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Enhancement of Image Transmission Using Chaotic Interleaver over Wireless Sensor Network

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***Abstract*— The wireless sensor networks different from classic wired networks, WMSN differs from other scalar network mainly nature and size of data transmitted, memory resources, and power consumption in each node for processing and transmission. The images broadcasting over wireless multimedia sensor networks that can be used in IEEE 802.15.4 (Zig-Bee) for short-range multimedia transmissions.**

In this paper a strong interleaver mechanism prepared to reduce or immune a burst error of network , this can be done by applying the chaotic interleaving on the pixel, bit ,and chip. The enhancement simulation for bit error rate and peak signal to noise ration by transceiver image cameraman though AWGN and Rayleigh fading channels are displayed. While transmitting the image by 20 dB signal to noise ratio on the Rayleigh fading channel, an improvement on the peak signal to noise ratio of the received image from 25.9 dB to 78.4 dB can be observed.

***Index Terms*—AWGN, Network, Simulation .**

I. INTRODUCTION

In recent years much attention to wireless networks. Wireless networks depend on two important factors: throughput efficiency and power efficiency. Wireless sensor networks such as Zigbee are widely used. Zigbee is constructed on the IEEE 802.15.4 standard. Its low power consumption that will obtain by allowing the network to sleep, that means short periods waking to active mode [1]. The IEEE 802.15.4 standard designed to operates in a three band frequency's (i) DSSS using BPSK working in the frequency of 868 MHz at 20 Kbps, (ii) DSSS using BPSK working in the frequency of 915 MHz at 40 Kbps, (iii) DSSS using O-QPSK working in the frequency of 2.4 GHzat 250 Kbps [2, 3, 4]. The Zigbee network includes few or no infrastructure. Also it has a control mechanism for theprimitive errors, which is the automatic repeat request (ARQ). The results of this mechanism is unable to limit the effects of the channel. Therefore, there is a requisite for any coding or interleaving techniques to combat the effects ofthe bad channel [5]. Many papers have been studied in the transceiver of images with IEEE 802.15.4 standard [6], the researchers studied the fragmentation process on the images that used to send through Zigbee network. There is a possibility burst errors while transmitting the images over mobile networks. The burst errors have a bad effect on the image. In this paper, minimizing the effect of error bursts on the transceiver of images by applying chaotic interleaver on the pixels, bits, and on the chip are performed.

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II. ZIGBEE PACKET FORMAT

The Zigbee Packet structure is shown in figure (1). The header consists of a three parts, preamble 32-bit to synchronization, start of packet delimiter 8-bits to signify end of preamble, and PHY header 8-bit to specify length of PSDU [7]

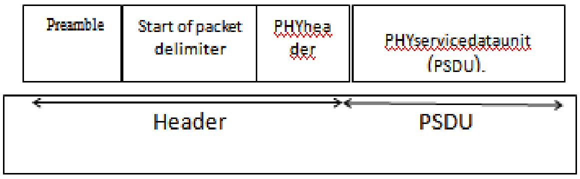


Fig. 1. Format for ZigBee packet. [7]

The Payload field contains a length of 0-127 bytes. The Zig-bee network is used to detect the error retransmission technique. To make sure a successful receiver of data, an allowed frame delivery protocol is supported to increase transfer reliability [8]. The Zig-Bee network uses the DSSS technique for data transmission shown in the table (1), it increases the immunity against interference. The built on the multiplication of the original bit stream witha wideband (PN) spreading code, which is produced in a wideband continuous time scrambled signal. DSSS technique improves the protection against interference signals, it's also offer the ability to multiple access, when they being used the some different spreading codes, it also provides security for a transceiver. DSSS 32-chip PN sequences technique is also used as a technique to generate ultra wideband signals [9]. As shown in figure (2) [10], the m (t) has a very greatly bandwidth than the input signal d (t) [11], [12].

