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A Review on Energy Efficient Modulation and Coding Techniques for Clustered Wireless Sensor Networks

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Abstract-A standard wireless sensor network comprises of a huge number of sensor nodes with data processing and communication capabilities. The sensor nodes pass the gathered data using radio transmitter, to a sink either straightforwardly or through other nodes in a multi-hop approach. Wireless sensor network is a power consuming system since nodes perform on restricted power supply which decreases its lifetime. Optimally selected modulation and coding is extremely vital technique in wireless sensor networks. This paper surveys the performance of different modulation schemes and error control codes used in Sensor Networks. The survey also analyzes the role of modulation and coding techniques apply to different channel conditions to improve the lifetime of the clustered sensor network.

Index Term: Energy Efficiency, Error Control codes, Modulation, Sensor Network

Wireless sensor network systems are now being applied by an international community for critical applications in healthcare, industry and security. These systems have exclusive features and face many implementation challenges. Amongst all, the requirement of extended lifetime for a Wireless sensor node under limited energy enacts the severe design constraints. This leads for advanced design methodologies to address the energy content. [12],[13]. Thisarticle provides a summary of energy efficient modulation and coding technologies for Sensor Networks.

The modulation and coding process played an important role to improve the energy efficiency and bandwidth efficiency of Wireless networks. Especially in a sensor network, its lifetime depends on the energy consumption of transceivers. This paper surveys the role of modulation and coding as they apply to Wireless sensor networks..Good error control code with an optimal selection of modulation techniques based on the characteristics of the communication channel to improve overall system performance.

Kun Yang et al. (2012) analyzed the performance of relay networks.Modulation techniques BPSK, QPSK, 16QAM, 64QAM and convolutional coding used to achieve a better overall system performance where, the two source nodes adaptively chosen the appropriate modulation and coding scheme based on the information from the feedback channels to ensure that the block error rate (BLER) of the relay system was under the system requirement. And also, derived closed- form expressions for the system performances over Rayleigh Channels, including average spectral efficiency and average BLER. [1]

Sami H. O. Salih et al. (2011) defended the use of an Adaptive Modulation and Coding (AMC) in Wireless technologies for yielding higher throughputs while covering long distances. Furthermore, implemented AMC features in WiMAX and the role of BPSK, QPSK, 16QAM, 64QAMwith RS codes in the physical layer design.Optimal selection of location aware modulation with error control codes can be applied to Wireless Sensor Network to achieve better energy consumption at the transceiver.[2]

Mohammad Rakibul Islam (2010) developed a step by step approach in finding suitable error control codes for wireless sensor networks (WSNs). Additionally few simulations were taken considering different error control codes (i.e. RS codes and Bose, Chaudhuri, and Hocquenghem (BCH) codes and the result showed that the RS (31, 21) fits both in Bit Error Rate (BER) and power consumption criteria. [3]

YousofNaderi et al. (2010) evaluated the performance of few error control mechanisms in Wireless mesh sensor networks(WMSN). Additionally, it provided an extensive comparison between automatic repeat request (ARQ), forward error correction (FEC), and hybrid FEC/ARQ error control mechanisms in terms of frame loss rate, frame peak signal to noise ratio (PSNR) and energy efficiency. [4]

Dongwook Kim et al. (2008) proposed an optimal modulation and coding scheme (MCS) selection criterion for maximizing user throughput in cellular networks. And adopted both the Chase combining and incremental redundancy based hybrid automatic repeat request (HARQ) mechanisms and it selected an MCS level that maximized the expected throughput which was estimated by considering both the number of transmissions and successful decoding probability in HARQ operation and also proved that the conventional MCS selection rule was not optimized with mathematical analysis. [5]

GopinathBalakrishnan et al. (2007) focused the study on the performance analysis of various error control codes interms of their BER performance and power consumption on distinctiveplatforms by transmitting randomly generated data through a Gaussian channel. Based on the study and comparison of the three distinctive error control codes such as BCH code, RS code and convolutional code, identified that binary-BCH codes with ASIC implementation were best suitable forWSNs. [6]

Mukesh et al. (2007) evaluated the energy performances of uncoded MPSK, MQAM,and MFSK modulations in both AWGN and Rayleigh fadingchannels are and compared for very short-range (lessthan 10 meters) communication. And concluded that MQAM was more energy more efficient than the other modulation schemes. [7]

Sheryl L. Howard et al. (2006) examined error control codes (ECC) such as RS code, LDPC, turbo code and convolutional code in WSNs to determine the energy efficiency of specific ECC implementations in WSNs that provided coding gain, resulting in transmitter energy savings, at the cost of added decoder power consumption. It furthermore derived an expression for the critical distance. [8]

James Yang et al. (2002) addressed the application of AMC for 3rd Generation (3G) Wireless systems. It furthermore proposed a new method for selecting the appropriate MCS(i.e. 16QAM, 8PSK, BPSK with turbo codes) according to the estimated channel condition and taken a statistical decision making approach to maximize the average throughput while maintaining an acceptableFrame Error Rate (FER). [9]

Morelos-Zaragoza et al. (2000) presented the conjectural computer simulation results on the error performance of multilevel coded modulations for Wireless networks.Performance analysis with unequal error protection achieved for coded modulation techniques.Multilevel codes over 8PSK and 64QAM signal sets and compared with theoretical upper bounds on the error performance with extended BCH codes. [11]

Table 1 – Comparison of different modulations and error control codes

S.No.	Modulations	Codes	Performance Parameters	Overall system performance	Channel		Simulation	
					AWGN	Rayleigh	MAT LAB	VHDL
1	BPSK QPSK 16QAM 64QAM	Convolutional	SE BLER	Good system performance		✓	✓	
2	BPSK QPSK 16QAM 64QAM	RS	BER	Efficient physical layer design	✓		✓	
3	-	RS BCH	BER Power	Better, energy efficiency	✓		✓	
4	-	RS FEC ARQ	Energy Frame loss rate Frame PSNR	Suitable for mobile Sensor Networks	✓		✓	
5	QPSK 16QAM	HARQ	Code rate SINR gain	Efficient error control mechanism	✓		✓	
6	-	BCH RS Convolutional	BER	BCH code comparatively better than other codes	✓			✓
7	MPSK MQAM MFSK	-	BER Energy Lifetime	Suitable for short distance communication	✓	✓	✓	
8	-	RS LDPC Turbo Convolutional	BER	Analog decoders are more energyefficient in this study	✓		✓	
9	16QAM 8PSK BPSK	Turbo	Avg throughput FER SNR	The maximum Avg throughput achieved	✓		✓	
10	8PSK 16QAM	Extended BCH	BER	Multistage decoding and modulation used	✓		✓	

CONCLUSION

This paper analyzes the performance of distinctive modulation scheme and error control codes for Sensor Networks to improve the energy efficiency,bandwidth efficiency and lifetime of the sensor nodes diffrent channel conditions.as many researchers are Currently developing technologies related todiffrent layers of the sensor network protocol.energy constraint nature invites the necessary to look at more efficient modulation and coding design and operation.furthermore,energy efficient physical layer designwith different energy efficient clustering protocols are necessary to give attention for future work

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