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A Survey on Applications of Smart Sensor Networks in Building a Futuristic Smarter World

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Abstract:
In today's world everything is getting smaller, technically advanced, intelligent smarter and automated to contribute to the smarter living.
Internet of Things is going to be the major contributing technology in building these automated and intelligent systems to build smarter world in the near future.
Thus there arises the need to know about the smart sensors which is an important tool in construction of the Internet of Things around us to build the automated and smarter systems.
This paper surveys about how the smart sensors networks can be used in various applications used to build the automated systems for the smarter and better living.

1. Introduction

Sensor node combines the sensing and computing abilities of devices which are connected through wireless communication. The network of such sensor nodes provides data as well as performing and controlling various tasks and functions. While implementing sensor nodes in simple or complex networks, the size and cost of individual sensor node is of vital importance. When sensor nodes are used in the networks of environmental data collection, target tracking and surveillance it yields various applications along with time-space context. Sensor networks can also be used for supporting and preventing rapid response during events and post recovery along with analysis after event. Large number of sensor nodes could be installed to benefit the environment in practical e.g. riverbanks, roads, buildings, coastal areas etc. New sensor nodes can be deployed depending upon the area of interest on demand or at random in specified area. A smart sensor node is a combination of sensing, processing and communication technologies.

2. Structure of Smart Sensor

A sensor node typically consists of five main parts: one or more sensors gather data from the environment. The central unit in the form of a microprocessor manages the tasks. A transceiver (included in the communication module in Figure 1) communicates with the environment and a memory is used to store temporary data or data generated during processing.

The battery supplies all parts with energy (see Figure 1). To assure a sufficiently long network lifetime, energy efficiency in all parts of the network is crucial. Due to this need, data processing tasks are often spread over the network, i.e. nodes co-operate in transmitting data to the sinks (Verdone et al., 2008). Although most sensors have a traditional battery there is some early stage research on the production of sensors without batteries, using similar technologies to passive RFID chips without batteries.

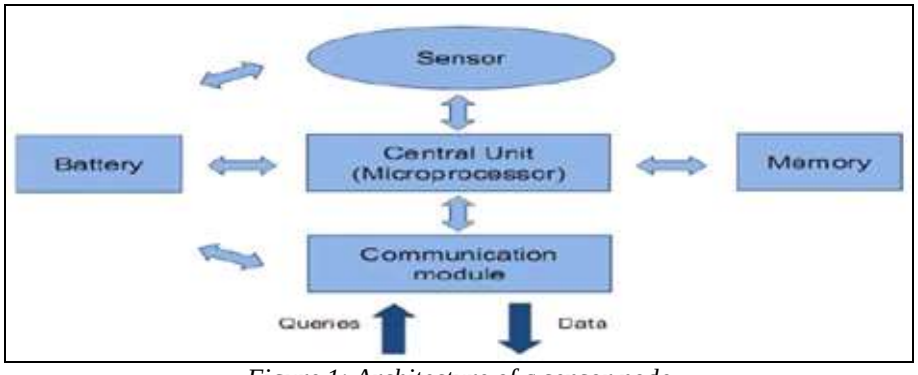

Figure 1: Architecture of a sensor node

3. Application of Smart Sensor Networks in Various Fields

There are numerous different fields of application of sensor networks. For example, they are used in the health care sector to monitor human physiological data. The following sections outline selected applications of wireless smart sensor networks.
This section briefly explains the areas of applications of WSN and Smart nodes but not limited to the list

