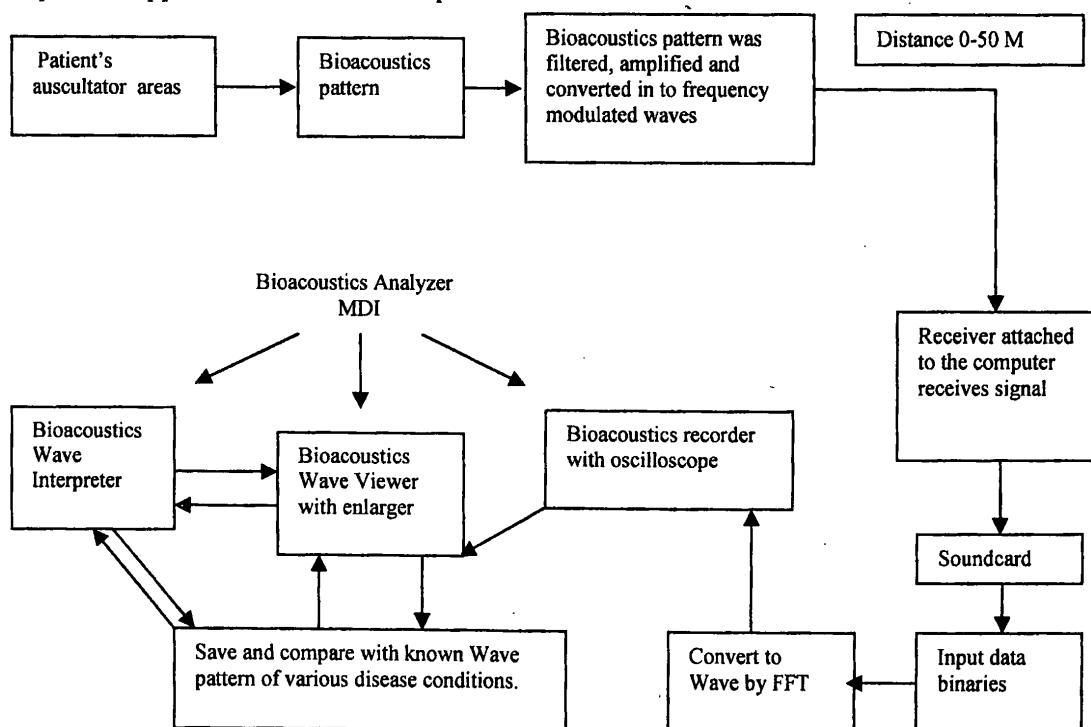


Fig. 1 Architecture of the program

## Conclusion

A Multi-purpose Bioacoustics analyzer is a new software with hardware support which integrate sounds with the visual wave pattern to analyze and interpret various disease conditions. It is also a very useful tool in teaching auscultation studies of heart, lungs and foetal studies. Extensive clinical investigations should be performed with new characteristic wave pattern appears through this software for the diagnostic purposes in clinical practice.

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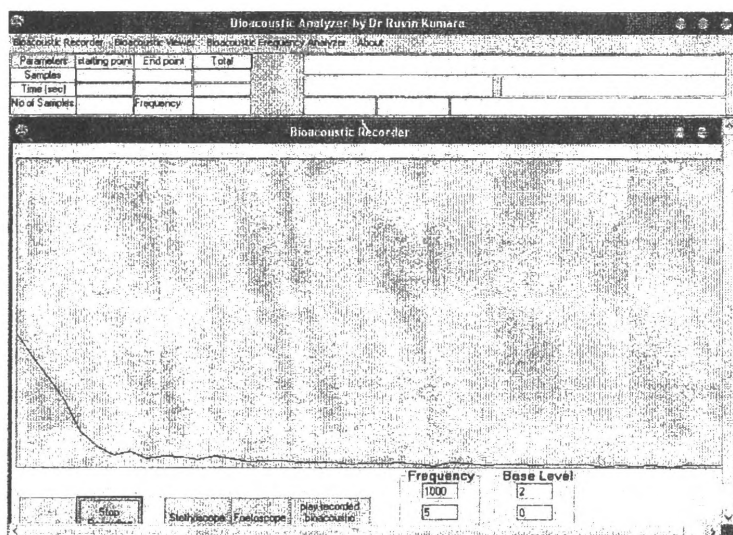


Fig.2. Bioacoustics Recorder

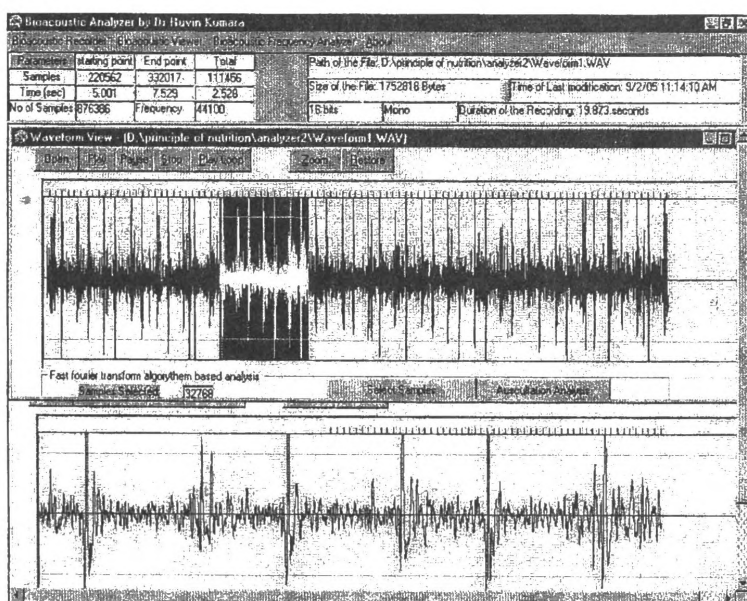


Fig. 3. Bioacoustics viewer.