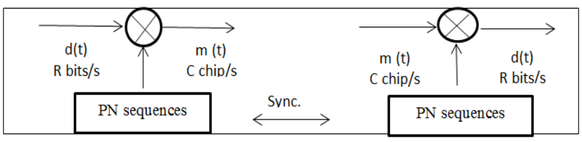


Fig. 2. DSSS technique[10]

Table I.Zigbee symbol to chip mapping [13]

Zig-Bee symbol	Chip value
0000	11011001110000110101001000101110
1000	11101101100111000011010100100010
0100	00101110110110011100001101010010
1100	00100010111011011001110000110101
0010	01010010001011101101100111000011
1010	00110101001000101110110110011100
0110	11000011010100100010111011011001
1110	10011100001101010010001011101101
0001	10001100100101100000011101111011
1001	10111000110010010110000001110111
0101	01111011100011001001011000000111
1101	01110111101110001100100101100000
1011	00000111011110111000110010010110
1011	01100000011101111011100011001001
0111	10010110000001110111101110001100
1111	11001001011000000111011110111000

III. CHAOTIC INTERLEAVING

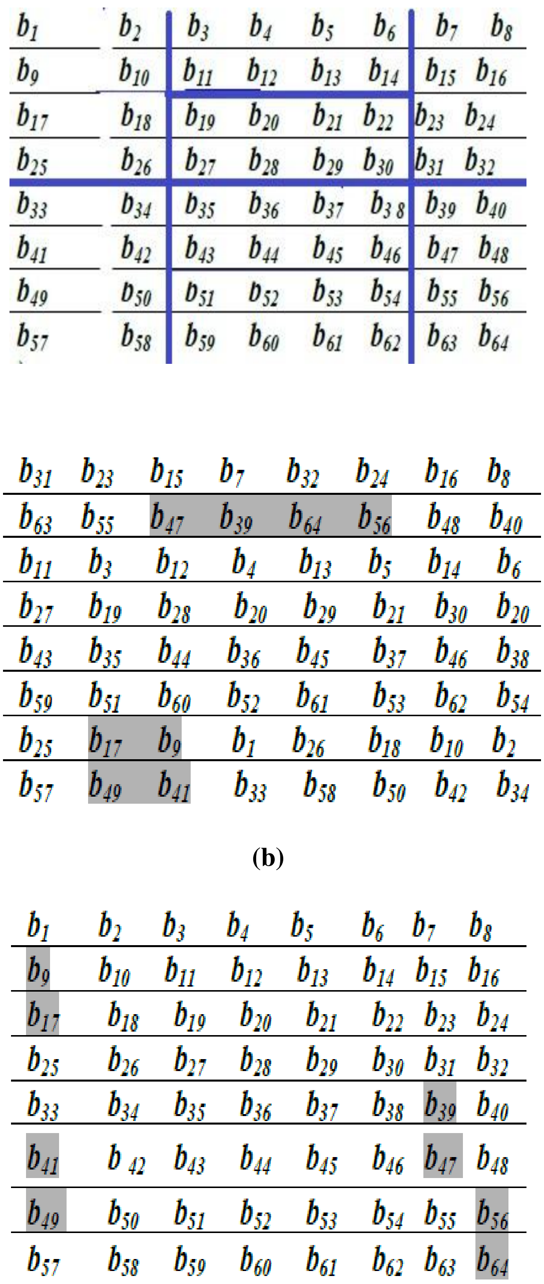
The present idea for chaotic interleaver by using the logistic map [14]. This logistic map is defined as a typical example for 1-D chaotic map. It is used with the turbo code [15]. The suggest chaotic interleaver is setup on a 2-D Baker map, which is a strong data randomization tool. This logistic map is widely used as an encryption tool [16], [17]. The 2- D chaotic map in its discretized version is a good useful candidate for this aim. After re-arrangement of bits into a 2-D shape, the chaotic Baker map is utilized to randomize the bits. Let B ($n_1,\dots,n_k$), Indicate the discretized baker map, Where the vector its [$n_1,\dots,n_k$], represents the key secret, S_{key}. Known as the total number of data items in one row, the S_{key} is chosen to make each integer n_i divides N, And must ($n_1+\dots\dots + n_k = N$). Let ($N_i = n_1 +\dots\dots + n_{i-1}$). The data item at the indices (r, s), is moving to the indices [18].

