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The Use of Wireless Sensors Network for Supporting Human Daily Activities

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Abstract: *This paper presents the comparative study of wireless sensors network, which are applied in a domestic environment, in the assembly production line of an industrial environment and in environmental applications. More specifically the recording), the explanation of the functional parts as well as their working scenario and application examples will be realized. The paper is completed with the recording of the results of comparing the applications of wireless sensors network (WSN) and of their advantages and the listing of their advantages and disadvantages.*

Keywords -*Wireless sensor networks, Smart home, Industry, Environment, WSN*

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I. Introduction

Research on Wireless Sensor Network – WSN started in the middle of the 20th century. In the following figure the evolution of WSN through time is presented.

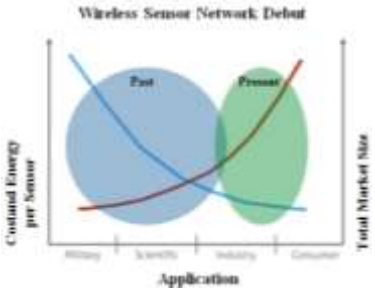

Figure 1: The evolution of Wireless Sensors Network through time

The two curves of the figure comprise the cost and the energy per sensor and the portion of the market that WSN occupy, whereas the blue and the green pertain to the width of WSN applications in the past and present (see [1]).

The construction of WSN consists of nodes which are spread in an area. Each node can collect various data, process them and finally send them back to the collector node (sink node) which in turn sends them to the users concerned. These data are sent via the central node (sink node) to the final users using a multihop, which doesn't have an architectural infrastructure. Afterwards, the sink node communicates with the internet or the satellite (see[2]).

In the following figure 2 the protocol stack of WSN is presented (see[3]).

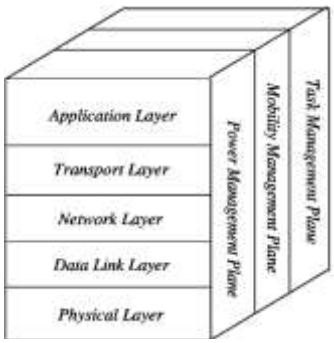

Figure 2: Protocol stack of a Wireless Sensor Network

Power, task and mobility management planes are responsible for the power, the movement and the dissemination of information between the sensor nodes. The power management plane is used to manage the power of a sensor node. The mobility management plane is responsible for the amplification and recording of the sensors movement. The task management plane can programme and balance the measurements made in an area by the sensor nodes (see[4]).

The wireless technologies are categorized according to the following criteria:

- The protocol use
- The type of connection
- The frequency of its operation

The applications that use WSN are numerous. WSN have high frequency sampling rate capability in an environment where human intervention is difficult. Figure 3 follows with the categories of WSN applications (see[5]).

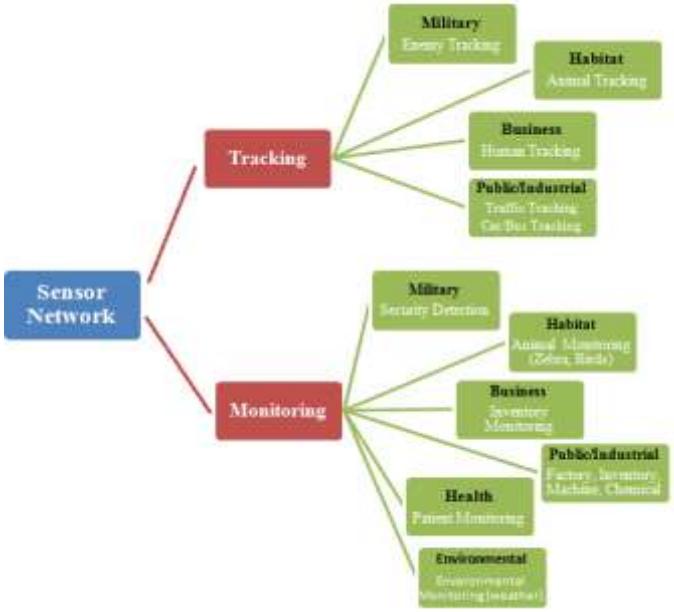

Figure 3: Categories of WSN applications

II. Parameters of WSN designing and architecture

2.1. WIRELESS SENSOR NETWORKS IN INDUSTRIAL ENVIRONMENT

For the development of a WSN industrial application a combination of knowledge from different disciplines is needed. The basic parameters for the design of a Wireless Sensor Network in industrial applications:

