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An Application-Based Review of Wireless Sensor Networks

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Abstract: *In real-time data exploration, wireless sensor networks (WSNs) are essential because they have lower latency than regular wireless networks. Although the functions of the wireless networks cannot be compared to WSN, consumption does. This article examines the features, application, and environment of WSNs. This article's inspiration is to provide a general covering of applications that can serve as a bridge to a fresh start*

Keywords*:* Wireless Sensor Networks, Network Protocols, Sensor Deployment

I. INTRODUCTION

The creation of smart sensor nodes has been made possible by the explosion of Micro-Electro-Mechanical System (MEMS) technology in recent years, which has led to a growing interest in wireless sensor networks (WSNs) globally. When compared to more traditional sensor nodes, these little, low-cost devices have fewer processing and computational capabilities. According to He et al. (2011), these sensor nodes are capable of sensing, gathering, and measuring data from the outside world. They can also transmit the perceived data to the user terminal based on a limited decision process.

Low power devices with one or more sensor nodes, memory, a processor, a power supply, an actuator, and a radio are called smart sensor nodes. In order to measure the qualities of the environment, a variety of thermal, mechanical, biological, chemical, magnetic, and optical sensors may be attached to the sensor node. In the meantime, a radio is placed for wireless communication to transfer data to the base station (e.g., a personal hand-held device, a laptop, or a fixed infrastructure access point), as the sensor nodes have limited memory and are typically deployed in difficult-to-reach locations. The primary power source in sensor nodes is batteries. Depending on the suitability of the location in which the sensor node is to be installed, a secondary power source that draws energy from the outside world, like solar panels, may be added (da Costa et al., 2011).

Typically, a WSN has minimal or no infrastructure. A wide range of sensor nodes, from a few tens to thousands, work together in a wireless sensor network (WSN) to monitor an area and gather data. WSNs come in two main varieties: unstructured and structured. A particularly dense collection of sensor nodes can be found in an unstructured WSN. It is possible to deploy sensor nodes into a region ad hoc1. After deployment, the WSN is left alone to complete monitoring and reporting tasks. With so many sensor nodes, unstructured WSN maintenance tasks like connection management and failure detection are challenging. Some or all of the sensor nodes in a structured WSN are deployed in advance. The benefit of a structured network is that fewer sensor nodes could be installed, resulting in less network maintenance and management expenses. Since sensor nodes are positioned at precise locations to provide coverage, fewer nodes may be deployed now than with an ad hoc deployment, which would leave some areas uncovered (Yick et al., 2008).

Wide Area Networks (WSN) exhibit significant potential for several scenarios, including military tracking and surveillance, biological health monitoring, disaster relief, seismic sensing, and hazardous environment research. A WSN can help with the identification and detection of intrusions in military surveillance and target tracking. Tank maneuvers and troop movements that are coordinated and spatially correlated are two specific examples. Sensor nodes are able to feel and monitor the environment in order to foresee natural disasters before they happen. Biomedical applications of surgical implants with sensors can aid in patient health monitoring. Seismic sensing uses ad hoc sensor node deployment in the volcanic zone to identify earthquake development and eruptions (Pilloni et al., 2016).

WSN research seeks to overcome these limitations through the development of new algorithms, new applications, enhanced and new protocols, and new design concepts.

The following summarizes our work's primary contribution:

Although our work is comparable to that of Sakthidharan et al. (2012), we have concentrated mostly on reviewing the more recent studies.

We list the primary restrictions in the WSN at the level of both individual and group sensor nodes.

We examine the WSN operating system, fundamental configuration, and real-time wireless sensor nodes.

We now bring this article to a close.

The rest of the article is structured as follows: the following part provides an outline of the factors impacting WSN, The main components of a sensor node are described in Section 3; real-time sensor nodes are defined in Section 4; wireless sensor node configuration is described in Section 5; the operating system of the sensor node is defined in Section 6; an overview of WSN applications is described in Section 7; and this article is concluded in Section 8.

