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Healthcare Monitoring Systems: A WBAN Approach for Patient Monitoring

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ABSTRACT*:* Healthcare Monitoring System, which is expected to reduce healthcare expenses by enabling the continuous monitoring of patient health remotely during their daily activities in healthcare environment. Healthcare applications based on Wireless Sensor Networks are gaining high popularity in all over the world due to their features like flexibility, mobility and ease of constant monitoring of the patient in both outside and inside the body sensed as more useful. The main focus of such system is remote monitoring of patient, inside and outside the hospital room and in ICU in the sense of implantable feature for analysing the patient data. Recent developments in combining sensors, communication systems, and other fields such as cloud computing and Big Data analysis have provided the perfect tools to develop cutting edge systems for improving energy efficiency and consumption with the datasets. Smart homes, smart sensors, and Internet of Things are just a few examples of these application based technologies that will lead to more sustainable and more resilient energy systems. This research work will focus on the Wireless Sensor Networks in terms of emerging wireless technologies which means supporting infrastructure and technology and challenge design issues and as well as security, mobility and energy consumption.

KEYWORDS*: Healthcare Monitoring System, Wireless Sensor Network, Wearable Body Area Network, Security and Energy consumption.*

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I. INTRODUCTION

One of the challenging processes in wireless sensor network is to distribute the data to several nodes. From this sensing the data, allocation of task, scheduling the task are the important consideration in wireless sensor networks. Operating systems and middleware architectures for WSNs implement a several services for distribution of data. Using Wireless Sensor Networks (WSNs) in health care system has yielded a tremendous effort in recent years. However, in most of these researches, tasks like sensor data processing, health state decisions making and emergency messages sending are completed by a remote server. Transmitting and handing with a large scale of data from body sensors consume a lot of communication resource, bring a burden to the remote server and delay the decision time and notification time. Wireless body area network is used to capture the patient's sensitive data so need to secure them in a proper way from unauthorized access. This paper concerns of major social implications like privacy and security. It mainly focuses on the causes and effects of these two issues. Basically, Wireless Sensor Network (WSN) is a wireless network consisting of spatially distributed autonomous devices that use sensors to monitor physical or environmental conditions. These autonomous devices, or nodes, combine with routers and a gateway to create a typical WSN system. Sensor networks are the key to gathering the information needed by smart environments, whether in buildings, utilities, industrial, home, shipboard, transportation systems automation, or elsewhere. Recent terrorist and guerrilla warfare countermeasures require distributed networks of sensors that can be deployed and have self-organizing capabilities. In such applications, running wires or cabling is usually impractical. A sensor network is required that is fast and easy to install and maintain. The smart gateway is designed to enable WSN and public communication networks to access each other with seamless internetworking.

Recent advances in wireless networks and electronics have led to the emergence of Wireless Sensor networks. It has been considered as one of the most important technologies that can change the future into perfect. These networks consist of small battery–powered motes with limited computation and radio communication capabilities. Each sensor in a sensor network consists of three subsystems: The sensor subsystem which senses the environment, the processing subsystem which performs local computations on the sensed data, and the communication subsystem which is responsible for message exchanges with neighbouring sensors. Advances in wireless sensor networking have opened up new opportunities in healthcare systems. Sensor-based technology has invaded medical devices to replace thousands of wires connected to these devices found in hospitals. This technology has the

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capability of providing reliability in addition to enhanced mobility. In future, we will see the integration of an enormous array of wireless networks into existing specialized medical technology. This paper will investigate the application of current state-of-the-art of wireless sensor networks in health care systems and will address how these concepts are integrated in our computer engineering program.

The paper is organized into five sections as follows: Section 2 discuss about the related works carried out in the field of Healthcare Monitoring System. Section 3 discusses about the modules to be proposed for Wearable Body Area Networks. Section 4 highlights discussion on the experiments to be done by Wireless Sensor Networks based on WBAN. Section 5 finally concludes the paper with future enhancement.

