EM Interference-Aware Routing Algorithm for Wireless Sensor Networks in Clinical Environments

Gowdemy Rajalingham, Thanh-Ngon Tran, Quang-Dung Ho, and Tho Le-Ngoc

Broadband Communications Research Lab, Department of Electrical & Computer Engineering, McGill University

ABSTRACT

This work proposes an adaptive and distributed routing protocol that attempts to reduce electromagnetic interference (EMI) introduced by wireless medical sensor networks for clinical environments. The proposed algorithm, EMI-Aware Routing (EMIR), assigns to each node a dynamically calculated potential value which ensures that radio activities are spatially spread out thus reducing the probability that operations of medical devices are affected by interference. This algorithm is then used in an advanced wireless communications network and software platform that can be deployed in clinical environments. Patients’ vital signs and clinical environmental parameters are remotely monitored in real-time. Collected data is processed to identify emergency situations and trigger alerts. Additionally, a web portal is implemented to enable fast, accurate, and secure data access with networked devices.

BACKGROUND

Wireless Sensor Networks (WSN) in clinical environments have the advantage of providing access to a large number of patients’ vital signs in real-time at a reduced cost of infrastructure and maintenance. However, this technology is not without risks as it is sensitive to electromagnetic interference (EMI). Hospitals currently ban the use of wireless technology in critical areas to prevent interference with other devices or the gateway. An EM interference-aware routing algorithm is proposed to improve the quality of healthcare services.

RESULTS

The average duty cycle for each node is lower & more distributed in the SPR case, whereas in the EMIR case, all packets are sent, the EMI distribution would be more even even throughout the network.

EMI-AWARE ROUTING ALGORITHM

The potential of each node is based on two main parameters:
- Node’s current radiating EMI level calculated by Eq. 1 as a function of duty cycle
- Distance from gateway: h - Euclidean distance but hop count to gateway (GW/data sink)

Step 1: Periodic broadcast of hello messages

Step 2: Minimal node potential determines the next hop neighbor for data transmission

Step 3: At the gateway (data sink)


EXPERIMENTAL SETUP

Network Topology

Data Collection

Node Collected Information

Gateway Collected Information

CONCLUSIONS

LIMITATIONS

- Memory of the chip is limited so complex algorithms must be managed
- Speed of the serial port must be considered to minimize data loss at the server
- Multi-hop routing could interfere with the real-time nature of the data

FUTURE WORK

- Test with mobile nodes
- Incorporate with multiple medical devices of the same kind

REFERENCES