

# Wireless Sensor Networks for Medical Care Applications: A Literature Survey

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**Abstract :** Wireless sensor networks is composed of tiny nodes with sensing, computation, and wireless communications capabilities. Networks serve the purpose to collect information from the surrounding and send the collected information to the base station for further processing/use. Advances in wireless sensor networking have found its use in healthcare systems. With the help of sensor based technology we are able to replace the bunch of wires attached with the devices in hospital. Above mentioned technology empower us reliability and enhanced mobility. We are assured to see the integrated vast array of wireless network in the present specialized medical technology. This survey will help us to dive deep in the implementation of current state-of-the-art of wireless sensor network in healthcare applications.

**Index Terms -** *Wireless sensor network, Medical Care, Survey.*

## I. INTRODUCTION

Wireless Sensor Network is made up of several hundred or thousands of small nodes. Constituent small nodes are entitled with sensing, computation, and wireless communications capabilities [1]. Basic schematic of wireless sensor network model is as shown in Fig.1. Area where sensor node are deployed is called sensing area. Nodes may be deployed in either of two ways i.e. Randomly or installed manually. Sensor nodes performs the accumulation of the information from the sensing region, process it, and revert the same wirelessly in either directions i.e other nodes or to an external base station A centralized point of control within a network is termed as Base station . It can be fixed or mobile and is close to the accessible communication infrastructure or to the internet as to enable too access the available data [2].

We know that Wireless sensor technologies have that much potential so that it may change the way we use it application in entertainment, travel, retail, industry, medical, emergency management and many other areas [3-5].

One of big concern is Healthcare as it affects the quality of life of a given individual may have. As best thing to prevent the disease instead to cure it, so, periodically an individual monitoring is must [6]. Aged mass of the population ensure a growing portion of government fund also presents a challenge to healthcare system. In the paper we put forward a literature survey involving health care applications of wireless sensor networks.

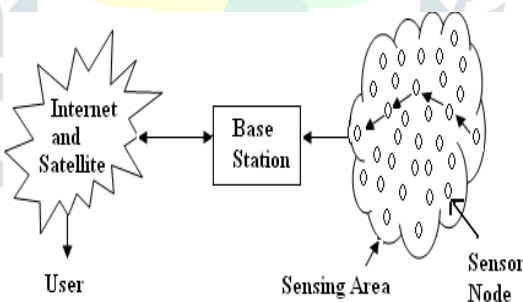


Fig. 1: Wireless sensor network model

Rest of the paper is structured like as follows. Next section contains reviews for background material in medical sensing, also in Section III will contain the illustration of number of application for wireless sensor network. Technical challenges in the wireless sensor network in wireless sensor networks are facing are in Section IV and describing representative research projects that address different aspects of these challenges are in section V. At the end we will conclude with the outline of challenges remains and future periphery for wireless sensor networks in healthcare.

## II. MEDICAL SENSING

Over a long time sensors had been used in public interest and medication. Different types of medical instruments in hospitals, clinics, and homes uses embedded. Sensors make patients and their healthcare providers avail a deep insight into physiological and physical health states that are critical to detect, diagnosis, treat, and manage the ailments [7].

The devices (sensors) like thermometers, blood pressure monitors, glucose monitors, EKG, PPG, EEG, and various forms of imaging sensors had made it cost effective and possible to eliminate the ailment. Measurement-ability of physiological state is also essential for interventional device like pacemakers and insulin pumps [8].

Medical sensors uses transduction for detecting electrical, optical, thermal, chemical, genetic, and other signals with physiological origin and finally with signal processing algorithms that computes features indicative of a person 's health status [9]. Sensors that indirectly measure the health state have also been practiced in medicine. For instance to improve delivery of

patient use of proximity and location sensor is common, this improves care and workflow efficiency in hospitals. Also to monitor people's health-related performances like activity levels and exposure to the environment with negative effect such as pollution. Three dimensions that will constitute the overall advances in medical sensing technologies have been there and here we do elaborate each of them as follows [10]:

*Sensing Modality:* Advanced technologies such as MEMS,

Imaging, and microfluidic and nanofluidic lab-on-chip happened to the forms of chemical, biological, and genomic sensing on the same hand analyzing them outside the lab at the instant. Deploying new inexpensive diagnostic caliber assure the revolution of healthcare both in aspects of resolving public health crisis due to infectious disease and there pre-detection and personalized detection.

