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A Survey on Applications of Wireless Sensor Networks in Health Care

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ABSTRACT
Advances in technology have diode to development of varied sensing, computing and communication devices which will be plain-woven into the physical setting of our daily lives. Such systems alter on-body and mobile health-care watching, will integrate data from completely different sources, and might initiate actions or trigger alarms once required. Finally, we tend to gift our results, demonstrate the practicability of our projected techniques and description the longer term directions. With recent developments within the wireless networks field, new and innovative medical applications supported this technology square measure being developed within the analysis likewise as industrial sectors. This trend has simply started and that we predict wireless networks square measure reaching to become an integral a part of medical solutions because of its advantages in reducing health care prices and increasing accessibility for patients likewise as networks within the medical field and discuss the problems and challenges. We have conjointly tried to spot a number of the standards in use. Another contribution because of this paper is that the identification of innovative medical applications of wireless networks developed or presently being developed within the analysis and business sectors. Within the finish we tend to conjointly refer the longer term trends during this field.

KEYWORDS: *Medical Applications, Wireless Networks, Detector Networks, Wireless Applications, Wireless homecare, Wireless Body Area Network, patient management,*

1. Introduction

During the last number of years, several new application eventualities appeared impressed by the analysis on detector networks [1], or in additional general, accidental networks. So as to find out concerning the variations between detector networks and alternative networks, the first properties and capabilities of detector networks ought to be listed. Detector networks accommodate an excellent several individual detector nodes. Every node is functioning autonomously on a given task like the examination of its setting [2]. The ultimate goal is to indicate an aborting behaviour of the world network, i.e. watching of an oversized space, exploitation self-organization methodologies. To alter this task, the detector nodes ought to be ready to collect detector data, to forward them over a billboard hoc network to a final destination like a watching station [3]. Typically, every one of those autonomously acting detector nodes has terribly restricted resources. Constraints square measure given on process power, offered memory, and communication information measure [6]. To boot, the communication path is usually supported a link with high loss chances and short transmission ranges. Moreover, energy consumption is a difficulty as a result of detector nodes square measure in operation put in battery because the main power supply and that they square measure needed to figure uninterrupted for several months or maybe years. Therefore, operation and communication mechanisms were developed (and still add progress), that shows energy-aware behaviour. We tend to square measure exploring applications of wireless detector network technology to a spread of medical applications, together with pre-hospital and in-hospital emergency care, disaster response, and stroke patient rehabilitation. Recent advances in embedded computing systems have diode to the emergence of wireless detector networks, consisting of tiny, powered "motes" with restricted computation and radio communication capabilities. Detector networks allow knowledge gathering and computation [4] to be deeply embedded within the physical setting. This technology has the potential to impact the delivery and study of resuscitative care by permitting very important signs to be mechanically collected and absolutely integrated into the patient care record and used for period sorting, correlation with hospital records, and long-run observation. Wireless networks technology has been systematically rising with time and progressively finding its manner into all aspects of our daily lives. Medical applications square measure a field wherever technologies like Wireless Networking have a promising future. Within the health care field, access and price saving square measure 2 of the most popular problems recently. Wireless Technologies have one thing to contribute towards serving to with each of those problems. During this survey paper we are going to be talking concerning

applications of wireless networks within the Medical field. We are going to begin out with some discussion on problems and challenges within the medical field. Then we are going to refer a number of the wireless technologies presently in use. Afterwards, we are going to gift example applications of wireless networks within the analysis and industrial sectors. Within the finish we are going to refer future trends and finish with a Conclusion.

1.1 Medical Applications Wireless Networks:

The applications for WSNs square measure several and varied. They are utilized in industrial and industrial applications to observe knowledge that will be troublesome or pricy to observe exploitation wired sensors. They may be deployed in geographic region areas, wherever they might stay for several years (monitoring some environmental variables) while not the requirement to recharge/ replace their power provides. They may type a fringe a few property and monitor the progression of intruders (passing data from one node to the next). There square measure several uses for WSNs.

