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Algorithmic Approach for Reliable Communication in Wireless Body Area Network for Patient Monitoring System

Vijay M. Birari Dr. J. B. Helonde Dr. Vijay M. Wadhai

Abstract — **Now a days, applications of Wireless Body Area Network (WBAN) have increased considerably. Mobility Management in WBAN for patient monitoring can be used which offers flexibility and mobility to patients. Use of a Mobile WBAN provides flexibility of setting up a remote monitoring system via internet or an intranet. For such a system it is very important that a WBAN can collect and transmit data reliably and in a timely manner. In this paper we propose algorithmic approach to mobile WBAN using A Demodulate and Forward XOR Network Coding Scheme to generate an efficient network code to determine the quality of the link to increase reliability during communication. We suggest network route quality identifier (RQI) and next hop identifier (NHI) to achieve reliability without increase in any overhead.**

Keywords- **Demodulate and Forward, XOR Network Coding, Next hop identifier, Route quality identifier, WBAN.**

I. INTRODUCTION

A Wireless Body Area Networks (WBAN) is a special purpose sensor network designed to operate autonomously to connect various tiny medical sensors and appliances, located inside and outside of a human body. The data gathered by the devices is transmitted to a central device or sink which can process and upload the result. WBANs form an important development towards achieving ambulant patient monitoring, which can be considered a key technology to improve support of a growing elderly population.

Mobility Management in WBAN for patient monitoring system[15] can offer two significant advantages compared to current electronic patient monitoring systems. The first advantage is the mobility of patients due to use of portable monitoring devices. Second advantage is the location independent monitoring facility. WBAN can also search and find a suitable communication network to transmit data to a remote database server for storage [1] [2] [15].

In WBAN, three layers play an important role for sensing accurate readings of patient's health and transmitting accurate information to medical servers, i.e. physical layer, MAC layer and network layer. Physical layer is concerned with energy, antennas and radios. MAC layer has the responsibility to manage data rates, which network layer has a role to search optimal route from source to destination [6] [15].

The possible application scenarios of WSN includes environmental monitoring, military surveillance digitally equipped homes, health monitoring, manufacturing process monitoring, conferences, vehicle tracking and detection (telemetric), and monitoring inventory control [5] [7].

The aim of wireless body area network (WBAN) is to make possible the continuously recording and monitoring of a person's health condition and transfer it over a long-distance communication network. A sensing system is to be worn by the individuals for a long duration. This limits the size of the battery. These factors have made energy the most critical resource in WBAN. The parameters sensed by the individual devices are to be transferred onto a mobile phone or a tablet via wireless network. This data is then gathered, stored and then sent to the doctor for continuous monitoring of the patient's health condition. The doctor can thus access the patient's health status on the go and this will help the patient to get immediate attention in life-threatening situations [3].

For reliability requirements of WBAN, fault-tolerant priority and queue are employed to adaptively adjust the channel bandwidth allocation. An important requirement in WBANs is the energy efficiency of the system. The sensors placed on the body only have limited battery capacity or can scavenge only a limited amount of energy from their environment. Therefore Reliable communication in wireless body area sensor network for health monitoring is required [4] [5] [16]

The remainder of this paper is organized as follows. Section II describes related work on reliable communication in WBANs followed by section III which presents the proposed network coding scheme, Routing model and algorithm and Conclusion in section IV. Section V finishes with References.

II. RELATED WORK

Majid Nabi et al [9] have presented a comprehensive configurable mobility model MoBAN for evaluating intra and extra-WBAN communication. It implements different postures as well as individual node mobility within a particular posture. The model can be adapted to a broad range of applications for WBANs. However it is not energy efficient.

Baozhi Chen and Dario Pompili [10] have proposed a novel in-network solution to prioritize the transmission of patient vital signs using wireless body area networks; the solution relies on a distributed priority scheduling strategy based on

the current patient condition and on the vital sign end-to-end delay/reliability requirement. The proposed solution was implemented in Tiny OS and its performance was tested in a real scenario. However there occurs delay and error due to loss of data.

Nabil Ali Alrajeh et al [6] have proposed a novel multi-radio multichannel framework for efficient communication among devices in WBAN. The focus of this research is to ensure energy efficient and reliable communication in WBAN. The multi-radio multi-channel offer efficient data delivery rate and reduced end-to-end delay. However, more energy consumption is observed in multi-radio multi-channel mechanism due to operation of extra radios.

