Introduction

Wireless sensor networks (WSNs) are one of the promising technologies for the future, where a close interaction with the physical world is essential. Which make us living in a world of connected things, objects and devices. These emerging tiny devices can detect and evaluate different type of data depends of course on the desired applications, and send back the data automatically to us.

WSNs offer a lot of advantages over the classic networks solutions such as low cost, scalability, reliability, flexibility and also the ease of deployment. All these factors together open the door to use them in different applications like in military, environment, healthcare, and security. In military, sensor nodes can be used to detect, locate, or track enemy movements. In case of natural disasters, sensor nodes can sense and detect the environment to forecast disasters in advance. In healthcare, sensor nodes can help in monitoring a patient's health. In security, sensors can offer vigilant surveillance and increase alertness to potential terrorist attacks.

However, the main obstacle over the development of these networks is the limited power supply and the high energy consumption. Therefore many techniques of energy efficiency have been used in wireless sensor networks in order to minimize the energy consumption in every single sensor nodes which leads at maximizing the lifetime of the whole network.

Wireless multimedia sensor networks (WMSNs) are a specific case, which deals with a large amount of data such as videos, images and even scalar data. In this case, an additional effort is really necessary in order to be able to reduce the energy consumption on these nodes like doing a low complexity image and video compression.

Real time processing and transmission using these devices requires image compression algorithms that can compress efficiently with reduced complexity. Due to limited resources, it is not always possible to implement the best algorithms inside these devices. In uncompressed form, both raw and image data occupy a huge amount of space. However, both raw and image data have a significant amount of statistical and visual redundancy. Consequently, the used storage space can be efficiently reduced by compression. In this thesis, a novel low complexity and embedded image compression algorithms are developed especially suitable for low bit rate image compression using these tiny devices.

However, in some cases we need some regions on the compressed image to be clear in order to be able to identify and recognize some important details such as: faces, moving objects…etc. So, the need of region of interest (ROI) coding is necessary in WSNs. The main idea of this coding is to compress and transmit only certain parts of an image which are of a higher importance to the end applications user (i.e. tracking, identification, recognition …etc) in detriment of the rest of the image.

Thesis outlines

This thesis is organized as follows:

In chapter 1, we will give a survey of wireless networks including wireless multimedia sensor networks and we will focus our study on energy conservation problems. Where, we describe the hardware design of a sensor node and we present the key features that influence its design, and we describe in detail the communication process in the network. Also, we will focus on energy problems and we will present a detailed explanation on power dissipation and the reasons of energy waste in wireless sensor networks. We end the chapter with the state-of-the-art solutions to these problems by the classification of energy efficiency techniques.

In chapter 2, we will focus on the available image compression algorithms and techniques under the constraints of WMSNs and explore their theoretical limits on achievable compression. We will also describe some standards of image compression like JPEG, JPEG2000 and SPIHT and their possible integration to WMSNs

In chapter 3, we will propose new DCTs approximations to more reduce the arithmetic complexity and also to maintain a good image quality. Thus, we will have a good trade-off quality /complexity, which is suitable for resource constrained low-power sensors nodes. Also we will prove that the discrete Tchebichef transform (DTT) is a useful tool in image and video compression. Thence we will propose a pruned discrete tchebichef transform (P-DTT) that exhibits low computational complexity and good image compression performance in terms of peak signal to noise ratio (PSNR) and structural similarity index (SSIM).

Finally, chapter 4 will concern the region of interest coding. Where, we will propose a ROI-based image compression. We presents the principles of this proposed method and evaluate it in terms of quality of received images, transmission energy, processing energy and the amount of transmitted data. We will give an extensive comparison to others state-of-the-art methods and we will show the efficiency of the proposed compression techniques.

Chapter 1

Introduction to wireless sensor networks

1.1. Introduction:

Wireless sensor network (WSN) has attracted much attention in recent years, and it has emerged as one of the most promising technologies for the future. They are used in many applications, where a close interaction with the physical world is essential. The simple deployment and the distributed sensing properties provided by a wireless communication system make WSNs an important component of our daily lives.