- Environmental watching
- Habitat watching
- Acoustic detection
- Seismic Detection
- Military police work
- Inventory trailing
- Medical watching
- Smart areas

Typical applications of WSNs embrace watching, tracking, and dominant. a number of the particular applications square measure surround watching, object trailing, setup dominant, hearth detection, traffic watching, etc. in a very typical application, a WSN is scattered in a very region wherever it's meant to gather knowledge through its detector nodes. Due to advances within the wireless networks field, new and innovative applications [5] square measure being thought of in medical likewise as health care field. Within the medical field applications starting from instrumentality management to patient management square measure being developed potency among hospital employees is redoubled by exploitation a number of these freshly offered applications and tools. Within the health care field, problems like long-run patient care support for old folks and good homes square measure being mentioned within the realm of wireless networks.

1.2 Characteristics

Unique characteristics of a WSN are:

- Small-scale detector nodes
- Limited power they harvest or store
- Harsh environmental conditions
- Node failures
- Mobility of nodes
- Dynamic configuration
- Communication failures
- Heterogeneity of nodes
- Large scale of preparation

A sensor node is fanciful as tiny computers, extraordinarily basic in terms of their interfaces and their elements. they sometimes accommodates a process unit with restricted machine power and restricted memory, sensors (including specific acquisition circuitry), a communication device and an influence supply sometimes within the sort of A battery. The bottom stations square measure one or a lot of distinguished elements of the WSN with rather more machine, energy and communication resources. They act as an entree between detector nodes and also the user.

2 SENSOR NETWORK CHALLENGES:

By early next century, detector integration, in addition to un- ceasing electronic shrinking, can create it potential to provide extraordinarily cheap sensing devices. These devices are ready to monitor a large sort of close conditions: temperature, pressure, humidity, soil makeup, transport movement, noise levels, lighting conditions, the presence or absence of bound forms of objects, mechanical stress levels on hooked up objects, and so on. These devices will be equipped with important (i.e., adore today's high-end transportable computers) process, memory, and wireless communication capabilities.

Rising low-level and low-power wireless communication protocols can alter these sensors. This capability can add a replacement dimension to the capabilities of sensors.

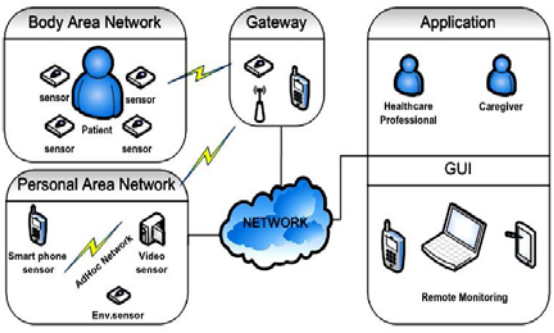

Figure 1 Overview of simple WSN application Scenario of Health Care

Sensors are in a position coordinate amongst themselves on a higher-level sensing task (e.g., reporting, with larger accuracy than potential with one detector, the precise speed, direction, size, an alternative characteristics of an approaching vehicle). Networking cheap sensors will revolutionize operation in a very sort

of things. Take into account the subsequent eventualities, organized in increasing order of complicated: every item of inventory in a very manufacturing plant warehouse or workplace complex has, hooked up to that, a tag. Adhesive sensors, discreetly hooked up to walls, or embedded in floors and ceilings, track the placement history and use of things. The detector network will mechanically find things, report on those needing union, analyze long-run correlations between progress and wear, and report sudden large-scale movements of things or important changes in inventory levels. Some systems nowadays (for example, those supported bar-codes) give inventory tracking; full sensor-net based mostly systems can eliminate manual scanning and supply a lot of knowledge than merely location. Thousands of disposable sensors square measure densely scattered over a country. A number of them fall under regions laid low with the disaster, say a fireplace these sensors square measure destroyed. The remaining sensors put together map these affected regions, direct the closest emergency response groups to affected sites, or realize safe evacuation methods.

