A MEDICAL TELEMETRY SYSTEM DESIGN BASED ON SPREAD SPECTRUM TECHNIQUE

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ABSTRACT

The aim of this paper is to design and implement a medical telemetry system. The device shall be critical in the application of Foetal and Maternal care. With wireless systems, patients can move freely around the hospital while their physiological parameters like Uterine activity, Foetal heart rate and Foetal ECG/Maternal ECG are measured. The captured data is then transmitted wirelessly to a receiver unit using frequency ranges within Wireless Medical Telemetry Service(WMTS) band. The spread spectrum transmission is used in the WMTS telemetry systems. It is a technique in which pseudo noise code is modulated with the data signal for spreading. The spreaded signals are used for suppressing the interference during the propagation. The interference occurs when number of users share a common channel bandwidth. The spreaded signal is then transmitted to the receiver, where the spread spectrum detector despreads the data signal. The data signal thus retrieved is used for monitoring and investigations.

KEYWORDS: *WMTS, Spread Spectrum, UA, US, FECG/MECG*

I. INTRODUCTION

Telemetry System is a system that provides a wireless means of transmitting data from a remote location to another place for its monitoring. It includes transmitting Ultrasound audio, Maternal/Fetal ECG and Uterine activity signals from an ambulatory mother to a bed side Maternal/Fetal monitor [1]. The WMTS frequency band is used for transmitting the data related to a patient's health. More than 30 years ago the wireless medical telemetry system was used in hospitals for foetal heart rate monitoring. Wireless medical telemetry offers the advantage of obtaining accurate physiological signals from freely moving, untethered patients [4]. The Federal Communications Commission (FCC), defined wireless medical telemetry device, as a device that transmits physiological signals via radio frequency (RF) from a transmitter worn by the patient to a remote receiver.

The development of Wireless Medical Telemetry systems have significant advancement in the healthcare institutions to provide optimal patient care for Maternal-Foetal Monitoring. With wireless systems, patients can move freely around the hospital while their physiological parameters like Uterine activity, Foetal Heart Rate and FECG/MECG are measured[1]. The Telemetry system consists of a Transmitter and a Receiver unit. The transmitter can capture Uterine Activity (UA),Foetal Heart Rate (US) and FECG/MECG parameters by the sensors. The captured data is then transmitted wirelessly to a receiver unit using frequency ranges within WMTS band[4]. Spread spectrum is the technique used in this

telemetry system. The receiver is a part of the Telemetry System that provides a wireless means of receiving these signals and is used for further processing and monitoring.
The rest of the paper is organized as follows. In Section II presents the technique used in the project. In Section III the Proposed System Design is presented. The Results are presented in Section IV. The Section V includes conclusion and future scope is presented in Section VI.

II. SPREAD SPECTRUM

Spread spectrum technique is a transmission technique in which a pseudo-noise code, independent of information data is used as a modulation waveform to spread the signal energy over a bandwidth much greater than data signal bandwidth. At the receiver the signal is despreaded using a synchronized replica of pseudo noise code.
The pseudorandom spread spectrum signals have noise-like properties when compared with the digital information data[6]. The spreading waveform is controlled by the pseudo-noise code, which is a binary sequence that is cross correlated by the data signal at the transmitter. The same signal is then demodulated at the receiver by cross correlation with the correct PN sequence, that despreads the spread spectrum signal and restores the original data, whereas cross correlating the signal from an undesired user results in a very small amount of wide band noise at the receiver output.
The most important properties of spread spectrum technique that make it well-suited for use in the mobile radio environment are:

- Interference rejection capability
- Multipath fading resistance

III. PROPOSED SYSTEM DESIGN

The telemetry system is the system used for the automatic measurement and wireless transmission of data from remote sources. The system consists of two parts, transmitter section and receiver section.

3.1. Transmitter

The transmitter section of the telemetry system is shown in the figure 1.