II. RELATED WORK

Uttara Gogate, Jagdish W. Bakal presented a cost and energy efficient 3 tier model for healthcare based on WSN to remove limitations of wired system and to use wireless technology efficiently. Their system continuously monitor the patient's body parameters like temperature and pulse rate and after detecting abnormal readings of any of the parameter, generating sms or email alert to the physician, duty nurse and close relative of the patient for emergency handling. Different available wireless standards are compared for the intermediate communication among the three tiers of the system based on various parameters. After comparing with the existing wireless technologies, they aimed to incorporate the recently developed ZigBee standard (IEEE 802.15.4) in their sensor network design using Arduino boards for tier 1 communication and WiFi existing in the hospital for tier2 communications. Finally tire 3 includes internet facility to transmits the patient's data to doctors, observers, dean or outside the hospital via Internet for expert advice and diagnose. Collected data is used for current monitoring system for hospital staff and also for long term data storage on Hospital's Centralized Server.

Kahtan Aziz et al focus on monitoring the patient's blood pressure, and his body temperature through GSM and GPS technologies. In their analysis death rates due to hypertensive heart disease shows that the blood pressure was a crucial risk factor for atherosclerosis and ischemic heart diseases. Their system will track, trace, monitor patients and facilitate taking care of their health; so efficient medical services could be provided at appropriate time. By using specific sensors, the data will be captured and compared with a configurable threshold via microcontroller which is defined by a specialized doctor who follows the patient; in any case of emergency a short message service (SMS) will be sent to the Doctor's mobile number along with the measured values through GSM module. Furthermore, the GPS provides the position information of the monitored person who is under surveillance all the time.

Hoda Ramin Hossein, S.S.Shaikh outline a model that uses Near Field Technology to address the patient information, an android application that will monitor the health parameters of the patients and a doctor application that will be able to view the patients data with the help of NFC tags and take actions accordingly. Their model will use a web server for storing the entire sensitive data of patients. Unlike Servlets that allows only clients of Java technology to be interfaced, their web server architecture will allow clients of various different technologies to be interfaced. Their system has overcome the disadvantages of using RFID system by using NFC tags. The servlets architecture has been replaced by the web service architecture which opens a space for other technologies to be implemented rather than being only java. Also the patient's status is automatically generated and stored in the cloud server and also alerts are generated if the patient is in a serious condition or unconscious state. Currently it is possible to conclude that for providing a better solution to the field of m-healthcare in many hospitals, NFC promises appear to be credible.

De-Thu Huynh, Min Chen proposed an energy efficiency solution for WBAN based on ZigBee applying Healthcare Monitoring System. Particularly, they utilized the ZigBee standard working in beacon enable mode to obtain the adaptive duty cycle. Consequently, the energy consumption in idle-mode is avoided, as well as the total energy consumption of sensors is also decreased and extended network lifetime. The simulation results conducted by OPNET Modeler show that their method can save efficient energy consumption of WBAN while the QoS is ensured in terms of network performances in long-term Healthcare Monitoring System. Finally they have proposed an energy efficiency solution for WBAN based on ZigBee applying Healthcare Monitoring System. In particular, it utilised the ZigBee standard working in beacon-enable mode to obtain the adaptive duty cycle by exploiting the BeaOrder (BO) and SupFraOrder (SO). Therefore, overall energy consumed in sleep-mode is avoided, as well as the overall energy consumed by sensors is decreased and extended network lifetime. It has been shown via simulation that their solution can save efficient energy consumption of ZigBee based WBAN while the QoS is ensured in long-term Healthcare Monitoring System.

