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Reliable Communication for Patient Monitoring in Mobile WBAN

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Abstract-**The proposed system offers mobility to patients and flexibility to Doctor & medical staff to obtain patient's physiological data on continuous basis via Internet or Mobile. The collected data is transferred to remote stations with a multi-hopping technique using the medical gateway. The gateway nodes connect the sensor nodes to the local area network and the internet. Medical professions can access patients' physiological signals anywhere in the medical centre or the data can also be accessed outside the medical centre. Nowadays hospitals are generally equipped with more electronic medical devices which results in high level of electromagnetic interference that leads to failure of medical monitoring device. In order to overcome these issues an interference free reliable communication technique is adopted 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. Also an efficient random partial coloring technique is used to increase spatial reuse and increase the energy efficiency. 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.**

Keywords:- **Demodulate and Forward, Network Coding, Reliable Communication, WBAN**

I. INTRODUCTION

A. WBAN

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.

WBAN 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].

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].

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 mobility management in wireless body area network (WBAN) for patient monitoring system[16] is to make possible the continuously recording and monitoring of a person's health condition and transfer it over a long-distance communication network[16]. 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].

B. Reliable communication

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]. .

The reliability is also affected by several factors: coverage and signal strength, available bit rate and prioritized transmission, delay performance, and failure of access points and interconnection architecture.

C. Problem Identification and Solution

Wireless Body Area Networks (WBANs) have been developed as the human-body monitoring systems to predict, diagnose, and treat diseases. Since the signal transmission in WBANs takes place in or around the human body the channel fading significantly affects packet error rate and overall network performance. Accurate and quick prioritization of patient vital signs under such environment is crucial for making efficient and real-time decisions.

As a result, a novel in-network solution for WBAN [10] system is proposed which continuously monitors vital signs of multiple patients and prioritizes data transmission based on patient's condition and data content.

For monitoring patient's vital sign two-tier architecture is used. This two-tier architecture calls for two different protocol stacks, one for intra-BAN and the other for inter-BAN communications. The inter-BAN protocol provides communication between BANs, while the intra-BAN protocol is employed to aggregate patient's vital signs.

For interference-aware prioritization service cross-layer communication solution is proposed. The modules include Medium Access Control (MAC), Routing, and Scheduling. Each module is individually designed to meet the domain-specific requirements; then, the three modules are jointly optimized and considered to obtain the best performance possible.

However the available energy is wasted on idle listening. While routing medium access collisions, protocol overheads occurs and interference occurs. Also error due to data loss occurs during data transmission.

II. Related works

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.

Manisha Mittal and Dr. D. K.Chauhan [8] have proposed an optimized BSN handover strategy, and hop by hop method to reach RBS (Sink), and a method to maximize the network throughput by using stable routes to avoid inter-flow and intra-flow interferences based on mobility prediction. However the computation cost depends upon the network size which is equal to total number of decryptions taking place in the key agreement process.

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.

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.

Shinsuke Hara et al [13] have proposed a cooperative scheme for ensuring reliable data transmission in a WBAN. For each sensor node on a human body, the proposed scheme autonomously assigns a sensor node as a cooperator out of other sensor nodes and the cooperator retransmits packets from the sensor node for a coordinator instead of the sensor node when the direct link between them is blocked. The performance of the proposed cooperative transmission scheme has been evaluated using the measured RSSI data. The proposed cooperator selection scheme based on "low blocking correlation between direct and indirect paths" works effectively, showing larger transmit diversity gains.

Shih Heng Cheng and Ching Yao Huang [14] have proposed a random incomplete coloring (RIC) with low time-complexity and high spatial reuse to overcome in-between wireless-body-area-networks (WBAN) interference, which can cause serious throughput degradation and energy waste. Interference-avoidance scheduling of wireless networks can be modeled as a problem of graph coloring. For instance, high spatial reuse scheduling for a dense sensor network is mapped to high spatial-reuse coloring; fast convergence scheduling for a mobile adhoc network (MANET) is mapped to low time-complexity coloring. The proposed coloring algorithm effectively overcomes inter-WBAN interference and invariably supports higher system throughput in various mobile WBAN scenarios compared to conventional colorings

III. PROPOSED WORK

In the existing works, they have not proposed any interference free 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 interference free reliable routing communication to monitor patients in WBAN.

