An Optimization Energy Consumption of Sensor Nodes for Car Parking Management

Maad M. Mijwil [1,*]
[1]*Computer Engineering Techniques Department, Baghdad College of Economics Sciences University, Baghdad, Iraq*

***Abstract*—Wireless sensor networks (WSNs) bring together advanced sensor technology and innovative network algorithms, making them a highly relevant field of research. WSNs can be deployed in a variety of environmental monitoring and information gathering applications. This paper, clarify a significant Structure of parking management using WSN. The parking management system, a number of sensor nodes is placed in the parking field to indicate the occupancy of the parking space. The information on the state of the parking spaces is sent to a base station posted on the parking entrance, to guide the drivers. The sensor nodes are equipped with a battery providing the energy to ensure their operation. This energy resource is very important for the sensor nodes and has a direct effectiveness on the sensor nodes life and thus entire WSN. In this paper, Hybrid communication mode is offered to optimize energy consumption. The energy consumption is compared in the proposed parking management architecture with the three modes of communication; a multi-hop, single hop, and hybrid.**

***Keywords*—Energy consumption, Wireless sensor networks, Sensor nodes.**

I. INTRODUCTION

The wireless sensor networks (WSNs) are the most auspicious research areas today because they focus on issues that address critical needs in areas such as safety, health, prevention, and production. [1]. These networks are composed of small-sized sensors connected to each other, which in turn are formed by a processor, a memory, a battery, an antenna and a sensor itself, which collect information from a specific medium and send it to a system that stores it to give it the corresponding use [2]. Although WSNs are being used in various fields, there is still much to improve, so it is necessary to work according to the requirements of each application, in technological solutions such as protocols, algorithms, etc., which allow you to observe the behaviour of the WSN, and then perform analyses and conclusions about such important aspects as energy consumption, the delivery of information to the destination, the delay, among other relevant aspects [3]. Sensor nodes appear as small autonomous systems cantered on data processing and storage units, wireless transmission units, and batteries. [4]. Organized as chain, these nodes have a mission to collect and send data to base stations, despite the limitations of computing, storage, above all energy resources [5]. The sensor be composed of the following four essential units. Sensing unit: containing two subunits, a physical unit seize device which obtains datum from the regional environment, well for an analog-to-digital converter called an ADC [6]. The sensor provides an analog / digital signal; the latter converts these signals into digital signals that can be understood by the processing stage unit. [7]. Processing unit: Components are grouped together: processor and decrease memory unit. It's permits to save and performs the perceptual task assigned to it [8]. Transceiver unit: which managing for all transmission and receiving of data on the medium. Power supply unit: The sensor is provided with power resources (battery) [9]. This power resource is restricted [10]. In many cases, energy is the highest significant resource of sensor nodes because it immediately affects the sensor lifetime and thus the total network. [11].

Each sensor uses a tiny battery as a power resource, which limits its life [12]. The specificity of the applications of WSNs (military, seismic and others) makes recharging or replacing these batteries a difficult task in some applications and almost impossible in others, which leads us to deduce that the service life of a sensor is essentially contingent by the lifetime of the battery [13]. Thus, the method of managing energy consumption constitutes a major constraint in this type of network [14]. The management of a parking lot is an application that can integrate a WSN [15]. Parking is a space or building specifically designed for parking vehicles. It is most often found next to public buildings (station, airport), workplaces, shopping malls or in front of supermarkets to accommodate users [16]. In this research, present a parking control architecture by using a WSN for the parking located in the centre of the town of Mansour in Baghdad, 81,835 automobiles, 35% of which is related to looking for a parking space. One in three drivers would therefore be looking for a parking space, from which such a proposed solution can significantly improve the traffic flow by accurately offering the free spaces number in the park. In order to evaluate the power consumption, the sensor sends the data directly to the main station and if the sensors send the data in multi-hop mode. Offering a hybrid mode to optimize energy consumption. The technique contains a WSN capable of indicating whether a parking space is occupied or not. Each sensor is glued either on the floor, or on the ceiling of each parking space. It works using a battery whose duration is limited.

Currently, there are options that represent true advances in terms of protocols, all of them seeking better alternatives in energy savings, location, communication reliability,

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*Corresponding author: mr.maad.alnaimiy@baghdadcollege.edu.iq

bandwidth utilization, etc. Perhaps the most important problem, that of energy consumption, is reduced by putting the node to sleep while it is not in action, since the activities in which the node consumes more energy are in which there is information transmission and the nodes must be powered by batteries, then their life time depends on their power source. In general, the WSN, have multiple proposals for communication, but each of them developed to meet requirements in a particular application or group of applications, so there is not yet a fully accepted standard in WSN.