*Size and Cost:* Conventional medical sensors have been complex and costly in exterior environment of the clinical lab. However, advances in microelectronics and computation made it in many forms of medical sensing more wide access to individuals' locations.

- <sup>1</sup> First of them was portable medical sensors for home use (like blood pressure and blood glucose monitors). Efficient use of them in measurement of critical physiological data without doctor visit have revolutionize the detection, analyses and treatment of diseases like hypertension and diabetes
- <sup>2</sup> Another, ambulatory medical sensors, miniaturization allowed them to be worn or carried by a person had emerged. These sensors sense the periodic measurement of physiological parameters during routine life activities. These include wearable heart rate and physical activity monitors and Holter monitors. Devices targets the fitness enthusiasts, health conscious individuals also to observe cardiac or neural events that may have not manifest during a short visit to the doctor.
- <sup>3</sup> In present scenario we can see emergence of implantable medical sensor for continuous measurement of internal health status and psychological signal. In other cases the objective was to steady monitoring of health parameters which were externally unavailable For instance intraocular pressure in glaucoma patients. On other hand the dealing was to use the measurements as triggers for physiological intervention that inhibits adverse events (like epileptic seizures) and for physical assistance (e.g., brain-controlled motor prosthetics). After all giving them there nature of implantation the devices are obstruct by several size constraints and the necessity of communicate and reception of power wirelessly.

*Connectivity:* Evolved from advances in IT medical sensors have developed a strong inter-network with other devices. Early medical sensors were largely isolated with integrated user interfaces for displaying their measurements. Interfacing of sensors can be done from wired interfaces such as RS 232, USB, and Ethernet. Recent advances in medical sensors include incorporated wireless connections, both short-range, like Blue-tooth, Zigbee, and other near fields to communicate wirelessly with computer nearby PDAs, or smart phones, and long-range and other devices such as WiFi or cellular communications, to communicate directly with cloud computing services. Besides the convenience of tether less operation, such wireless connections permit sensor measurements to be sent to caregivers while patients continue to daily work life away from home, thus signal to an age of pervasive real-time medical sensing. We took a notice that with portable and ambulatory sensors, the wired or wireless connectivity to cloud computing resources is fragmentary (e.g., connectivity may be available only when the sensor is in cellular coverage area or docked to the user's home computer).

So these sensors make a part of volatile memory for uploading at a later time when they are shared with healthcare personnel and further analyzed.

### III. SIMPLE WIRELESS SENSOR NETWORK APPLICATION SCENARIO

We can categories the users of healthcare applications in five groups other than super users of the system namely administrator and developers.

These can be like-

1. Children –This group of users are not able to take care of themselves like babies, infants, toddlers. They still require to be observed.
2. Elderly and chronically ill – People with cognitive difficulties and medical disorders lie under this these are more susceptible to all of the sudden falls.
3. Healthcare Professionals – these are the professional caregivers like physicians and other medical staff who are responsible from the constant health status monitoring of the elderly and the **CHRONICALLY** ill people and are capable of giving the immediate response in case of an emergency situation.
4. Physically disabled persons- People with physically disable by birth or due to an accident fall under this category.
5. Animals and birds

The overview of a simple wireless sensor network application scenario is depicted in Fig. 2. Users continually interact with the wireless sensor network healthcare systems by using diverse subsystems:

- (i) Body Area Network Subsystem, (ii) Personal Area Network Subsystem, (iii) Gateway to the Wide Area Networks, (iv) Wide Area Networks, and (v) End-user healthcare monitoring application.

### IV. HEALTHCARE APPLICATIONS

Variety of healthcare applications that uses WSNs as the fundamental like physiological monitoring, measuring and report vital sign of a person, motion and activity monitoring, Since number of applications for continuous monitoring of activity at different level and can measure limb movements, muscular activity and also another implementation may be for huge analysis.

