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Better Performance Codes Of UWB Based Systems For Wireless Body Area Network

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Abstract- In this paper, I will propose and analyze binary ZCD (zero correlation duration) code and PN (pseudonoise) codes of ultra wide band (UWB) systems for wireless body area network (WBAN). In wireless body area network, there are many types of wireless communication devices on a human body, multiple access interference (MAI) can occur. Systems with less MAI effect have more efficiency and less harmful effect. The performance is checked and resulted in terms of BER (bit error rate) of UWB system for different devices in WBAN channel and different length of ZCD and PN (pseudonoise) codes. Firstly for two devices(one with ZCD code and one with PN code) and then for three devices. From simulation results, it is confirmed that the UWB system with the ZCD code achieves better performance compared with that of (PN) code.

Key Terms — Multiple access interference (MAI), UWB, WBAN, ZCD code, PN code.

I. INTRODUCTION

As there is increment being developed of remote correspondence innovations, as per client necessities, and the high velocity interactive media administrations, there are versatile system situations and a ton of studies for another field of system. As there is rise of remote body region system (WBAN) in 2006, different sorts of examines on WBAN have been done to execute in a genuine field.

The WBAN is made out of various versatile and reduced intercommunicating remote sensor hubs. These hubs are associated through a remote correspondence channel and from a system that commonly extends over the assemblage of an individual. It is an appropriated framework with different equipment arrangements and working frameworks.

The WBAN can be connected to a few promising fields, which are pharmaceutical, military, games, security, and sight and sound. These applications make focal point of the unconstrained opportunity of development that the WBAN offers.

Criterion	WBAN mode		
Field of applications	Non-medical		Medical
Location	In-body	On-body	Off-body
Speed	Low	Middle	High

TABLE.1- Classification of WBAN

Groupings of the WBAN frameworks for a few criteria are demonstrated in Table above. As per the field of utilizations, the WBAN types are isolated into two classes. One is non-restorative circle, where, for instance, multi-media administration can be offered to the client by using remote association between a MP3 player and a headset. The other can show up in the human services area. A patient can wear correspondence gear with the WBAN made out of sensors that always measure particular natural capacities, for example, temperature, circulatory strain, heart rate, electrocardiogram (ECG), electroencephalogram (EEG), breath, et cetera. When we consider the area of types of gear, there are three branches, that is, in-body, on body, and off-body frames. Plus, for the transmission speed, these can part up into three sections of low speed, center pace, and fast.

In the WBAN, information is transmitted close to a human body. Therefore, it is important to plan the system so that emanated force level keeps up as low as would be prudent. As a promising answer for this issue, UWB (ultra wide band) framework has been framework has been considered on the grounds that power level of the UWB framework can be sufficiently low so there are not any unsafe consequences for the body.

Customarily, spread range based UWB frameworks are isolated into two sorts: PAM-DS (pulse amplitude modulation-direct sequence) and PPM-TH(pulse position modulation-time hopping) based UWB frameworks. These frameworks utilize a DS code or a TH code as the spreading code. Furthermore, a configuration system for the spreading code makes an extraordinary impact on the UWB framework execution in various access impedance (MAI) and multi-way blurring situations. In a DS based UWB framework, pseudo clamor (PN) code is ordinarily utilized as the spreading code. It is realized that its execution is enhanced with the length of the PN code. Then again, the PN code is not consummately orthogonal. Additionally, it is unrealistic to make the length of PN code unendingly long on account of framework multifaceted nature.

In this paper, we propose and reproduce the UWB framework with paired zero relationship term (ZCD) code as a spreading code for defeating the MAI when there are a few gadgets of WBAN. What's more, we break down the framework execution as far as bit mistake rate (BER) with a few presumptions.

This paper is composed as takes after. In Section II, properties of two fold ZCD code are presented. What's more, the UWB framework model considered in this paper is portrayed in Section III. In Section IV, framework execution is examined. When we examine the framework execution, the standard Gaussian estimate (SGA) theory is utilized. Recreation results are exhibited in Section V. At long last, conclusions are attracted Section V.