The rest of this study is arranged as pursue: Section 2 Energy consummation in WSNs, current system architecture and power consumption are described in Section 3. Section 4 summarizes the simulation results. Then, section 5 concludes the work.

II. Applications of Sensor Nodes

In recent years, WSNs have grown due to unit growth and improvements in low power radio technologies [17]. As the fee of sensors and connection networks have been decreased, a lot of probable applications, containing those have emerged to be used for civil and environmental purposes [18]. In what follows, a more detailed explanation of the different applications is presented as clarified in figure 1 [19]:

Fig. 1. Sensor networks applications

1. Condition monitoring:

Condition monitoring includes detection of human presence, vibration of objects, sound, stress, acceleration, power, etc. [20].

2. Environmental monitoring:

This domain covers the largest scope of WSNs today. It includes the monitoring of the state of the ambient air, the quality of the water (for example the control of its degree of pollution, etc.), the control of dangerous environments, especially those that are vulnerable to fire, flood or landslide. In addition, this area of application includes weather forecasts [21].

3. Health Surveillance:

Embedding sensors for health is an interdisciplinary field that revolutionized telemedicine systems by enabling cheap and continual health observation through the real-time updates of medical recordings over Internet. In fact, WSN is integrated into hospital buildings to trace and monitor patients and the medical resources [22].

4. Control the Traffic:

The sensor networks used the traffic lights and monitor vehicle movement. Cameras are also often applied to monitor high-traffic road segmentations [23].

III. Models of Networks and Energy

In this section, shows the architecture of network and the energy used model. The duration of life of the sensor is highly based on the duration of the battery. The main application task of this sensor, is to detect parking space occupancy, develop the data processing then send the outcomes to the main station behind the parking. This stage of energy consumption by the sensor, can be split into three stages: capture, processing and connection. These three stages, the data connection stage, consume the maximum energy, because of the large number of components of electronic built into the circuit. This stage includes two steps: sending and receiving data. Evaluate energy consumption by applying the model proposed in sensor node simulation. Knowing that sensor networks are based on single-hop communication to reach base stations or on hybrid hops. In hybrid hop communication, each node also acts as both a data initiator and a router. In a hybrid hop, each sensor sends its data to neighbouring nodes, latter sends information to neighbouring nodes until the information arrives at the base station. Sensor are built to operate quarter year or years. Therefore, to maximize network life, the energy capacity of these sensor should be used effectively. Note, when a sensor runs out of power, it is rate faulty. Therefore, the more likely to lose the network connection. Figure 2 show a radio model.

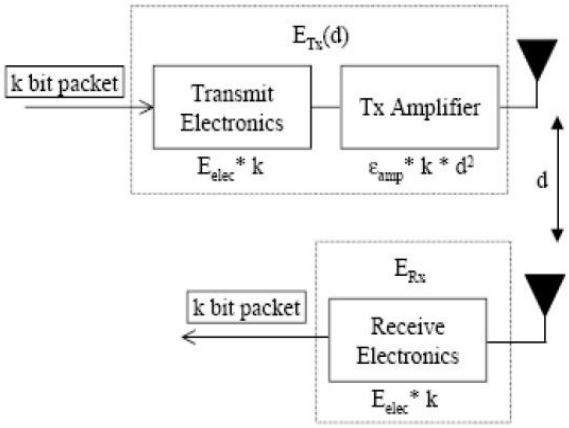

Fig. 2. Radio model

For a transmission of a k-bit message over a distance d, the sensor node consumes $E_{Tx}(k,d)$ given by Equation (1) and (2). And for receiving a k-bit message, the sensor node consumes $E_{Rx}(k)$ given by Equation (3).

$$E_{Tx}(k,d) = kx\,E_{elec} + kx\varepsilon_{fs}xd^2 \qquad d < d_0 \qquad (1)$$

$$E_{Tx}(k,d) = kx\,E_{elec} + kx\varepsilon_{amp}\,xd^4 \qquad d \geq d_0 \qquad (2)$$

$$E_{Rx}(k) = kx\,E_{elec} \qquad (3)$$

Where E_{elec} is the amount of energy consumed for a bit.

ε_{fs} is the amplification of the signal in a distance less than the threshold distance d_0 .If the emission distance is greater than d_0 , amplification ε_{amp} is used.