Disaster recovery nowadays is by comparison terribly human intensive. Each vehicle in a very giant metropolis has one or a lot of hooked up sensors. These sensors square measure capable of detection their location; vehicle sizes, speeds and densities;road conditions so on. As vehicles pass one another, they exchange data summaries. These summaries eventually diffuse across sections of the metropolis. Drivers will set up alternate routes, estimate trip times, and be warned of dangerous driving conditions. Un- just like the centralized systems generally seen nowadays, one supported native communication would scale because the variety of vehicles grows and supply abundant larger native detail. These art movement eventualities bring out the 2 key necessities of detector networks: support for terribly giant numbers of unattended autonomous nodes and adaptively to setting and task dynamics. Several large-scale networks exist today; the net could be a prime example. Detector networks gift an essentially harder drawback, though, as a result of the quantitative relation of act nodes to users is far larger. Every notebook computer on the net contains a user an agency will resolve or a minimum of report all manner of minor errors and issues. This human part permits the net to operate with abundant less sturdy computer code. Detector networks, by comparison can exist with the quantitative relation of thousands of nodes per user (or more). At such ratios, it is not possible to pay special attention to any person node. Moreover, although it was potential to think about every node, sensors are also inaccessible, either as a result of their embedded in physical structures, or thrown into inhospitable piece of land. Thus, for such a system to be effective, it should give exception-free, unattended operation (the term exception-free is because of Mark Weiser). It’s not fully true that there aren't any giant scale unattended systems nowadays. Automatic factories, for example, might contain many for the most part unattended computers. This instance illustrates the second demand of detector networks: they operate and should answer terribly dynamic environments. Automatic factories square measure deployed with terribly careful designing and react to only a few external events. Detector networks instead are deployed very accidental manner (possibly thrown down at random). They’re going to suffer substantial changes as nodes fail because of battery exhaustion or accident, new nodes square measure superimposed, nodes move or square measure carried. User and environmental demands conjointly contribute to dynamics as what square measure being perceived moves and what's thought-about fascinating changes. Therefore detector networks should mechanically adapt to changes in setting and necessities. One hypothesis for the style of a detector net- work is that it's comfortable to style detector network applications exploitation net technologies in addition to ad-hoc routing mechanisms. In such a style, every detector node is Internet-capable device [7] (has one or a lot of IP addresses) and might run applications and services. Once deployed, detector nodes establish ad-hoc network amongst themselves; thenceforth, application instances running on every node will communicate with one another. Applications, motor-assisted by directory and resource discovery services, square measure structured abundant a similar manner as ancient net applications. We believe, however, that detector network necessities square measure completely different enough from those of ancient wired and wireless networks to warrant considering a special style. This style has the subsequent features: Data-Centric not like ancient networks, a detector node might not want an identity. That is, detector network applications square measure unlikely to raise the question: what’s the temperature at detector Rather, applications specialize in the information generated by 1In some things, for instance, for querying a selected faulty detector, the power to deal with a personal detector is clearly necessary. Sensors knowledge is known as by attributes and applications request knowledge matching bound attribute values. So, the communication primitive during this system could be a re- quest: wherever square measure nodes whose temperatures recently exceeded thirty degrees? This approach decouples knowledge from the detector that made it. This permit for a lot of sturdy application design: although detector dies, the information it generates is cached in alternative (possibly neighboring) sensors for later retrieval.

Application-Specific ancient networks square measure designed to accommodate a large sort of applications. We tend to believe it's affordable to assume that detector networks are tailored to the sensing task at hand. Especially, this suggests that intermediate nodes will perform application specific knowledge aggregation and caching, or aware forwarding of requests for knowledge. This can be in distinction to

routers that facilitate node-to-node packet change in ancient networks. If we tend to admit this design, however may we tend to style applications on prime of a detector network that provided this type of communication? Recall that detector network applications of interest to square measure those within which detector nodes coordinate to perform a higher-level sensing task. Clearly, this type of coordination is structured in a very centralized manner. Individual sensors report their knowledge to a central node that then performs the computation needed for the appliance. This centralized structure could be an unhealthy selection for many reasons: it provides one purpose of failure, it is energy incident, and it does not scale to giant networks [8]. We tend to expect that detector network coordination applications square measure higher complete exploitation localized algorithms. We tend to use this term to mean a distributed computation within which detector nodes solely communicate with sensors at intervals some neighbourhood; however the computation achieves a de- sired world objective. What's the explanation for exploitation localized algorithms in detector networks Since the sensors them-selves square measure physically distributed, it's not unnatural to style detector networks exploitation [9] distributed algorithms. Moreover, localized algorithms have 2 enticing properties. First, as a result of every node communicates solely with alternative nodes in some neighborhood, the communication overhead scales well with increase in network size. Second, for the same reason these algorithms square measure sturdy to network partitions and node failures. We tend to square measure simply starting the work of collateral this hypothesis through style and experimentation. Within the next section, we tend to describe the challenges exhibit by the look of localized algorithms in data-centric, application- specific detector networks.