II. BINARY ZCD CODE

A periodic correlation function for two codes of $C_N^{(x)} = [c_0^x, c_1^x, \ldots, c_{N-1}^{(x)}]$ and $C_N^{(y)} = [c_0^y, c_1^y, \ldots, c_{N-1}^{(y)}]$ can be defined as:-

$$Cor_{x,y}(\tau) = \sum_{n=0}^{N-1} c_n^{(x)} c_{n\oplus\tau}^{(y)}, \quad (1)$$

where N is a time of code, + speaks to modulo N expansion, and "tao" is a period shift. In the event of x = y, a mathematical statement of (1) gets to be auto-connection capacity (ACF), while else, it gets to be cross-relationship capacity (CCF). The ZCD is time span when most extreme levels of side lobes of ACF and CCF are both zero. Since orthogonality between spreading codes is kept up for the ZCD, the framework utilizing the ZCD code is hearty for MAI (different access obstruction) and multipath blurring. In this paper, the double ZCD code is received.

A procedure of constructing a ZCD code is shown in steps. The very first step of constructing a binary preferred pairs by using initial basic matrix *G*, which is defined as

$$G = \begin{bmatrix} + & + & + & - \\ + & + & - & + \\ + & - & + & + \\ - & + & + & + \end{bmatrix}, \quad (2)$$

Where + and − represent +1 and −1 , respectively. If we denote any low of G or -G as $G_4^{(a)} = (g_0^{(a)}, g_1^{(a)}, g_2^{(a)}, g_3^{(a)})$, $G_4^{(b)} = (g_0^{(b)}, g_1^{(b)}, g_2^{(b)}, g_3^{(b)})$ can be defined from $G_4^{(a)}$

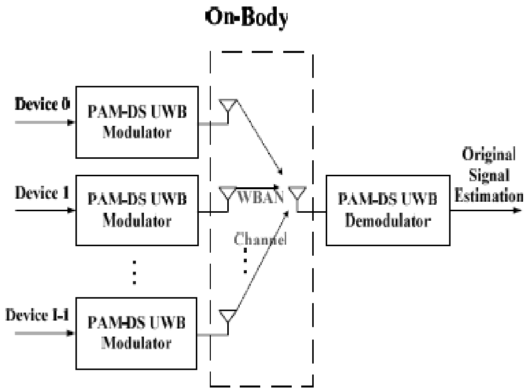

Fig 1.PAM-DS UWB system model in WBAN environments.

$$\mathbf{g_q^{(b)} = (-1)^q g_q^{(a)}} \quad (3)$$

Where q = 0, 1, 2, 3 . Then, a pair of $\{G_4^{(a)}, G_4^{(b)}\}$ is the initial binary preferred pair.

The second step is to construct sets of binary ZCD codes. A set of *M* binary ZCD codes is a binary code set that has ZCD ≤ (N/2) +1 chips and a family size of *M* . This set can be constructed from the chip-shift operation with $\{G_N^{(a)}, G_N^{(b)}\}$ The ZCD and *M* of the generated code are as follows.

$$\mathbf{M = 2(K+1)} \quad (4)$$

$$\mathbf{ZCD = 2\Delta - 1} \quad (5)$$

III. SYSTEM MODEL

In this paper, it is assumed that *I* devices operate simultaneously in WBAN environments of on-body, and PAM-DS UWB systems are considered. Overall UWB system model is shown in Fig. 1.

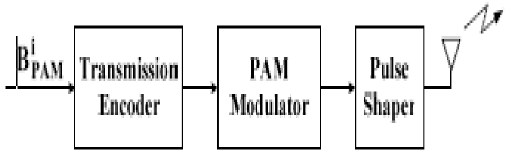

Fig. 2 Block diagram of PAM-DS UWB transmitter of the ith device.

A. UWB Transmitter

Fig. 2 shows a PAM-DS UWB transmitter of the *ith* device. Given the binary sequence

$B_{PAM}^{\,i} = (\ldots, b_{0,PAM}^{i}, b_{1\,PAM}^{i}, \ldots, b_{j\,PAM}^{i}, \ldots)$

Where $b_{j,PAM}^{i}$ is modeled as a wide-sense stationary random process composed of equally likely binary symbols, of the *ith* device to be transmitted, generated at a rate of $R_b = 1/T_b$ bits/s, a transmission encoder applies a binary ZCD code

$C_{PAM}^{\,i} = (\ldots, c_{0,PAM}^{i}, c_{1\,PAM}^{i}, \ldots, c_{j\,PAM}^{i}, \ldots)$

composed of ±1 's and period *Ns* to the sequence

$B_{PAM}^{\,i} = (\ldots, b_{0,PAM}^{i}, b_{1\,PAM}^{i}, \ldots, b_{j\,PAM}^{i}, \ldots)$

and generates a new sequence D^i_{PAM}.