$$B(r,s) = [\frac{N}{n_i}(r - N_i) + s \bmod(\frac{N}{n_i}), \frac{n_i}{N}(s - s \bmod (\frac{N}{n_i})) + N_i]$$

Where $N_i \le r < N_i + n_i$, $0 \le s < N$, and $N_1=0$. In these steps, the chaotic permutation as follows:

1. The square image N * N is divided into N rectangles with width rectangle ni and number of elements N.
2. Each rectangle from elements will be rearranged into a row in the permuted rectangle. The elements are taken first from left to right with lower elements then upper ones.
3. Within each element, the selecting procedure begins from the bottom left corner to upper elements.

Figure (3) show an example for backer map chaotic interleaver for a 8 × 8 square matrix (i.e. N = 8). The Skey = [n1, n2, n3] = [2, 4, 2].[18]



(c)

Fig. 3. Chaotic interleaving of an 8×8 matrix: (a) the 8×8 matrix divided into rectangles (b) chaotic interleaving of the matrix, (c) effect of error bursts after de-interleaving. [10]

IV. PROPOSED MODIFICATIONS

The specifications of 802.15.4 Zigbee transceiver worked in 2.4 GHz. The data modulation scheme used here is DSSS technique (32-chip PN sequences) minimum shift keying (DSSS-MSK). The block diagram of 802.15.4 Zigbee transceiver system includes spreading and modulating of input bits. In the first stage, the coming bits are grouped into four bits, so it denotes to a Zigbee symbol. These four bits are used to select one of the 16 orthogonal (PN) sequences to the transmitter. The PN sequences are related to each other through cyclic shifts and the successive selected PN sequences are concatenated and sent to the MSK modulator. The waveform in MSK modulation technique is nonstop in phase, hence, there are no sudden changes in waveform amplitude. The side lobes of MSK are very small.

Consequently, bandpass filtering is not needed in MSK modulation to avoid interference. The medium with burst error characteristics decreases the performance of error correction and peak signal to noise ratio. This problem can be solved by using the chaotic interleaving. The aim from using chaotic interleaver to prevent the focused burst error in one place within the received image by distributing this error along stream data and can be corrected in demoing through converted from chip to bit.

A. Pixel Chaotic Interleaver

The chaotic interleaving mechanism has a better treatment to error bursts than other interleaving mechanism. Moreover, a better fragmentation and distribution of burst errors to the pixel after de-interleaving in the proposed chaotic interleaving scheme. As a result, a better peak signal to noise ratio (PSNR) of images received can be achieved with this proposed mechanism. Furthermore, it adds a security to the image, at the receiver of the Zig-Bee system, a chaotic de-interleaving step is performed. The chaotic Baker map on pixel is that produces a permuted pixel sort of a square matrix show in figure (4).

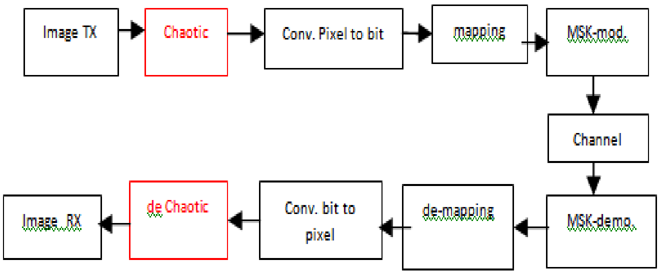


Fig. 4.Block diagram of Pixel Chaotic Interleaver

B. Bit Chaotic Interleaver

In this section, operations nearly returned the same operations in the previous section, but the processing on the bits, we will increase the size of the matrix to which they apply in chaotic Interleaver, that represent each pixel from an image will be converted to the 8 bits. The key of Chaotic will increase in the sender and the receiver. This leading to more permutation in the original image hence these yields to more security, as show in figure (5).

