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A Modified Digital to Digital Encoding Method to Improve the Wireless Body Area Network (WBAN) Transmission

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***Abstract*—online healthcare plays an important role in the information and communication age. Wireless Body Area Network (WBAN) is one of the utilized networks in healthcare. Secure and accurate data transmission is very important in WBAN. This paper presents a new digital to digital encoding by improving None Return to Zero-Inverse (NRZ-I) digital to digital encoding. The proposed digital to digital encoding, which is called Modified NRZ-I (MNRZ-I), has great improvement in synchronization between transceiver. The results show that the propose method has considerably improvement in the direct current component, the number of invalid bits and bandwidth in comparison with other digital to digital encoding method.**

Keywords—Data Transmission; Digital to Digital Encoding; NRZ-I; WBAN

I. INTRODUCTION

According to the World Health Organisation (WHO) [1], cardiovascular disease causes 30 percent of all deaths in the world. Most peaple interest in vital signs control and health diagnosis regardless of time and place. Wireless Body Area Network (WBAN) [2] monitors human physiological signs at home, in hospital and even when moving and transmits sick vital signs to medical database. In data transmission process most of the energy is spent on communication. So improvement the data transmission method has great importance [3]. We are faced with the power limitation and sensitivty in the data transmission accuracy. So finding the new methods in comminucation and transmission can be a valuable step in quickly to wrap up this technology [4].

A. Wireless Body Area Network

WBAN is a set of independent nodes such as sensors and actuators that are situated deeply in tissues, under the skin, on the body or in the clothes [5]. WBAN emerged as a new technology for E-healthcare [6], communicated using short-range wireless communication techniques and allows the data and parameters of a patient's vital body move to be collected in medical database [7].

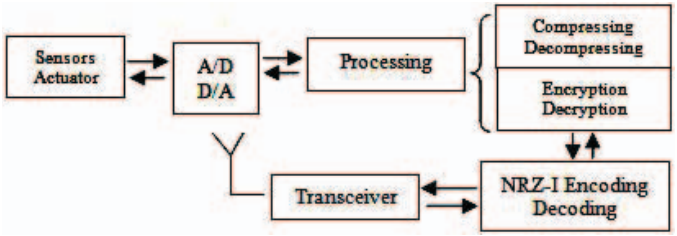

Fig.1. WBAN Block Diagram

As it is shown in figure 1, first of all sensors detect vital signs analog. Next convert them to digital. Then CPU proceses the data (Compression and Encryption [8] for decrease Bandwidth consumption and increase data security for data transmission). The data send to receiver by digital to digital encoding NRZ-I. The receiver does this step vice versa to achieve main data [5].

B. WBAN Totally Architect

1) First level

The first level is a set of intelligent sensors and actuator or nodes. Some sensors such as Electro-cardiograms (ECG), Electro-encephalograms (EEG), Electro-myograms (EMG), Saturation of peripheral oxygen (SpO2), temperature, breathing sensors, blood pressure and glucose sensors [9].

2) Second level

The second level is the personal server (personal digital assistant, cell-phone or PC). Here collects patient vital data from nodes [9].

3) Third level

The third level encompasses remote servers that manage patient medical information [9].

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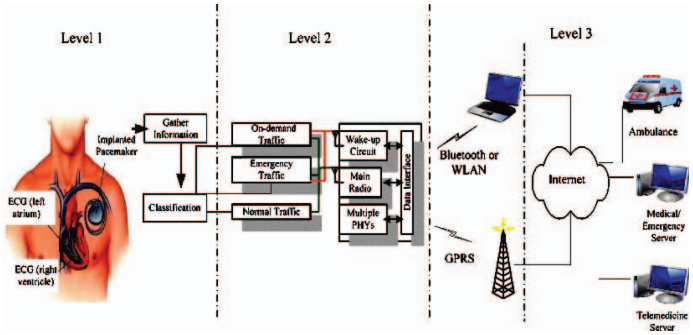

Fig.2. WBAN Totally Architect [9]

C. *Bio Signal*

Bio signal is a short term for type of signal that can measure and control live creature's vital signs continuously [10]. In fact, the sensors located in/on any organ for measure electrical current and electrical resistance changes and report gained values. Incompatibility of values with standard values, means disorder in organ. If this happens, PDA warns disruptions to person [11].

Now after acquaintance with WBAN, we consider to introduce NRZ-I digital to digital encoding that uses for bio signal transmission.

II. NRZ-I Digital To Digital Encoding

"I" i.e. inverse. "Z" i.e. zero that shows zero voltage level. "I" shows if in start of bit interval signal polarity would be inverse, the bit equals "1". If in start of bit interval hasn't change level, the bit equals "0". NRZ-I is a differential method that less affected by the noise. NRZ-I method is edge base [12].

