Efficient Network System Using WBAN For Medical Applications

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Abstract-This project Efficient Network System Using WBAN (Wireless Body Area Network) is an innovative method to increase the efficiency of real-time health monitoring systems. To improve care and patient outcomes for emergency conditions that need constant surveillance, hospitals are increasing their use of patient monitoring solutions. Here we implement continuous monitoring of patient in the hospitals and the collected information is shared with the help of Wireless Sensor Networks (WSN). The system can be used to monitor physiological parameters, such as heart rate and temperature of a human body.

Keywords-WBAN; Wireless Sensor Networks; health monitoring; Routing

I. INTRODUCTION

We explore a wireless body area network (WBAN) based on ZigBee technology. All nodes in the WBAN are organized with star topology, and sensor nodes are managed by a central control node. Moreover, the central control node is used as an access point by which the biomedical signal from sensor nodes can be transferred to hospital network over wireless communication network. [8] [9] The WBAN works in a mode named "wake up on-demand" which means the WBAN is set in a sleep mode where most circuits are turn off and fewer circuits keep monitoring the wireless channels at low power consumption. Once the WBAN is waked up, all modules begin to work and all biomedical signals are obtained, stored and transmitted.

In workload management a group of servers are managed together and participated. Nodes or individual application servers are in clusters. A node is usually a physical computer system with a distinct host IP address that is running one or more application servers. Clusters can be grouped under the configuration of a cell, which logically associates many servers and clusters with different configurations and applications with one another depending on the discretion of the administrator and what makes sense in their organizational environments.

Clusters are responsible for balancing workload among servers. Servers that are a part of a cluster are called cluster members. The application is automatically installed on each cluster member, when you install an application on a cluster. You can configure a cluster to provide workload balancing with service integration or with message driven beans in the application server

II. WIRELESS BODY AREA NETWORKS (WBAN)

WBAN is a wireless network of wearable computing devices. To connect various medical sensors and appliances a special purpose network called WBAN is designed to operate autonomously which is located inside and outside the human body.

The WBAN protocols communicate between the sensors on the body to communicate from a body node to a data center connected to the internet. Intra and extra are the two types of this communication.

The operation of this is done close to a human body with its communication range restricted to a few meters. It can handle patients who are suffering from chronic diseases such as asthma and heart attack.

III. RELATED WORK

WBAN is defined in IEEE standards as 802.15.6. In general WBAN (Wireless Body Area Network) is a RF based wireless networking technology. It is a low power sensor node which can be miniaturized and integrated with intelligence.

It is classified as Wearable and Implantable WBAN. Here patients health condition can be monitored anytime and anywhere using Wearable device. It continuously monitors the health conditions of patients.

For medical, consumer electronics and other applications a communication standard is optimized by low power devices for their operation on, in and around the human body. It is a closed loop bio-feedback system which is easy to access and saves a lot of time.

3.1. Proactive And Reactive Protocols

We use proactive and reactive protocols to find energy consumption in a network. In proactive protocol the nodes switch on their sensor and transmitters, sense the environment and transmit the data to a base station through the predefined route. Example the low energy adaptive clustering hierarchy protocol (LEACH) utilizes this type of protocol. In reactive protocol if there are sudden changes in the sensed attribute beyond some pre-determined threshold value, the node immediately react. This type of protocol is used in critical applications. Example the Threshold sensitive Energy Efficient sensor Network (TEEN) utilizes this type of protocol. Hybrid protocol contains both proactive and reactive concepts. They first compute all routes and then improve them at the time of routing. Example, Adaptive Periodic Teen (APTEEN).

3.2. Hierarchical Protocols

Alternatively, WSN routing protocols are categorized by their structure, as either flat or hierarchical. The hierarchical protocols, such as low-energy adaptive clustering hierarchy (LEACH), split the network up into clusters. Sensor nodes then forward data to a cluster head, which then forwards it to the sink. This approach has been shown to reduce energy consumption in static sensor networks. However, the requirement of nodes to first elect and then associate themselves with a cluster head can cause significant overhead, especially if nodes are frequently moving between different clusters.

Hierarchical protocols are for energy efficient routing i.e. higher energy nodes can be used to process and send the information. Low energy nodes are used to perform the sensing in the area of the interest. Examples are LEACH, TEEN, APTEEN.

3.3. Flat Routing Protocols

Contrastingly, flat protocols are used to find the rate at which a packet is delivered from source to destination. It distributes routing information to the routers that are connected to each other without any organization or segmentation structure between them. Without considering the network hierarchy, distribution and composition they enable the delivery of packets among routers through any available path. The entire participating node addressed by flat routing protocol performs an equal role in the overall routing mechanism. RIP (Routing Information Protocol), IGRP (Interior Gateway Routing Protocol) and EIGRP (Enhanced Interior Gateway Routing Protocol) are some of the examples.

