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ECC: Multi Coding Schemes for Efficient Wireless Sensor Networks

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Abstract:

Reduced energy consumption in sensor nodes is one of the major challenges in Wireless Sensor Networks (WSNs) deployment. In this regard, Error Control Coding (ECC) is one of techniques used for energy optimization in WSNs. Similarly, critical distance is another term being used for energy efficiency, when used with ECC provides better results of energy saving. In this paper three different critical distance values are used against different coding gains for sake of energy saving. If distance lies below critical distance values then particular encoders are selected with respect to their particular coding gains. Coding gains are used for critical distances estimation of all encoders. This adaptive encoder and transmit power selection scheme with respect to their coding gain results in a significant energy saving in WSNs environment. Simulations provide better results of energy saving achieved by using this adaptive scheme.

Keywords:

Wireless Multimedia Sensor networks, delay, Energy efficiency, life time.

I.INTRODUCTION:

Wireless sensor networks (WSNs) are becoming increasingly popular in many spheres of life. Application domains include monitoring of the environment (such as temperature, humidity and seismic activity) as well as numerous other ecological, law enforcement and military settings. Regardless of the application, most WSNs have two notable properties in common: (1) the network's overall goal is typically to reach a collective conclusion regarding the outside environment, which requires detection and coordination at the sensor level, and (2) WSNs This work was done while visiting at the University of California, Irvine act under severe technological constraints: individual sensors have severely limited computation, communication and power (battery) resources and need to operate in settings with great spatial and temporal variability

At the same time, WSNs are often deployed in public or otherwise un-trusted and even hostile environments, which prompts a number of security issues. These include the usual topics, e.g., key management, privacy, access control, authentication and DoS resistance, among others. What exacerbates and distinguishes security issues in WSNs is the need to miniaturize all security services so as to minimize security induced overhead. In other words, if security is a necessary hindrance in other (e.g., wired or MANET) types of networks, it is much more so in WSNs. For example, public key cryptography is typically ruled out as are relatively heavy-weight conventional encryption methods. Security in WSNs is a popular research topic and many advances have been reported on in recent years. Wireless Sensor Networks (WSNs) consists of a large numbers of wireless sensor nodes dispersed in an area of interest with one or more base stations, where data is collected. Base stations have external network connectivity to the end user as shown in Fig. 1. Sensor nodes can be deployed on ground, in air, under water, in or on human bodies, in vehicles and buildings [1].

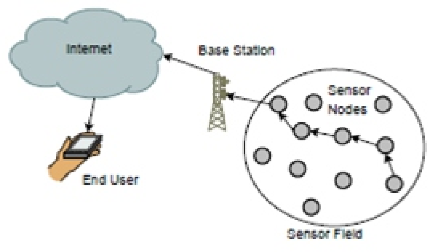

Fig. 1: A Typical Wireless Sensor Network

A sensor node is normally a small device that is composed of four basic components: the sensing unit which is equipped with sensors that are able to take measurements of the specific physical or environmental condition like temperature, humidity, sound, vehicular movement, lightning condition, pressure, soil makeup, noise levels, the presence or absence of certain kinds of objects, mechanical stress levels on attached objects, and the current characteristicssuch as speed, direction, and size of an object [2], the processing subsystem which is generally associated with a small storage unit, accomplishes procedures that make sensor node to cooperate with other nodes to carry out the assigned sensing tasks [3], the communication subsystem has a transceiver that is used for transmitting and receiving data within the network. The most important part of sensor node is the power unit which can be regarded as the soul of the sensor node because it supplies energy to node to carry out the assigned tasks. The power unit, in most cases, consists of batteries that have limited energy. Commonly, sensor nodes are deployed in remote unattended geographical areas where it is difficult or sometimes even impossible to replace batteries that supply energy to nodes. So the sensor nodes are generally operated by irreplaceable power sources. Aggregation techniques are used to reduce the amount of data communicated within a WSN and thus conserves battery power. Periodically, as measurements are recorded by individual sensors, they need to be collected and processed to produce data representative of the entire WSN, such as average and/or variance of the temperature or humidity within an area. The network coding methods can be applied in uni-cast, multicast, or broadcast applications. Moreover, some of the network coding approaches have been proposed just for one-hop, two-hop, or multi-hop networks. Therefore, we classified the methods based on their objective, application, and network topology assumption . Energy efficiency has always been a critical design parameter for wireless networks. Recently, the trend towards designing energy-aware communication protocols has become more intense due to the scarcity of the energy resources. By using the concept of adaptive modulation [20], mobile stations in multi-rate wireless networks assign the modulation scheme and transmission rate according to the detected Signal-to-Noise-Ratio (SNR) and the required transmission quality. Each modulation scheme could be further mapped to a range of SNR in a given transmission power.

To achieve high transmission efficiency in wireless systems, stations select the highest available rate modulation scheme according to the detected SNR. The protocols of this class [15–18] transform single one-hop transmissions to multi-hop transmissions according to the channel conditions. Specifically, the routing of the packets takes place by taking into account the channel state between the source, the relay and the destination, and therefore a multi-hop transmission may be preferred instead of the direct one. In some applications such as health or medical applications, lifetime is not the only concern; receiving the data of all sensors correctly at the sink might be more important to prevent making any wrong decision at the sink [4].

In a noisy environment, it is more difficult to receive all data correctly at the sink. Therefore, using Error Correcting Codes (ECC) is essential in sensor networks to improve data integrity [6,7] in spite of its adverse effect on the lifetime due to the energy required for the encoding and decoding processes.