1. Efficiency and quality of rendered services: The efficiency and quality of services rendered in industrial wireless sensor networks are examined in relation to their reliability, coexistence of WSN with other systems, time delay, deadline and time limit, safety, data streaming input, adaptability to new settings and transmissions, cost effectiveness.
2. Operating power: It consists a major design drawback for battery-powered wireless sensors.
3. Versatility and expandability: Wireless Sensor Networks must have the capability to support a small or large number of sensors and actuators without the performance of the system being influenced.
4. Topology: Mesh networks are characterized by their large potential for expansion, offering higher power performance than the equivalent one hop networks, as well as service quality.
5. Wireless transmission: With the proper radio frequency technologies the influence of interference in a wireless sensor network can be minimised.
6. System and software: In the applications software, access must be provided using an Application Programming Interface – API and it has to be adaptable to the demands of standards and customers, for the quicker development and installation of a network.

2.1.1. Example of a wireless sensor network use in industrial environmentWireless Sensor

Wireless sensor networks are applied to many applications in industrial automation. Below is an example of a wireless sensor network in industrial environment.

At the University of Oulu, tests were made on the performance of a wireless network in industrial environment, on a demo system in the mechanical control laboratory.

For the sake of the experiment four measurements were made, one for the steam pressure and three for the temperature. Temperature measurements were made in the combustion chamber (around 1500oC), on the surface of the pipe (about 300oC) and the gas supply pipe (about 300oC), while the steam pressure measurement was conducted by the cursor bypass cursor (around 13 bar).

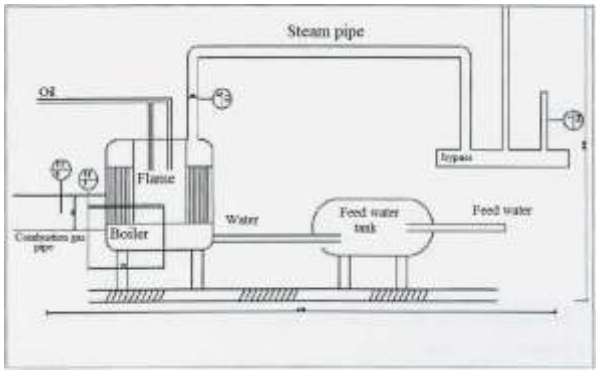

Figure 4: Steam boiler example

In the figure below (15), the wireless network sensors and sensors applied to record temperatures and pressure of steam boiler are presented (see[7]).

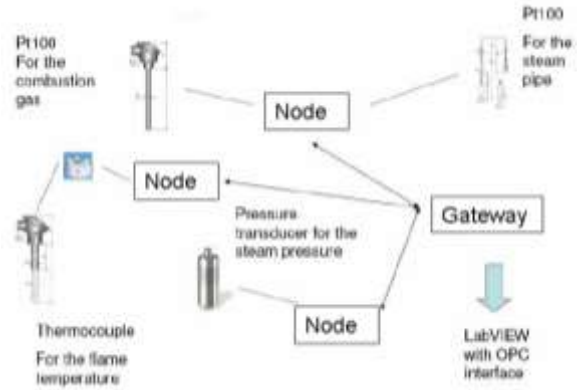

Figure 5: The WSN and sensors used to monitor the temperature and pressure of the steam boiler

2.2. WIRELESS SENSOR NETWORKS IN "SMART HOME"

1. Examples of using WSN in "Smart home"

In indoor building places solar lamps are suitable for saving energy in combination with photovoltaic systems. The combination of luminaires with presence sensors make an intelligent lighting for the interior and the exterior of a dwelling (see [7]).