2. Wireless Networks Technologies in Use

Due to accessibility and quality necessities wireless is that the most well-liked medium in medical applications. Because of restricted quality, most of the pricy and enormous machines that are around for a protracted time don't seem to be getting used to their fullest. Wireless technologies square measure being developed to provide new interfaces [10] to those machines and create them act with any new machines and procedures needed in medical field.

3.1 Wireless Technologies in Use - Current and Past

In this section we are going to refer some recent and past wireless networks based mostly technologies utilized in the world of medical applications.

3.1.1 WBAN (Wireless Body space Network)

WWBANs are a pivotal part of a multi-tier telemedicine system as illustrated in Fig. 1. Tier 1 encompasses a number of wireless medical sensor nodes that are integrated into a WWBAN. Each sensor node can sense, sample, and process one or more physiological signals. For example, an electrocardiogram sensor (ECG) can be used for monitoring heart activity, an electromyogram sensor (EMG) for monitoring muscle activity, an electroencephalogram sensor (EEG) for monitoring brain electrical activity, a blood pressure sensor for monitoring blood pressure, a tilt sensor for monitoring trunk position, and a breathing sensor for monitoring respiration; and motion sensors can be used to discriminate the user's status and estimate her or his level of activity.

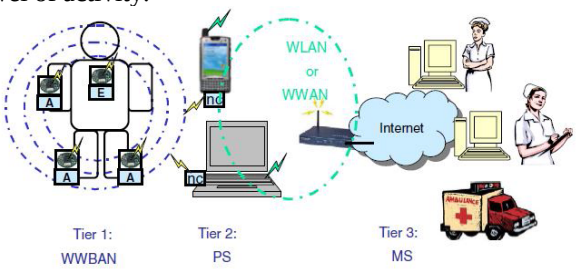

Figure 2 WWBAN integrated into a telemedical system for health monitoring

Tier 2 encompasses the personal server (PS) application running on a Personal Digital Assistant (PDA), a cell phone, or a home personal computer. The PS is responsible for a number of tasks, providing a transparent interface to the wireless medical sensors, an interface to the user, and an interface to the medical server. The interface to the WWBAN includes the network configuration and management. The network configuration encompasses the following tasks: sensor node registration (type and number of sensors), initialization (e.g., specify sampling frequency and mode of operation), customization (e.g., run user-specific calibration or user-specific signal processing procedure upload), and setup of a secure communication (key exchange). Once the WWBAN network is configured, the PS application manages the network, taking care of channel sharing, time synchronization, data retrieval and processing, and fusion of the data. Based on synergy of information from multiple medical sensors the PS application should determine the user's state and his or her health status and provide feedback through a user-friendly and intuitive graphical or audio user interface. Finally, if a communication channel to the medical server is available, the PS establishes a secure link to the medical server and sends reports that can be integrated into the user's medical record. However, if a link between the PS and the medical server is not available, the PS should be able to store the data locally and initiate data uploads when a link becomes available.

Tier 3 includes a medical server(s) accessed via the Internet. In addition to the medical server, the last tier may encompass other servers, such as informal

caregivers, commercial health care providers, and even emergency servers. The medical server typically runs a service that sets up a communication channel to the user's PS, collects the reports from the user, and integrates the data into the user's medical record. The service can issue recommendations, and even issue alerts if reports seem to indicate an abnormal condition. More details about this architecture and services can be found.

WBAN Prototype

In order to better understand various issues in designing a wearable wireless sensor network for health monitoring, we ventured into the development of a prototype system aimed to satisfy the above-mentioned requirements for small size, low power consumption, secure communication, and interoperability. Our WWBAN prototype consists of multiple ActiS sensor nodes that are based on a commonly used sensor platform and custom sensor boards [11] and [12]. The initial WWBAN setting includes a sensor node that monitors both ECG activity and the upper body trunk position and two motion sensors attached to the user's ankles to monitor activity. Such a WBAN allows one to assess metabolic rate and cumulative energy expenditure as valuable parameters in the management of many medical conditions and correlate that data with heart activity. Fig. 3 shows heart activity and acceleration data collected by our prototype during normal walking with a motion sensor attached to the right ankle.