Direction of Body	Γ [ns]	Fk (Δk	σ [dB]

		[dB])	
0	44.6346	5.111 (22.2)	7.30
90	54.2868	4.348 (18.8)	7.08
180	53.4186	3.638 (15.8)	7.03
270	83.9635	3.983 (17.3)	7.19

Table.2: WBAN CHANNEL PARAMETERS FOR DIFFERENT DIRECTION OF BODY.

B. UWB Receiver

A PAM-DS UWB beneficiary model is introduced in Fig.3.Given the channel model and the vicinity of warm clamor at the channel yield, the got signal r(t) at the receiver is given by the total of all signs starting from the I transmitters, and can be composed as:

$$r(t)=\sum_{i=0}^{I-1}\sum_{l=0}^{L-1}\sum_{j=-\infty}^{\infty}\sqrt{E_{l,RX}^{i}}\,m_j^i\,p\left(t-jT_s-\tau_l^i\right)+n(t),$$

Where $E_l^i{}_{,RX} = E_{tx}^i(\alpha_l^i)^2$ and $n(t)$ is complex additive white Gaussian noise (AWGN) with zero mean and variance σ_N^2 . If we assume that the receiver is listening to the first device and the clock time between the first transmitter and the receiver is perfectly synchronized, the time delay τ_l^0 is known by the receiver. And one can assume that τl0=0 given that only relative delays and phases are relevant. Then, the received signal can be rewritten as

$$r(t)= r_w(t)+ r_{MAI}(t)+ n(t)$$

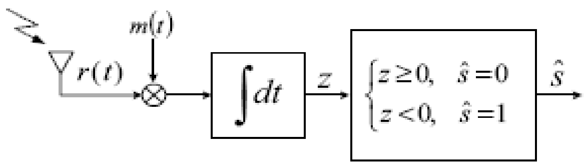

Fig. 3 Block diagram of PAM-DS UWB receiver.

where $r_w(t)$ is the wanted signal and $r_{MAI}(t)$ is the MAI signal at the receiver input.

IV. PERFORMANCE ANALYSIS

In this Section, we infer the framework execution when there are MAI motion and in addition needed sign. The examination determined in this Section, is made under the theory that there is stand out proliferation way between every gadget and the recipient. Thus, L =1 is accepted. The framework execution is communicated by the bit slip likelihood.

The correlated output in Fig. 3 can be written as:

$$Z = Z_w + Z_{MAI} + Z_n$$

where Z_W , Z_{MAI} , and Z_n represent a wanted signal, MAI, and thermal noise at the correlator output. The SGA hypothesis assumes that *ZMAI* and *Zn* are a zero-mean Gaussian random process characterized by variance σ_{MAI}^2 and σ_N^2, respectively.

V. RESULTS AND DISCUSSION

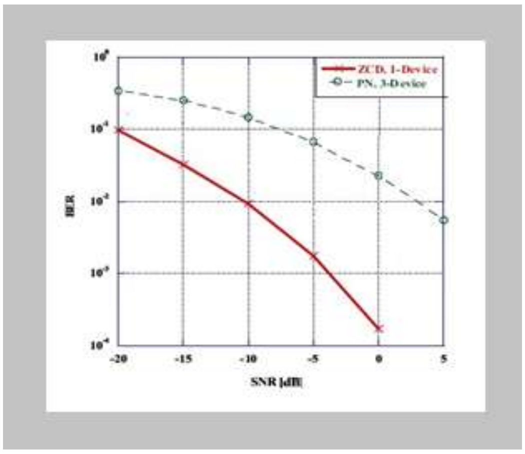

Fig.4: This graph shows BER vs. SNR performance of UWB system for two devices in WBAN channel (64 chip codes).

