

Wireless vital signal detection systems and its applications at 1.9GHz and 10GHz

J. M. Park, D. H. Choi, and S. O. Park

School of Engineering

Information and Communications University, P.O.Box 77, Yusong, Daejeon, Korea 305-600

Abstract

Wireless vital signal detection system, which is analogous to Doppler radar, can measure respiration and heart rates with periodic movement of skin and muscle near the heart. The detection system is consisted of antenna, RF transceiver (transmitter and receiver), and baseband section. In this paper, the link budget about the detecting system is analyzed and the signal detected from the system is compared with the electrocardiogram (ECG) signal of monitor which is used for patient monitoring in hospital. Then the detection of vital sign is also performed according to various environments such as the different distances and behind the wall.

1. Introduction

One of the world's recent medical trends is to pursuit remote healthcare system. With this tendency, the parts of remote sensing technology have been studied by many laboratory members. The study about the wireless detection of respiration and heart rate has been started from 1975 [1], [2].

The remote medical sensing instrument using RF system is profitable in cost aspects compared with expensive medical instruments. Because the sensing system is easy to handle, even ordinary person who is not instructed about usage of the instruments can use it.

Two systems are considered in this research. Each system is consisted of antenna, transceiver and A/D converter. The transceiver for sensing both heart rates and respiration can be one or two parts. If it is consisted of two parts, the antennas used on the experiment must be also two. But if the transmitter and receiver part are integrated into one, only one antenna is required on this experiment. In this paper, we use the identical transceiver which is consisted of coupler, attenuator, LNA, circulator and mixer. The baseband section is consisted of amplifiers, filters and A/D conversion part.

The principle of operation for this sensing system, based on the Doppler theory, is very simple. If the target has velocity toward the direction of the radar, the reflected signal on the surface of moving target is shifted in frequency in proportion to the velocity of target toward the direction of the radar. The shifted frequency is $f_s = 2f_0v/c$ where f_0 is transmitted frequency from antenna, c is the velocity of light and v is the velocity of target toward the direction of the radar [3],[4]. Then the received frequency is $f_0 \pm f_s$. The shifted frequency is extracted from mixer after compared with reference signal (f_0). If the surface of moving target is the skin near heart, heart rates and respiration will be detected by its periodic back and forth movement. In this paper, we will analyze the systems and show detecting results which are sensed in several different distances and behind the wall.

2. Operation principle of the systems

The block diagram of the sensing system, shown in Fig. 1, is similar to homodyne radio. The reflected signal from the object is mixed with the reference signal of transmitter to produce an output signal with its magnitude proportional to the phase difference between them. The dielectric constant and conductivity of each medium near the heart is listed in Table 1 at each frequency. As shown in