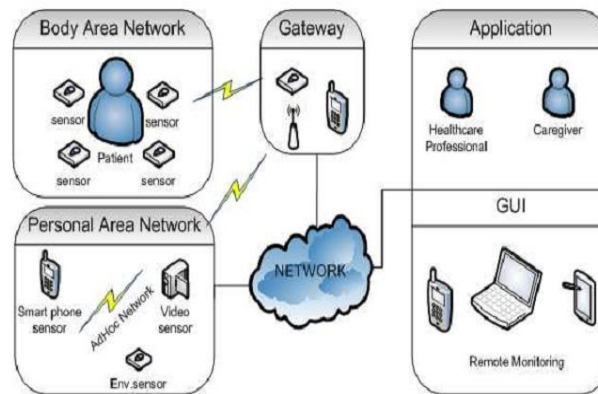


Fig. 2. Overview of a simple WSN application scenario for healthcare

#### *Monitoring in mass casualty disasters:*

The disaster like extreme heat or cold weather or may be the situation of flood, earthquakes, fires or wild fire, are characterized under natural disasters and also Mass casualty disaster. Another hazards especially technical hazard comprises like building collapse and major industrial accidents [11]. Under these types of hazards, Personal aids we need to put forward the emergency medical service for multi causality incidents for a huge mass, So we need to improve the access of the first responder's health during similar multi casualties. This technology will scale and being portable will ensure the efficient and effective report to the concerned medical team. Any spread of the new disease can be tracked and controlled ad coordinated with the existing resources. It can provide regular information to concerned department and authorities.

#### *Sleep safe:*

Mortality rate of Infants with the age of one month to one year happened to sudden death with unexplained disease sudden infant death syndrome (SIDS) [12]. There is no justified cause for SIDS casualties but several things that control the incidence of SIDS . If infant shows up the activity on sleeping on their bellies the risk heads up to 12.9 times to die with SIDS rather than normal death .Generally, Doctors prescribe ask there parents to make sure baby tke full sleep on their back but for parents its not that easy task to monitor the same , it can be done via implementing automation Y doing so we can withdraw this percentage of SIDS up to 40%. SIDS occupy a share in developing as well as in developed countries, statics shows that approx. 2500 deaths per year are due to SIDS, the death probability is maximum for the infants of 4-6 months. A device can be made to automate the process of monitoring the same purpose that a accelerometer is attached to the infant clothing and the base station is kept with parents this wireless network will assure the safe sleep of the infant with the sensitivity delay that is adjusted with parent's risk factor For automatic monitoring of infant a simple device is built based on wireless sensor network This system detect the sleeping position of infant. Base station comprise a TinyOS program having a accelerometer to detect the direction of the infant a laptop which is ready to alert the parent if the orientation of the child goes wrong.

#### *Monitoring health of Fire fighter or other rescue man:*

Fire department response at the rate of 20 seconds but then also meets a death of 100 annually even firefighter technology have been improved in last three decades , half of them are due to sudden cardiac arrest 24.1% injuries that are because of physical and psychological strain with having the tools worth of 75 pounds as a cause of which we need a real time monitoring of firefighter 's health . Anomaly in which can be signal imminent cardiac heart failure early detection of these abnormalities and operating them early the fire fighters can be prevented from the casualties. Fire line, wireless real time heart rate sensing system could be used for health monitoring [13]. This device has WSN Tmote, it is a custom made heart sensor board that is also paired with three reusable electrode.

#### *Wearable Smart Shirt Application*

Under this section comes the wearable physiological monitoring devices for instance we have a t-shirt that monitors all the Physiological parameters like Heart rate, blood pressure, body temperature and galvanic skin response electrocardiograms [14]. In this the smart shirt can measure electrocardiograms and acceleration signal for continuous monitoring and real time healthcare. All this data is transferred via IEEE 802.15.4 communication standard.

#### *Implantable artificial retina for blind people.*

Blind person, if provided a good resources to pair up there handicaps may prove a good human resource to the society . This all can be realised by helping them with the help of these wireless sensor. The blind persons can be paired with the visibility by implantable sensor network in healthcare and that is IWBAN [15]. Partial blind or fully blind peoples can be impaired with an appropriate amount of the visibility via a retina prosthesis chip with a human implanted eye.

#### *The iCabiNET*

iCabiNET [16] is a powerful tool to the elder peoples as it is indoor application. It interfaces with the residential networks like TVs and other home appliances that co-ordinate together from the drug bought to home to thereafter its end. Then if the supply of the drug is less the TVs show the ads for alternatives drugs in this way it help the user. Alternatively, If the person forget to medicate it reminds of the same to them. Similarly it can interface with telephone network and provide the report of medication to the close family members.

#### *MobiHealth*

It is another powerful tool in the system of WSN as it includes all the wearable sensors (i.e PDA 's mobile phones and all types of watches that a person carries around during the day ) The sensor transmits physiological data in the form of audio and video recording to the service provider to allow fast and reliable assistance the convergence is like BAN ,PAN and WAN to enable personalized and mobile healthcare [17].