WSN technology offers numerous advantages over the classical existed networks, where the most important fact is the ease of deployment that allows their use in a wide range of diverse applications [1]. With advancements in this field of research and sensors getting smarter, smaller, and cheaper, a huge number of wireless sensors are being deployed in numerous applications. Some of the potential application domains are military, environment [2-4], healthcare [5-7], and security. In military [8-10], sensor nodes can be used to detect, locate, or track enemy movements everywhere and at any time. In case of natural disasters, sensor nodes can sense and detect the environment to predict disasters in advance. In healthcare, sensor nodes can help in monitoring the health of patients and also to make a remote coordination between doctors and their patients. In security, sensors can offer vigilant surveillance and increase the caution to potential terrorist attacks.

A sensor network is composed of a large number of tiny devices called sensor nodes, where each node is connected to one or several sensors. Each sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting.

Sensor nodes are densely deployed either inside the phenomenon or very close to it and their position do not need to be engineered or pre-determined, this allows random deployment in inaccessible areas. On the other hand, this also means that sensor network protocols and algorithms must possess self-organizing capabilities.

One of the most important constraints on sensor nodes is the low power consumption requirement. Sensor nodes have limited power sources. Therefore, while traditional networks aim to achieve high quality of service (QoS) provisions, sensor network protocols must focus primarily on power conservation. They must have inbuilt trade-off mechanisms that give the end user the option of prolonging network lifetime at the cost of lower throughput or higher transmission delay.

In this chapter, we will present a survey of wireless networks and focus our study on energy conservation problems. In section 1.2, we will give an overview on wireless sensor networks describing the hardware design of a sensor node and present the factors that influence on wireless sensor network functioning. Section 1.3 details the communication process for sending and receiving a specific data in the wireless sensor network. Section 1.4 focuses on energy problems and present a detailed explanation on power dissipation and the reasons of energy waste in wireless sensor networks. We will also try to give a solution to these problems by the classification of energy efficiency techniques. Finally, a general overview on wireless multimedia sensor networks and theirs characteristics is given in section 1.5.

1.2. Wireless sensor networks characteristics

The design of WSNs requires a huge knowledge of a wide variety of research fields including wireless communication, networking, embedded systems, digital signal processing, and software engineering. This is motivated by the close coupling between several hardware entities of wireless sensor devices as well as the distributed operation of a network of these devices.

1.2.1. Internal structure of a sensor node:

Figure 1.1 illustrates the most common scheme of sensor node design. Also the main blocks of each sensor node are represented. Generally, it is contains on four basic components as shown in Fig. 1: a sensing unit, a processing unit, a transceiver unit and a power supply unit. They may also have application dependent additional components [11] such as a location finding system, a power generator and a mobilizer.

Sensing unit: it may generally include several sensor units and each sensor unit is responsible for gathering information of certain type such as: temperature, humidity, or light… etc. they usually composed of two subunits: sensors and analog to digital converters (ADCs). The analog signals produced by the sensors based on the observed phenomenon are converted to digital signals by the ADC, and then fed into the processing unit.

***Processing unit*:** which is generally associated with a small storage unit, the processing unit manages the procedures that enable the sensor node to perform sensing operations, run associated algorithms, and collaborate with the other nodes through wireless communication [12]. *Microcontrollers* carry out the function of controlling all the components, and also process data received from sensing element of this sensor node, as well as data received from other sensor nodes. Microcontrollers are widely used as control elements in a sensor node, by the reason of their low cost, low energy consumption, small size. And also, the ability of finding easily additional modules with various digital and even wireless interfaces, and also with the necessary performance.

***Transceiver unit*:** communication between any two wireless nodes is performed by the transceiver units. A transceiver unit implements the necessary procedures to convert bits to be transmitted into radio frequency (RF) waves and recover them at the other end. Essentially, the WSN is connected to the network through this unit.

Power supply unit: One of the most important components of a sensor node is the power supply unit.

Usually, battery power is used, but also other energy sources are also possible. Each component in the wireless sensor node is powered through this unit and the limited capacity requires energy-efficient operation for the tasks performed by each component [11].