Influencing Factors

Constraint of topology

Several hundred or thousands of sensors are placed throughout the field. They are situated a short distance apart in terms of meters. As many as thirty sensors per millimeter can be found. When deploying a large number of sensors, rigorous topology maintenance management is required. We look at topology-related issues and divide them into three categories:

Sensors are not deployed in bulk or in the sensor field one by one during the deployment and pre-deployment phases. These nodes were dropped from the aircraft, installed by a robot or a person, and delivered into artillery, missile, and rocket shells.

Topology changes in the post-deployment phase are caused by faulty sensors, shifting impediments, reachability, residual energy, and task specifics.

According to Intanagonwiwat et al. (2000), the additional sensors may be re-deployed at any time to replace a failed sensor or as a result of dynamic job changes.

The type of topology chosen will depend on how well the sensors fit the needs of the environment. environment's power limitations; a network's star topology could be employed. Similarly, a mesh network might be utilized for multiple hop communications. It is possible to strategically use sensor network power factor by choosing an appropriate topology (Younis, Mohamed et al., 2014).

Hardware constraint

Under constraint, the application of the sensor nodes would be transparent. Hardware terms may be determined to outfit that particular site in order to facilitate. For example, if the application is intended for agricultural use, temperature and humidity are crucial information to send and detect to the sink or server. The node would be able to allocate precise temperature and humidity data in the environment above. Applications might be adequately exact and run correctly in real time with improved hardware.

Environmental constraint

The deployment of sensors are very dense either closed to each other or directly inside the observed phenomenon. Hence, they are usually working in areas of remote geographic or unattended. WSN might be working in large machinery interior, at ocean bottom, in a chemically or biologically contaminated region, in field of battle beyond the lines of enemy, and in large buildings and home.

The WSN can be fixed in any below environment

In an area with heavy traffic,

Below sea level,

On the battlefield,
In a home or apartment,
Mobile automobiles
Hazardous chemical or biological fields
Scalability constraint
The quantity of sensors used to carry out an operation could range from hundreds to thousands. The sensor number may reach the maximum value of millions, depending on the type of application. To manage these nodes' quantity, innovative approaches are needed. These methods could make use of dense sensor networks. The density might range from a few to thousands of nodes in the region, and the diameter could be at least ten meters.
It is possible to place more nodes in some environments. A network could manage all data transfers between them if there were a thousand or hundred of them (Bulusu et al., 2001).

Constraint of power

The microelectronic component that makes up the wireless sensor has a restricted power supply. It may not be possible to switch the power source in some applications. lifetime of the sensor; hence, there is a strong reliance on battery longevity. Every sensor in a multiple-hop ad hoc network serves as both a data originator and a data router. A few failed sensors could result in significant topological changes, necessitating packet rerouting and network reconstruction. Nonetheless, power management and conservation are not as important. For these reasons, the researchers are currently concentrating on power-aware design techniques for wireless sensor networks (WSNs).
Power is necessary for sensors to perform sensing, processing, and communication. In order to save power usage, sensors that are not operating in one of these modes are saved for sleep mode. The sensor battery design is a fascinating one. Even while batteries nowadays can be designed to be recharged, they still require a power outlet. However, the current approach uses solar energy instead of a backup source. This might be expanded to the next level by constructing it using a clever, perceptive sensor.

Wireless media constraint

Wireless media and communication sensors are connected in a multiple-hop sensor network. The optical, infrared, and radio media might be used to create these connections. It is possible for the chosen transmission medium to be globally accessible in order to support network worldwide operation. The sensors are an essential tool for data processing, transfer, and management. The type of medium may be defined by the application design. Radio frequencies are typically utilized for localized communication. However, it consumes more energy. When there are less sensors, the Bluetooth equipment can be employed as the transmission medium. In a similar vein, this will require more energy for data transmission. Furthermore, according to Akyildiz et al. (2002), infrared can also be utilized as the transmission medium.

Wireless Sensor Node Components

The transceiver unit, processor unit, power unit, and sensing unit make up the four main parts of the sensor node itself. They may be overly reliant on the application. similar to the power generator, mobilizer, and location detecting system.

