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Performance Analysis of PSSK Modulation Scheme for High-Data Rate Implantable Medical Devices

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Abstract*— Biomedical applications are concentrated in WBAN (Wireless Body Area Networks) for high data rate transfer. In this paper, a new PSSK (Phase-Silence Shift Keying) modulation approach for the high-data rate WBAN in-body systems is presented and the results are compared with other modulation techniques. 8-PSSK scheme can have more gains compared to any other modulation techniques in terms of performance, spectrum growth and power transmission. A link budget analysis qualified that 8-PSSK system can obtain more link margin at least above 4 dB than any other modulation techniques for the high-data rate WBAN in-body systems.

Index Terms—**Biomedical, data rate, modulation, power.**

I. INTRODUCTION

Recently medical/nonmedical applications are concentrated more on the (WBAN) technology that supports data rates of several kilobits per second to tens of megabits per second according to application usage within 3 m. The WBAN systems are composed of in-body and on-body systems. The in-body applications which interconnect the implanted apparatus in the human body and the apparatus sticking on the human body supports a wide range of medical applications. The on-body systems serve various applications between the devices on or around the human body including medical, consumer electronics, personal entertainment etc. One of the special features that the WBAN is distinguished from other existing wireless standards such as wireless personal area network and wireless local area network is that the information technology-biotechnology (IT-BT) convergent applications are implanted in the human body [1].
In case of the high-data rate implant applications such as the wireless capsule endoscope and the bionic eye, we should take the following issues into consideration. First is that the implanted systems must be operated with low-power consumption because the system with a small-sized battery inside the body should persist for a long time and the battery is not easy to change. Second is high-data rate transmission. Currently, the commercially available capsule endoscopy technologies support 2-3 Mbps data rates. However, to assign enough data rate for the high-quality video, there is a need for higher bandwidth data transmission of more than 10 Mbps for a future capsule endoscope. Therefore, it is essential to select a proper modulation scheme that provides the stable performance in the human body channel. Unlike propagation channel through path in the air, the transmitted signals undergo severe degradations due to the attenuation from various tissues and organs within the human body [2]. The third issue is that it should support bidirectional communication link which makes the devices of outside body possible to control the behavior and processing of an implanted device. The miniaturization is the last issue. The implant applications such as a capsule endoscope should be as small as possible.

II. CONVENTIONAL MODULATION TECHNIQUES

In the conventional implantable wireless devices, the low power modulation techniques have been chosen for a few megabits per second data transmission. The characteristic of low power is the key issue, since they must be operated at least for several hours with small-sized batteries. Therefore, low power consumption is prioritized heavily to decide the suitable modulation technique for WBAN in-body applications. However, in the high-data rate transmission, it is highly required to choose a high-sensitivity modulation and demodulation approach in order to overcome serious attenuation in the human body channel.

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In a coherent system, BPSK is 3 dB better than the performance of frequency-shift keying (FSK) and ON-OFF keying (OOK). In other words, FSK and OOK systems need to transmit 3 dB more power than BPSK for the same performance. However the BPSK transmitter requires generally back-off power gains to maintain the linearity of a power amplifier (PA). For this reason, FSK or OOK is better than BPSK if we consider the power consumption in the transmitter. The OOK systems could be implemented by a relatively straightforward choice because they have a simple architecture. Their transmitters require less power than that of FSK because the transmitted signals of OOK operate alternately between ON and OFF modes. Nevertheless, the OOK and FSK systems have a weak point of low-spectral efficiency. The Gaussian filtered FSK can improve the spectral efficiency. However, it lacks link margin for the high-data rate applications that provide speed of 20 Mbps enabling high-definition image streaming [3], [6].

In terms of spectral efficiency, phase-shift keying (PSK) could be the best choice, but a transmitter of PSK needs more transmit power to eliminate significant nonlinear distortion of the transmitted signal. The modulated signals with low-level envelope are more advantageous than the signals with high-level envelope in the power efficiency of the transmitter. In this point of view, pulse-position modulation (PPM) in which symbol signals have zero- or silence-envelope, is more efficient than prevalent modulation such as PSK. However, its drawback is poor bandwidth and poor efficiency. In the following section, we propose a new modulation scheme called Phase-Silence Shift Keying (PSSK). It has advantages in terms of power consumption and performance for WBAN in-body communication systems.

III. PSSK SYSTEM FOR WBAN

The PSSK is a kind of phase-shift key schemes and it is more bandwidth efficient than the orthogonal modulations such as PPM, FSK, and OOK. In addition, PSSK can achieve power spectral efficiency because every symbol of PSSK has a zero-envelope period like PPM techniques. In the case of M-ary PSSK, one bit determines the silence-envelope position of the symbol and ($\log_2 M - 1$) bits determine the phase of the symbol. It is the improvement of the combination of either PSK and PPM techniques or PSK and OOK techniques. Instead of traditional PPM, where some bits determine the position of the pulse, PSSK uses one bit to determine the absence which in turn is the position of the silence-envelope of the symbol. Because the transmitter of PSSK transmits the only half energy of a symbol for a symbol period, it can save the transmit power by 3 dB. In terms of the performance, PSSK achieves better performance than PSK because the minimum distance between two adjacent symbols of PSSK can be much greater than those of PSK at the same level of M-ary as shown in Fig 1 and 2.