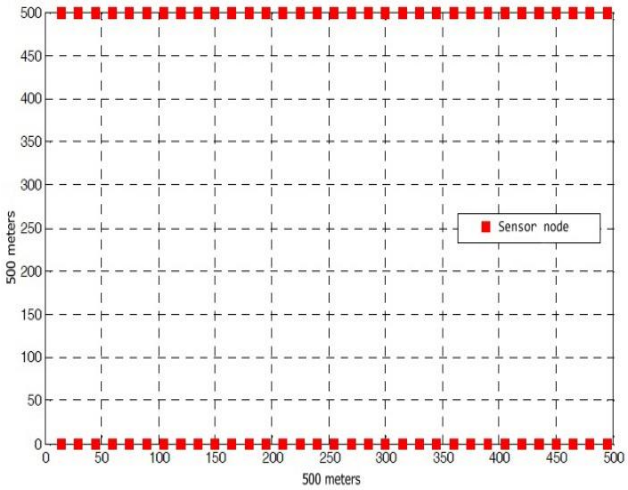

Fig. 3. Parking with WSN.

Figure 3 models the parking the distance between one sensor node and another is 15 meters. In region of 500 meters' x 500 meters, we will need 66 sensor nodes.

IV. SIMULATION

In WSNs, energy is a strong constraint compared to traditional networks. Extending the life of WSN is related to minimizing the power consumption of the nodes of sensor. Matlab environment is applied to simulate the operation of the parking sensor nodes and calculate the energy consumption. Considering a non-persistent Carrier-sense multiple access (CSMA) channel access mode. Table 1 shows the simulation parameters.

TABLE I. THE SIMULTION PARAMETERS.

Parameter	Value
Region	500 m x 500 m
Package Size	1000 bits
Distance d_0	87 m
Number of sensor nodes	66
E_{elec}	*50 nJ/bit*
ε_{fs}	10 pJ/bit/m^2
ε_{amp}	0,0013 pJ/bit/m^4

We propose a hybrid sample of connection within the sensor and the main station between two modes single and multi-hop to minimize the energy consumption. The hybrid mode is defined as follows: If the sensor node S_i can reach the base station SB by direct communication, this node uses the single-hop mode to send its information on the state of the parking space. Otherwise, the sensor node sends its multi hop information to the sensor node closest to the main station. For each sensor, we look for the shortest path to the main station. The intermediate sensors are chosen such that:

$$E_{Tx}(k, d = distace\,between\,S_i and S_j) + E_{Tx}(k, d = distace\,between\,S_i and\ SB) < E_{Tx}(k, d = distace\,between\,S_i and\ SB)$$

Figure 4 shows the transmission power consumption for the single and multi-hop communication modes, and the hybrid mode proposed for each sensor to reach the main station. The proposed hybrid mode consumes less power than the other two modes because the distance in the hybrid mode is minimized.

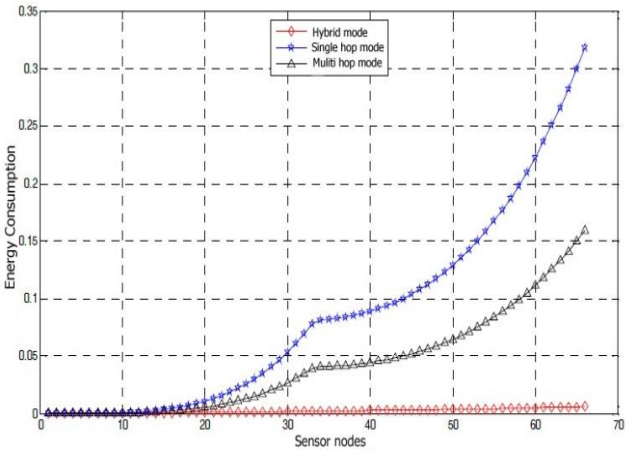

Fig. 4. Power consumption with single-hop, multi-hop and hybrid mode.

V. CONCLUSIONS

Sensors have become unavoidable elements in all systems where information from the external environment is needed to evaluate and act. A sensor network architecture is proposed for parking management. We also simulated the energy consumption (a very important metric in the WSNs) of the sensor nodes in this architecture, we proposed a hybrid communication mode to optimize the energy consumption of the nodes of sensor. We assent that WSNs can be a very promising automation technology for use in car park management and other applications. We will proceed to the experimentation of our proposal in the near future as an aspect of a national research's project.

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