Unit of sensing

The main part of the sensor node is enclosed by the sensing unit. That is going to have a particular node application. A thermistor must be utilized as the sensing device if WSN is being used for temperature monitoring. The sensor device may vary depending on the application.

Unit of processing

As the processing unit, the programmable microcontroller module functions. By giving instructions to control commands in tandem, this processing unit manages the sensor's whole operation. Appliances from Texas, Siemens, Atmel, and other manufacturers that offer microprocessor chips are some of the leading brands in the market for microcontrollers.

Unit of transceiver

The device that houses the common circuit or performs both transmitter and receiving functions in single shares is called a transceiver.

Unit of power

The sensors are given life by a power unit. This device stores the battery, usually with the option to recharge it. As previously said, advancements in power units could result in solar indicting. The extended life power standby with smart power sentient allows for both regular power and solar energy boosting on demand. This will accelerate the sensor network process in the amazing application that this period sorely needs.

Realtime Sensor Nodes

The need for ongoing, closed surveillance grows as the number of elderly persons rises. In addition to being necessary for the assessment of when and how much medication to take, continuous and real-time monitoring may also be necessary for the detection of emergencies. Typically, the ambulatory system may permit such monitoring. Numerous small, continuous monitoring devices had been developed. In this case, the researchers are funding the sensors, and academics, developers, and form factor assessors are all acknowledged in the section that already exists.

The ring sensor

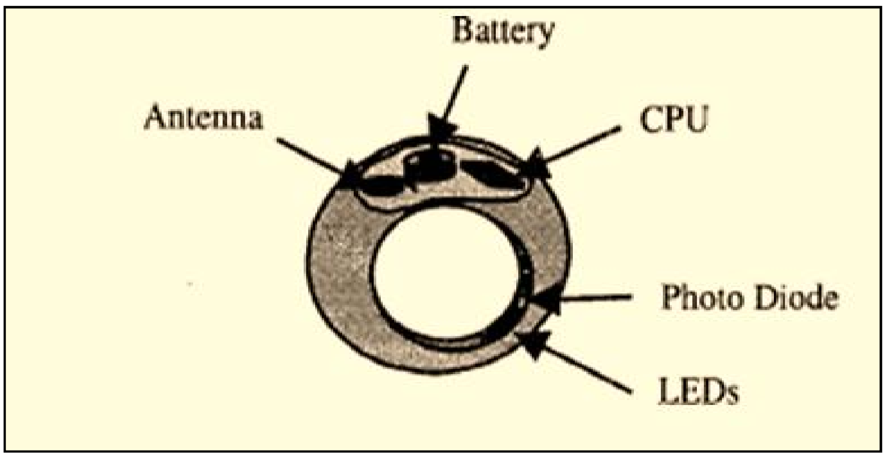

Figure 1: The ring sensor conceptual diagram

The serious medical technology is closed-loop, continuous monitoring. As a result, the number of elderly individuals living alone is continuously rising, making health monitoring for them at home extremely important. In a similar vein, there is an urgent need for operational technologies that can continually and remotely monitor a patient's health and identify any characteristics of potential hazards or abnormal circumstances after the patient is discharged from the hospital. Two small, unending surveillance devices were in place. for the purpose of providing elder care. However, the functionality of these devices lacks age for wearers' comfort and measurement, which has prevented widespread acceptance. One of the greatest solutions is the ring sensor (Boo-Ho et al., 1998).

Smart dust

In 2001, Kristopher Pister unveiled the first smart dust sensors—environment monitoring tools with self-organizing capabilities. These devices have the capacity to measure various factors, process data, and transmit it wirelessly to the user. This sensor's memory, power supply, microcontroller, and transmitter are its main, effective components. The primary power source for smart dust is the battery (Denis Spirjakin et al., 2015).