Joonyoung Jung et al [7] have developed a ubiquitous healthcare system consisted of a physiological signal devices, a mobile system, a device provider system, a healthcare service provider system, a physician system, and a healthcare personal system. In this system, wireless body area network (WBAN) such as ZigBee is used to communicate between physiological signal devices and the mobile system. WBAN device needs a specific function for ubiquitous healthcare application. They propose a scanning algorithm, dynamic discovery and installation, reliable data transmission, device access control, and a healthcare profile for ubiquitous healthcare system.

Baozhi Chen et al [11] have developed a novel wireless communication solution that seamlessly supports patient mobility and that prioritizes vital signs transmission using Wireless Body Area Networks (WBANs). This solution overcomes the current limitations of patient monitoring in pre- and hospital environments, which represent an important barrier for developing improved trauma triage strategies. However there occurs signal error due to packet loss.

Samaneh Movassaghi et al [12] have proposed a novel cooperative transmission scheme for Wireless Body Area Networks (WBANs) to enhance reliability and throughput. In the proposed scheme, namely Random XOR Network Coding (RXNC), each relay demodulates the received signal from each sensor node and then selects d different coded symbols amongst them and XORs them to generate a network coded symbol. The proposed RXNC scheme outperforms the no-cooperation and conventional bitwise network coding schemes in all channels Signal to noise ratios (SNRs) from 0 dB to 18 dB. However there occurs error propagation.

III. PROPOSED WORK

In the existing works, they have not proposed any reliable routing model. Therefore in our solution the routing modules are considered and Random XOR Network Coding (RXNC) is applied to these routing modules to provide reliable routing communication to monitor patients in Mobile WBAN. Here for data transmission we can use Random XOR Network Coding (RXNC) [12] [16]. In this, each relay demodulates the received messages from each of the source nodes. In order to generate each network coded symbol, the relay randomly selects d different symbols from the hard-decision symbols of the source nodes, and XORs them. This network coding scheme has less complexity and reduces error propagation at the relay nodes.

A. Estimation of Metrics

This section describes about the different metrics used for reliable while low delay routing model. [16]

B. Route Quality Identifier (RQI)

It is a metric which is used to estimate the route quality from source S to destination D, represents link quality identifier (LQI) [16]

C. Next hop Identifier (NHI)

It is a metric used to identify the best available next hop with the best RQI [16]

D. Received Signal Strength

It is metric used to represent the received signal strength at the any relay based on the path loss model.[16]

E. Demodulate and Forward XOR Network Coding Scheme (DXNC) [16]

This section describes about reliable network coding scheme based on demodulate and forward along with XOR operation and the routing Model.

F. Routing Model

In [10], they have proposed a cross-layer protocol in which the next hop node is selected based on estimated Route Quality Identifier (RQI) and Link quality Identifier (LQI) as shown in Fig 1. In this case when a node want to route traffic to the sink, then it selects next hop based on best RQI in the routing table. But they have not considered any interference free or reliable communication for patient monitoring in WBAN. Hence we propose an interference free reliable communication for patient monitoring by applying DXNC and RPI technique which is described in the following section.

In Fig 1 the link with maximum RQI is selected that (1-9-2-3-Sink) where each coded symbol is connected with 2 decided relay to increase the reliability for the communication.

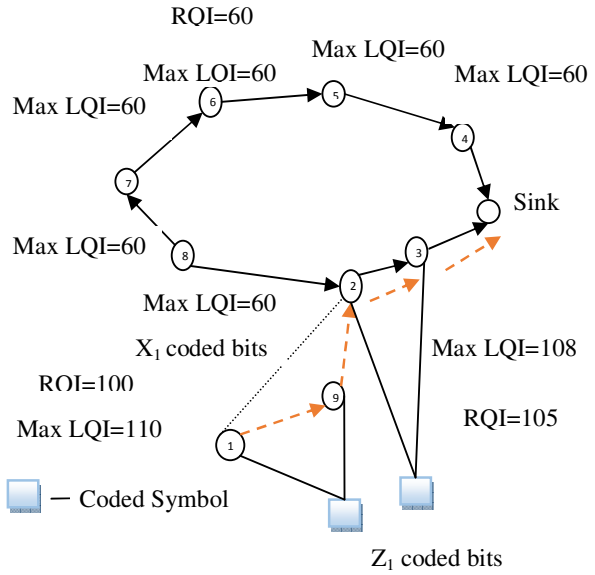

Fig.1. Proposed DXNC along with Routing

G. Network Coding

In this technique, first each source encodes its m information symbol with help of T channel code for example LDPC code or any convolution code in order to generate coded symbols. After that coded symbols are modulated and transmitted to the relays. Once coded symbols is received at the relay, it performs demodulate and forwards in order to generate network-coded symbols. The DMF an efficient technique to create some network-coded symbols and transmits them to relay.