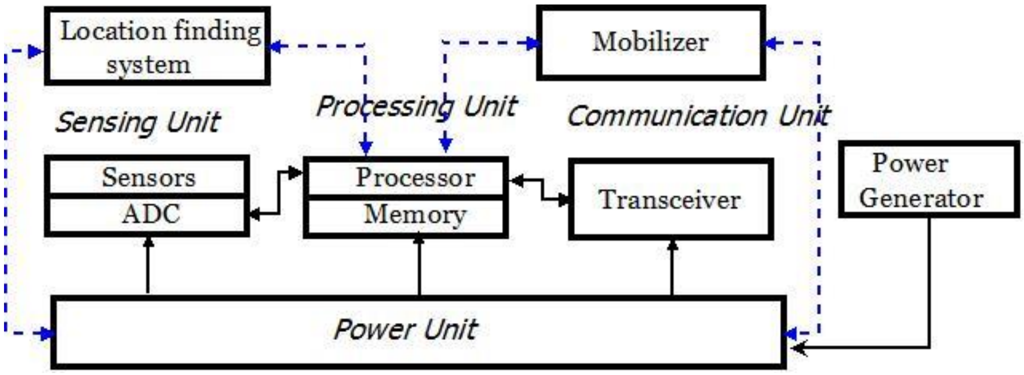

Figure1.1. *Hardware architecture of a sensor node*

***Location finding system*:** Most of the sensor network applications, sensing tasks, and routing techniques need knowledge of the physical location of a node. This module system may consist of a GPS module for a high-end sensor node or may be a software module that implements the localization algorithms providing location information through distributed calculations.

Mobilizer: A mobilizer may sometimes be needed to move sensor nodes when it is necessary to carry out the assigned tasks. Mobility support requires extensive energy resources and should be provided efficiently.

Power generator: While battery power is mostly used in sensor nodes, an additional power generator can be used for applications where longer network lifetime is essential. For outdoor applications, solar cells can be used to generate power. Similarly, energy harvesting techniques for thermal, kinetic, and vibration energy can also be used [13].

1.2.2 Key features influencing sensor network design:

Before designing any sensor node, we must take into consideration the main features and factors that affect directly the capabilities of the whole WSN. The most important of these factors are platform flexibility and scalability; production size and costs; sensor network topology; reliability; power consumption, transceiver Performances and information security. These factors [11] have been addressed by many researchers in a wide range of areas concerning the design and deployment of WSNs. Moreover, the integration of solutions for these factors is still a major challenge because of the interdisciplinary nature of this area of research.

Platform flexibility and scalability: The number of sensor nodes deployed to study a phenomenon may be in the order of hundreds or thousands. Therefore, the networking protocols developed for these networks should be able to handle these large numbers of nodes. The density can range from a few to hundreds of sensor nodes in a region, which can be less than 10m in diameter. The node density depends on the application for which the sensor nodes are deployed. Moreover, the majority of real applications require flexibility and adaptability of the WSN platform. However, each sensor node platform must have the ability to be adjusted to meet the requirements of a specific application.

Production size and costs: Miniaturization, price reduction and the diversity of applications are the keys that lead to the widespread use of WSNs. And since the sensor networks consist of a large number of sensor nodes, the cost of a single node is very important to justify the overall cost of the networks. If the cost of the network is more expensive than deploying traditional sensors, then the sensor network cost cannot be justified. As a result, the cost of each sensor node has to be kept low. Note that a sensor node also has some additional units such as sensing and processing units. In addition, it may be equipped with a location finding system, cameras, mobilizer, or power generator depending on the applications of the sensor networks. As a result, the cost of a sensor node is a very challenging issue and it is proportional to a given amount of functionalities.

Energy consumption: The main concern for operation of WSNs is the energy consumption. For most applications, the sensor nodes are deployed in hard to access areas which make it not feasible to replace batteries of the sensor nodes. Thus, a WSN is required to operate for a long time over months or even years in order to reduce maintenance intervention and gain in time and cost.

Reliability: Reliability in a WSN is the ability of the network to maintain its functionality regardless of the failure of nodes because some sensor may fail or be blocked because of lack of power, physical damage, or environmental interference [14-16]. This should not affect the overall task of sensor network.