Audace Manirabona, Saadi Boudjit, Lamia Chaari Fourati proposed a scheduling strategy at the coordinator of a WBAN based Health Monitoring System called Priority-Weighted Round Robin. Their proposed scheduling strategy provides good results in terms of reducing delay of emergency and medical data. Simulation and analytical results for peer-networks involved in a WBAN based HMS

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show that, if PWRR is set, the behavior of WIFI, WIMAX and LTE networks remains the same in keeping all flows as per their priorities by mitigating the end-to-end delay. Moreover, it was shown that the increase of the arrival rate of emergency flows increases the delay of these latter too whereas the emergency flows have low arrival rate though in reality. It was also noticed that all data flows have lower delay in PWRR than in FIFO except the nMD flow whose delay increases if its arrival rate exceeds 0.45, hence the importance of considering the transmission rate of all involved flows. Ultimately, the WBAN based Health Monitoring System should implement a scheduling mechanism at the coordinator and the PWRR seems to be the better candidate.

Aleksandar et al demonstrates the use of WWBANs as a key infrastructure enabling unobtrusive, continual, ambulatory health monitoring. This new technology has potential to offer a wide range of benefits to patients, medical personnel, and society through continuous monitoring in the ambulatory setting, early detection of abnormal conditions, supervised rehabilitation, and potential knowledge discovery through data mining of all gathered information. We have described a general WWBAN architecture, important implementation issues, and our prototype WWBAN based on off-the-shelf wireless sensor platforms and custom-designed ECG and motion sensors. We have addressed several key technical issues such as sensor node hardware architecture, software architecture, network time synchronization, and energy conservation. Further efforts are necessary to improve QoS of wireless communication, reliability of sensor nodes, security, and standardization of interfaces and interoperability. In addition, further studies of different medical conditions in clinical and ambulatory settings are necessary to determine specific limitations and possible new applications of this technology.

III. METHODOLOGY

Wearable health monitoring systems allows an individual to closely monitor changes in her or his vital signs and provide feedback to help maintain an optimal health status which is based on data. If integrated into a tele-medical system, these systems can even alert medical staff when life-threatening changes occur inside or outside the body. In addition, patients can benefit from continuous long-term monitoring as a part of a diagnostic procedure, can achieve optimal maintenance of a chronic condition, or can be supervised during recovery from an acute event or surgical procedure because of continuous listening. Long-term health monitoring system can capture the diurnal and circadian variations in physiological signals. These variations are a very good recovery indicator in cardiac patients after myocardial infarction method. In addition, long-term monitoring can confirm adherence to treatment guidelines (e.g., regular cardiovascular exercise) or help monitor effects of drug therapy for particular patients. Other patients can also benefit from these systems; for example, the monitors can be used during physical analysis after hip or knee surgeries, stroke analysis, or brain trauma analysis in order to recover fully by using monitoring systems with the help of datasets.

Recent technology advances in integration and miniaturization of physical sensors, embedded microcontrollers, and radio interfaces on a single chip; wireless networking; and micro-fabrication have enabled a new generation of wireless sensor networks suitable for many applications. For example, they can be used for habitat monitoring, machine health monitoring and guidance, traffic pattern monitoring and navigation, plant monitoring in agriculture, and infrastructure monitoring. One of the most exciting application domains is health monitoring. A number of physiological sensors that monitor vital signs, environmental sensors (temperature, humidity, and light), and a location sensor can all be integrated into a Wearable Wireless Body/Personal Area Network (WWBAN). The WWBAN consisting of inexpensive, lightweight, and miniature sensors can allow long-term, unobtrusive, ambulatory health monitoring with instantaneous feedback to the user about the current health status and real-time or near real-time updates of the user's medical records. Such a system can be used for computer-supervised rehabilitation for various conditions, and even early detection of medical conditions. For example, intelligent heart monitors can warn users about impeding medical conditions or provide information for a specialized service in the case of catastrophic events. Accelerometer based monitoring of physical activity with feedback can improve the process of physical rehabilitation. When integrated into a broader telemedical system with patients' medical records, the WWBAN promises a revolution in medical research through data mining of all gathered information. The large amount of collected physiological data will allow quantitative analysis of various conditions and patterns. Researchers will be able to quantify the contribution of each parameter to a given condition and explore synergy between different parameters, if an adequate number of patients are studied in this manner.