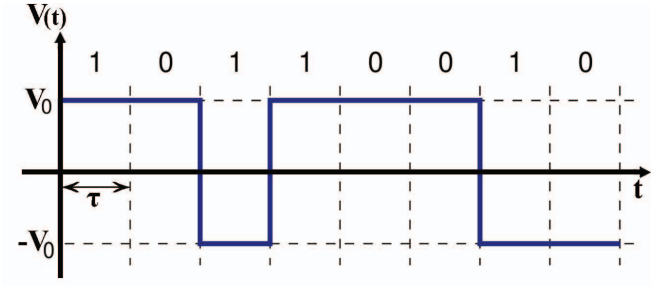

Fig.3. NRZ-I Digital to Digital Encoding [12]

A. *WBANs Ceriteria*

The most important WBAN bio signal transmission criteria are as follows:

- High bit rate
- Sync problem (Long string of one or zero will be lost in time)
- Reducing or eliminating the DC (Direct Current) component
- Less influence from noise

These criteria are our research base for comparison NRZ-I with MNRZ-I. Evaluation of NRZ-I with these criteria show in the table 1.

TABLE I. NRZ-I Evaluation

Criteria	Condition	Description
Bit Rate	Good	Low bandwidth loss ($R=R_s$).
Synchronization	Bad	When is burst. Diagram is direct line. So cock pulse is losing.
DC Component	Good	DC component≠0.
Less Influence Against The Noise	Excellent	It's edge base.

So far, we introduce NRZ-I encoding method that used it for WBAN transmission data. Now, we introduce and comparison MNRZ-I with NRZI and consider its advantages.

III. Our Proposal (MNRZ-I)

The proposed method is edge base. For solving the synchronization problem (Clock loses) between transmitter and receiver also for inappropriate DC component in NRZ-I encoding, we do as follows:

A. *Synchronization*

Every bits clock send with its signal, but for bandwidth loss prevention instead in all of bits send with its clock, after every two zero bits, only third zero bit send with its clock. With this process, receiver will able to detect repeated more than two zero bits similar to each other and prevents from asynchronous between transmitter and receiver.

B. *DC Component*

With the change made is clear that area under the diagram is close to zero. It's an improvement on DC component.

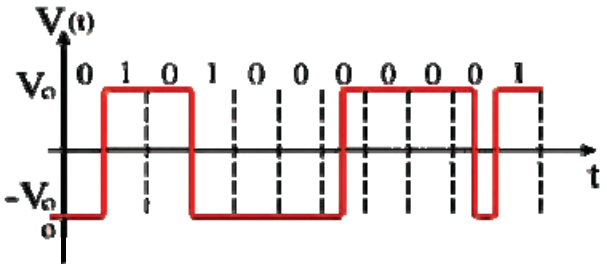

Fig.4. MNRZ-I Digital To Digital Encoding

IV. Simulation Result and Discussion

NRZ-Is evaluation table shows synchronization criteria at the sending zeros burst time, the receiver will be in trouble for time separation. This make asynchronous, therefore will cause

the creation of wrong in bit detection. In the other hand, with the accuracy of DC component it's clear because of non-identical on up level and down level diagram; amount of DC component is far from the desired value, i.e. 0.

Now, we improve synchronization and DC component in MNRZ-I comparison with NRZ-I. Table 2 shows criterion in MNRZ-I.

TABLE II. MNRZ-I Evaluation

Criteria	Condition	Description
Bit Rate	Good	Low bandwidth loss ($R=R_s$).
Synchronization	Excellent	When is burst. Diagram is direct line. So cock pulse is losing.
DC Component	Excellent	DC component≈0.
Less Influence Against The Noise	Excellent	It's edge base.

We simulated the proposed method using MATLAB. Our sample in simulation is 2000 bits string that every bit string length is 100 bits. They generate randomly. These simulations execute for the both of NRZ-I and MNRZ-I. According to simulation results, the average of DC component for NRZ-I = -1.266 and MNRZ-I = -.513. The average of results improvement is 75%.

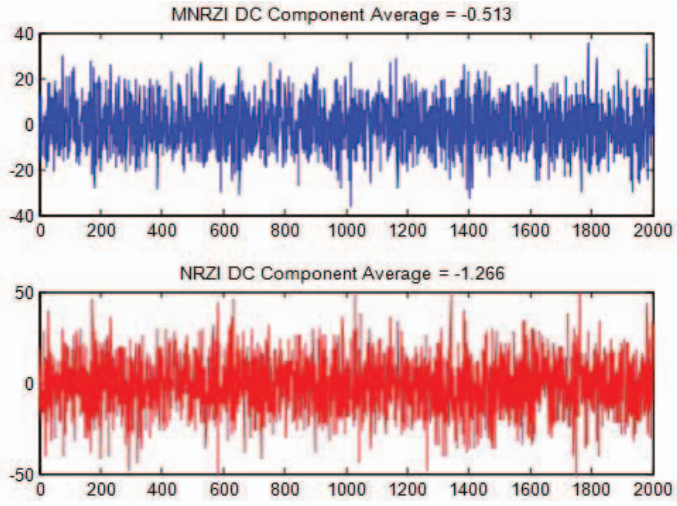

Fig.5. Comparison of Average DC Component Between NRZ-I And MNRZ-I

We simulated 5 times that results is shown in table3.

