

Low Cost Electronic Stethoscope

Nilmini, K.A.C. and Illeperuma, G.D.

Department of Physics, Open University of Sri Lanka. Nawala, Nugegoda, Sri Lanka

Email: amithanilmini17@gmail.com, gdilleperuma@gmail.com

Abstract

Among many medical devices, stethoscope is the most widely used device for medical diagnosis. Auscultation is a non-invasive, pain less, quick procedure that can identify many symptoms and was used as early as 18th century. However, major drawbacks of conventional stethoscope are extremely low sound level and lack of ability to record or share the heart and lung sounds. These problems can be overcome by an electronic stethoscope and have the potential to save many lives. Although electronics stethoscopes are already available in the market, these are very expensive. Therefore, objective of the project was to build a low cost electronic. At the basic level, it would facilitate listening to the heart sounds more clearly. Among other facilities is the ability to control the sound level, to record the sound and share as digital information and also to display the sound using graphs for improved diagnostics. Recording and sharing facilities were included due to the importance of tracking patient's medical history, and also to discuss among group of physicians. It can also facilitate remote diagnostics where experts may not be readily available. 50 mm sized chest piece of an acoustic stethoscope was used as the chest piece due to its optimized design. Chest piece's diaphragm was placed against the chest of the patient to capture heart sounds. Those sounds were converted to electronic signals by a microphone. Electret condenser microphone was selected from several other types of microphones due to the smaller size (radius 3 mm) and ability to detect the low frequency sounds (~ 30 Hz). Those electrical signals were amplified by the pre amplifier. TL072 integrated circuit was used as a pre operational amplifier. It provided a gain of 3.8. Output signal of the preamplifier circuit was sent to the Sallenkey low pass filter circuit. It filtered the first heart sound (S1, from 30 Hz to 45 Hz), and second heart sound (S2, 50 Hz to 70 Hz). Filtering was done by setting the cut off frequency as 100 Hz and that value was given by the capacitor values 0.047 μ F and resistor value 33 k Ω . Getting the advantage of TL072 being a dual operational amplifiers in the single die, second operational amplifier was for the filter circuit. Output signal of the filter circuits was amplified to the appropriate amplitude by using audio power amplifier for the headphones and speakers. LM386 integrated circuit was used as the audio power amp. It provided an gain about 20. Speakers and headphones were used as the output. Facility was provided to use any standard 3.5 mm headphones. Constructed circuit was validated by, comparing the original heart sound and amplified output via a digital oscilloscope. Once the implementation was completed, it was compared for the sound quality against an acoustic stethoscope by six independent observers. Five of them heard the heart sounds more clearly by the electronics stethoscope than the acoustic stethoscope. Accuracy of the heart sound was consolidated by a

person who has grip knowledge about anatomy. Recording facility was provided using open source software “audacity” and using the computer audio card to capture the sound. Saved file of the heart sound can be used in several ways such as; it can be stored in a database, can be share via e mail and also for play back for further examine in diagnosing process. Heart sounds were visualized as a graph on the computer. An Arduino was used to digitize (1024 resolution) the audio signal and send the data through virtual com port to the computer for graphing. It can also be used to record sounds to an SD card when a computer is not available. As a result similar sound quality has been found when comparing between direct listening and a recorded sound. In conclusion, the implemented system was considered a success due to low cost, ease of implementation and the ability to provide the most useful functions required from an electronic stethoscope.

Keywords: *Electronic Stethoscope, Heart Sounds, Auscultation*