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Traffic Control Thermal-Aware Routing in Body Area Networks

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Abstract

Due to increasing developments of medical science, early detection and receiving exact information in treatment of diseases and even preventing them are very important. Body Area Networks (BANs), a subset of Wireless Sensor Networks (WSNs), can deliver vital signs of patients to physician by collecting and analysis of patients' data and with applying different types of medical sensors. Since in-vivo sensors nodes transfer biomedical data to the neighboring nodes, produced temperature will be appeared from processing and communications in the human body. Routing protocols can have important role in balancing the temperature of sensors. In this paper, a thermal-aware routing protocol is proposed which uses two thresholds. The first threshold is used for preventing the increase of more temperature and the second threshold is used for decreasing sensor temperature. We evaluate the performance of the protocol using extensive simulations. The results of simulation show that the proposed protocol improves average temperature rise, packet delivery ratio and packet delay compared to the similar routing protocols.

Keywords: Body Area Network, Thermal-aware, Routing, Hop by Hop

1. Introduction

Body Area Networks (BANs) as special type of Wireless Sensor Networks (WSNs) are applied in different fields especially in medical science for supervision on the human body. Traditional health supervision system in addition to false issue of information involves the issue of cost increasing of healthcare (Latré et al., 2011; Chen et al., 2011). Small and smart sensor can connect to the human body as a result of the development of microelectronic and microelectromechanical systems. This device collects vital signs of patient and sends it to medical personnel such as pharmacists and nurses for more experiment and analysis.

Implanting biomedical sensors inside the human body causes damages on environmental tissues. Since the sensors inside the body transfers biomedical data to the neighboring node, produced heat of processing and communications inside the human body will be appeared. The operation on node produces heat and causes increasing the temperature in its surrounding. When the power consumption of node is very low or node practically does not send data, it may not produce considerable heat. But when node always sends and receives data in considerable time, produced heat with node could not be ignored (Oey and Moh, 2013).

One of the methods for dealing with this problem is thermal-aware routing. In the existing thermal-aware routing protocols in BANs, traffic is redirected to avoid hot spot areas in the network. Traffic redirection causes unbalanced traffic in the network, leading to more packet delay and more energy consumption of the nodes. Therefore, a thermal-aware routing protocol not only should decrease the temperature rise of the nodes, but also needs to balance traffic in the network.

Proposed protocol is a thermal-aware routing protocol that manages the temperature of sensors with traffic control through two stages. In the first stage, if the temperature of a sensor will be upper than the first threshold, the rate of traffic sending to that sensor will be controlled by previous nodes. In the second stage, if controlling traffic rate is not effective and the temperature of sensor will be beyond the second threshold, the traffic which sent to this sensor redirects and will be sent toward other sensors until this sensor will be cool. Node with the lowest hop counts to the sink is selected as next alternative node. If several nodes have the equal hop counts to the sink, node is selected with the least temperature. In normal conditions of network means the state in which the temperature of sensors are lower than the first threshold, the node of next hop of each node will be selected based on criteria of the number of hop and remaining energy and packets will be sent to them.