TABLE III. Comparison of Simulation Results

NO	MNRZ-I DC Component Average	NRZ-I DC Component Average
1	- 0.0445	+ 1.203
2	- 0.4345	- 0.433
3	- 0.069	- 0.958
4	- 0.3815	- 0.72
5	- 0.365	- 1.091

V. Conclusion

The WBANs play an important role in the healthcare [13]. As a result, fast and accurate transmissions of bio signals have particular importance. This paper faced to bugs such as synchronization between transmitter and receiver in zero bursts and unsuitable DC component in the NRZ-I. This paper solved mentioned bugs by introduce MNRZ-I method. The proposed method has been simulated using MATLAB. The simulation results show that the proposed method make better synchronization between transmitter and receiver. Moreover, the DC component in the MNRZ-I method is improved up 75%. It should be noted that, both of them play an important role in WBAN traffic and bandwidth reduction that is very important in data transmission. MNRZ-I improve the WBAN bio signals transmission. Since the WBAN is a new technology and has wide field for development, we are planning to improve IEEE 802.11 wireless communication for WBAN as future work.

References

[1] WHO Stablish," World health statistics 2013 a wealth of information on global publication", geneva, Switzerland, pp. 1-12 (2013)

[2] N. Bradai, L.Ch. Fourati, L. Kamoun, "WBAN data scheduling and aggregation under WBAN/WLAN healthcare network", Ad Hoc Networks 25, pp. 251-262, (2015)

[3] A. Rezai, P. Keshavarzi, Z. Moravej, "Secure SCADA communication by using a modified key management scheme". ISA Transactions, 52(4), 517-524 (2013).

[4] R. Khalilian, A. Rezai, E.Abedini, "An Efficient Method to Improve WBAN Security", Advanced Science and Technology Letters, Vol.64, pp.43-46, (Security 2014)

[5] G.K. Ragesh and K. Baskaran, "A Survey on Futuristic Health Care System: WBANsProcedia Engineering, 30, 889 – 896 (2012).

[6] K.S. Deepak, A.V. Babu, "Performance Evaluation of Forward Error Correction Schemes in Wireless Body Area Networks", National Institute of Technology Calicut, Advances in Intelligent Systems and Computing 343, Calicut 673601, Kerala, India, © Springer India, pp 469-478, (2015)

[7] H, Wang, A.V. Vasilakos, M. Sarrafzadeh, Ch. Lu, "Emerging Wireless Body Area Networks (WBANs) for Ubiquitous Healthcare",IEEE jurnal emb publication medline, (2013)

[8] A. Rezai, P. Keshavarzi, "High-performance implementation approach of elliptic curve cryptosystem for wireless network applications". In Proc. IEEE International Conference on Consumer. Electronics, Communications and Networks (CECNet 2011)., 1323-1327, IEEE Press(2011).

[9] H. Chougrani, J. Schwoerer, P. Horrein, A. Baghdadi, F. Dehmas, "UWB-IR digital baseband architecture for IEEE 802.15.6 wireless BAN", 978-1-4799-4242-8/14/$31.00 c, IEEE, pp. 866-869, (2014)

[10] Carrara, L. Bolomey, C. Boero, A. Cavallini, E. Meurville, G.De Micheli, T. Rezzonico Jost, M. Proietti, Fabio Grassi, "Remote System for Monitoring Animal Models With Single-Metabolite Bio-Nano-Sensors", IEEE SENSORS JOURNAL, VOL. 13, NO. 3, MARCH, pp. 1018-1024, (2013).

[11] Kh.Abu. Al-Saud, A. Mohamed, M. Mahmuddin, "Survey On Wireless Body Area Sensor Network For Healthcare Application: Signal Processing, Data Analysis And Feedback", Proceedings of the 3rd International Conference on Computing and Informatics, ICOCI, Bandung, Indonesia, pp. 279-289, 8-9 June (2011)

[12] W. stallings, "Data and Computer Communications", New Jersey, Prentice Hall, 8th Edition, (2007)

[13] K. Jeong Gil, L. Shenyang, M. B. Srivastava, J. A. Stankovic, A. Terzis, and M. Welsh,"Wireless Sensor Networkworks for Healthcare," Proceedings of the IEEE, 98(11), 2010.