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Wireless Sensor Networks for Healthcare

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Abstract An important component of ubiquitous healthcare is wireless sensor network (WSN). WSNs are an emerging technology that is poised to transform healthcare. The WSNs promise to make life more comfortable by significantly improving and expanding the quality of care across a wide variety of settings and segments of the population. This paper provides a brief introduction on applications of wireless sensor networks in healthcare.

Keywords wireless sensor networks, healthcare, ubiquitous healthcare sensor networks

Introduction

Recent advances in electronics and wireless networks have led the way for the emergency and proliferation of wireless sensor networks (WSNs). WSNs have become essential in many domains including industrial automation, infrastructure, healthcare, agriculture, environment, and military command.

The healthcare industry faces a number of challenges: skyrocketing costs, growing incidence of medical errors, inadequate staffing, aging population, etc. Healthcare practitioner are under pressure to provide better services in spite of the challenges and embrace modern technological advances. Ubiquitous healthcare can reduce long-term costs and improve quality of service [1]. Wireless sensor networks provide efficient solutions to the ubiquitous healthcare system.

WSNs for healthcare have emerged in recent years due to advances in medical sensors and low-power network systems. The wireless senor network is emerging as a significant component of the next generation healthcare system. They are essentially multi-hop Zigbee-based system that use broadcast or multicast to deliver vital information. The key feature of such system is fast and reliable delivery of messages [2].

Basics of WSN

The use of wireless technology has increased rapidly due to its convenience and cost effectiveness. A wireless sensor network (WSN) usually consists of a large number (hundreds or thousands) of sensor nodes deployed over a geographical region. Typically, sensors are deployed in a high-density manner and in large quantities. The wireless sensor nodes are compact, light-weighted, and battery-powered devices that can be used in virtually any environment. The sensor nodes monitor physical or environmental conditions such as temperature/heat, humidity, sound, vibration, pressure, light, object motion, pollutants, presence of certain objects, noise level or characteristics of an object such as weight, size, speed, direction, and its latest position. As shown in Figure 1, each sensor node is made up of four components: a power unit, a transceiver unit, a sensing unit, and a processing unit [3]. The node may also have some application-dependent components such as power generator, location finding system, and mobilizer. Communication among the nodes is done in a wireless fashion, and thus, the name *wireless sensor networks*.

WSNs belong to the general family of sensor networks that employ distributed sensors to collect information on entities of interest. In general, there may be both sensing and non-sensing nodes in a WSN; i.e. all sensors are nodes but not all nodes are sensors. A sensor has four operating modes: transmission, reception, idle listening, and sleep. Collision occurs when there are two or more nodes transmitting at the same time.

WSNs typically operate at 900 MHz (868- and 915-MHz bands). A sensor node is designed to use an operating system (OS). TinyOS (developed at UC Berkeley) is perhaps the first operating system specifically designed for WSNs. It is a general-purpose OS. Both the TinyOS and programs written for it are written in a special programming language called NesC, which is essentially an extension of C programming language [4].

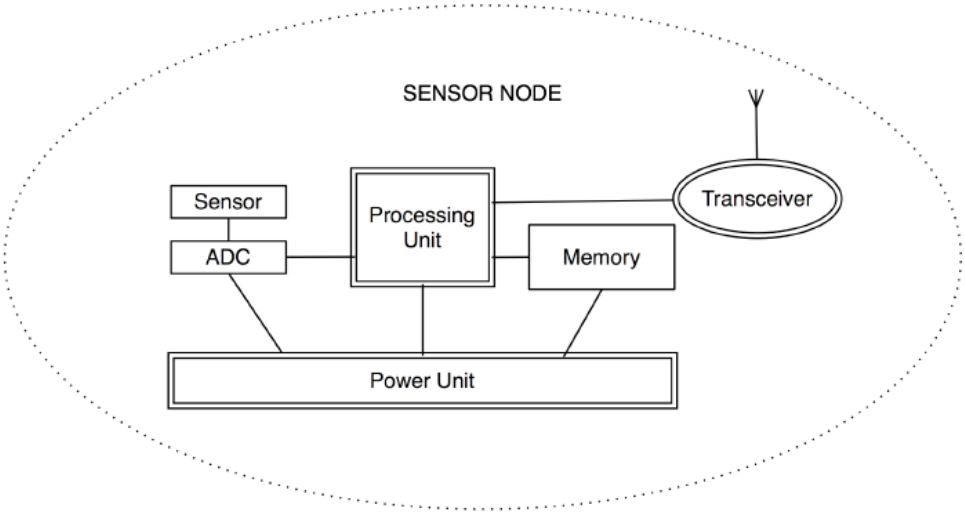

Figure 1: Components of a sensor node in a wireless sensor network [3]

Applications

Wireless sensor networks find applications in many areas such as industrial automation, automotive industry, precision agriculture, and medical monitoring. They can effectively be used in healthcare for health monitoring, smart nursing homes, in-home assistance, telemedicine, and wireless body area networks.