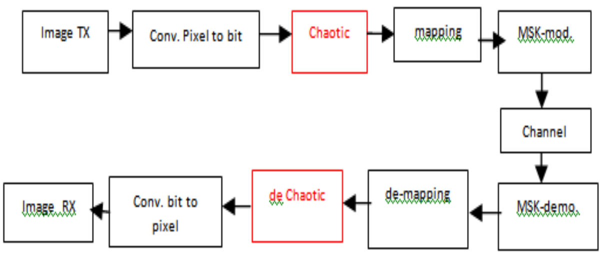


Fig. 5.Block diagram of bit Chaotic Interleaver

C. Chip Chaotic Interleaver

As mentioned in the first subsection, the Chaotic interleaver on the pixel and bits is not more permutation Compare with chip Chaotic Interleaver show in figure (6). Hence need to apply Chaotic on the chip to produce more permutation in the image to get the more security and more distribution the error on Stream Data that can correct error bits by using DSSS-32chip. This produces a very high improvementin PSNR and bit error rate.

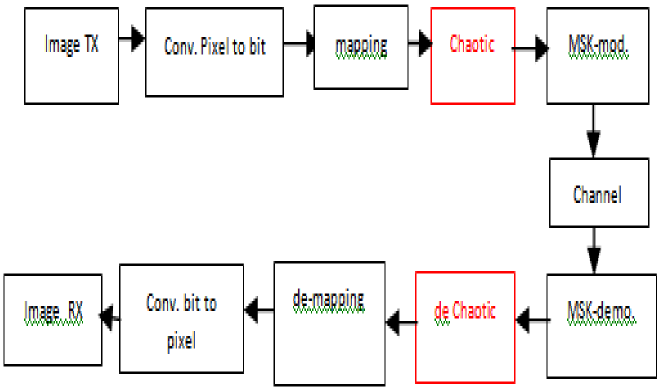


Fig. 6.Block diagram of bit Chaotic Interleaver

V. SIMULATION RESULTS

In this section, the results of computer simulations will presented. The importance used in a simulation, the packet will be discarded if there is an error results in any part of the header or in the PHY service data unit. By applying the data over Rayleigh fading channel. Jake's model will be used, assume mobile velocity is 10 miles/hour, frequency carrier is 2.46 GHz. In the first simulation, the image is transmitted over a Rayleigh fading channel with SNR= 20 dB. Four scenarios are presented, no chaotic interleaving, chaotic interleaving apply over a pixel, chaotic interleaving apply over bits and chaotic interleaving apply over a chip. The results are shown in Fig. 8 The image (D), it's have PSNR=78.4 dB which is more clarify from other images because the chip chaotic interleaving will segmentation and distribution burst error on the stream data and can be a correction by de-mapping in using DSSS. Replace this experiment by transmitted image over AWGN channel with SNR= 0 dB. The results are shown in Fig. 7. Also image (D) have a high PSNR=28.6 dB from other by using chaotic interleaving over a chip.