Transceiver Performance: One of the key sensor node characteristics is transceiver performance. The main parameters of transceiver performance which affect the sensor node characteristics are maximum data transfer rate, frequency range, modulation method, receiver sensitivity and transmitter power.

In the transceiver parameter between two sensor nodes in WSN has a direct relation between the power of sensor node transmitter and the impact of the interference in the quality of transmitted signal, so the maximum distance allowed between two consecutives sensor nodes specifies the minimum number of sensor nodes necessary for covering the given space by WSN.

Sensor node receiver *sensitivity* represents the ability to receive weak signals. However, increasing the power and sensitivity of sensor node transmitter and receiver leads to higher energy consumption and cost of the sensor nodes. Thus, the benefit in increasing the range of sensor node is not so great. That is why the most common characteristics of transceivers measure up with ones mW of power, which is acceptable in terms of energy consumption and provides reliable wireless connection between sensor nodes at the distance of about 10 meters.

Frequency range of transceiver affects the maximum possible rate of data exchange and the maximum possible distance between the sensor nodes and also the size of the transceiver antenna. Concerning the rate transfer, it is clear the higher is speed of transmission, the less time is necessary for transmitting the same data; hence, transceiver will be switched on for less time. But high speed of transmitting also requires more computing power and energy for this computing, which is not always acceptable in wireless sensor networks constraints.

Sensor network topology: For the raison of its high density in the observed area, sensor nodes must be able to adapt their functionalities in order to maintain the desired topology.

Information security: In wireless sensor network, there are some applications like in applications used in military where the information security is a very important task. In order to meet the security requirements, sensor nodes must be capable of performing complex encrypting and authentication algorithms.

In fact, radio communication channels and the internal memory of a sensor node can be easily tapped and become available for intruders. For communication channel, the only way to avoid it is encrypting of all data transmitted in the WSN by adding an encryption module to the sensor node device and the level of sophistication depends on the required application. But in any case, encryption requires additional expenditure of energy, and it has negative impact on WSN lifetime.

1.3. Sensor networks communication architecture

1.3.1 Overview of the network architecture:

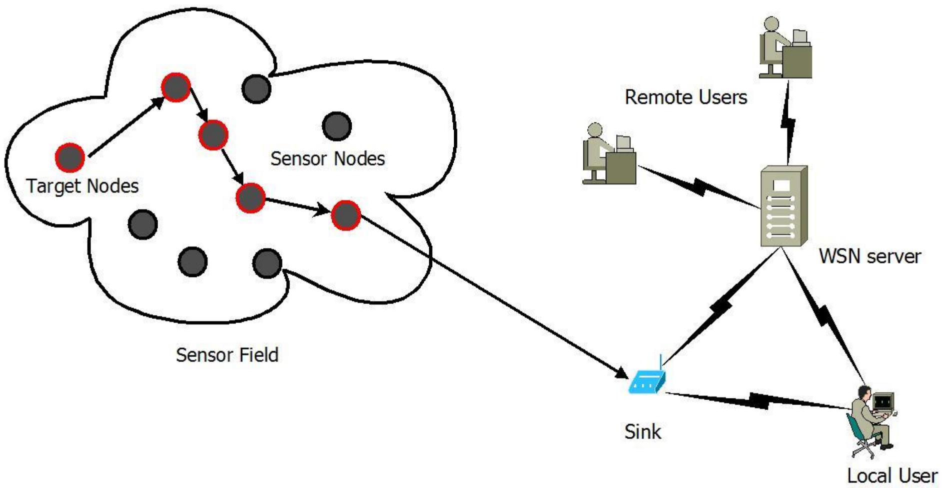

Figure.1.2. *Wireless Sensor Networks (WSNs) structure.*

Sensors networks are a type of wireless networks similar to ad-hoc mobile networks [17]. WSNs are spatially distributed systems which consist of high number of sensor nodes, it could be about dozens, hundreds or even thousands sensor of these devices. They are interconnected with each other through a wireless connection channel to form a single network.

Usually sensor node is an autonomous device. Each sensor node in a WSN measures some physical conditions, such as temperature, humidity, pressure, vibration, and converts them into digital data. After that, it processes the data and stores it in order to transmit them back to the sink and then to the user.