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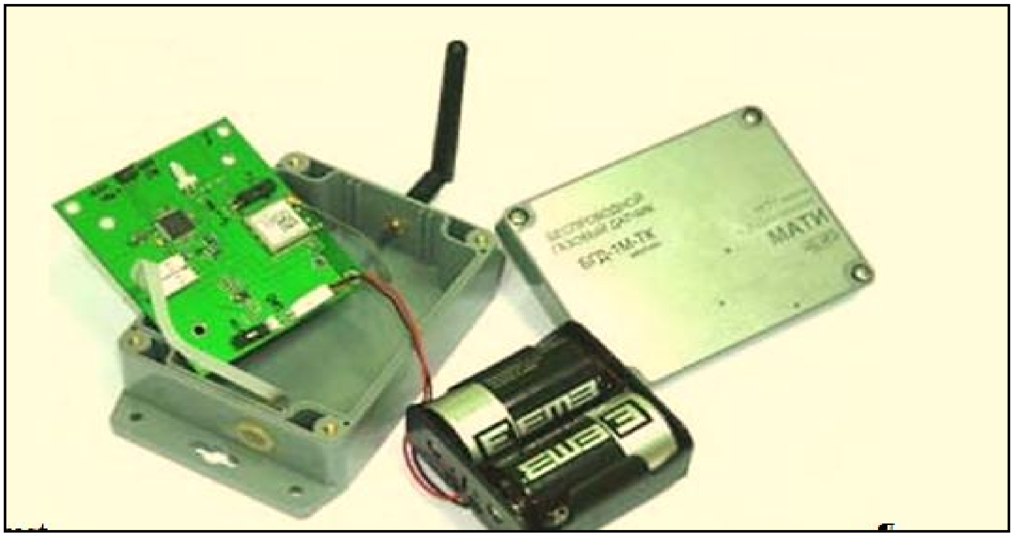

Figure 2: The smart dust

E - Nose

Kristopher Pister created self-organizing smart dust sensors in 2001 for environmental monitoring. These devices measure parameters, process data, and send it wirelessly. This sensor's memory, power source, microcontroller, and transceiver are efficient. Smart dust relies on batteries (Denis Spirjakin et al., 2015).

WINS NG

Figure 3: WINS NG

WINS (Wireless Integrated Network Sensors) technology combines independent sensor nodes, CPUs, actuators, and self-accumulated wireless networks.

The Mote MICA

The Emerging model form of 1mm2 sensor nodes is MICA. Motes can control LEDs, send brief radio messages, and connect to PCs via serial ports. Motes with two arrangements:

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Rectangular mote: This mote is 5.7 x 3.18 cm and fits on top of two AA batteries.

Figure 4: The Mote Rectangular

Circular mote: This mote measures 2.5 x.64 cm. These motes top 3V button cells.

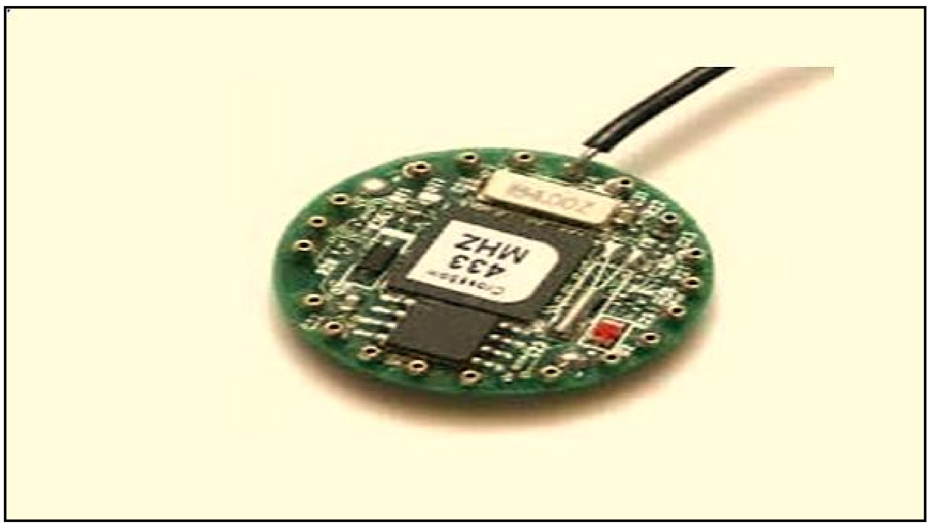

Figure 5: Circular Mote

Typical Sensor node

The battery and typical sensor are illustrated in figure 4. Such sensor nodes are used for that purpose. Section 3 defines programmable microcontrollers as situation-specific programs. This allows the construction, design, and deployment of various sensor nodes.

