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Healthcare Monitoring System Using Wireless Sensor Networks

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Abstract
Health monitoring of patients is a common task in healthcare areas from nursing homes to hospitals. Medical staff needs to monitor patients closely and collects their monitoring body parameters. This proposal will help the medical staff to control the overall state of monitored patients in autonomous, real-time and remotely way. The application of healthcare wireless Sensor networks to these scenarios could perform this job. Through a network it is possible to reach each one of the patients' nodes anytime anywhere as long as a network terminal is accessible. Here the main idea is to propose a reliable continuous monitoring solution of hospitalized patients (in a hospital infirmary) based on a healthcare wireless sensor network (HWSN) with mobility support. The patients carry a batch of body sensors (according to their pathology needs) to collect their body parameters. Medical staff evaluates the overall state of each patient and analyzes the values gathered by these nodes.

Keywords
Healthcare Wireless Sensor Network, Mobility Support, Handover, e-Health.

I. Introduction

Wireless sensor network has become one of the prime topics of research in the very recent years where majority of the research work is concentrated on restricted user-groups, where various nodes oblige to communicate [1]. A wireless sensor network is a gathering of nodes structured into a accommodating network. Each node consists of processing ability (one or more microcontrollers, CPUs or DSP chips), may include several types of memory (program, data and flash memories), have a RF transceiver (usually with a single omni-directional antenna), have a supremacy source (e.g., batteries and solar cells), and lodge various sensors and actuators. The vital idea of sensor network is to disperse tiny sensing devices; which are proficient of sensing some changes of incidents/parameters and communicating with other devices, over a precise geographic area for some explicit purposes like intention, scrutiny, ecological monitoring etc. Healthcare wireless sensor networks (HWSNs) are a growing research subtopic of wireless sensor networks (WSNs)[2]. The application of WSNs infrastructures to health environments can help the automation of certain medical procedures. Small sensor nodes are placed on patients to collect physical health parameters.[3,4]. These nodes will have the capability to communicate wirelessly can send collected data through a wireless network to remote locations over the Internet [5]. In order to provide the internet connection to WSN nodes, nodes must have their own Internet Protocol (IP) address. A gateway is placed at the edge of a WSN and can act as an interface between the WSN and the Internet (using IPv4 and/or IPv6)[6].The Gateway allows a WSN to receive data from the Internet and sends data to IPv6 hosts through 6LoWPAN.

Here the proposed paper exhibit a reliable continuous monitoring solution of hospitalized patients (in a hospital infirmary) based on a healthcare wireless sensor network (HWSN) with mobility support. The patients carry a batch of body sensors (according to their pathology needs) to collect their body parameters.

Medical staff evaluates the overall state of each patient and analyzes the values gathered by these nodes. The access to these values is paramount to promote better healthcare. The use of wireless sensors (nodes) for patients monitoring promotes the paradigm of information access anytime and anywhere. In order to support the continuous connection to the nodes placed at the patients' body a HWSN is used. The paper also presents a literature survey in section 2. Section 3 describes the system design and architecture. Section 4 concludes the paper along with the further research and references.

II. Literature Survey

The use of WSNs with nodes mobility support in healthcare environments allows patients to be monitored continuously and remains always under medical control. These solutions provide continuous access to the patients' sensor nodes through a network infrastructure. This infrastructure provides remote access to the nodes. Therefore, the patients' state can be monitored from the place where a network terminal is available.

In[7], we address the problem of mobility management in WSNs by proposing a tree-based routing protocol able to support mobile sensor nodes. Distinctive features of the proposed routing solution are the provision of bi-directional uplink/downlink connectivity to mobile sensor nodes, the use of proactive procedures to speed up the association/reassociation phase, a reduced impact of the signaling overhead to manage node mobility by resorting to "local" handover management procedures. The routing protocol has been implemented on commercial hardware and thoroughly evaluated in terms of reactiveness and overhead through test bed experiments, as well as detailed simulations. The tree based routing protocol is based on a beacon scheduling registration process between routers and mobile nodes. The registration of a mobile node to a router remains active if the node receives, at a pre-defined interval, any beacon or data frames. If any of these frames does not arrive in the pre-defined time interval, then the node assumes that router is no longer accessible. At that time it starts to find another router to register. From the routers that response to the registration solicitation the node chose to register to the one with best link quality indicator (LQI). This approach does not guarantee a continuous communication to the mobile node once the handover procedure only starts when the nodes become inaccessible.

