A Remote and Real-time Monitoring System for Smart Healthcare Applications

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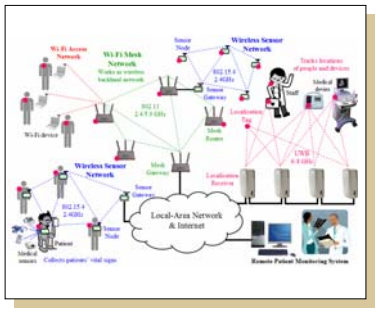
(hSITE: Healthcare Support through Information Technology Enhancements)

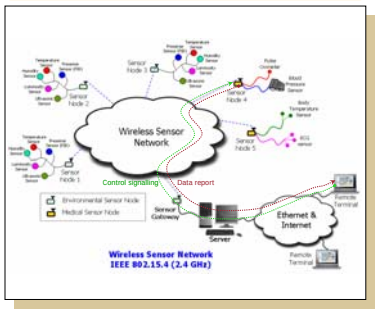
Abstract

This work designs and implements advanced wireless communications network and software platform that can be deployed in clinics, emergency rooms, hospitals, ... in order to reduce costs and to improve the quality of healthcare services. Patient's vital signs (including heart rate, oxygen saturation, blood pressure, ECG waveform, body temperature) and clinical environmental parameters (including temperature, humidity, light intensity) are remotely monitored in real-time by wireless sensor networks. Collected data is processed to identify emergency situations and trigger actionable responses. Additionally, a web portal is implemented to enable fast and accurate, and secured data access with networked devices

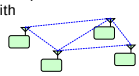
Overall Network Architecture



Medical Sensor Network

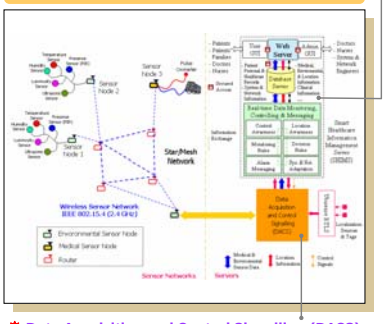


- Numerous routing protocols are implemented to offer multi-hop wireless connectivity with
  - self-healing capability
  - context awareness, and
  - QoS differentiation



- Implemented protocols: fixed table-driven routing, flooding, gossip routing, geographic routing,Electro-Magnetic-Interference-aware Routing (EMIR), Energy-Efficient Convergecast Routing (EECR), etc.
- Traffic routing adaption (in response to any change in the system) is enabled by a monitoring & controlling channel between network devices and servers
  - configuring parameters of a given routing protocol
  - switching between different routing protocols

Software Platform



- **Data Acquisition and Control Signalling (DACS)**
  - sensor drivers
    - data encoders/ decoders, and
    - network signalling protocols
- Ensure that the **sensed data** and **control signals** can be distributed **reliably** and **securely** between sensors and servers over integrated networks
- Capable of monitoring patients in **real-time** with a set of pre-defined **medical monitoring rules** and **decision rules** for a specific disease or patient
- In emergency cases, the server can automatically generate **alarm message**s with detailed medical situation descriptions and recommended **actionable responses** to related components and medical staff

- **Smart Healthcare Information Management Server (SHIMS)**

consists of real-time data monitoring, controlling, and messaging center, database server, web server, and user and administrator GUI's

- analyzes received data
- identifies different contexts
- recognizes emergent situations
- generates messages to inform patients/patients' family members, or warn medical staff, and
- generates control messages to adapt systems/networks

Wireless Sensor Devices

Graphical User Interfaces and Real-life Applications


Log-in with securities to ensure privacy


Medical staff's main page


System administration page


Patient medical information and alerts


Enviromental information and alerts


Defining medical information alert rules


Defining enviromental information alert rules

Remotely monitoring vital signs of patients in real-time (Pulse oximter, Blood pressure, ECG, and Body Temperature)