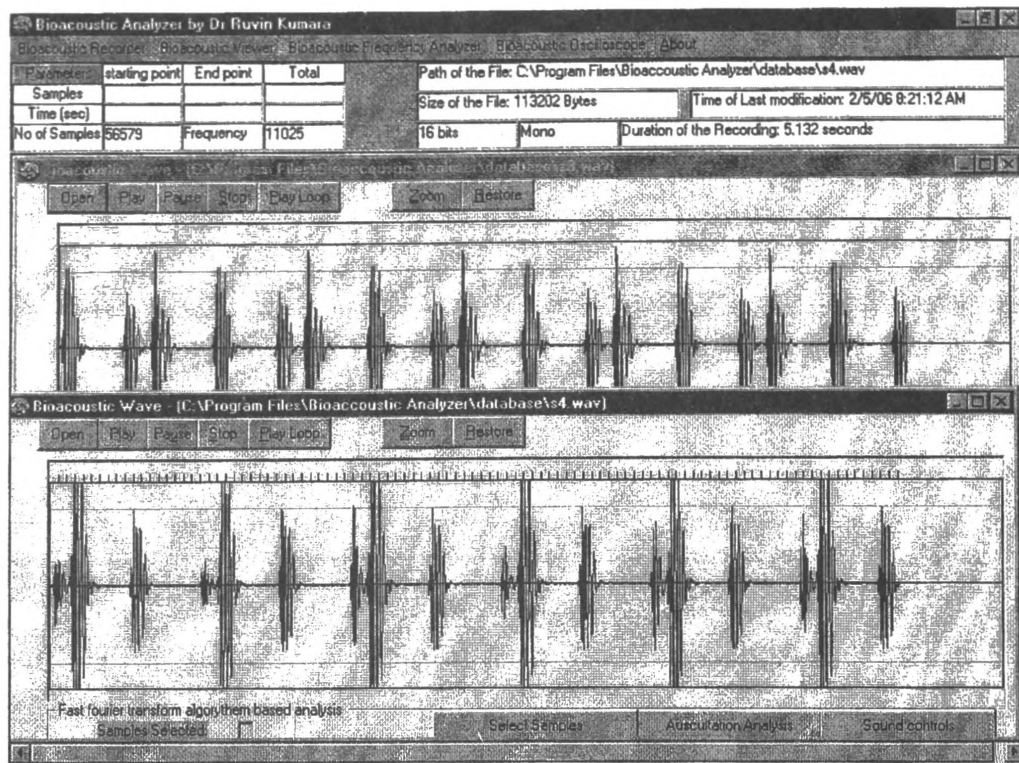


Fig.4. Side by side comparison of heartbeat wave pattern in different disease conditions

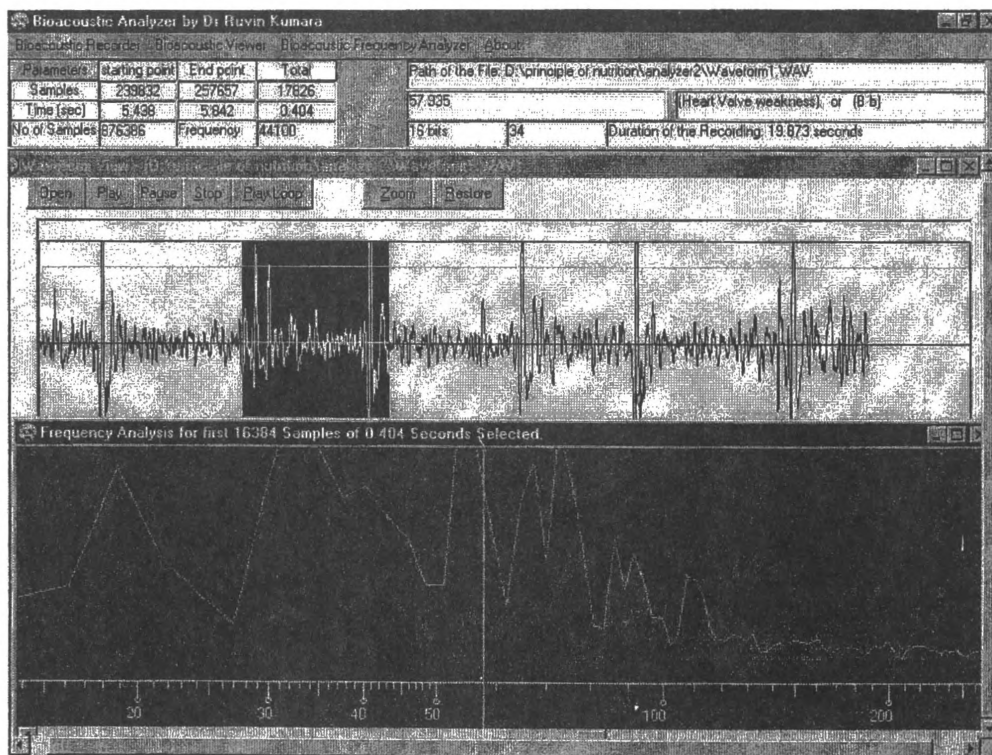


Fig. 5. Analysis of Wave pattern by bioacoustics interpreter.