

Temperature Aware Routing Protocols for Wireless Body Area Networks to Reduce the Node Temperature

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Abstract:- Researchers in the tech community are focusing on wireless body area networks because of their various applications. For both military and medical applications, remote health monitoring devices were implanted into the skin of the body to detect the critical component, which is the regular and constant operation of a sensor node for a longer effect in raising the temperature of the appropriate tissue. Additionally, electromagnetic radiation from the implanted biomedical sensor nodes poses a serious risk of harming delicate human tissues. WBANs ignored the goal of energy saving and route selection optimization in favor of their primary focus on reducing temperature. A comparable QoS parameter is used to do analytical simulations. The outcome shows improved performance compared to the state-of-the-art wireless body area network in terms of node temperature, throughput, power maintenance, and temperature control.

Keywords: Wireless Body Area Network, Temperature, Sensor, Human body.

1. Introduction

There are numerous medical and non-medical applications for WBAN's type of health sensor, including remote health monitoring, coaching, sports participation, and physical protection techniques. The overall goal of WBAN is to modify people's lifestyles by making certain tasks simpler for them. [8].

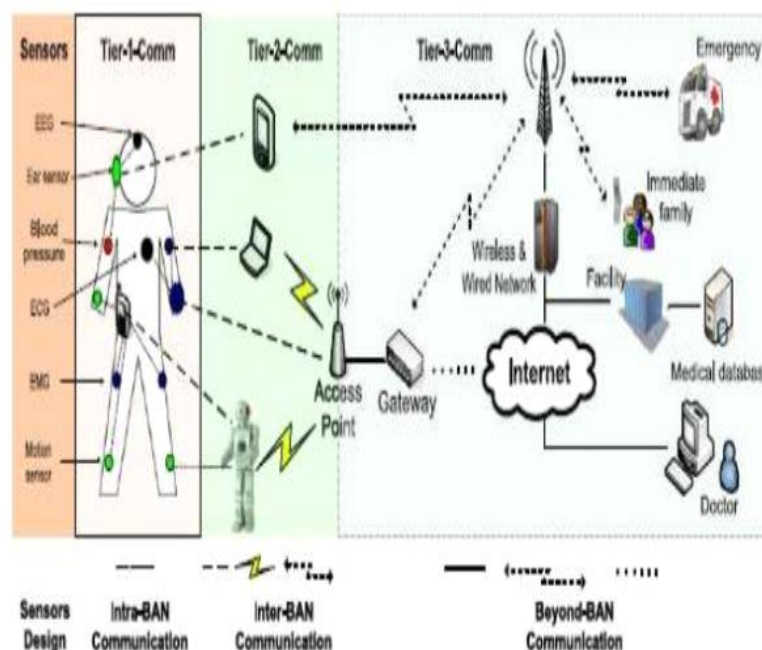


Figure 1. The architecture of the wireless body area network

2. Review Literature

WBANs include tissue damage, radiation absorption from antenna size, restricted power, reliable data transfer, and real-time data. Other relay nodes are notified when the hotspot relay node's temperature hits a predetermined threshold. The thermal-aware routing protocol seeks to minimize the average temperature increase caused by radiation absorption between implanted sensor nodes. [6].

Table 1: Reduce the node temperature

Methods to reduce the node temperature	protocol
High Power consumption by the receiver.	Zigbee protocol
Distance-based small between transmitter and receiver antennas.	IEEE 802.15.4
Bandwidth Limitations.	IEEE 802.15.3
Power consumption is higher in dynamic conditions.	IEEE 802.15.2
Receiver Complexity.	IEEE 802.15.1

2.1 Methods and Materials

Numerous nodes embedded in the human body that are capable of wireless connectivity link communication make up a wireless body area network. Furthermore, cellular networks and other wireless networks can be connected to the wireless body area network.