3.4. Aloha

Aloha protocol is used to find throughput in a network. The Alohanet solution was to allow each client to send its data without controlling when it was sent, with an acknowledgement/retransmission scheme used to deal with collision. Pure aloha and slotted aloha are its types.

Whenever station has a data, it transmits i.e. frames are transmitted at completely arbitrary times. By listening to the broadcast from the destination station sender finds out whether the transmission was successful or experiences any collision. Sender retransmits after some random time if there is any collision.

In slotted aloha, if two stations try to send at the beginning of the same time slot there is still a possibility of collision. Slotted aloha still has an edge over pure aloha has a chance of collision reduced to one-half.

IV. PROPOSED SYSTEM

In this system, we proposed wireless sensor network to monitor the patient health parameters in hospital, here we used the node based techniques for monitoring each and every patients. The health parameters like body temperature and heart rate is monitor with help of sensors, for example we monitor the two patient health conditions at the time. The first patient is considering as the node1 and the second patient is considering as node2. This coordinator node has attached on patient body to collect all the signals from the sensors and sends them to the base node (DOCTOR) through WSN. If the condition is normal for both the patient the sending data must like NP1, NP2 (PATIENT1 NORMAL, PATIENT2 NORMAL) this system can detect the patient1 is abnormal conditions, and send a data like EP1, NP2 (PATIENT1 ABNORMAL, PATIENT2 NORMAL). Based on the priority level of received patient health details the doctor can precede a further step. [14]

4.1. Dynamic Source Routing Protocol

In wireless networks, a self-maintaining routing protocol is Dynamic Source Routing (DSR). With cellular telephone systems and mobile networks this protocol can function with up to about 200 nodes. A Dynamic Source Routing network can configure and organize itself independently of oversight by human administrators. In Dynamic

Source Routing, each source determines The route to be used is determined by the source in transmitting its packets to selected destinations. The two main components are Route Discovery and Route Maintenance. Route Discovery determines the optimum path for a transmission between a given source and destination. Even when the network conditions change in route maintenance, the transmission path remains optimum and loop-free, even when the route is changed during a transmission.

The protocol is composed of the two main mechanisms of "Route Discovery" and "Route Maintenance", which work together to allow nodes to discover and maintain routes to arbitrary destinations in the ad hoc network. The protocol operate entirely on-demand in all aspects, to react to changes in the routes it allows the routing packet overhead of DSR to scale automatically to only that is currently in use.

The protocol allows multiple routes to any destination and allows each sender to select and control the routes used in routing its packets, for example for use in load balancing or for increased robustness. Support for use in networks containing unidirectional links, loop-free routing which is easily guaranteed, very fast recovery when routes in the network changes and using "soft state" in routing only are the examples of DSR. The DSR protocol is designed mainly for mobile ad hoc networks of up to about two hundred nodes, and is designed to work well with even very high rates of mobility.

4.2. Protocol Description

Adaptive Load Balancing (ALB) provides an increased bandwidth and fault-tolerance. It is the most flexible Network Interface Controller (NIC) bonding technique that can be enabled on the storage nodes. There is typically no special switch configuration required to implement ALB. Both NICs are made active in the storage nodes, and for active-active port failover they can be connected to different switches. At 2 gigabits of aggregated bandwidth ALB operates. Adaptive Load Balancing is only supported for NICs with the same speeds. [8]

4.3. Topology

Capturing and dissemination of its own data which serves as a relay for other nodes is topology. Here every device has a point to point link with other devices. It uses dedicated link so that each link can carry only its own data load. It provides maximum reliability and redundancy so it is very well suited for effective transmission.

4.4. Performance Metric

The performance metrics is used for checking how efficient a system performs in spite of various obstacles such as fault tolerance, cost, hardware constraints, power consumption, packet loss etc.

For example if the packets are transmitted from source to destination based on the patient’s criticality, certain parameters are taken into consideration for effective transmission (such as packet loss, throughput, end to end delay, lifetime of the network and power consumption). If there is any deviation in the metrics then the patient life is at risk. Thus it plays a major role in this system.

4.5. Packet Priority

Packets with the priority bit set are designated as priority packets, whereas packets with the priority bit cleared are designated as diversity packets. A diversity packet is one that has been forwarded by a node with the same location index as the one that transmitted it.

For example, a node with a location index of 3 broadcasts a priority packet to its neighbours. The neighbours with a location index of 2, store the packet for forwarding and the neighbours with a location index of 4 simply drop the packet. The neighbours that also have a location index of 3 clear the priority bit and store the packet for forwarding. The route diversity of the protocol is increased by the priority bit and the dead-end problem is also alleviated.