A network sink is a kind of a sensor node which aggregates useful data from other sensor nodes. As a rule, network sink has a stationary power source and is connected to a *server* which is processing data received from WSN. Such connection is implemented directly, if server and WSN are placed on the same object. The interconnection of the sink with an infrastructure network for example internet with a satellite linkage, allows the remote interconnection of the sensor nodes with the user as it is shown in figure1.2. In this case, the sink plays the role of a gate with the external world.

In some cases sensor nodes get in sort of difficult situations where establishing connection with other sensor nodes is not easy. So, successful WSN deployment depends on both the hardware characteristic and the network self-organization protocols which are used.

1.3.2 Sensor networks communication

In WSNs communication is implemented through wireless transmission channel using low power transceivers of sensor nodes. Communication range of such transceivers is set up in the first place for reasons of energy efficiency. So, the sensor node transceiver has limited energy content so a limited range for transmission, this fact makes it impossible for the most spatially remote sensor nodes to transmit their data directly to the sink. So, in WSN every sensor node transmits its data only to a few of its neighbors which, in their turn, they retransmit those data to their nearest sensor nodes and so on. As a result, after a lot of retransmissions the data finally reach the network sink.

However, the sensor node may turn off its receiver after receiving a message from one of its neighbors in order to avoid getting duplicated messages. Also, when the power level of the sensor node is low, the sensor node broadcasts to its neighbors that it is low in power and cannot participate in routing messages. So, the remaining power will be reserved for sensing only.

The microcontroller in each sensor node is the one responsible for collecting data and connecting with other sensor nodes. Microcontroller firmware has a set of algorithms to control the transceiver and the sensing element. These algorithms make it possible to provide an automatic and autonomous sensor node functioning. So, the microcontroller detects and registers the movement of sensor nodes and keeps track of who are their neighbor sensor nodes. By knowing who the neighbor sensor nodes are, the sensor nodes can balance their power and task usage.

WSN has a self-organization feature, in case there is a connection problem with some sensor nodes, it does not make the whole system fail, but the sensor nodes adapt themselves automatically which simplify their installation and maintenance. This fact makes WSN more reliable because network reconstruction can be done in real-time mode, and it allows the WSN to quickly react to the environment changes or sensor nodes failures. In addition, self-organization algorithms can provide optimization of energy consumption for data transmission. From the whole sensor network standpoint, the collaboration between the sensor nodes in each WSN is so efficient, so the lifetime of the sensor networks can be prolonged.

Data collected by all the sensor nodes are usually transmitted to the server which provides the final processing of all the information collected by the sensor nodes. In general, a WSN includes one or a few sinks and gates which are collecting data from all the sensor nodes and transmitting these data for further processing. At the same time, gate forwards the data from the WSN to other networks. In this way communication between WSNs and other external networks, like the Internet, is being provided.

1.4. Wireless sensor networks and energy problems

1.4.1 Power dissipation in a wireless sensor node :

In order to find an efficient solution for energy conservation, we must identify power bottlenecks in the system of a wireless sensor node. In this section we analyze a sensor node from a power consumption perspective and discuss which units can significantly impact the system energy consumption.

Microcontroller Unit: The power-performance characteristics of MCUs have been studied extensively, and several techniques have been proposed to estimate the power consumption of these embedded processors [18], [19]. While the choice of MCU is dedicated by the required performance levels, it can also significantly impact the node power dissipation characteristics. A microcontroller can operate in the energy-saving mode (or *active, idle, and sleep* modes). It can shut down most of its inner blocks and then turn them on again. Power consumption can be reduced up to 1000 times in this mode. For power management purposes, each mode is characterized by a different amount of power consumption. According to the example in [20], the Strong-ARM consumes 50 mW of power in the *idle* mode which means the sensor node is listening and waiting to receive the data, and just 0.16mW in the Sleep mode. However, transitioning between operating modes involves a power and latency, overhead. So, the power consumption levels of the various modes, the transition costs, and the amount of time spent by the MCU in each mode all have a significant energy consumption which influence on the battery lifetime of the sensor node.