2. Energy efficient fireplace

A modern fireplace includes a specialized sensor system, suitable to detect CO2. The user controls the above functions through from smartphone (see [9]).

3. Gas detection system

In the kitchen or toilet through smoke detection sensors or gas leakage, they warn, through measurements, for the concentration of excess gas quantity. The sensors are connected with those of the windows, opening them to assist the ventilation of the house (see [10]).

2.3. WIRELESS SENSOR NETWORKS IN "ENVIRONMENTAL APPLICATIONS"

A wireless sensor network installed in a field or in a farm differs in function depending on the intended use. There are a lot of sensors used by herders or farmers, to carry out measurements or tasks, to improve their way of working.In figure 6 the architectural structure of such a Wireless Sensor Network is depicted.

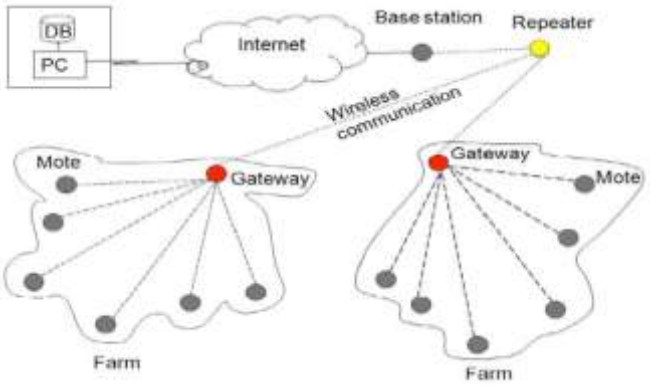

Figure 6: Wireless sensor networks in "environmental applications"

Some of the sensors used are the following:
- For the measurement of the environmental temperature
- For livestock monitoring
- For tracking plant diseases and moisture
- For monitoring the direction and speed of the wind.

2.3.1. Examples of wireless sensor networks use in"environmental applications"

1. WSN application in the cultivation of potatoes

The purpose of using a wireless sensor network in potato cultivation is the improvement of its quality and the regulation of irrigation.

2. WSN application on animal collars

A sensor has been positioned on the collar making various measurements for the herder to use. Getting the values of the measurements, the herder, can check the behavior of the animal under any change to the environment at any time (see [11]).

3. Habitat and wetland monitoring network

For the monitoring of ecosystems, a wireless sensor network offers many benefits as they provide immediate information on specific conditions, such as the behavior of animal and vegetable organisms (see [12]).

III. WSN comparison

Wireless sensor networks have sparked the interest of many researchers lately, and a result of these studies is the improvement of many applications, using the WSN. Originally a WSN is easy to install and maintain and can be installed in areas hard to access. The installation cost is low and its application scope is not limited.In addition, it supports a multitude of protocols, covering any need to design and change system conditions.Finally, the data transfer rate and the large error tolerance makes a wireless sensor network more competitive compared to a wired network.

3.1. COMPARISON OF WIRELESS SENSOR NETWORKS IN INDUSTRIAL ENVIRONMENTS

In previous years the use of wired networks was more common than wireless networks. This was due to the large financial costs of their installation. In recent years however, the cost has dropped and they are increasingly installed.

In an industry, the interference coming from electromagnetic noise is likely to degrade the signal quality of the system. To ensure network stability, a radio spectrum should be used.The quality of the services offered by a WSN is high, providing high accuracy in data delivered to central control.The security provided by a wireless sensor network is limited, since there are many ways to intercept, jamming and seizure of nodes, creating serious problems in the network.Another factor rendering a wireless sensor network appealing is the large degree of flexibility.Table 1 with the advantages and disadvantages of using wireless sensor networks in industrial production.

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Table 1: Advantages and disadvantages of WSN use in industrial environments

ADVANTAGES	DISADVANTAGES
✓ Low cost of installation and maintenance.	✓ Limitation on supply power.
✓ Reduction of electromagnetic interference via radio spectrum.	✓ Possibility of data theft.
✓ Define network security in the original design.	✓ Potentially expandable system within the radius of the network.
✓ Data accuracy	✓ Time limit in data reception.
✓ Great flexibility and scalability.	✓ Coordination is required between nodes.
✓ Improved services offered.	
✓ Increase of the nodes without interruption in the production process.	
✓ Installation in hard-to-access places.	
✓ Coexistence with other wireless network standards.	
✓ Variety of networking protocols.	