#### *AlarmNet*

It includes MSN system with negative components. The mobile body sensors like heart rate, ECG are developed in Code Blue project [18]. The parameters like luminosity sensor and temperature can be used for the designing purpose. It serves as gateway between gateway between data accumulation and storage parts. Also it is responsible for privacy, power management and query management. The caregivers are provided with the query data with the data of patient's pulse rate and PDA devices display that data on the display and so the healthcare professional can monitor that.

#### *The LifeGuard*

This was a device that was developed for astronauts in the RST place, The system mainly consist of three components One of them is sensor part and that supports number of the devices such as ECG, respiration, pulse meter, blood pressure . The wearable device also called Crew Physiological Observation Device (CPOD) [19]. It has 3-axis accelerometer and skin temperature sensor internally. The base station is compactable with Bluetooth capable tablet PC. It store and display the data streaming from CPOD for after event actions.

#### *ZebraNet*

It is a mobile wireless sensor network used to track animal migrations. ZebraNet [20] is composed of sensor nodes built into the zebra's collar. The node consists of a 16-bit TI microcontroller, 4 Mbits off-chip flash memory, a 900 MHz radio, and a GPS unit. Positional readings are taking using the GPS and sent multi-hop across zebras to the base station. The goal is to accurately log each zebra's position and use them for analysis. A total of 6–10 zebra collars were deployed at the Sweetwater's game reserve in central Kenya to study the effects and reliability of the collar and to collect movement data. After deployment, the biologists observed that the collared zebras were affected by the collars. They observed additional head shakes from those zebra in the first week. After the first week, the collared zebra show no difference than the uncollated zebra. A set of movement data was also collected during this study. From the data, the biologists can better understand the zebra movements during the day and night.

## V. TECHNICAL CHALLENGES

As the implementation of the WSNs, is offered with inherent constraints, offers a variety of challenges in technical aspects in whichever field they are happened to be deployed . The challenges can be like scalability, reliability and efficiency of core computer system based [21].

*Wearability:* To achieve non-invasive and unobtrusive continuous monitoring of health, wireless medical sensors must be lightweight and small. Size and weight of sensors are mainly determined by the size and weight of batteries. We can expect that further development of technology and advances in miniaturization of integrated circuits and batteries will help developers to improve medical sensor wearability and the user level of comfort.

*Trustworthiness:* Conventional WSNs have a constraint of bandwidth and energy constraints. Also the unreliable wireless media, there occurs really serious problem of trustworthiness of the serious data, after being received from the sensor network. This also had obstructed the problem to healthcare applications, as a cause of which demand the end user security data delivery.

*Resource Scarcity:* WSN works on low power which is obvious to work with the modest available resources to boost their lifetime. This limitation offers challenges for the designing of the system. After taking all these constraints in mind the system should be carefully designed. The scant memory calls for use of lean, event driven models, and thus, precludes traditional OS design. A appropriate amount of the on – board processing is needed to be reduced during the transmission. The application should follow the complexities of node's energy budget and process the data to extend the battery life time limitation and other regulatory norms.

*The power challenge:* It is in every field and also the wireless network poses the same ,although ongoing researches do provide the power wirelessly. Operational heat is also a challenge For example in some cases interacting with environment do not allow direct cooling with them. A typical alkaline battery, for instance, provides about 50 W-hr. For this translation takes about a month for every node in full active mode. In real system it is necessary that network do not require replacement and remain operational as long in their lifetime.

*Continuous operation:* It is one of the important thing to be taken care of infant it is must to be ensured all along the lifetime of the biosensor which will not be of use if it vary in its duty cycle techniques. These operation require robustness and fault tolerance .Biosensors may be operational during a month or week without operator intervention. Finally overall integration of the wireless sensor network mechanism should be there for security and uninterrupted functionality

## VI. CONCLUSION

The conclusion of the paper inclines that wireless sensor network is very helpful in medical application in different aspects .WSN ensures improved quality of life of patient with reduced cost. The technology also enables us to predict the future scope with the help of wearables sensor. As this all will change the overall general men's life tremendously .Trade off will always be there between the social issues and being legal. Cheapness and compactness of electronics instrument is an incentive for the patients and hospital .Overall study of various discussions on WSN is found with net positive aspect.

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