Radio: Generally, Transceivers which provides access to the radio channel are with a low-rate and short-range. According to [21], some transceivers used in sensor nodes operate at a transfer rate to 250 kbps and distances about 10 m. However, several factors affect the power consumption characteristics of a radio, including the type of modulation, data rate; transmit power, and the operational duty cycle. In general, radios can operate in four distinct modes of operation: *transmit*, *receive*, *idle*, and *sleep*. In the case of *idle* mode the power consumption is significantly high, almost equal to the power consumed in the *receive* mode [22]. Thus, when the sensor node is not transmitting or receiving any data, it is important to completely shut down the radio rather than transitioning to *idle* mode. Another relevant factor is that as mode changes, the transitory activity causes a significant amount of power dissipation in the radio electronics. According to [20], when the radio switches from sleep mode to transmit mode to send a packet, a significant amount of power is consumed for starting up the transmitter itself [23].

Sensors: Sensing is the task for a sensor device which is created for, and each sensor node in WSN measures some physical conditions and it translates the physical phenomena to electrical signals. There are several sources of power consumption in a sensor, including: signal sampling and conversion of physical signals to electrical ones; signal conditioning, and analog-to-digital conversion. In general, passive sensors such as temperature, seismic, etc., consume negligible power relative to other components of sensor node. However, active sensors such as sonar rangers, array sensors such as imagers, and narrow field-of-view sensors that require repositioning such as cameras with pan-zoom-tilt can be large consumers of power.

1.4.2 Reasons of energy waste

In WSNs, there are different forms of energy dissipation from the different unit of the sensor device. In the processing unit, the high amount of data requires a lot of energy, so minimizing the size of the data will significantly reduce the processing treatment and the time of transfer. Transmitting or receiving data demands much more energy than the other units, this makes communication subsystem is a greedy source of energy. According to [24], there is also a great amount of energy wasted in states that are useless from the application point of view, such as [25]:

- *Collision:* when a node receives more than one packet at the same time, these packets collide. All packets that cause the collision have to be discarded and the transmission of these packets is required another time which makes a waste of time and energy.
- *Overhearing*: when a sender transmits a packet, all nodes in its transmission range receive this packet even if they are not the intended destination. Thus, energy is wasted when a node receives packets that are destined to other nodes.
- *Control packet overhead*: in some protocols the overhead of the packets is much more than the data itself. So a minimal number of control packets should be used to enable data transmissions.
- *Idle listening*: it happens when a sensor node is waiting for a packet and even if it is not sure of receiving it. This mode requires a lot of energy, so it is one of the major sources of energy dissipation.
- Interference: each node located between transmission range and interference range receives a packet but cannot decode it.

1.4.3 Identifying possible energy efficiency techniques:

Since the sensor nodes are usually placed in hard to access areas, battery replacement is a complex and expensive operation almost in every WSN. That is why one of the most important WSN efficiency criteria is the network lifetime. This section is about finding and identifying common efficiency techniques which affect and extend the lifetime of WSNs. We can identify five main energy efficient techniques [24] which are:

1) ***Data reduction****:* concentrating on reducing the amount of data to be produced, treated and transferred. For example, data compression and data aggregation are the most used in such techniques.

2) ***Protocol overhead reduction****:* Some protocols have a high packet on the overhead, so the aim of this technique is to increase protocol efficiency by reducing this overhead. However, some existed techniques adapt the transmission periods according to the distance and the topology of the network.

3) ***Energy efficient routing****:* network lifetime is related on each individual components of the network, which, in its turn, depends on the energy content of batteries and power consumption in different modes: transmission, reception, idle and sleep. Furthermore, network lifetime depends on algorithms and protocols for data transfer, processing, routing and other operations. For instance, the choice of routing protocols should be designed with the target of maximizing network lifetime by minimizing the energy consumed by the end-to-end transmission without modifying the hardware implementation of the sensor nodes.

4) ***Duty cycling:*** it is used to schedule the activity mode and the sleep mode of a sensor node. Transmitting, receiving and idle mode consume a lot of energy but only the sleep node saves the energy resources of the sensor node. Thus, the key technique for extending the sensor node battery life is the reduction in duty-cycle, by shutting down all the main components of the sensor node in the sleep mode, excepting the part which is responsible for returning from the sleep mode when needed.