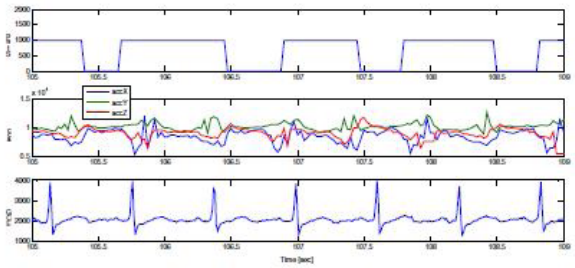

Figure.3. ECG, acceleration, and foot switch data collected by the WWBAN prototype during normal walking.

3.2. Hardware platform

The ActiS sensor node features a hierarchical organization employed to offer a rich set of functions, benefit from the open software system support, and perform computation and communications tasks with minimal power consumption. Each ActiS node utilizes a commercially available wireless sensor platform Telos from Moteiv [13] and a custom intelligent signal processing daughter card attached to the Telos platform (Fig. 4). The daughter boards interface directly with physical sensors and perform data sampling and in some cases preliminary signal processing. The pre-processed data is then transferred to the Telos board. The Telos platform can support more sophisticated real-time analysis and can perform additional filtering, characterization, feature extraction, or pattern recognition. The Telos platform is also responsible for time synchronization, communication with the network coordinator, and secure data transmission.

Figure. 4. Photo of two ActiS sensors with customized daughter boards

3.3 Wireless LAN (802.11)

Most hospitals, universities and company offices recently give wireless LAN access. Some advantages embrace unbound access to the net. Hospitals will use the wireless LAN channels to transfer patient knowledge round the hospital. Communication between medical devices is additionally created potential exploitation this wireless channel.

3.3.1. Deployment scenarios

Figure-5 illustrates three typical scenarios using WWBAN. The configuration on the left can be deployed at home, in the workplace, or in hospitals. Wireless medical sensors attached to the user send data to a PDA, forming a short-range wireless network (e.g., IEEE 802.15.1 or 802.15.3/4). The PDA equipped with a WLAN interface (e.g., IEEE 802.11a/b/g) transmits the data to the home (central) server. The home server, already connected to the Internet, can establish a secure channel to the medical server and send periodic updates for the user's medical record.

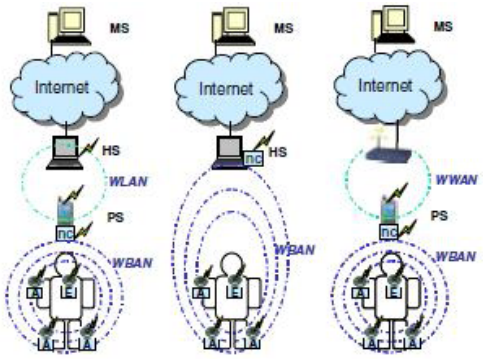

Figure 5: WWBAN deployment scenarios. Legend: A, activity sensor; E, heart sensor; WBAN, wireless body area network, PS, personal server; WLAN, wireless local area network; WAN, wide area network; HS, home server; MS, medical server; nc, WBAN network coordinator.

The modified configuration in the middle is optimized for home health care. The sensor network coordinator (nc in Fig.5) is attached to the home personal server that runs the PS application. The medical sensor nodes and the network coordinator form a wireless personal area network. By excluding the PDA, we can reduce system cost. However, this setting is likely to require more energy spent for communication due to an increased RF output power and lower Quality of Service (QoS), requiring frequent retransmissions. The configuration on the right illustrates ambulatory monitoring applicable any time and everywhere – the PS application runs on a Wireless Wide Area Network (WWAN) enabled PDA/cell phone (e.g., 2G, 2.5G, and 3G) that connects directly to the medical server. To illustrate, we will follow a user (let's call him Sam) who has a predisposition for heart disorders. Sam continues his normal daily activities, but now equipped with several non-invasive medical sensors applied in his clothes or as tiny patches on his skin. The PS application can discriminate Sam's state (walking, running, lying down, sitting, riding, etc.) using the data from the motion sensors, and can recognize an arrhythmic event, analyzing the data from the ECG sensor. If Sam's activity, heart rate, and personalized thresholds indicate an abnormal condition, he will receive a warning. In addition, a precise incident report can be sent to the medical server at Sam's hospital or doctor's office.