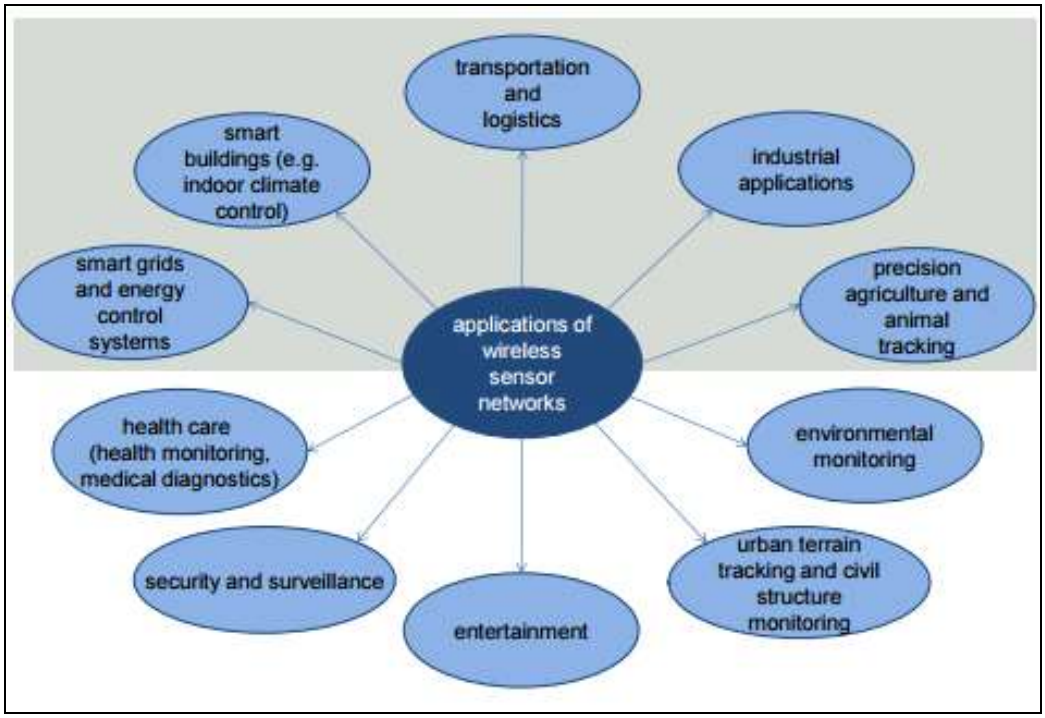

Figure 2: Applications of wireless Smart Sensor network

3.1. Flood and Water Level Monitoring System

In order to cope with natural disasters like earth quakes and floods in a fast and highly coordinated manner, the system which gives information about concerned situation is important. WSN technology has newly emerged which can handle these types of disasters. But deploying these kind of sensor networks for flood monitoring requires lots of potential

3.2. Environmental Monitoring

Environmental monitoring system is very important in analysing the important data for forecasting weather and even for measuring the possible environmental threat, that to be prevented before they occur. Environmental monitoring system involves collecting of information from a large geographical area by which even minute variations in the environment can be calculated. Seabird habitats can also be monitored using WSN.

3.3. Traffic Monitoring and Controlling

The need for having an efficient traffic controlling and monitoring system is very demanding. Deployment of smart sensors along with the roadside made many developed countries possible to collect live data or to monitor irresponsible vehicle violating the speed limit. Placing sensor nodes at the identified spots with the addition of wireless communications could help for the development of a smart traffic monitoring system. Apart from above mentioned system, a simple traffic signal system could also be equipped with intelligent sensing devices at the road intersections. The smart sensing device would gather information of upcoming objects towards the intersection; perform scheduling to determine the time-towait (TTW) interval for signals to be changed. Time-to-wait is determined by the time gap between different crossing objects. Hence, automated signal changing would never keep the motorist waiting in one side for a longer time.

3.4. Energy Saving in Artificial Lighting

Saving energy in smart environment systems is one of the main goals of smart environment research. Wireless sensor networks (WSNs), large networks of embedded devices, containing microcomputers, radios, and sensors open new methods and approaches to saving energy. WSNs are used to retrieve data on lighting conditions. Several approaches have been proposed to save energy in this scenario. One approach considers inhabitant preferences about lighting and learns them in order to automatically adjust lighting to satisfy these preferences. A theoretical computation of how many lumens are provided by our artificial lighting setup can be made.

3.5. Remote System Monitoring and Equipment Fault Diagnostics

WSN provides feasible and cost-effective sensing solutions for these types of systems. Large scale efficiently monitoring system can provide complete; information on the conditions of system components, including generation units, transformers, transmission lines, motors, etc., in a remote and online manner.

3.6. Transport and Logistics

An intelligent transportation system (ITS) can be defined as "the application of advanced and emerging technologies (computers, sensors, control, communications, and electronic devices) in transportation to save lives, time, money, energy and the environment" The ITS can be categorised into intelligent infrastructure and intelligent vehicles.

3.7. Industrial Applications

In industrial field, machines or equipment are monitored and controlled for checking pressure, overall health, humidity, temperature and also vibrations. When critical information about any parameter is achieved the nodes communicates with each other and sends the information to network where it is processed and then predictive maintenance is carried out according to the parameter values.

3.8. Precision Agriculture and Animal Tracking

In precision agriculture, sensor networks can be used to soil monitoring, climate monitoring, insect-disease-weed monitoring as well as plant/crop monitoring.