A WSN mobile solution over 6LoWPAN networks was presented in [8]. Here we propose a new mobility management protocol for 6LoWPAN which uses the technology of Proxy Agents and aims to enhance the handoff time by predicting or rapidly responding to

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a handover event. The proposed protocol lessens the involvement of the mobile node in mobility-related message exchange. In order to support a network-based solution an entity called 6LoWPAN proxy agent (PA)is introduced. The 6LoWPAN PA belongs to the Full Function devices category. The use of 6LoWPAN proxy entities is supportive in mobility scenarios in order to reduce the number of signaling between the MN and the Home Agent. The idea is to force the 6LoWPAN PA to be responsible for MNs mobility signaling and operation with the HA and just inform the MN, whenever necessary, to handoff to a new serving proxy (within or outside the same PAN). Any other data that is sent to, or received from, the mobile node is routed using multi-hop communication via the other nodes of the PAN. When the MN is switched on for the first time it has to establish connectivity by receiving beacons and associate with a specific channel. After that, it should run the Neighbor Discovery (ND) procedure to retrieve information from the network like the network prefix. Finally, the Duplicate Address Detection (DAD) procedure should be run to ensure that the global address obtained by the MN is unique.

Wireless sensor network (WSN) technologies are considered one of the key research areas in computer science and the healthcare application industries for improving the quality of life. Paper[9] provides a snapshot of current developments and future direction of research on wearable and implantable body area network systems for continuous monitoring of patients. In this paper, medical sensors were used to collect physiological data from patients and transmit it to Intelligent Personal digital Assistant (IPDA). This paper explains the important role of body sensor networks in medicine to minimize the need for caregivers and help the chronically ill and elderly people live an independent life, besides providing people with quality care. Although offering significant benefits, the field of wearable and implantable body sensor networks still faces major challenges.

In[10], we present an idea of 6LoWPAN that opens a great opportunity for wireless sensor networks (WSNs) to be operated from the Internet. But, 6LoWPAN requires a gateway in order to make the use of IPv6 feasible inside the WSN. In this approach, a gateway is designed and constructed to interconnect 6LoWPAN wireless sensor networks with IPv6 clients, enabling them to receive sensor nodes readings or send commands to the 6LoWPAN WSN at anytime through direct communication with the sensor nodes.

In[11] we present Body Area Sensor that enable healthcare monitoring in an unobtrusive way. The main idea is to present a solution for intra-body temperature monitoring based on a new intra-body sensor, communication and desktop application tool. This new biosensor provides data collection that may be used to study the relation between temperature variations and women health conditions, such as, ovulation period (for both natural contraception and in vitro fertilization purposes) among others.

III. Sysyem Architecture

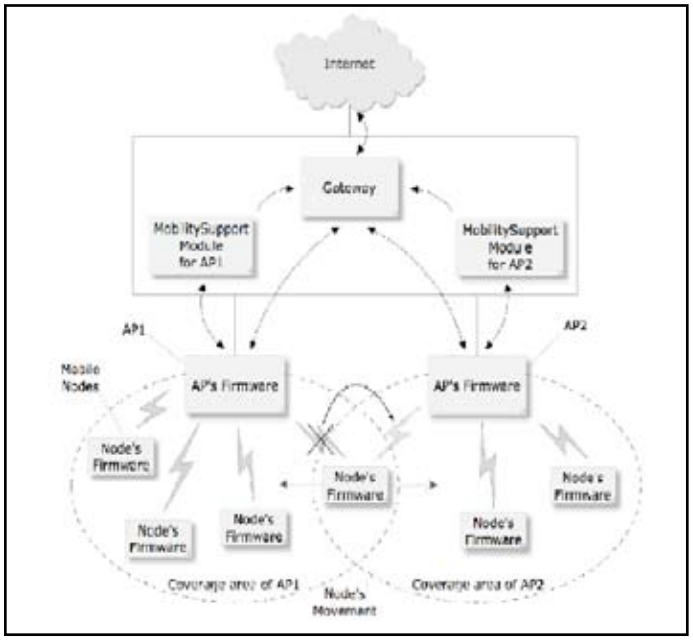

Fig 1: System design and Architecture

The Figure 1 shows the system design and architecture of the proposed system which comprises the following four parts: WSN gateway, mobility support module (MSM), APs' firmware, and nodes' firmware.

This solution offers end-to-end connectivity with sensors in the HWSN. Each AP device in the scenario executes APs' firmware as well as each mobile node device also runs nodes' firmware. The gateway performs the interface between the Internet and the HWSN. The access to the nodes is performed through several APs available in the scenario. The APs' firmware only forwards messages form/to the gateway to/from the nodes available in their coverage area. Each AP has a correspondent MSM responsible for the mobility support in this AP coverage area.