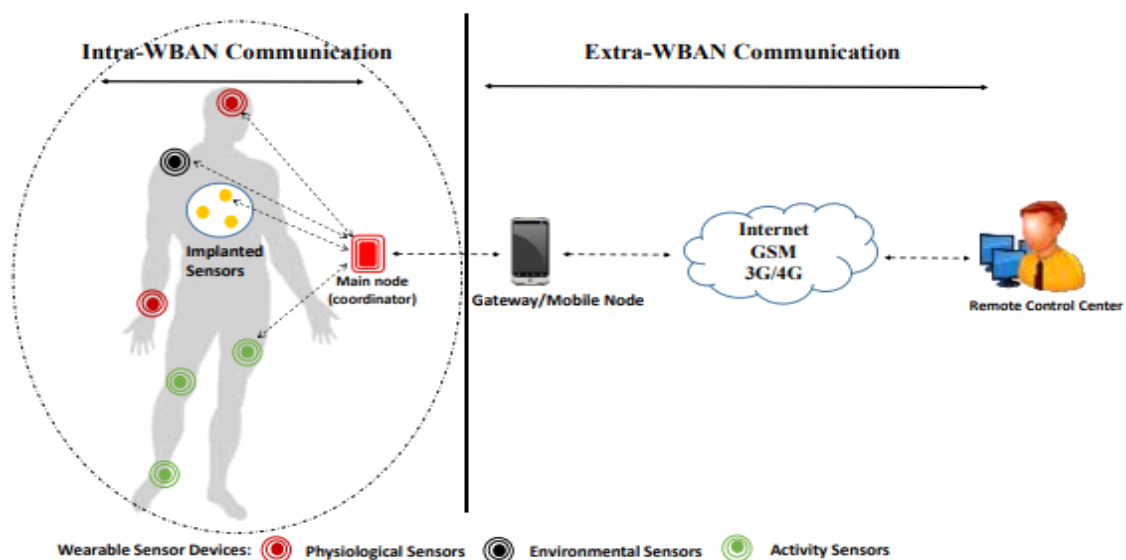


Figure 2. Intra-WBANs and Extra-WBANs Communication

Low-power sensor networks known as wireless body area networks (WBANs) offer the healthcare system a dependable and effective infrastructure that includes wearable, non-implanted, and implanted sensors.

Table 2: Characteristics of implanted/wearable sensors

Sensor Type	Sensor Node	Power Consumption	Quotes (Stringent Delay)	Privacy
Implanted (Medical Sensors)	Glucose Sensor	Extremely Low	Yes	High
	Pacemaker	Low	Yes	High
	Endoscope Capsule	Low	Yes	Medium
	ECG	Low	Yes	High

Sensor Type	Sensor Node	Power Consumption	Quotes (Stringent Delay)	Privacy
Wearable (Medical Sensors)	Spo2	Low	Yes	High
	Blood Pressure	High	Yes	Medium
Wearable (None Medical Sensors)	Music for Headsets	Relatively High	Yes	Low
	Forgotten Things Monitor	Low	No	Low
	Social Networking	Low	No	High

2.2 Proposed Work

Relay nodes use the total number of packets sent and received to calculate the temperature rise of the nodes that are close to them. It thinks that every package that a relay node sends causes its temperature to rise. For the optimal path, they included a composite routing measure made up of link-delay, residual energy, and temperature.

$$CF = \text{Trans}_{\text{time}} \times \text{Trans}_{\text{temp}} + \text{Rec}_{\text{time}} \times \text{Rec}_{\text{temp}} + \text{Idle}_{\text{time}} \times \text{Idle}_{\text{temp}}.$$

Where

CF – Cost function

$\text{Trans}_{\text{time}}$ - Transmit time

$\text{Trans}_{\text{temp}}$ - Transmit temperature

Rec_{time} - Receive time

Rec_{temp} - Receive temperature

$\text{Idle}_{\text{time}}$ - Idle time

$\text{Idle}_{\text{temp}}$ - Idle temperature

2.3 Route Discovery Phase (RDP)

During the RDP phase, a biomedical sensor node looks for a route entry in its routing table. It must satisfy energy and temperature criteria if there is a path to the sink node. Finally, each intermediate relay node and the reverse route add temperature and residual energy data to the route request packet.