A. Overview

Here for data transmission we can use Random XOR Network Coding (RXNC) [12]. 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.

To overcome the interference problem, we can apply random incomplete coloring (RIC) algorithm [14] with low time-complexity and high spatial reuse. RIC coloring has two major components: 1) a proposed random-value

coloring method and 2) a proposed incomplete coloring approach. By relaxing the coloring rule, the distributed coloring algorithm RIC avoids the tradeoff and satisfies both high spatial-reuse and fast convergence requirements. The proposed block diagram is shown in Fig 1.

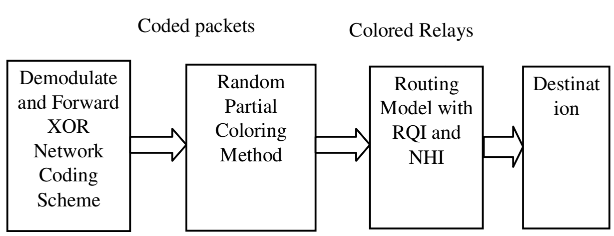

Fig 1: Block Diagram

B. Estimation of Metrics

This section describes about the different metrics used for interference free reliable routing model.

C. Route Quality Identifier (RQI)

It is a metric which is used to estimate the route quality from source S to destination D. It can be calculated as below:

$$RQI_{SD} = \min_{(i,j)\in P_{SD}} \max_{b\in ACL_{i,j}} LQI^{b}_{i,j} \quad (1)$$

Where (i, j) represents link from I to j, P_{SD} represents sets of links towards route from S to D. $ACL_{i,j}$ represents set of available channels for link (i, j) and $LQI^{b}_{i,j}$ represents link quality identifier (LQI) from link i to j through channel b.

D. Next hop Identifier (NHI)

It is a metric used to identify the best available next hop with the best RQI which is given as below:

$$K^{*} = \arg\max_{K\in N_{(i)}} RQI_{ijD} \quad (2)$$

Where $N_{(i)}$ represents set of $i^{'s}$ non-busy neighbors . It is calculated by observing overhead RTS/CTS packets along with data packet length. RQI_{ijD} represents RQI value of route from link i to sink D through j.

E. Received Signal Strength

It is metric used to represent the received signal strength at the jth relay based on the path loss model which is given as below:

$$Y_{i,j} = C_{i,j} x_i + m_{i,j} \quad (3)$$

$C_{i,j}$ represents channel coefficient which is determined by path loss model. $m_{i,j}$ represents additive zero mean white Gaussian noise with variance η^{2}_{n} .

F. Vertices per Color (V_p)

It is described as average number of vertices colored by each color considered which is used to estimate average spatial reuse of periodical coloring.

High V_p indicates more number of wireless nodes which can concurrently transmit packet by using same color, that means the system make higher spatial reuse on average.

IV. CONCLUSION

In this paper reliable communication technique for patient monitoring in mobile WBAN is proposed. A Demodulate and Forward XOR Network Coding Scheme used to generate an efficient network code to increase the reliability during communication. Once network coding is done, the selected relay are sent for the coloring. In this efficient random partial coloring technique spatial reuse is adopted and hence it increases the energy efficiency. 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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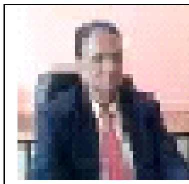

Dr. J. B. Helonde

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

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Currently working as Principal of Maharashtra Institute Of Technology, College Of Engineering, Pune. Research guidance and mentoring for working professionals in industry and academics Recognised PhD supervisor in Computer Engg. and Electronics & Telecommunication Engg. 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)