4.6 General Operation

The flowchart in Fig. 1 summarises the operation, which shows how the parameters of each patient is prioritized and checked with the threshold value. When the threshold value exceeds then the information is passed to the doctor with minimal amount of loss thereby notifying about the criticality of each node.

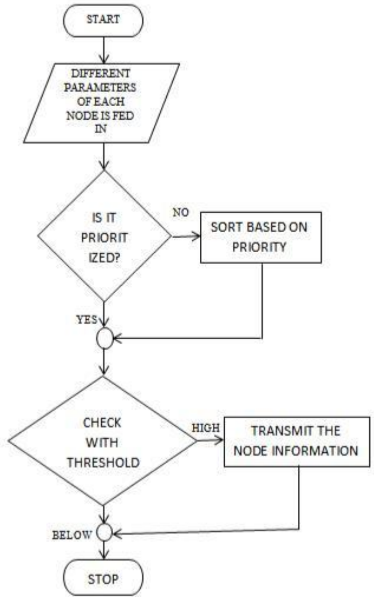

Fig. 1. Flowchart representation of Transmitting sensor operation

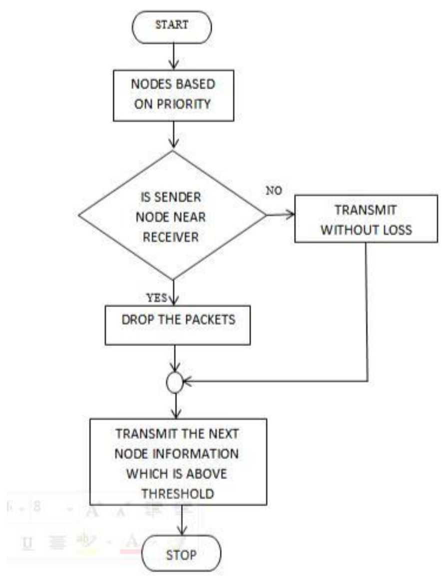

Fig. 2. Flowchart representation of Receiving sensor operation

4.7. MAC Layer

The medium access control (MAC) protocol is primarily responsible for regulating access to the shared medium.Network transmissions are due to errors and interferences which lead to the choice of MAC protocols and have a direct bearing on the reliability and efficiency in wireless communications. By ensuring that each node can use its allocated resources Collisions can be avoided exclusively. FDMA and TDMA are examples of fixed assignment strategies. Responsibilities of MAC layer include:

- decide when a node accesses a shared medium
- resolve any potential conflicts between competing nodes
- correct communication errors occurring at the physical layer
- perform other activities such as framing, addressing, and flow control.

A MAC protocol for a WSN should be able to gracefully adapt to such changes without significant overheads. This requirement generally favors protocols that are dynamic in nature. This protocol makes medium access decision based on current demand and network state.

The choice of MAC layer is an important aspect of this protocol. One of the most popular MAC layers is the 802.11 MAC, which uses the technique of carrier sense multiple access (CSMA) with collision avoidance (CA).

This technique requires a node to first listen to the channel; if it is clear then the packet can be sent, else it should wait for a random amount of time before trying again. Using CSMA/CA in WBAN, a node may transmit to all of its neighbours, and then each of them will listen to the medium. At this point it is likely that more than one of the neighbours will sense the channel to be free and try to transmit, causing collisions.

V. COLLECTION OF RECORDED DATA

Records of medical data from actual patients were collected from hospitals.

Table I. Recorded Data – Set 1

Patient No	Pulse (60-90) per min	Blood Pressure (120/80) mm of Hg	Glucose (70-110) mg/dl	Body Temperature (98.6) F	SpO_2 (100%)
1.	80	120/80	124	98.4	94%
2.	72	120/70	98	99.2	92%
3.	74	110/70	110	96.8	99%
4.	78	90/60	40	98.4	92%
5.	88	120/70	150	98.2	98%
6.	78	100/70	134	97.6	99%
7.	110	130/110	200	98.3	89%
8.	88	120/90	124	98	100%
9.	99	140/90	145	97.9	100%

Different parameters which need to be transmitted from the patients such as blood pressure, body temperature etc. were collected from different patients to be sent as sensor data. These values collected from the sensors were used as input to the simulation of the protocol.

The medical data of different patients were collected from hospitals - Fortis Malar Hospital, #52, 1st Main Road, Gandhi Nagar, Adyar, Chennai-600020 under the guidance of Dr. Vinod Prem Anand M.B.B.S. and Nalam Medical Centre, East Coast Road, Thiruvanmiyur, Chennai-600041.