5) ***Topology control***: Network topology defines the way where all the sensor nodes and the sink communicate with each other by transmitting and receiving the data. There are some many topologies in WNSs standards. So, the idea is to control the topology in such a way to maintain reduced energy consumption while preserving network connectivity and coverage.

1.5. Wireless Multimedia Sensor Network

In the previous sections, we described a typical wireless sensor network and also we discussed the different factors and elements that affect the functioning of the whole wireless sensor network, from designing and from energy consumption point of views. Hence, the following sections are dedicated to a specific type of WSN which is wireless multimedia sensor network [26].

WMSN preserves the same characteristics of a typical WSN, however, some additional changes are provided depending on its specific task.

1.5.1 WMSN and their applications:

A new technology called CMOS (Complementary Metal Oxide Semiconductor), which generally used for the manufacture of computer processors, has been used for video cameras. Using CMOS technology, image sensors can be implemented with a lens, an image sensor, and an image processing circuit on the same chip. This significantly reduces the scale and cost of image sensors. Since CMOS image quality closely follows the Charge Coupled Device (CCD) quality for low-and medium-resolution sensors, the reduction in size does not affect the quality. Moreover, CMOS sensors consume much less energy than their CCD counterparts [27], which make them suitable candidates for WMSNs.

Wireless multimedia sensor networks have found a variety of applications in numerous different fields [28] such as: battle field reconnaissance, security monitoring [29], traffic surveillance and control, automated assistance for elderly and family, health care, and environmental monitoring [30] etc. Multimedia data, including audio, images and video is typically bandwidth intensive and delay sensitive. These characteristics result in high demands on the communication and computing aspects of these systems, and thus a very high demand on energy resources.

Similar to traditional WSNs, each component in WMSNs is constrained in terms of battery, memory, processing capability, and data rate [27]. The increased traffic volume as well as the significantly higher processing requirements of encoders signifies the importance energy-efficient operation in WMSNs. Consequently, the existing resources need to be efficiently consumed for multimedia delivery.

Multimedia applications generate high volume of traffic, which require longer transmission times for battery –constrained sensor devices. While transmission is usually mitigated through in-network solutions in traditional WSNs, the extensive processing requirements of multimedia data may make these techniques unsuitable for WMSNs. Solutions for WMSNs need to guarantee the quality of service (QoS) requirements of applications while minimizing the energy consumption.

1.5.2 Structure of wireless multimedia sensor networks

Figure 1.3 presents a general wireless multimedia sensor network structure, it consists of three parts: wireless multimedia node (WMN), wireless cluster head (WCH) and a network node.

Each WMN consists of a camera or audio sensor, processing unit communication unit and power unit. Each node captures the wanted scene, called image frames, within its Field Of View (FOV). The acquired data passes through a processing unit to perform the necessary treatment to reduce the high amount of scene data.