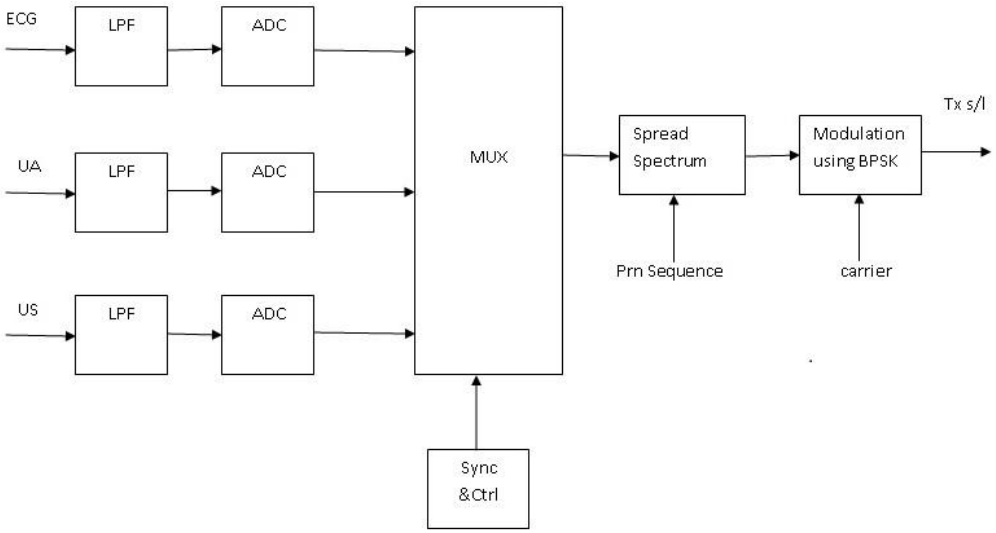

Figure 1. Transmitter Section

The biomedical signals like ECG, Uterine activity signal, Ultra Sound signals sensed by the sensors are amplified and then passed through a low pass filter. The low pass filter is then followed by an ADC, which converts the analog signal measured by the sensor into a digital signal. These three digital signals

are then passed into a MUX(multiplexer)where it is controlled by a sync signal. The output of the MUX is then passed for the spreading action of the transmitter side.

Spread Spectrum is the technique used for the spreading action. Here the digital signal from the ADC is spreaded with a pseudo random sequence(prn sequence).Thus the bandwidth of the spreaded signal is much greater than the information bandwidth. The advantage of this spread spectrum technique is that the interference of the noise can be reduced in a great manner. The spreaded signal is then modulated by BPSK(binary phase shift keying),where the carrier is modulated as 180^0 in phase or out phase depending upon the input signal. The modulated signal is then transmitted via WMTS RF band.

3.2. Receiver

The transmitted signal is received by the antenna via WMTS RF band. The block diagram of the receiver section is shown in the figure 2.

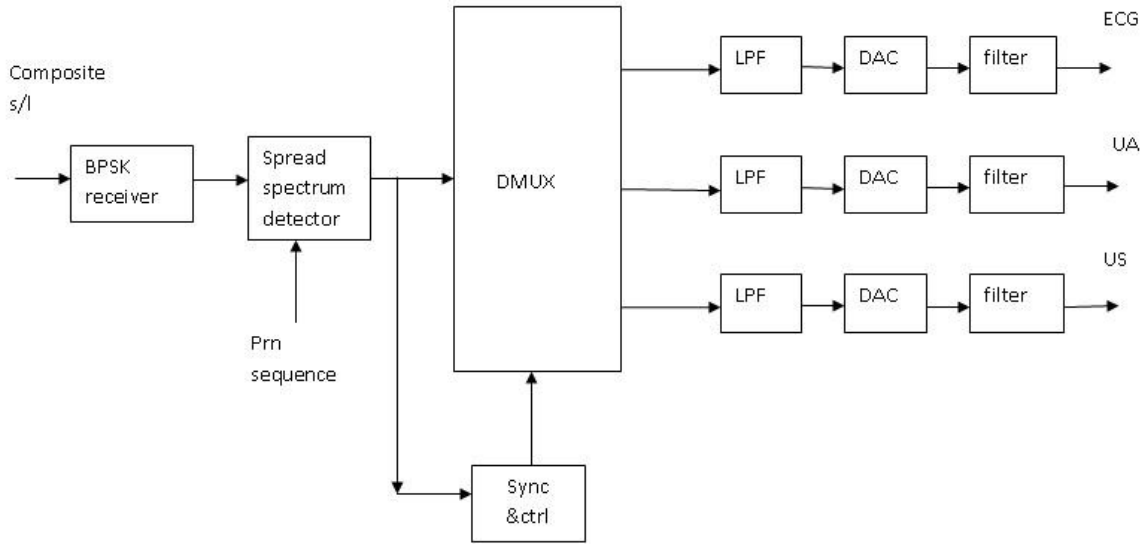

Figure 2. Receiver Section

The composite signal received is firstly demodulated by BPSK, where the carrier is removed and is then passed through a spread spectrum detector. The spread spectrum detector despreads the composite signal by the prn sequence. The property of the pseudo random sequence is that the transmitter and the receiver should use the same prn sequence, then only the transmitted data signal can be retrieved in the receiver section. Thus by despreading the data signal obtained is the passed through a DMUX, which is controlled by a sync signal. The composite signal can then be separated out into three signals i.e ECG,UA and US.

The biomedical signal received is digital in nature can be converted into an analog signal by using a DAC(Digital to Analog Converter).Then the signal is passed through a filter and is then filter out to three signals which can be monitored in a Doctor's monitoring system. Thus the patients health conditions can be analyzed and monitored by using this method.

IV. RESULTS

The results show the modulation and demodulation process in the spread spectrum technique. The simulation is done by using MATLAB software.In the modulation process the data signal selected is spreaded by modulating it with the pseudo noise code and is then modulated with the carrier sinusoidal wave for the transmission process in a high frequency range(WMTS band)The spreading process done in the transmitter section is shown in the figure 3.