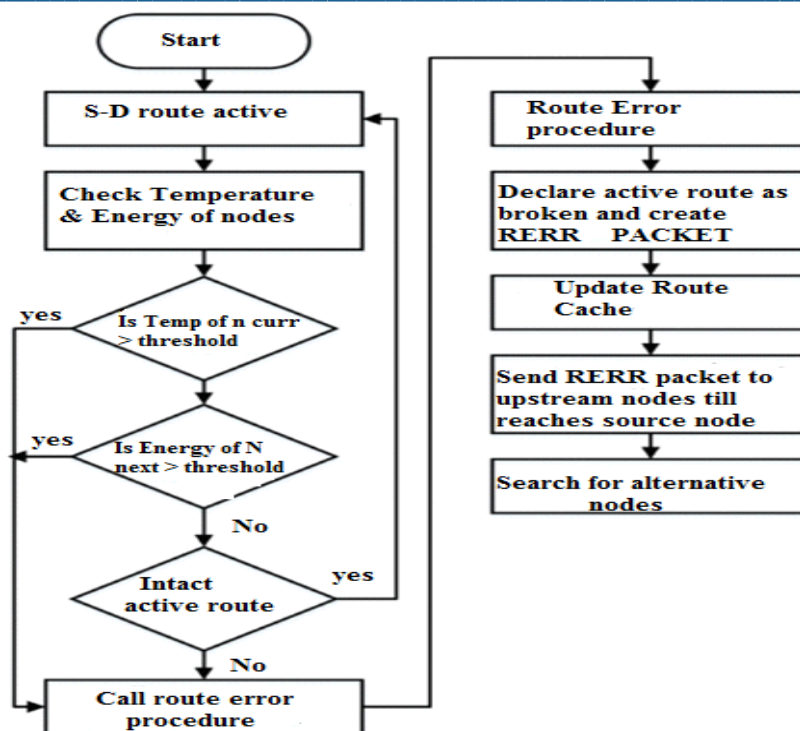


Figure 3. Route maintenance scheme for temperature.

2.4 Temperature Based Route Discovery Scheme for WBAN

Algorithm:

1: procedure RREP_PROC

2: Initialize RREP Packet

3: RREPTemp←∅, RREPEnergy←∅, RREPLDE←∅,

4: Unicast RREP packet to upstream nodes

5: Nodeprev←Nodecurr

6: Nodecurr←This Node

7: Evaluate Temperature of Nodes in Network Diameter at time t

8: $T_t(x,y) = (1 - \Delta t b_p C_p - 4 \Delta t K_p C_p \Delta 2) T_{t-1}(x,y) + \nabla t C_p S A R + \Delta t b_p C_p T_b + \Delta p C_p P_c + \Delta t K_p C_p \Delta 2 (T_{t-1}(x+1,y) + T_{t-1}(x,y+1) + T_{t-1}(x-1,y) + T_{t-1}(x,y-1))$

9: Where x, y are neighbouring nodes

10: if $T(x,y) \text{Node-}prev > T_{thresh}$ **then**

11: $T(x,y) \text{Node-}prev \leftarrow \text{Hotspot_Node}$

12: Suspend this node for the predetermined time

13: Discard RREPnode-prev

14: end if

15: if Nodecurr=Source Node **then**

16: Compute Route Cost from the Received RREP Packets

17: Route $Cost = w_1 \times RREPT(x, y) + w_2 \times RREP_{Energy} + w_3 \times RREPLDE$

18: if Route_Costcurr < Route_Costprev then

19: Update Route_Costcurr for the route in cache

20: end if

21: Update RREPT(x, y), RREP_{Energy}, RREPLDE

22: end procedure RREP_PROC

23: END

2.4.1 Temperature Aware Routing Protocol:

1. Adaptive Thermal-Aware Routing (ATAR):

procedure is suggested within the allotted period of time. There is nothing for a node to send. To conserve power, it switches to a standby state and declares itself an idle node. This protocol finds an alternative optimal path by using the multi-ring routing technique.

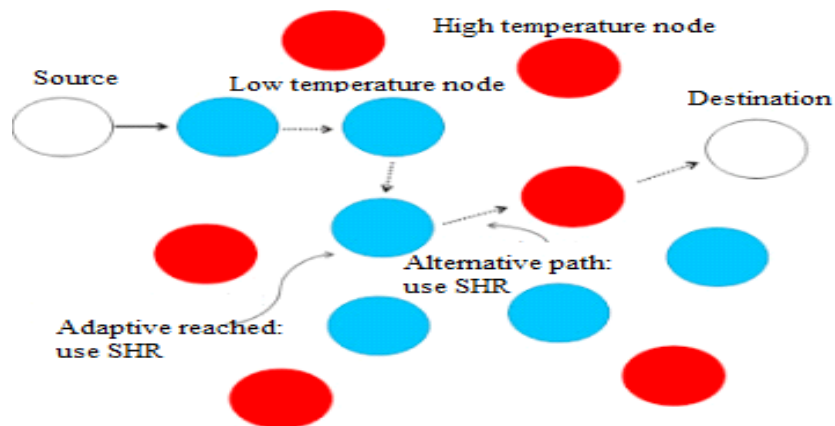


Figure 4. Adaptive Thermal-Aware Routing.