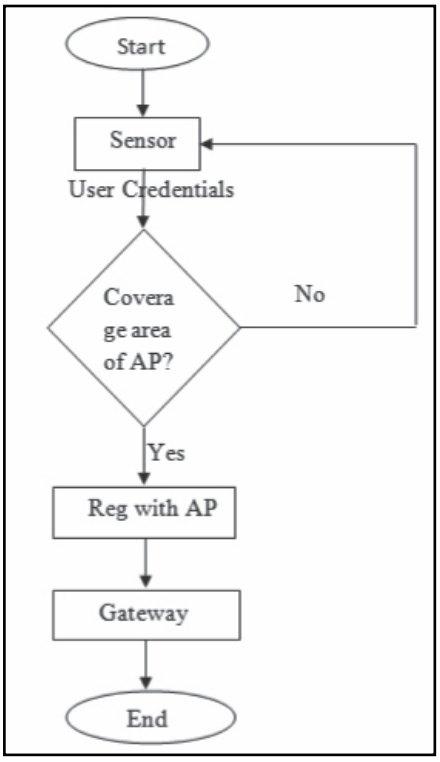

Fig.2: Flowchart showing the flow of events in the system

The MSMs allow the nodes to move freely between APs' covered areas always ensuring their accessibility. Therefore, due to the nodes movement, if one moves out of an AP's coverage area it has to find a new AP to register and consequently unregister to the old one. The fig 2 also shows the flow of operation between all the modules.

IV. Implementation

Our proposed system is implemented as four modules they are sensor nodes, Access Point, Mobility support module and Gateway.

A. Sensor Node

A sensor node is a node in a wireless sensor network that is capable of performing some processing, gathering sensory information and communicating with other connected nodes in the network. A wireless sensor network (WSN) of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure etc. and to cooperatively pass their data through the network to a main location. Here the sensor node will do the registration with the access point. After successful registration the sensor will start sending the data. The sensor can change the location by moving from one access point to another access point and sensor node will get registered with new access point and start sending data to access point.

B. Access Point

An access point (AP) is a device that allows wireless devices to connect to a wired network using Wi-Fi, or related standards. The AP usually connects to a router (via a wired network) as a standalone device, but it can also be an integral component of the router itself. With the creation of the wireless Access Point (AP), network users are now able to add devices that access the network with few or no cables. An AP normally connects directly to a wired Ethernet connection and the AP then provides wireless connections using radio frequency links for other devices to utilize that wired connection. Most APs support the connection of multiple wireless devices to one wired connection. Modern APs are built to support a standard for sending and receiving data using, these radio frequencies.

An access point gets registered with the gateway, find the neighbor details and authenticate with neighbor. After that an access point will read registration request from sensor and it will find out new sensors in its coverage area. If any of the nodes were present in the coverage area those nodes will also get registered with the access point. If the sensor does not belong to this coverage area, the sensor node will get registered with the new access point and it will collect data and send it the access point.

C. Mobility Support Module

The MSM stores all the nodes that have active registrations with this AP and even the nodes that previously have been registered. The MSM periodically (in these trails 1 second was used) sends registration messages (unicast) to each node that has been registered with this AP once. If one of these nodes could be reached, the node compares the LQI of the received message with the LQI of the last message exchange with the current registration AP. If it is greater, then the node ends the registration with the current AP by sending a break message and acknowledges the new AP to confirm the new registration. This MSM will work in access point.

D. Gateway

An IP Gateway is a node that allows communication between networks. An IP Gateway, sometimes known as a router can be as simple as a computer that controls the data flow between two networks or the modem that connects your home computer to the Internet. An IP Gateway is needed to provide the communications between your computer and the World Wide Web. Here the gateway will read request from access point. If the access point is registered successfully the access point collects neighbor details and forwards it to the gateway.

V. Conclusion

The random movement of nodes in WSN is very difficult for identification. Here the proposed solution supports nodes' mobility without any restrictions in communication. Here we presented a reliable solution to support nodes mobility in a controlled scenario such as a hospital infirmary. The solution proposes a new approach for an intra-handover mechanism that minimizes the messages exchange between nodes and their network attached points (APs). It guarantees continuous communication to the mobile nodes even if they move around different WSN APs coverage areas.

The future direction will be towards implementing the proposed model and comparing the proposed model with existing models in terms of efficiencies, performance evaluation study through simulation, the analysis of this proposal, and results comparing to other approaches should be performed.

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