Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 120 (2017) 99–103

Procedia Computer Science

www.elsevier.com/locate/procedia

9th International Conference on Theory and Application of Soft Computing, Computing with Words and Perception, ICSCCW 2017, 24-25 August 2017, Budapest, Hungary

Use of DVB-T and DVB-S2 in telecardiology

Waleed Alsaadi[a], Ali Serener[a]*

[a]*Department of Electrical and Electronic Engineering, Near East University, 99138, Nicosia, North Cyprus, Mersin 10 Turkey*

Abstract

Telemedicine uses telecommunication and information technologies and provides clinical health care for people who are at a distance. Telecardiology is a type of telemedicine that can send electrocardiogram (ECG) signals over a wireless network to remote healthcare professionals. The aim of this paper is to simulate the transmission of ECG signals over a communication system that uses digital video broadcasting –terrestrial (DVB-T) or digital video broadcasting –satellite version 2 (DVB-S2) technologies. Bit error rate (BER) performance of this system is analyzed over an additive Gaussian white noise (AWGN) channel and compared to theoretical results. Keeping in mind that wireless channel suffers from multipath propagation, multiple-input multiple-output (MIMO) antenna technology is additionally used along with DVB-T in a fading environment. It is shown that DVB-S2 technology offers performance improvements of up to 18 dB over DVB-T in an AWGN channel. It is also shown that using MIMO along with DVB-T mitigates the effects of multipath and improves the performance. This improvement is around 5 dB. Being a superior technology, however, does not necessarily mean DVB-S2 should be chosen over DVB-T in every circumstance. For example, in the case where less delay is important (i.e. in real-time transmission) DVB-T might still be the choice of transmission of ECG signals if performance degradation can be tolerated.

Peer-review under responsibility of the scientific committee of the 9th International Conference on Theory and application of Soft Computing, Computing with Words and Perception.

Keywords: Telemedicine; telecardiology; DVB-S2; DVB-T; MIMO; ECG signals.

1. Introduction

A huge number of individuals pass on every year from illnesses; the elderly are more vulnerable to such illnesses. Numerous retirement homes are introducing frameworks that can constantly and remotely monitor the electrocardiograms (ECGs) of their residents. For instance, Alarm Net (Ubeyli, 2008) is a helped living and private

* Corresponding author. Tel.: +90-392-223-6464 Ext. 299; fax: +90-392-223-6624.
E-mail address: ali.serener@neu.edu.tr

1877-0509
Peer-review under responsibility of the scientific committee of the 9th International Conference on Theory and application of Soft Computing, Computing with Words and Perception.
10.1016/j.procs.2017.11.215

checking system that opens up new doors for nonstop observing of the elderly and those needing restorative help. Wearable ECG sensors can remotely monitor a patient's pulse, alarming medical staff to changes in status (Ghaffari et al., 2007).

There are two issues related to data transmission of ECGs: a) the information from a 12-lead ECG with 11-bit for one day of 300 Hz signal will be about 500 MB. Transmitting these amounts of information wirelessly will need high speed networks. b) remote channels are normally much noisier than wired connections and suffer from both multipath fading and shadowing, which can have a shocking effect on the apparent nature of a reproduced ECG signal.

Telemedicine is the use of advanced telecommunication technology in order to diagnose, monitor and cure illnesses. It enables transmission of data between where the patient lives and a specialized medical call center (Reimers, 1996).

Telecardiology is a highly developed discipline of Telemedicine. In addition to providing care to patients with heart disease, it plays animportant role in patient educationon the severity of their conditions, improves their willingness to medical therapy, and guides them in following healthy life habits. Especially, Telecardiology is important in rural communities as it can overcome the obstacle of the large distances needed to be covered forgetting medical assistance.

Human heart has four major sections called atria and ventricles. They propel the blood around the body. Besides these chambers, other sections of the heart exist that divide atria from ventricles and slow or speed up impulse propagation etc. ECG electrodes pick up electrical impulse that circulates through heart and all specialized cells in different directions and speed, forming ECG waveforms (Clifford et al., 2006) (Camm et al., 2009). Problems in different parts of heart effect ECG wave's direction and morphology (Luna, 2008).

Electrocardiogram is formed from avariation of bio-electric potential with respect to time of a person's heart beats. Each heartbeat cycle is formed from waveforms,namely P wave, QRS complex and T wave. Time intervals, waveform structure and orientation show physiological processes related to heart and nervous system. Advanced tools are used today in order to detect heart-beat arrhythmias and other defects.Still, ECG record eye inspection is the first step in diagnosis (Ghaffari et al., 2007).

Notwithstanding, to make ECG checking effective, we should have the capacity to monitor a few patients progressively. ECG analysis algorithms that are efficient and fast are required in clinical practice as well asoutside the hospital since early treatment are shown in clinical findings to significantly improve a patient's outcome (Purvis et al., 1999). Use of ECG test outside hospital may possiblyaffectmanagingthe patients that have acute myocardial infarction through wider, faster in-hospital use of reperfusion ways and greater use of invasive methods.These factors all may likely decrease short term death rates (Jakes, 1994). In medical literature, it is suggestedthat ECG is clinically important in not only recognizing heart problems themselves, but also other health issues that are represented on ECG as a symptomatic phenomenon, like ECG patterns showing antidepressant treatment.

We aim in this paper to simulate and analyze the use of Digital Video Broadcasting (DVB) technology in ahealth care application, namely Telecardiology. Specifically, DVB-T (terrestrial) and DVB-S2 (satellite version 2)standards are utilized during investigations. Simulations are carried out in additive white Gaussian noise (AWGN) channel and compared with theoretical results to see what amount of improvement there is. Additionally, multiple-input multiple-output antenna (MIMO) technology is used in DVB-T to lessen the effects of terrestrial multipath fading.

2. System Performance Analyses

Two Telecardiology systems are assumed in additive white Gaussian noise (AWGN) channeland simulations are run to see the performances of these systems when ECG signals are transmitted through them. Specifically, transmissions through DVB-T and DVB-S2 systems are analyzed. MIMO is then added when fading is presentin the DVB-T system to see how it affects the performance.

Normally, an ECG signal is obtained with the assistance of ECG electrodes. ECG sensors can be placed at the midsection of the patient or generally at the wrist.This research does not use real ECG data. Therefore, the first step in Telecardiology transmission simulation becomes the ECG signal generation.

The following sections show the performance analyses of these systems.