2. Adaptive Least Temperature Routing:

The adaptive version of LTR is called Adaptive Least Temperature Routing. A node examines the hop count value of each packet it accepts. Packages will be routed in the same LTR if the value exceeds the adaptive cost.

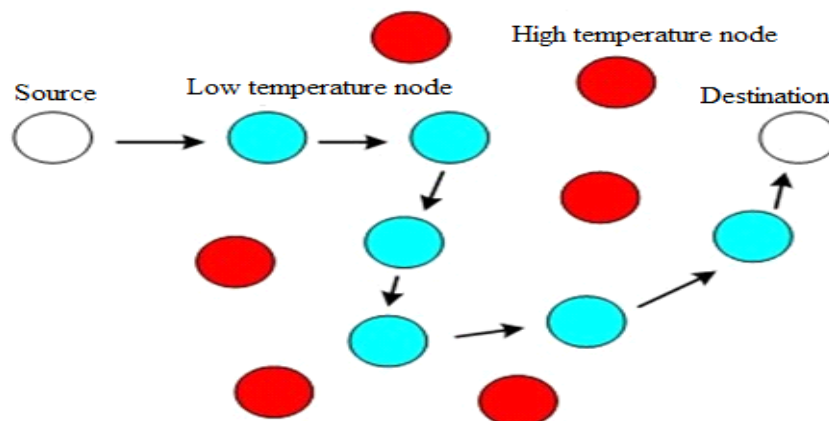


Figure 5. Adaptive Least Temperature Routing (ALTR)

3. Thermal-Aware Routing Algorithm:

Temperature as a routing protocol metric was initially introduced by the Thermal-Aware Routing Algorithm. Sensor function transmitter radiation and node circuit power dissipation are analysed to determine the temperature.

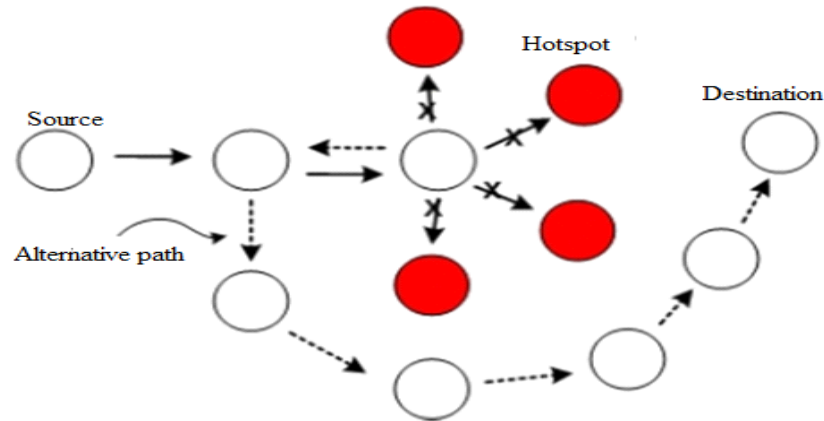


Figure 6. Thermal-Algorithm for Aware Routing.

2.5 Parameter setup

Wireless body area sensor network's main goal is to provide biofeedback data. It can provide continuous parameters such body/intra-body temperature, sensor device, control unit, and end time slot controls.

3. Result and Discussion

3.1 Packet delivery ratio:

Although the packet delivery ratio of the compared scheme decreases with increasing data rate, ATAR delivers packets at a higher rate than the withdrawn policy, which keeps packets in buffer most of the time unless the node's temperature drops or the buffered packet exceeds its time constraints. ALTR continues to work on finding the network's most interesting neighbours in order to route packets.