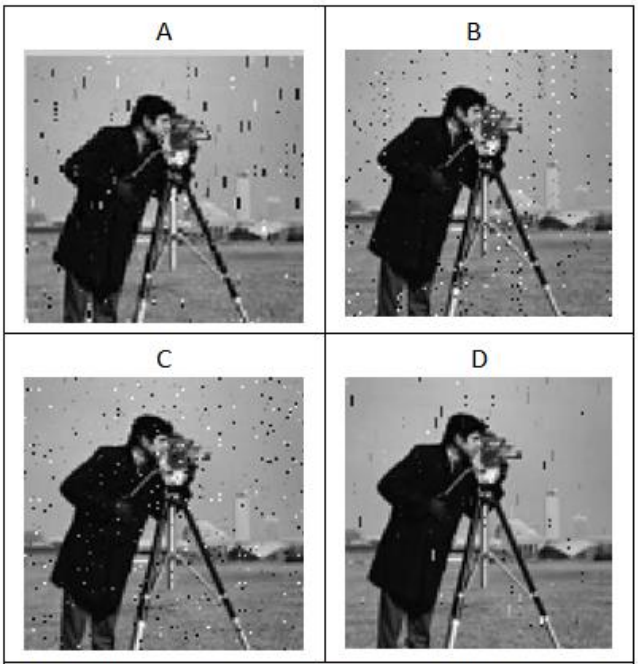


Fig. 7. Received cameraman image over AWGN channel at SNR = 0 dB with (a) PSNR = 23.0dB, (b) PSNR =23.8dB, (c) PSNR = 23.7dB, and (d) PSNR = 28.6dB.

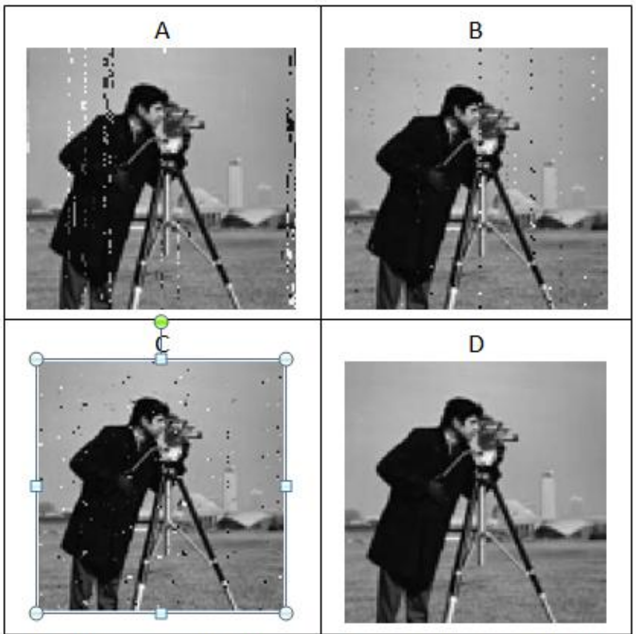


Fig. 8. Received cameraman image over Rayleigh fading channel at SNR = 20 dB with (a) PSNR = 25.9dB, (b) PSNR =27.0dB, (c) PSNR = 27.9dB, and (d) PSNR = 78.4dB.

It has been sent cameraman image in SNR value and show the following. Figure 7 and Figure 8, the image (A) send the cameraman image in normal case (without any interleaver) and apper the effect of burst error on the image in badly. In mage (B), and mage (C) will distribution the burst error by pixel and bits in all the image process and this leads to clarity for image with staying on the same values PSNR approxmation. But in image (D) and the final the processing apply on chip, itis the distribution of burst error will lead to correction the error and clarity of the image dramatically with increase in value of PSNR.

The medium with burst error characteristics decreases the performance of error correction and so the re-transmission is increased. This problem can be solved by using the interleaving. Therefore, it has been suggested that, the chaotic Baker map interleaving will be add to the systems transmitter after spread spectrum (chip interleaving) to improve BER, throughput and energy efficiency performance of the systems mentioned, shown in Fig.(9), Fig.(10), Fig.(11) and Fig.(12).

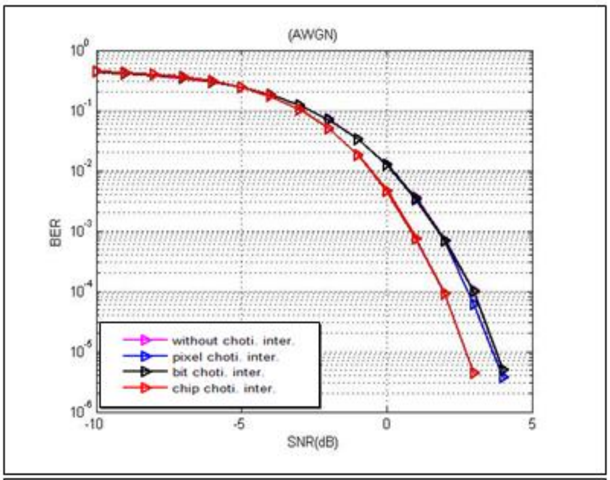


Fig.9. BER against SNR for the received cameraman image over AWGN channel.