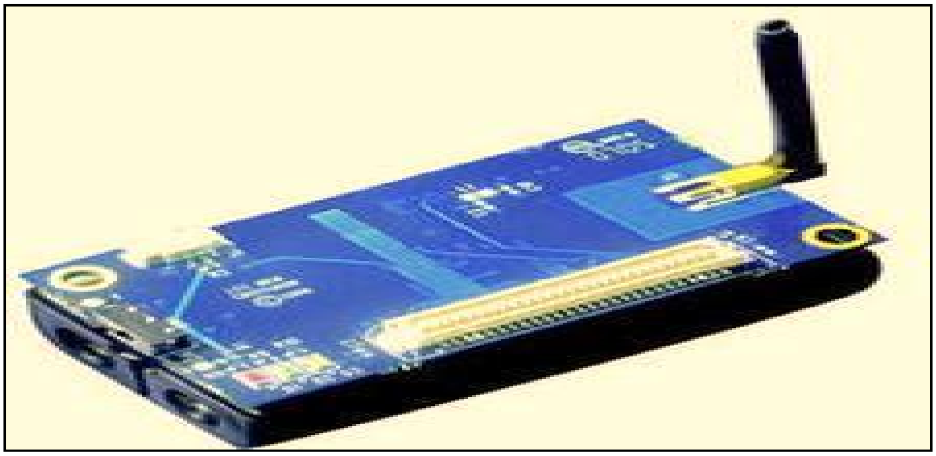

Figure 6: Typical Sensor node

Configuration of Sensor Node

This section contains certain sensor nodes with basic configurations that have optimistic internal functioning. The following sensors are reserved for major I/O, memory, CPU, and radio appliance use. Which helps choose the best structure for a certain application.

The Tmote

Texas Gadgets 8 MHZ CPU with MSP430 microcontroller, 48k Flash, 10k RAM. I/O Integrated Temperature, Light, and Humidity sensors with 250kbps radio and 2.4 GHz IEEE 802.15.4 Chip-con Wireless Transceiver.

Sensoria WINS 3.0

The 32MB Flash and 64MB SDRAM Intel PXA255 CPU (scalable from 100 to 400 MHz) has I/O sensor nodes with single port device, GPS, RS-232 serial, USB-2 host ports, Audio in/out, Card-Bus/PCMCIA. Dual 802.11b radio modules.

Uamps Mit

It has a StrongARM CPU SA-1100 with 512KB ROM and 16Mb RAM memory, acoustic and seismic sensors, and a radio interface with ISM 2.45 GHZ operating band, 1Mbps data rates, and 15-meter range.

The EYES

This design has a 5 MHz, 16-bit MSP 430F149 CPU, 60 Kbs programmable memory, 2 Kbs data memory, and 4 Kbs EEPROM. UART, I/O, AD, sensor board with compass and JTAG interface, temperature, accelerometer, pressure, light, push button lines, and microphone. Also, the RFM hybrid TR1001 transceiver.

The IPAQ UCLA

IPAQ UCLA has a 206MHz Intel StrongARM CPU, 32 Flash and 64MB RAM memory, a speaker, microphone, USB and RS232 serial interface I/O Acoustic sensor. The IEEE 802.11 radio supports 11Mbps.

Mica2

Mica2 has an Atmel-ATmega 128L CPU with 128K RAM and 4K Flash memory, a large I/O sensor extension connection, and a multi-channel transceiver with 38 K-baud data rates for 433, 315, or 868/916 Mhz.

Imote

The Imote has 512 KB Flash, 64KB SRAM, and 12MHZ ARM core CPU. Sensor I/O is via UART and USB. A 30m Bluetooth radio for wireless communication.