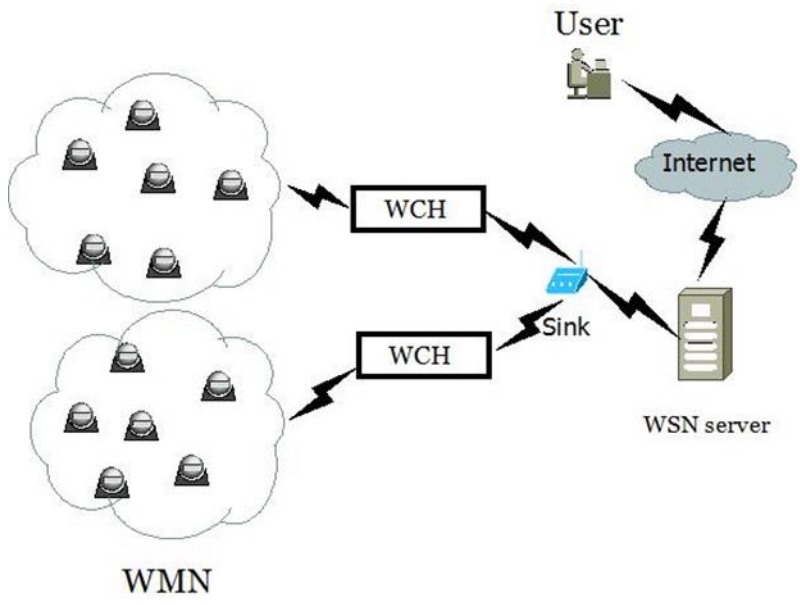

Figure.1.3. *Wireless Multimedia Sensor Networks (WMSNs) structure*

The WCHs connect a group of WMSNs and receive the data from them. Each WCH consist of a processing unit, communication unit and power unit. The Field Of View of WMNs may overlap so the WCH can reduce the unnecessary data by performing event aggregation and combination. The WNN performs the same role as for a traditional wireless sensor network and consists of a communication unit and power unit. The communication unit relays the data from node to node until it arrives at the sink. The base station or the sink gathers all the data of the network and send it to the user.

1.5.3 Characteristics of wireless multimedia sensor nodes in terms of energy consumption:

Wireless sensor networks have typically the same characteristics of a general wireless sensor network. But, since the WMSNs deals with a large amount of data, there are some additional requirements in sensing, processing and communication units. In this section, we present some characteristics of this type of sensor networks:

Extend the battery lifetime**:** Since multimedia data contains videos, images and scalar data that consumes a lot of energy which make the battery of this sensor nodes drains quickly. Thus, an additional effort is used in the different units; from sensing to receiving the data and going through a huge and extensive processing and communication process, with the aim to conserve in battery, memory and extend the lifetime of the whole WMSNs.

High Bandwidth Demand and communication requirements:

The energy consumption in the WMSN will determine the network lifetime. The energy consumed for communication is much higher than that for sensing and computation and grows exponentially with the increase of transmission distance. Therefore it is important that the amount of transmissions and transmission distance be kept to a minimum to prolong the network lifetime and it could be possible by minimizing the amount of data to be sent [27].

To reduce the transmission distance, there are many communication schemes available in WMSN architecture such as a multi-hop short-distance communication scheme. In this scheme, a sensor node transmits data towards the sink through one or more intermediate nodes. The architecture of a multi-hop network can be organized into two types: flat and hierarchical. This process not only reduces the energy consumption for communication but also balances the traffic load and improves scalability when the network grows.

In WMSN, There are some data that needs to be delivered in real time, so, some quality of service which deals with latency and delay, reliability and quality of transmitted data must be considered.

WMSN platform: According to [31], WMSN has three categories of platform depending on their processing power and storage, which are: lightweight-class platforms, intermediate-class platforms and PDA-class platforms. Lightweight-class platforms designed with low processing power capability, small storage and are usually equipped with basic communications only. Intermediate-class platforms better than the first category in memory storage and computational processing power, but they have almost the same in communication protocols. However, PDA-class platforms are used to process high quality multimedia content and have more powerful processing capability and memory requirement and they have better communication system with a high consummation of energy.

Image and video compression: Exploiting the intraframe and interframe redundancy is absolutely necessary to reduce the amount of data to be processed and transmitted, which leads to a meaningful decrease in energy consumption. Moreover, the type of compression algorithms used, may add more computational complexity where wireless multimedia sensor networks systems do not allow it. So, the choice of a low complexity image and video compression scheme is a relevant step to take to increase the lifetime of a sensor node. We will discuss this fact in detail in chapter 2,3 and 4.

1.6. Conclusion:

In this chapter, we did a detailed study on wireless sensor networks and we exposed some necessary basics in order to better understand the problematic of this thesis.

As WSN devices are the most emerged technologies nowadays, many researchers are focusing on the evolution of these networks to be more and more used in different applications. The main burden on the development of these networks is the limited power supply and the high energy consumption. So many techniques of energy efficiency have been used in a wireless sensor networks in order to minimize the energy consumption in every single sensor node, which leads at maximizing the lifetime of the whole network.

We have presented a specific case on wireless sensor networks which is wireless multimedia sensor networks. Since this network processes high amount of data which are images and videos, not like the classic network which manipulates only scalar data, an additional effort is really necessary to be able to manage the existing energy conservation techniques and reduction the energy consumption in these networks.

In the next chapter, we will focus in image compression techniques in order to minimize the size of the data to be transmitted and gain in the network lifetime.