3.2. COMPARISON OF WIRELESS SENSOR NETWORKS IN "SMART HOME"

Applications that are used in a residence, based on a system of wireless sensor networks, are aimed at optimizing of existing applications used in this, with human intervention.

Installing a node sensor system in a residence is costly for the user. Over time, the service cost of older technologies becomes more affordable to the general public.The main advantage of such applications is the monitoring conducted remotely, without the human presence in site.The user can check remotely using their mobile phone or via Internet.A "Smart home" has the potential, if programmed properly to take initiatives and to perform actions automatically.By activating and deactivating various applications within the residence using wireless sensor network, extended energy saving is possible. The user can manage the electrical loads consumed.Moreover, the safety of individuals in the premises as well as the building's is largely guaranteed. A WSN is able to promptly identify and notify about an occurring problem, in real time.The summary table 2, with the advantages and disadvantages of using wireless networks of sensors in a "smart home" can be found below.

Table 2: Advantages and disadvantages of WSN use in "Smart home"

ADVANTAGES	DISADVANTAGES
✓ Remote monitoring ✓ Automated functions ✓ Time saving ✓ Energy saving ✓ Safety for individuals and residence ✓ Living standards improvement	✓ Costly installation for the user

3.3. COMPARISON OF WIRELESS SENSOR NETWORKS IN ENVIRONMENTAL APPLICATIONS

Human activities affect the environment around them. Through the technology of wireless sensor networks, people are given the possibility to monitor both the impact of environmental conditions and that of human activities on the environment and to intervene directly on them.

If the environment for study is huge (e.g. many acres estate), the number of sensor nodes that will be installed should be large, so that more measurements are recorded. This of course, has a high cost in relation to the employer, but in this way their needs will be met properly.On the other hand, the recordings made by wireless sensors will save money on the user, as they will be able to know precisely the environmental conditions and to act accordingly, without unnecessary waste of money. Furthermore, the employer sets up all actions without the physical presence in the area. In this way working hours are reduced.The main problem of wireless sensors in this application category is the energy consumption by the nodes. Specifically, when the expansion understudy is large, the energy consumed by the nodes is large too.Table 3 with the pros and cons of applying the wireless networks of sensors in the environment is shown below.

Table 3: Advantages and disadvantages of WSN in environmental applications

ADVANTAGES	DISADVANTAGES
✓ **Accurate monitoring of environmental conditions** ✓ **Money saving** ✓ **Protect the environment from unnecessary actions** ✓ **Remote monitoring** ✓ **Fewer working hours**	✓ High cost of installation in cases of a study on large expansions. ✓ High power consumption

IV. Conclusions & Future Recommendations

Wireless sensor networks consist of sensor nodes, autonomous, that are designed to monitor and record various conditions. In this dissertation, a comparative study was conducted based on applications of wireless sensor networks. Specifically, it examined the wireless sensor networks applied in industries, smart homes and in environmental applications which create a smart environment, which is capable to serve human needs.

A wireless sensor network in industrial environment is the best choice of technology, in order to achieve more effective communication in network data. For better utilization, proper planning needs to be made from the start. The design of the network, all restrictions within an industrial environment as well as its demands should be taken into consideration. With the proper modifications, mobile devices could be installed in the wireless sensor network, so as to exploit more data and increase the number of applications to cooperate with the network.

The option to install a wireless sensor network in a "Smart home" can bring primarily significant benefits to people living in it. Their installation facilitates the use of devices that are located inside the residence, but also in the building itself since it ensures a high degree of safety. In the future a monitoring system for patient with impaired mobility or vision could be created, so they can look after themselves.

Through the wireless sensors networks, monitoring of environmental applications have significantly improved. Despite the large amount of energy consumed by nodes in wireless networks, the advantages for the user are many. Studies should be done to find and create protocols appropriate to balance the energy consumed by the system.

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