It is assumed that BPSK modulation is used.

In order to generate different network coded symbol, relay select h different bits randomly from the decided coded symbols and then apply XOR to generate network coded symbols. This procedure continues till relay generates R coded symbols..

In Fig.2 DXNC scheme is described through bipartite graph. In this scheme coded symbols from each source is considered as a variable node and each decided symbol at the relay is considered as check node. As shown in Fig 2 each coded symbols is correctly connected 2 decided symbols.

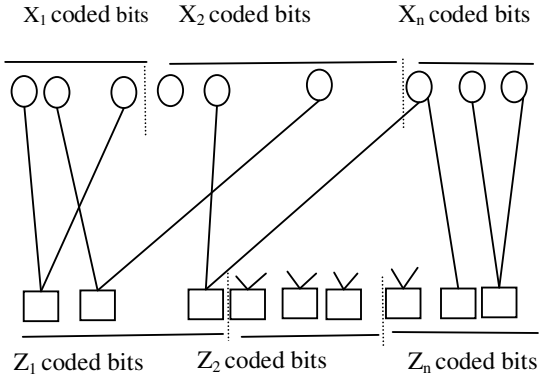

Fig.2. Bipartite graph for DXNC scheme

H. Algorithm

//Network coding//

1. *Calculate log probability of relay j*
2. *Compare log probability* $H_{i,j}$ *with 0*
   if $H_{i,j}(f_{i,o}) > 0$
3. *then* $f_{i,o} = 0$
   else $f_{i,o} = 1$
4. *Obtain the coded message*

// Routing Model//

5. *Determine RQI and NHI*
6. *if (RQIi,j and* NHI_j *is max)*
7. *then select link i, j and j as relay*
8. *else reject*

Fig 3: Proposed Algorithm

IV. Conclusion

In this paper we proposed algorithmic approach for reliable communication technique for patient monitoring in mobile WBAN. A Demodulate and Forward XOR Network Coding Scheme is used to generate an efficient network code to increase the reliability during communication. In order to increase the reliability without any overhead in the network, route quality identifier (RQI) and next hop identifier (NHI) is estimated to determine the quality of the link. The link with the best RQI is selected for transmission and the best hop is selected based max value of NHI.

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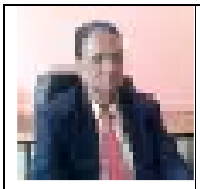
AUTHOR'S PROFILE

Vijay M. Birari
received the master's degree in electronics & telecommunication engineering from Dr. BA Technological University in 2005. He is currently working toward the Ph.D. degree in electronics engineering at RTM University, Nagpur. His interests currently include wireless sensor networks, wireless body area networks, body channel models, and telemedical platforms.



Dr. J. B. Helonde
Dr. J. B. Helonde did his graduation, post graduation and doctoral degree in Engineering with a consistent good academic record. He has 31 years of rich academic experience as Professor and Head, Principal. He was Chairman, board of studies in electronics engineering & member of Academic council of Nagpur University and contributed for design, development and up gradation of various schemes and syllabus of electronics based courses of the University. He is associated with research activities and supervised 3 Ph.D. candidates and 10 candidates are pursuing their Ph.D. He published more than 100 research papers in National and International Journals and Conferences

Dr. Vijay M. Wadhai
Currently working as Principal of Maharashtra Institute Of Technology, College Of Engineering, Pune. Research guidance and mentoring for working professionals in industry and academics Recognized PhD supervisor in Computer Engineering. and Electronics & Telecommunication Engineering. at various Universities. Driving force in establishing new VLSI design part of core team in developing Research Lab approved by university of Pune at MAE Alandi, Pune. Technical Director, international radio frequency group IRF India. Member of Advisory board Director research and innovation of Parallel minds Technology solution Pvt. Ltd. Pune. Published 52 International Journal and 61 International and National Conference papers. More than 20 Research Scholars under his guidance in various fields like cognitive radio, wireless network, VANET, Body Area Network domain, Near Field Communications (NFC) and VLSI area field communications(NFC)