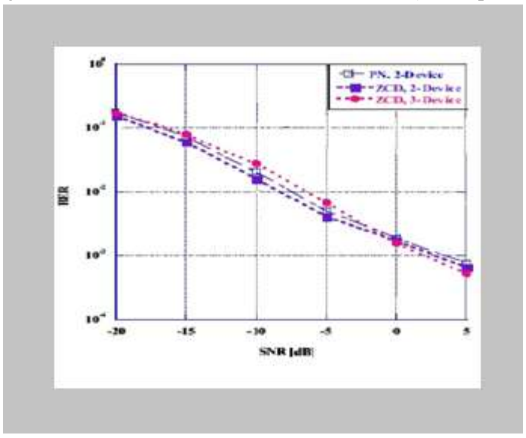

Fig.5: This graph shows BER vs. SNR performance of UWB system for three devices in WBAN channel (64 chipcodes).

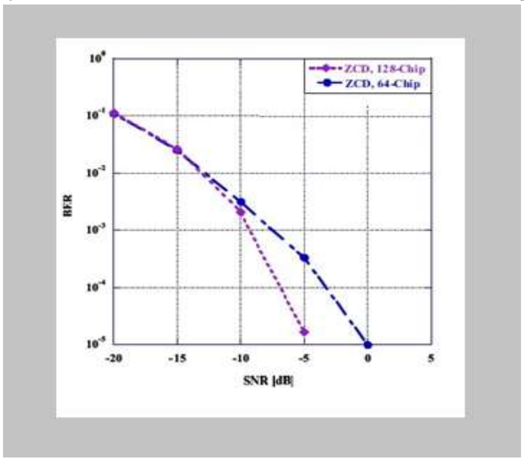

Fig.6: This graph shows BER vs. SNR performance of UWB system for different length of ZCD codes (2 devices).

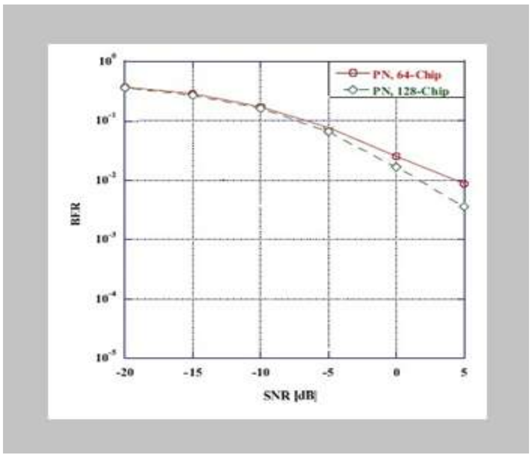

Fig.7: This graph shows BER vs. SNR performance of UWB system for different length of PN codes (2 devices).

In this Section, the performance of the proposed system is evaluated through simulation. In order to verify the performance, bit error rate (BER) is tested when there are several devices in the WBAN environments with LOS (line-of-sight) path. The PN and ZCD codes of 64 and 128 chips are employed for comparison.

Figure.1 show the BER vs. signal-to-noise ratio (SNR) performance when the length of PN and ZCD codes is 64 chips and there are 2 devices.

Figure.2 shows the BER vs. signal-to-noise ratio (SNR) performance when the length of PN and ZCD codes is 64 chips and there are 3 devices.

As expected, the BER performance is degraded with the number of devices where more devices represent more MAI. And, for the same number of devices, it is demonstrated that the UWB system with the ZCD code shows better BER performance than that with PN code. Especially, when the number of devices increases from two to three, the performance difference between two cases becomes more significant. This is because orthogonality of the ZCD code is maintained while reducing the MAI.

Figure.6 the BER vs. SNR performance is presented for different length of spreading codes for two devices in WBAN.

Figure.7 the BER vs. SNR performance is presented for different length of spreading codes for two devices in WBAN.

We can see that the MAI rejection capability is improved as the length of spreading code. It is seen that UWB system with the ZCD code 64 chips achieves better BER performance than the PN code of 128 chips. It can be stated that the system performance can be made better i.e. its performance can be enhanced without increasing the system complexity but also by employing the ZCD code.

VI. CONCLUSION

In this paper, we investigated and reproduced the execution of UWB frameworks utilizing the ZCD code in WBAN situations. It was accepted that there were a few remote specialized gadgets, which were PAM-DS UWB frameworks, on a human body. At that point, MAI situations were considered.

From simulation results, in the presence of MAI, the BER execution with the ZCD code was superior to that with PN code. It was likewise shown that without expanding the framework many-sided quality, the UWB framework execution could be enhanced by applying the proposed ZCD code. The aftereffects of this paper can be connected to plan and execution of the UWB framework for WBAN applications.

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