4. Upcoming Applications of the Smart Sensors Networks

In near future there are several application domains which will be directly impacted by the emerging Internet of Things using Smart Sensor network as the major component .The applications can be classified based on the type of network availability, coverage, scale, heterogeneity, repeatability, user involvement and impact

. We categorize the applications into four application domains:

- Personal and Home
- Enterprise
- Utilities
- Mobile

4.1. Personal and Home

The sensor information collected is used only by the individuals who directly own the network. Usually Wi-Fi is used as the backbone enabling higher bandwidth data (video) transfer as well as higher sampling rates (Sound). Ubiquitous healthcare has been envisioned for the past two decades. IoT gives a perfect platform to realize this vision using body area sensors and IoT back end to upload the data to servers. For instance, a Smartphone can be used for communication along with several interfaces like Bluetooth for interfacing sensors measuring physiological parameters. So far, there are several applications available for Apple iOS, Google Android and Windows Phone operating systems that measure various parameters. However, it is yet to be centralized in the cloud for general physicians to access the same. An extension of the personal body area network is creating a home monitoring system for elderly care, which allows the doctor to monitor patients and the elderly in their homes thereby reducing hospitalization costs through early intervention and treatment. Control of home equipment such as air conditioners, refrigerators, washing machines etc., will allow better home and energy management. This will see consumers become involved in the IoT revolution in the same manner as the Internet revolution itself .Social networking is set to undergo another transformation with billions of interconnected objects. An interesting development will be using a Twitter like concept where individual 'Things' in the house can periodically tweet the readings which can be easily followed from anywhere creating a TweetOT. Although this provides a common framework using cloud for information access, a new security paradigm will be required for this to be fully realized

4.2. Enterprise

We refer to the 'Network of Things' within a work environment as an enterprise based application. Information collected from such networks are used only by the owners and the data may be released selectively. Environmental monitoring is the first common application which is implemented to keep track of the number of occupants and manage the utilities within the building (e.g., HVAC, lighting). Sensors have always been an integral part of the factory setup for security, automation, climate control, etc. This will eventually be replaced by a wireless system giving the flexibility to make changes to the setup whenever required. This is nothing but an IoT subnet dedicated to factory maintenance. One of the major IoT application areas that is already drawing attention is Smart Environment IoT There are several test beds being implemented and many more planned in the coming years.

4.3. Utilities

The information from the networks in this application domain is usually for service optimization rather than consumer consumption. It is already being used by utility companies (smart meter by electricity supply companies) for resource management in order to optimize cost vs. profit. These are made up of very extensive networks (usually laid out by large organization on a regional and national scale) for monitoring critical utilities and efficient resource management. The backbone network used can vary between cellular, Wi-Fi and satellite communication. Smart grid and smart metering is another potential IoT application which is being

implemented around the world. Efficient energy consumption can be achieved by continuously monitoring every electricity point within a house and using this information to modify the way electricity is consumed. This information at the city scale is used for maintaining the load balance within the grid ensuring high quality of service. Video based IoT, which integrates image processing, computer vision and networking frameworks, will help develop a new challenging scientific research area at the intersection of video, infrared, microphone and network technologies. Surveillance, the most widely used camera network applications, helps track targets, identify suspicious activities, detect left luggage and monitor unauthorized access. Water network monitoring and quality assurance of drinking water is another critical application that is being addressed using IoT. Sensors measuring critical water parameters are installed at important locations in order to ensure high supply quality. This avoids accidental contamination among storm water drains, drinking water and sewage disposal. The same network can be extended to monitor irrigation in agricultural land. The network is also extended for monitoring soil parameters which allows informed decision making concerning agriculture.

4.4. Mobile

Smart transportation and smart logistics are placed in a separate domain due to the nature of data sharing and backbone implementation required. Urban traffic is the main contributor to traffic noise pollution and a major contributor to urban air quality degradation and greenhouse gas emissions. Traffic congestion directly imposes significant costs on economic and social activities in most cities. Supply chain efficiencies and productivity, including just-in-time operations, are severely impacted by this congestion causing freight delays and delivery schedule failures. Dynamic traffic information will affect freight movement, allow better planning and improved scheduling. The transport IoT will enable the use of large scale WSNs for online monitoring of travel times, origin–destination (O–D) route choice behavior, queue lengths and air pollutant and noise emissions. The IoT is likely to replace the traffic information provided by the existing sensor networks of inductive loop vehicle detectors employed at the intersections of existing traffic control systems. They will also underpin the development of scenario-based models for the planning and design of mitigation and alleviation plans, as well as improved algorithms for urban traffic control, including multi-objective control systems.

5. Conclusion

In recent technologies, WSN has got the spotlight on it because of its unbeatable potential, significance and wide range of application areas. As wireless sensor technology has evolved, it has become possible to predict the future by using Smart environment which was not possible in the past. "Smart Sensors" is Wireless Sensor Network's one step further. This paper is mainly focuses on the study of smart sensors and their possible and existing usage in various fields. It gives an overview of sensor and sensor networks applications. It discusses selected fields of application which have a high potential to tackle many environmental challenges.

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