CONSTELLATIONS OF PSK AND PSSK:

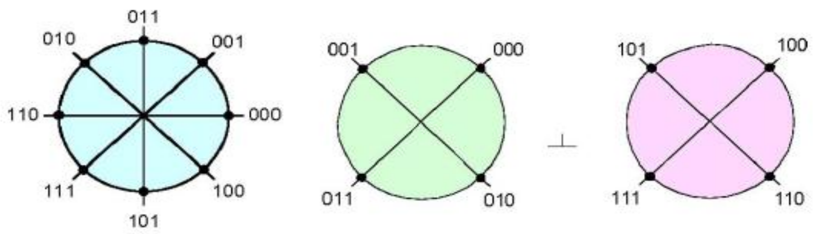

Fig:1 Constellation of 8-PSK.
Fig:2 Constellation of 8-PSSK.

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IV. SIMULATION RESULT

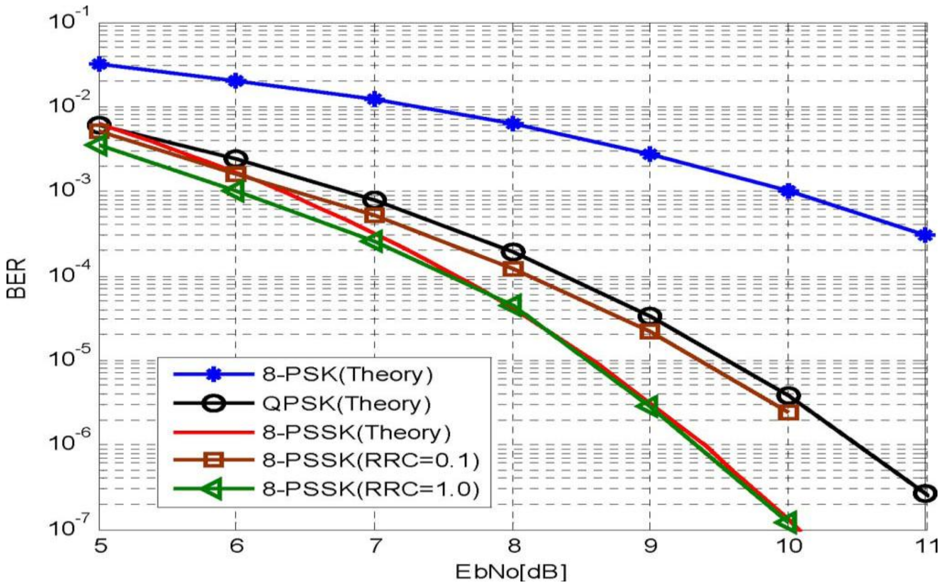

Fig.3. Simulation result

Thus the simulation results show that the performance of PSK is better than any other modulation schemes and the BER (Bit Error Rate) decreases considerably.

V. CONCLUSION

Thus the proposed PSSK modulation approach is valid for the high-data rate WBAN in-body systems. The simulation results are presented and it is compared with other modulation techniques. 8-PSSK scheme can have more gains compared to any other modulation techniques in terms of performance, spectrum growth and power transmission. This technique can achieve more link margin at low values of dB for high data rate in-body systems

REFERENCES

[1] IEEE P802.15, TG6 Technical Requirements Document, IEEE, Piscataway, NJ, Sep. 2008.

[2] C. Y. Lin, M. Wu, J. A. Bloom, I. J. Cox, and M. Miller, “Rotation, scale, and translation resilient public watermarking for images,” IEEE Trans. Image Process., vol. 10, no. 5, pp. 767-782, May 2001.

[3] J. G. Proakis, Digital Communications, 4th ed. Boston, MA: McGraw- Hill, 2001.

[4] D. K. Kim and H. S. Lee, “Phase-silence-shift-keying for power-efficient modulator,” IEICE Trans. Commun., vol. E92-B, no. 6, pp. 2324–2326, Jun. 2009.

[5] A. Ambroze, M. Tomlinson, and G. Wade, “Magnitude modulation for small satellite earth terminals using QPSK and OQPSK,” in Proc. IEEE Int. Conf. Commun. (ICC 2003), vol. 3, May, pp. 2099–2103.

[6] L.C. Palmer, S.A.Rhodes, and S.H. Lebowitz, “Synchronization for QPSK transmission via communications satellites,” IEEE Trans. Commun vol. COM-28, no. 8, pp. 1302–1314, Aug. 1980.

[7] B. Hashem and M. S. El-Hennawey, “Performance of the pi/4-DQPSK, GMSK, and QAM modulation schemes in mobile radio with multipath fading and nonlinearities,” IEEE Trans. Veh. Tech., vol. 46, no. 2, pp. 390– 395, May 1997.

[8] R. Raich and G. T. Zhou, “Analyzing spectral regrowth of QPSK and OQPSK signals,” in Proc. IEEE Int. Conf. Acoust., Speech, Signal Process., vol. 4, May 2001, pp. 2673–2676.