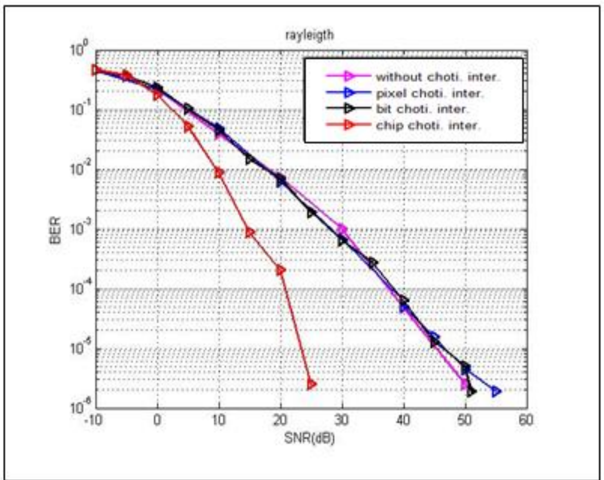


Fig.10. PSNR against SNR for the received cameraman image over Rayleighfading channel.

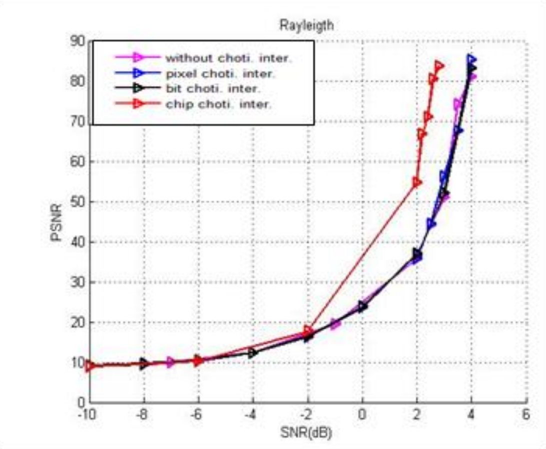


Fig.11. PSNR against SNR for the received cameraman image over AWGN channel.

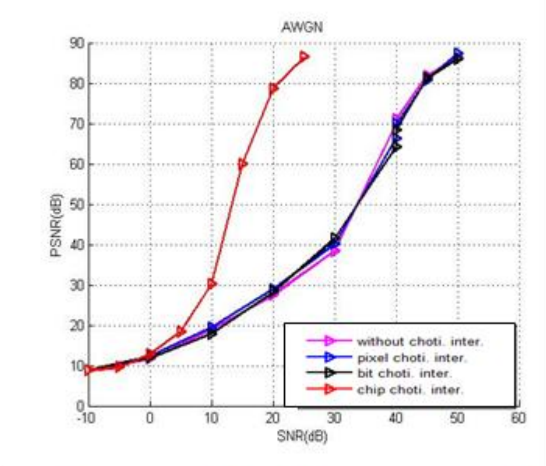


Fig.12. PSNR against SNR for the received cameraman image over Rayleighfading channel.

VI. CONCLUSION

The performance analysis of the Zigbee transceiver in Wireless Multimedia sensor networks is studied in terms of Symbol BER and PSNR. These parameters are measured under different conditions such as AWGN and Rayleigh fading channel. The simulation results show that the performance of Zigbee transceiver is better under AWGN and Rayleigh fading channel with chaotic interleaver applied on the chip. Also, the improved chaotic interleaver security level over the Zigbee network link, as it is created on the chaotic map encryption.

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