- *Health Monitoring*: WSNs can be used to monitor a patient in the clinical setting or at home regardless of the patient's or a caregiver's location. Monitoring system is often necessary to constantly monitor a patient's vital parameters such as blood pressure, heart rate, body temperature, and ECG. Sensors and location tags can be used to track both healthcare personnel and patient. Since prevention is better than cure, managing wellness rather than illness is paramount. To achieve this, individual health monitoring is needed at a periodic interval. Due to the fact that the system is wireless, it is flexible and it is not required that the patient be limited to his bed [5]
- *Wireless Body Area Networks*: They cover real-time healthcare information gathering obtained from different sensors. Important features of these networks include wireless communication protocols, frequency bands, data bandwidth, encryption, power consumption, and mobility. A typical wireless body area network is shown in Figure 2 [6]. The design of wearable sensors enables user to continuously monitor physiological data aided by WSNs in healthcare. A body area network continues health monitoring during the patient's stay at the hospital or home. It can be useful for emergency cases, where it sends data about the patient's health to the healthcare provider. It can also help people by providing healthcare services such as memory enhancement, medical data access, cancer detection, asthma detection, and monitoring blood glucose [7].
- *At-home Healthcare*: This addresses the social burden of the aging population. It is achieved by using medical WSNs. Longevity has given rise to age-related disabilities and diseases. Providing quality healthcare to elderly population has become an important social and economic issue. At-home healthcare provides affordable care to the elderly while they live independently [8].
- *Telemedicine*: Telemedicine (also known as tele-care) is a medical approach that allows clinical work to be performed using information and communication technology. Telemedicine using WSN has recently become a trend in healthcare. It refers to the provision of healthcare services and education over a distance using information and communication technologies. It allows for remote medical evaluations. The use of telemedicine reduces the overall cost of healthcare.

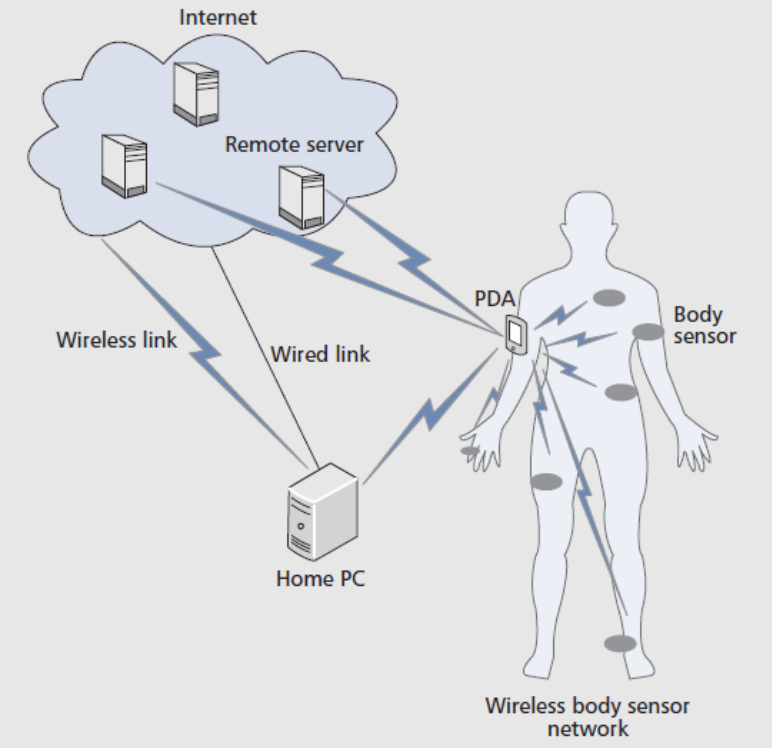

Figure 2: Wireless body sensor network [6]

Benefits

WSN in healthcare has the following benefits [9]:

Flexibility: The system collects and communicates data wirelessly with minimal input from the patient. It is not required that the patient be limited to his bed.