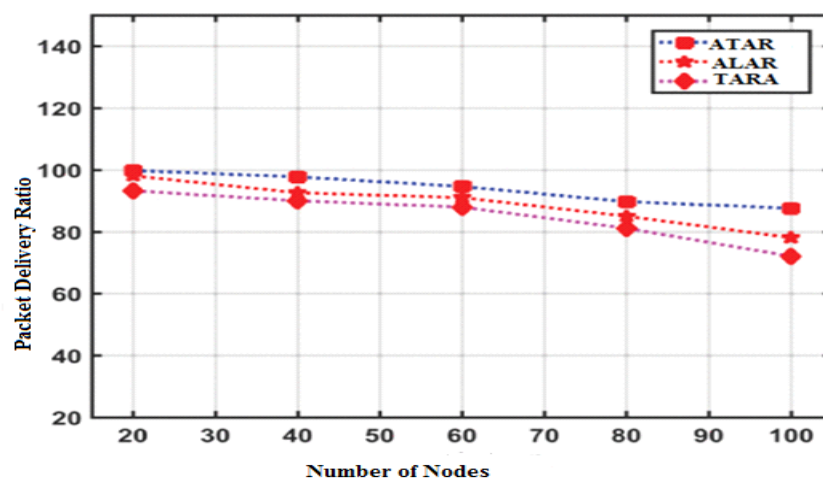


Figure 7. Packet delivery ratio.

3.2 Throughput Ratio:

The data rate increases, throughput is observed to increase as more data packets are transmitted to the network. However, when the data rate gets close to 100 Kbps, throughput starts to decline as network demand strains wireless links.

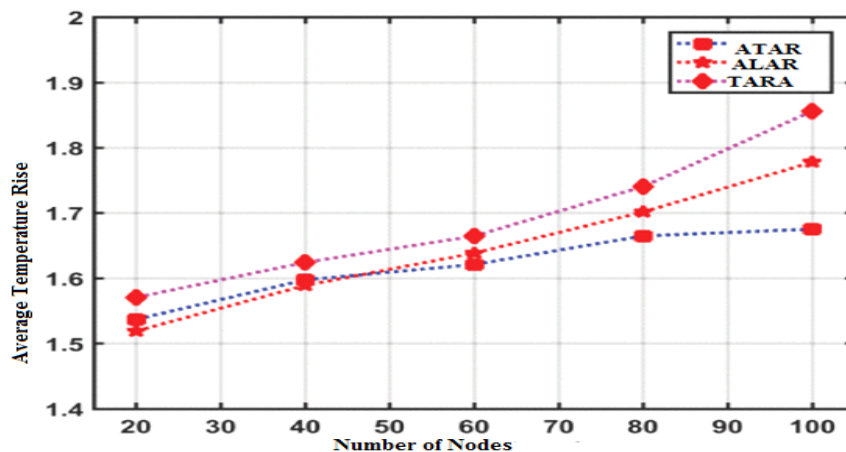


Figure 8. Throughput ratio.

3.3 Average End-to-end delay:

End-to-end latency is the average time it takes for each packet to reach the target node. end-to-end delays because a specific node's processing delay will increase as the number of possible paths decreases.

Received time - sent time = end-to-end delay.

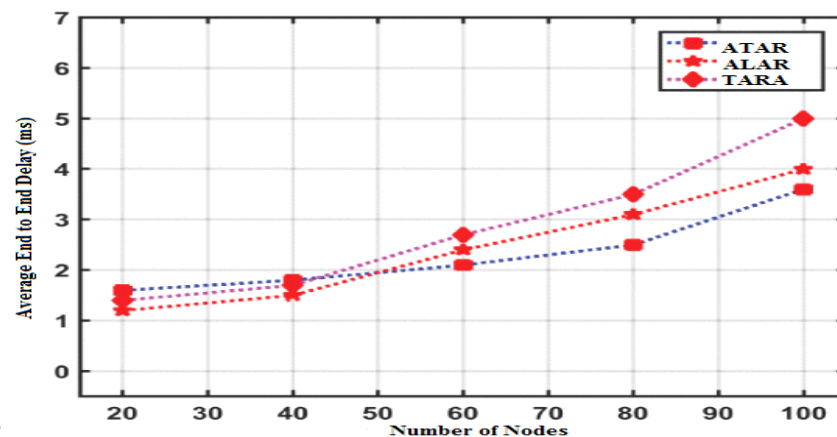


Figure 9. Average end to end delay.

4. Conclusion

This low-powered WBAN gadget tracks physiological factors including electrocardiograms and electromyograms and forecasts health data. This gadget might be implanted within the body or worn. That connects wirelessly to a base station, which is a monitoring station. Because there are fewer nodes in an urban setting, we can loosen routing protocol restrictions. The heat value and residual energy of the node are used to choose the data forwarder. Each cycle, a single node's temperature rise is estimated in order to locate a hot spot node.

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