

# Wireless Tele-Auscultation for Phonocardiograph Signal Recording Through Zigbee Networks\*

Jusak Jusak

Dept. of Computer Engineering

Institute of Business and Informatics, Stikom Surabaya

Surabaya, Indonesia

jusak@stikom.edu

Ira Puspasari

Dept. of Computer Engineering

Institute of Business and Informatics, Stikom Surabaya

Surabaya, Indonesia

ira@stikom.edu

**Abstract**— Some factors that arise from difficulties in identifying in detail the cardiac signal can lead to heart disease diagnosis process becomes biased. For example, diagnosis process is strongly influenced by the subjectivity of the doctor, this is primarily due to exposure of patient chest area during the process of measurement. One solution to cope with this problem can be done by allocating doctors and patients in separate rooms. Hence, this was the main motivation of our work. In this paper, we examine the use of a wireless tele-auscultation system for transmitting and recording phonocardiograph signal. The data is transmitted through the Zigbee-like (called the Xbee) networks in local area networks. Based on the study, it is shown that the Type A loss can be omitted without affecting the validity of the received signal as long as time length of measurement is longer than the transmission delay. In terms of the Type B loss, it can be argued that the transmission process is considered as valid, i.e. even though there are loss packets, the number of the loss packets is not significant. In addition to that, it can be observed that variation of the sampling period and the serial interface data rate do not contribute well to the improvement of the throughput of the streaming heart sound signal transmission. The throughput of the system is probably influenced by the surrounding environment and hardware or memory capability of the Xbee.

**Keywords**—phonocardiograph; cardiac signal; tele-auscultation; Zigbee networks

## I. INTRODUCTION

### A. Bacground

Based on the latest data released by the World Health Organization (WHO) in April 2011, deaths caused by non-communicable coronary heart disease has reached 37% of the total number of deaths in Indonesia [1]. In addition, in another WHO report states that in 2020, it is estimated that the coronary heart disease will be the major killer diseases in countries throughout Asia-Pacific [2]. The main cause of the coronary heart disease is the presence of excessive fat built up in the lining of the coronary vessel wall veins, causing the blood flow through these arteries become blocked. Modern medicine suggests that if the symptoms of heart disease can be recognized earlier, then the death caused by the heart disease can be reduced significantly.

In general, there are two types of signals that can be used

for monitoring the performance of the heart and to diagnose cardiac signals, i.e., phonocardiogram signal (PCG) and the signal electrocardiogram (ECG) [3]. PCG signal is obtained by a doctor using a stethoscope to recognize the symptoms of abnormalities in the heart, while the ECG signal obtained by performing data retrieval through electrodes attached to some point of the body (right arm, left arm and right leg/left) [4]. The signal measurement using either a stethoscope or ECG is often referred to as auscultation.

In this study, we will focus on the PCG signal only. The PCG signal is obtained through process of recording an acoustic wave generated by the mechanical movement of the heart. It is known that there are two types of vibration that can be generated from measurements of the PCG, i.e. the heart sound and the heart murmurs. Based on the characteristics of heart sounds and murmurs, generally classic stethoscope can be used to detect early symptoms leading to a variety of heart problems. However, retrieving signal through the classic auscultation process often limited by low accuracy measurement results, this is mainly because the stethoscope produces a weak voice. Another weakness of the conventional methods is that the auscultation heart signal can never be saved for further analysis. Therefore, doctor's experience as well as physical limitations affects directly to interpretation of the results.

In addition to the difficulties in identifying detail of the cardiac signal, there are other factors that can lead to heart disease diagnosis process becomes biased, i.e., diagnosis process is strongly influenced by the subjectivity of the doctor [4], this is primarily due to exposure of patient chest area during the process of measurement. It is commonly known that the subjectivity due to the physical proximity can affect the interpretation of the diagnosis of heart disease. One solution to cope with this problem can be done by allocating doctors and patients in separate rooms. Such a process is known as remote auscultation (tele-auscultation). Applying tele-auscultation requires the use of network as a medium for data transmission. For example, wireless networking technology can be utilized as it has some advantages, i.e., ease of installation as well as flexibility in terms of the area that can be covered.

\*Supported by the Competitive Grant 2014, Indonesian Ministry of Research, Technology and Higher Education.