Always-on: The physiological and environment data can be monitored continuously allowing for real-time response by caregivers. The WSNs allow patients to be monitored and remain always under medical control.

Self-organization: Physicians can change the mission of the network as medical needs change.

Low-cost: Using WSNs in healthcare provides a low-cost communication infrastructure that is suitable for monitoring.

Challenges

Although healthcare applications of WSN have significant benefits, they faces some challenges such as low power, limited computation, low bandwidth, reliable data transmission, continuous operation, interference, node mobility support, vulnerability, security, timely delivery of data, security, privacy, congestion, and regulatory restraints. WSN devices are generally limited in terms of power, computation, and communication. The low amount of power directly limits computation. WSNs are vulnerable to various sensor faults and this vulnerability hinders efficient and timely response in healthcare applications. Security is an important issue for any system, especially in healthcare WSNs, where we are dealing with sensitive medical data of individuals. Security breach in healthcare applications of WSNs is a major concern [10]. Privacy is another major concern of patients and the greatest barrier to electronic healthcare deployment. Healthcare applications impose constraint on end-to-end reliability, which measures how well they system performs in the presence of disturbances. Congestion must be curbed since it affects flow of data and delay in data delivery. The integration of multiple sensing devices operating at different frequencies cause interoperable problem.

Conclusion

Wireless sensor networks have gained a considerable attention in healthcare industry with a wide range of capabilities. Application of wireless sensor networks in healthcare consists of wearable and implantable sensor

nodes than can sense biological information and wirelessly transmit it over a short distance. The first generation of wireless sensor networks for healthcare has indicated its potential to alter the practice of medicine [11]. Researchers in computer networking and medical fields are collaborating to make broad vision of smart healthcare realizable [12].

References

[1]. H. P. Kew and D. U. Jeong, "Wearabke patch-type ECG using ubiquitous wireless sensor network for healthcare monitoring application," *Proceedings of the 2nd International Conference on Interaction Sciences: Information Technology, Culture and Human*, Seoul, Korea, 24-26 November 2009

[2]. S. Khianjoom and W. Usaha, "Anycast Q-routing in wireless sensor networks for healthcare monitoring," *Proceedings of the 11th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology*, May 2014.

[3]. P. Neves, M. Stachyra, and J. Rodriques, "Application of wireless sensor networks to healthcare promotion," *Journal of Communications Software and Systems*, vol. 4, no. 3, September 2008, pp. 181-190.

[4]. M. N. O. Sadiku, S. M. Musa, and O. D. Momoh, "Wireless sensor networks: opportunities and challenges," *Journal of Engineering Research and Applications*, vol. 4, no. 1, Jan. 2014, pp. 41-43.

[5]. M. Aminian and H. R. Naji, "A hospital healthcare monitoring system using wireless sensor networks," *Journal of Health & Medical Informatics*, vol. 4, no. 2, 2013.

[6]. J. Sun, Y. Fang, and X. Zhu, "Privacy and emergency response in e-healthcare leveraging wireless body sensor networks," *IEEE Wireless communications,* February 2010, pp. 66-73.

[7]. M. Anwar et al., "Wireless body area networks for healthcare applications: An overview," *Telkomnika*, vol. 15, no. 3, September 2017, pp. 1088-1095.

[8]. A. Minaie et al., "Application of wireless sensor networks in health care system," *Proceedings of the 120th ASEE Annual Conference & Exposition*, Atlanta, June 2013, pp.

[9]. G. Virone et al., "An advanced wireless sensor network for health monitoring," https://pdfs.semanticscholar.org/3706/f2446de9ac8a466efdbdd8e0fd1f358631a5.pdf

[10]. M. A. Ameen, J. Liu, and K. Kwak, "Security and privacy issues in wireless sensor networks for healthcare applications," *Journal of Medical Systems*, vol. 36, no. 1, February 2012, pp. 93-101.

[11]. J. Ko et al., "Wireless sensor networks for healthcare," *Proceedings of the IEEE*, vol. 98, no. 11, November 2010, pp. 1947-1960.

[12]. H. Alemdar and C. Ersoy, "Wireless sensor networks for healthcare: A survey," *Computer Networks*, vol. 54, 2010, pp. 2688-2710.

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