VI. SYSTEM IMPLEMENTATION

In order to implement a mobile wireless sensor network, different modules implementing the sensors, mobile relay and sink (medical database or server) are written in Java programming language.

6.1 Performance Metrics

The different performance metrics can be calculated for WBAN by writing the required C codes in the XWin Server.

1) Average end-to-end Delay
Average time between a node creating a packet and the time received at the sink.

$d_{end\text{-}end}= N[d_{trans} + d_{prop} + d_{proc} + d_{queue}]$ = Start time - End time where,

N = number of hops
dend-end = end-to-end delay
dtrans = transmission delay
dprop = propagation delay
dproc = processing delay
dqueue = queuing delay

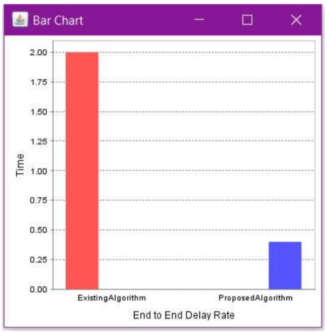

Fig. 3.Average end-to-end Delay

2) Energy consumption
The energy level of nodes in the network is represented by the energy model. The energy model defined in a node has an initial value that is the level of energy the node has at the beginning of the simulation.[1]
Difference between the energy at initial stage and current stage,
EC = Initial energy – Current energy
It is measured in joules per node.

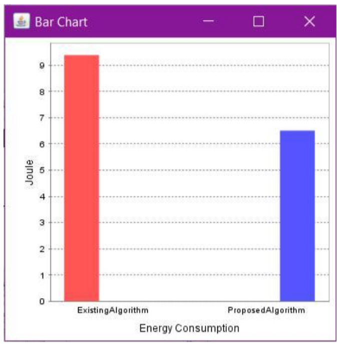

Fig. 4. Energy consumption

3) Packet Delivery Ratio
PDR is the ratio of the number of delivered data packet to the destination. This illustrates the level of delivered data to the destination. [5]
PDR = Σ Number of packet received / Σ Number of packet sent where,
P_{tx} = Number of packets transmitted
P_{rx} = Number of packets received

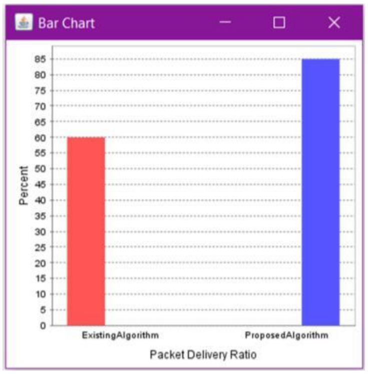

Fig. 5. Packet Delivery Ratio

4) Packet Loss Ratio
The failure of reaching the destination of one or more packets of data travelling across a computer network, packet loss occurs. It is caused by network congestion.
Packet loss is measured as a percentage of packets lost with respect to packets sent.[15] Packet Loss = (Number of packets sent / Number of packets received) * 100

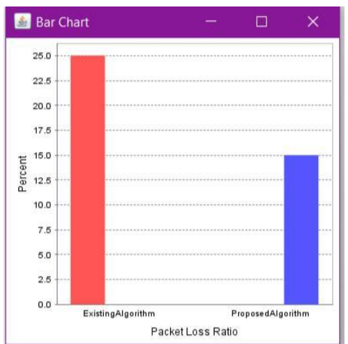

Fig. 6. Packet Loss Ratio

5) Throughput
Throughput is the amount of work that a node can do in a given time period. Throughput has been a measure of the comparative effectiveness of dense network that run many tasks concurrently. [5]
Throughput = (Number of packets * 9) / Data Duration

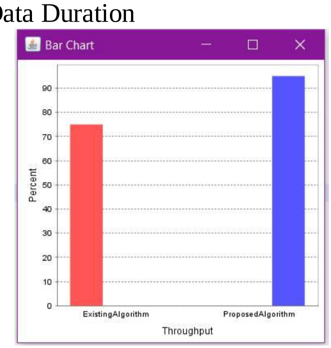

Fig. 7. Throughput

VII. CONCLUSION AND FUTURE WORK

Thus the project has been developed to increase the efficiency of real-time health monitoring systems which make use of Wireless Sensor Networks. The high reliability and low latency requirements of this application is addressed by using Wireless Body Area Network (WBAN). To make it reliable and fast, it has high PDR and low average end-to-end delay. The overhead has also shown to be low, which gives WBAN a low level of energy consumption.
In future applications, the protocol used can be further optimized in the following aspects:

- Optimization is done using Adaptive Load Balancing Protocol.

- Increasing the throughput and reducing energy consumption based on priority.
- Better strategies for a node decide to drop the packet based on the priority bit value.

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