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Figure 1: ActiS sensors with customized daughter boards [17].

Above figure ActiS sensor which is designed with customized daughter boards. They described a general Wireless Wearable Body Area Network architecture as well as our prototype WWBAN designed using Telos motes and application-specific signal conditioning modules. The prototype consists of several motion sensors that monitor the user's overall activity and an ECG sensor for monitoring heart activity. Every sensor that included in this process will send the information to the storage level.

The architecture of a WBAN consists of a WBAN Coordinator and End Device sensor nodes. All of the Device nodes are directly cooperating with the WBAN Coordinator node. The main objective of this work is to optimize energy consumption based WBAN while considering the QoS of network performances (e.g., Band, Energy, Scale, Bit Rate) in Healthcare Monitoring System.

The main objectives of this proposed system is

- Obtaining real-time feedback from people and adding new parameters to the control states Decision variables of an energy consumption control unit. (Energy Consumption)
- Adaptation of the energy consumption profiles based on the obtained data like distribution of people as a new state variable in order to increase the energy efficiency and also to improve people's level of comfort. (Energy Efficiency)
- Increasing the flexibility and functionality of the current solutions and presenting an intelligent system that can adapt itself to the energy state of the system in real-time. (User Friendly)

Table 1: Parameters

S.No	Parameters	Values
1	Frequency Band	2.4 GHz
2	Initial Energy	1.5 V
3	Network Scale	100 m x 100 m
4	Energy Model	MICA
5	Bit Rate	250 kbps

Table 1 shows the parameters which are used in this research work based on Healthcare Monitoring system. It presents frequency band level, initial energy taken, network scale ratio, energy model which is chosen for this model and bit rate in the range of kbps. The network coordinator is also implemented on a Telos platform. It feeds their application through its USB connector and manages the WBAN – transmits the messages from the PS that establish a session, assigns the individual sensor contains ID, distributes keys if secure data are encrypted, and assigns communication slots for process. The network coordinator autonomously emits beacon messages for time synchronization. After the initial startup, it receives data from individual sensors, aggregates the data, and forwards it to their application.

In order to increase the level of convenient, it is possible to collect feedback from people through the wearable devices (WBAN) and modify control strategies based on those feedbacks. Here data analytics is included to process the data which is collected through the wearable devices. Dataset contains different types of data with different set of variables and parameters and also includes feedbacks for problem rectification. Every wearable device measures their near body temperature, humidity and heart rate and sends the collected data to the servers through the sensor nodes. These data help to exploit dynamic and adaptive control strategies that not only consider the ambient temperature, but also human body temperature and their cause factors. Hence, this can provide a higher level of comfort for people with respect to the static control ideas using the datasets.

IV. CONCLUSION

Wireless Body Area Network is the prominent technology and plays an important role in developing Healthcare Monitoring System as wearable method. Therefore, more and more research is needed on WBAN to realize the Healthcare Monitoring System which will bring to a lot of advantages in caring the patient's health by monitoring every second. Nowadays consuming high power brings more money consumption which results user suffers lot in the form of cost. In order to overcome that limitation several concepts are discovered. In this paper, three different concepts are taken for analyses which are based on cost, security and power consumption. Moreover all the three sensor nodes use low power to process and produce likely results. Each sensor node having some pros and cons which are based on their working performance and also based on locality made. This paper addressed several key technical issues such as sensor node, network time synchronization, and energy conservation. Further efforts are necessary to improve QoS of wireless communication, reliability of sensor nodes, security, and standardization of interfaces and

interoperability. In addition, further studies of different medical conditions in clinical and ambulatory settings are necessary to determine specific limitations and possible new applications of this technology with respect to environment.

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