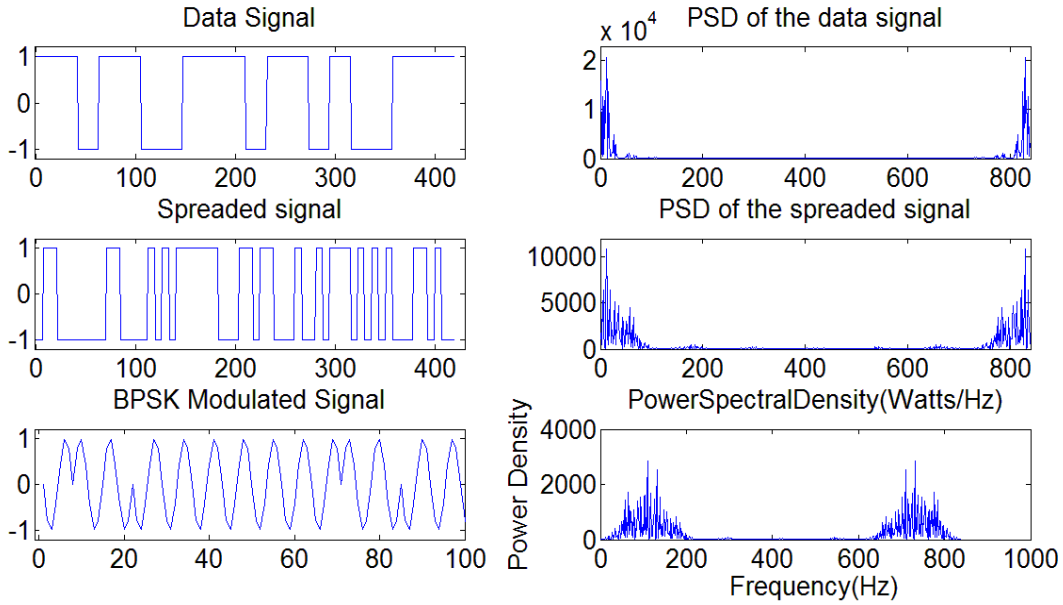

Figure 3. Simulation Results of Transmitter Section

In the receiver, the received signal is firstly demodulated by the carrier and it is then despreaded to recover the data signal. The signal with maximum low pass energy and with minimum delay is shown in the figure 4.

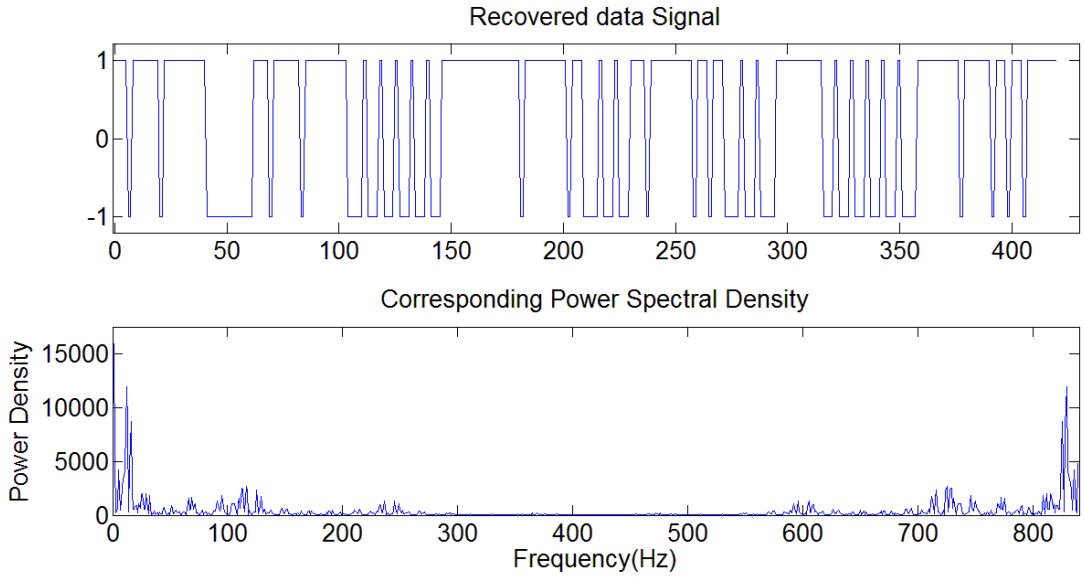

Figure 4. Simulation Results of Receiver Section

V. CONCLUSIONS

The wireless telemetry system can be used for measuring Uterine activity, Foetal Heart Rate and FECG/MECG .The captured data is then transmitted wirelessly to a telemetry receiver unit using frequency ranges within WMTS band. The design should be cost effective and to cater optimized performance. The medical telemetry systems use WMTS as the only designated frequency spectrum for

transmission the spread spectrum transmission is used in the wireless system. The patients are protected from interference due to other wireless devices by using this technique.

VI. FUTURE SCOPE

The concept can be extended for the real time implementation of medical telemetry system in FPGA.

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