II.RELATED WORK AND MOTIVATION:

After analyzing ECC Sheryl et al. [1] estimated minimum transmit power for energy efficient transmission of data in different environments like free space model and far field region. Then, analyzed bit error rate for different values of with different encoding schemes. He also analyzed decoder power consumption when data is reached to its destination. Then lastly, he calculated energy savings achieved from different ECC techniques. Pellenz et al. [2] in his work focused on radio channel models, that may experience different channel impairments, these impairments can effect data being transmitted, and if it happens so retransmissions of that data is required that consumes extra energy on other hand. So, in his work error control strategies and error correcting codes have been used to avoid this thing. He investigated tradeoff between transmission energy consumption and processing energy consumption using convolution codes.

His work enabled appropriate selection of encoder complexity in order to improve network life time. At the same time work of Atta et al. [3] was also based on adaptively selection of code rate in an Orthogonal Frequency Division Multiplexing (OFDM) system. Sonali et al. [4] discussed that how energy is affected by ECC and modulation type used. She discussed utilization of ECC from energy saving perspective. She discussed that error correcting capability and code word length of ECC and modulation type are of great importance in sense of energy consumption. So, optimal ECC and modulation scheme is used for better energy saving. Sapna et al. [5] discussed a method to correct errors based on Euclidean codes.

On the basis of minimum Euclidean weight errors are corrected in transmitted data. To prolong network life time Meghji et al. [6] used multi-hop concept with transmit power control in WSNs. He tested transmit power control in multi-hop networks to check energy consumption results. Then showed that energy using short range multi-hop concept cannot be saved.

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Transmit power for WSNs discussed by Lavratti et al. [7] is adaption of minimum transmits power for extension of network life time, and to guarantee that transmitted data has been successfully received. He presented Transmission Power Self Optimization (TPSO) technique, by providing greater amount of efficiency, whether it's a noisy medium. Due to constraints of fault tolerance, Scalability and cost and power consumption Akyldiz et al. [8] presented that new techniques are required to overcome these problems over different layers by presenting several projects that are being performed in WSNs. Sandra et al. [9] provided a survey for main causes of energy loss in WSNs. They considered that most of loss occurs because of electronic circuitry then they provided a comparison between different MAC and routing protocols that have been designed to overcome power consumption problem and by providing efficient and reliable data transfer. Work of Pranali et al. [10] is based on 802.16e to enhance power efficiency by employing power saving strategies used for standard sleep mode operation. They proposed an algorithm to save power consumption and mean delay of power saving mechanism for sleep mode operation. From looking all above discussed works we proposed our adaptive transmit power and encoder selection scheme for energy saving in WSNs, that is somehow a major issue in sensor networks domain.

a.ECC:- In ECC extra bits are added in information for receiving exact information that was originally transmitted. For example, information that is being sent is u with length k then extra parity bits are added to information u to form a codeword x, these extra redundant bits enables decoder to correctly decode x received bits. So, over noisy channel where there are maximum errors occurring chances there ECC provides a better Bit Error Rate (BER) at given Signal to Noise Ratio (SNR) value. Difference between SNR levels to reach a certain BER value in coded and un-coded system is called coding gain. Here, in our paper we used three different types of encoders based on coding gain of these encoders. Reed Solomon Encoder (RS), Convolution Encoder with Hard Decision Decoding and Convolution Encoder with Soft Decision Decoding are these encoders. RS codes are block based error correcting codes, where information after adding redundant bits is sent in form of blocks. For example, there are k data symbols of s bits to make n symbol codeword. Therefore, n-k parity symbols of each s bit, and decoder for RS encoding can correct up to t symbols that contain errors in codeword.

Convolution codes are frequently used to correct errors in noisy channels and have good error correcting capability over bad channels. Threshold Decoding, Sequential Decoding and Viterbi decoding are decoding methods for convolutionaly encoded data. Here, Viterbi with Hard and Soft decision decoding is used. In Hard Decision decoding is performed when received sequence is digitized 1st then decoding is performed, so it makes an early decision without considering a bit is 0 or 1. While, in Soft Decision decoding is performed before digitizing received data. In our case, selection of encoders is performed on the basis of distance, depending on distance encoders are used adaptively for better results energy savings.

b.Multi Coding Scheme in WSN :-As mentioned in the previous section, the problem of using the single coding scheme is the code rate of the used BCH which is the only factor that affects the throughput irrespective of the BER. Furthermore, the lifetime remains approximately constant for different lengths of BCH code, because the processing energy is negligible with respect to the transmitting energy using the pro-posed hardware implementation. Therefore, another coding scheme is investigated to improve overall performance. In this scheme, the coding method from the sensor to the NM and from the NM to the sink will be completely different in length or in type or in both. In the deployment area, the average distance from the NM to the sink is larger than the distance from the sensor to the NM which means that the channel from the NM to the sink is noisier than the channel from the sensor to the NM.

This result is taken a step further by applying the low rate code at the sensor in the link between the sensors and the NM and the high rate code at the NM in the link from the NM to the sink. Simulations show that this method has a very good effect on the lifetime. Wireless Sensor Networks (WSN) has become one of the most interesting fields of research where the major challenge is prolonging network lifetime. But in some applications where it is necessary to receive the data intact, the throughput may be more important. So, this paper focuses on improving the throughput without affecting the lifetime by using efficient coding techniques to re-duce the bit error rate and introducing a simple hardware implementation for the encoder and decoder circuit of the coding technique. The coding is done at both the sensor and the NM, where the sensor encodes the data and sends it to the NM that decodes then re-encodes the data again before sending it to the sink.

III.CONCLUSION:

This paper presents the efficient encoder selection and transmits power with respect to its critical distance results in energy saving in WSNs. Encoder selection is performed by using critical distance which is estimated from coding gain of that encoder. Transmit power is estimated for selected encoder to transmit data efficiently. ECC in this context, becomes energy efficient as encoders and their transmit powers are selected adaptively, that results in energy saving to these particular encoders.

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