The WSN Operating System

OS represents hardware functional components. After selecting the right configuration, the sensor gathers application data and must involve all processor-related external and internal devices. The operating system does this. Overall sensor design succeeds. This section clearly considers design and directs operating system spending.

The Tiny OS

Tiny OS has component graph and scheduler. This component has four associated fragments: event handler set, command handler set, basic task bundle, and frame fixed-size. Frame context execution and state manipulation commands, handlers, and tasks. Every part announces instructions and commands, making modularity easy. Non-blocking commands are sent to lower-level components. These handler of event are appealed which deals with the event of hardware. Tasks complete application work. But events may be pre-empted.

FIFO is the task's scheduler because it uses constrained data structure scheduling. Power awareness is crucial for schedulers. This is BSD-licensed open source community contribution. The independence of an Open source OS for real-time system development benefits researchers, developers, and academics.

The tiny OS supports low-powered wireless policies including sensors, personal networks, and tiny memory devices to power research, design, and small procedures. NesC contains small OS's system, apps, and library. NesC is a new programming language module classification. This language fits surrounded structure well.

This application uses C-like syntax. That fully supports the TinyOS concurrency model by arranging, linking, and identifying software components into a powerful system.

SOS

Sensor nodes' operating system, the SOS, provides embedded software reconfiguration runtime. SOS has a statically compiled kernel with dynamically loaded modules. One or more SOS modules interact via function calls or asynchronous messages. Module binaries implement specified functions or tasks individually.

II. CONCLUSION

Sensor network development is unlikely and stable. This evaluation shows sensor node comprehension, software design, and hardware and configuration module limits. SensSIM, NS2, and GlomoSIm simulate sensor environments in various ways. In application, this offers wonderful opportunity to improve various real-time applications that can help humans protect themselves.

REFERENCES

[1]. He, Cairan, et al. "A MEMS self-powered sensor and RF transmission platform for WSN nodes." IEEE Sensors Journal 11.12 (2011): 3437- 3445.

[2]. da Costa, Murilo NJ, et al. "Building smart sensor nodes according to IEEE 1451.3 standard." 2011 Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE, 2011.

[3]. Yick, Jennifer, Biswanath Mukherjee, and Dipak Ghosal. "Wireless sensor network survey." Computer networks 52.12 (2008): 2292-2330.

[4]. Pilloni, Virginia, et al. "Deployment of Applications in Wireless Sensor Networks: A Gossip-Based Lifetime Maximization Approach."

[5]. Sakthidharan, G. R., and S. Chitra. "A survey on wireless sensor network: An application perspective." Computer Communication and Informatics (ICCCI), 2012 International Conference on. IEEE, 2012.

[6]. Younis, Mohamed, et al. "Topology management techniques for tolerating node failures in wireless sensor networks: A survey." Computer Networks 58 (2014): 254-283.

[7]. Akyildiz, Ian F., et al. "A survey on sensor networks." IEEE communications magazine 40.8 (2002): 102-114.

[8]. Intanagonwiwat, Chalermek, Ramesh Govindan, and Deborah Estrin. "Directed diffusion: a scalable and robust communication paradigm for sensor networks." Proceedings of the 6th annual international conference on Mobile computing and networking. ACM, 2000.

[9]. Bulusu, Nirupama, et al. "Scalable coordination for wireless sensor networks: self-configuring localization systems." International Symposium on Communication Theory and Applications (ISCTA 2001), Ambleside, UK. 2001.

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[10]. Yang, Boo-Ho, Sokwoo Rhee, and Haruhiko H. Asada. "A twenty-four hour tele-nursing system using a ring sensor." Robotics and Automation, 1998. Proceedings. 1998 IEEE International Conference on. Vol. 1. IEEE, 1998.

[11]. Spirjakin, Denis, Alexander M. Baranov, and Vladimir Sleptsov. "Design of smart dust sensor node for combustible gas leakage monitoring." Computer Science and Information Systems (FedCSIS), 2015 Federated Conference on. IEEE, 2015