3.4 RFID (Radio Frequency Identification)

Radio Frequency Identification (RFID) technology could be a hot topic recently each in terms of its potential advantages and misuses RFID tags square measure utilized in hospitals to stay track of kit. Even be planted on patients likewise as doctors to grasp at time wherever there. RFID square measure extraordinarily low hopped-up radio devices that do not want any battery power and therefore have potential uses in storage areas. Alternative potential uses square measure in watching hospital offer stocks. Hospitals will manage their resources properly and grasp in period.

3.5 WPAN (Wireless Personal space Network)

WPANS exploitation 802.15.4 or Bluetooth have potential uses within the medical fields. These square measure short vary networks which will be deployed for instance, at intervals a patient's space. Nurses square measure ready to monitor patients in period while not having to go to them. This protects them time and offers them the chance to require care of a lot of patients. Alternative uses of WPANs square measure in interfacing multiple pricy and enormous devices [13] at intervals the hospital. Knowledge from one device is forwarded directly from one machine to a different while not doctor's dalliance by transferring this data by hand.

3.5.1 Detector Networks

Sensor Networks technologies like square measure being combined with WBANs to create smaller scale networks which will be placed on human vesture (or alternative objects) and supply unobtrusive access to their health data. Detector Networks also are progressively getting used in natural sciences for instance in watching wild life or alternative phenomenon. Because of lower power necessities they will be deployed for a protracted amount of your time. Because of restricted vary, they're deployed in giant numbers and therefore type a distributed network covering an oversized portion of area [14]. An honest example of an application of detector networks within the medical field is that the CodeBlue project being developed at Harvard. Alternative experimental applications embrace fire detection and path trailing exploitation accidental detector networks. Since sensors networks devices square measure rock bottom, they will be deployed anyplace in giant numbers. A number of the wireless detector networks based mostly devices square measure terribly subtle. They treat their own OS known as the TinyOS. Thus they will be programmed over the air, creating their management terribly straightforward.

3.5.2 GPRS/UMTS

GPRS and UMTS wireless technologies have conjointly found their uses within the space of medical applications. AN application known as MobiHealth [12], that we are going to discuss in a very later section, had been designed by exploitation BANs with GPRS/UMTS for net property.

4. Future Trends:

Although wireless technology within the field of medical applications remains comparatively new, industrial merchandise square measure being developed by many corporations to resolve wide go issues. In some cases these new applications square measure style strictly social health advantages i.e.reducing interference to everyday life once coping with long run patient care. During this section we are going to refer the trends in wireless networks use in medical applications by giving many samples of what is to return.

Conclusion:

Wireless networks for Medical Applications are getting a hot topic within the trade. With its potential uses within the medical and residential health care fields, wireless networks have a vital contribution in rising lives of patients. Besides transfer comfort to patients, there square measure giant industrial advantages within the space of reducing prices and rising instrumentality and patient management. In this survey paper, we tend

to mention the advantages of exploitation wireless networks for medical applications. we tend to talked concerning however these new technologies is wont to doubtless scale back prices for hospitals, government and insurance corporations. With wireless networks-based medical technologies, applications are designed to be less intrusive in patient's daily lives. All applications supported scientific ways have a development lifecycle. This can be ordinarily beginning out with an enquiry project and moving onto commercialization. Lessons learned here square measure applied once planning newer applications within the future. We tend to talked concerning current and past analysis comes. We tend to conjointly brought in some industrial applications that square measure presently offered within the market. a number of these merchandise square measure terribly innovative and have probabilities of succeeding. With all new technologies, there square measure probabilities of failures and success. A numbers that we tend to talked (i.e. CodeBlue) concerning square measure long run project and components of them have already created the transition to commercialization. Homecare is a locality wherever wireless networks for Medical Applications have the foremost potential. Smart home based mostly technologies square measure being designed which can eventually take care of our old and patient UN agency want long run care.

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