# Chapter 8
# Data Gathering with Multi-Attribute Fusion in Wireless Sensor Networks

**Kai Lin**
*Dalian University of Technology, China*

**Lei Wang**
*Dalian University of Technology, China*

**Lei Shu**
*Osaka University, Japan*

**Al-Sakib Khan Pathan**
*International Islamic University, Malaysia*

## ABSTRACT

*This chapter addresses the problem of data gathering with multi-attribute fusion over a bandwidth and energy constrained wireless sensor network (WSN). As there are strong correlations between data gathered from sensor nodes in close physical proximity, effective in-network fusion schemes involve minimizing such redundancy and hence reducing the load in wireless sensor networks. Considering a complicated environment, each sensor node must be equipped with more than one type of sensor module to monitor multi-targets; hence, the complexity for the fusion process is increased due to the existence of various physical attributes. In this chapter, by investigating the process and performance of multi-attribute fusion in data gathering of WSNs, we design a self-adaptive threshold to balance the different change rates of each attributive data. Furthermore, we present a method to measure the energy-conservation efficiency of multi-attribute fusion. Then, a novel energy equilibrium routing method is proposed to balance and save energy in WSNs, which is named multi-attribute fusion tree (MAFT). The establishment of MAFT is determined by the remaining energy of sensor nodes and the energy-conservation efficiency of data fusion. Finally, the energy saving performance of the scheme is demonstrated through comprehensive simulations. The chapter concludes by identifying some open research issues on this topic.*

DOI: 10.4018/978-1-61350-110-8.ch008

## INTRODUCTION

With the advancements in distributed computing and Internet technologies, networks such as wireless sensor networks (WSNs) are increasingly finding their usage in various distribute computing applications. In the dual role of wireless communication technology and chip fabrication technology, WSNs appeared for different types of tasks (Vuran, Akan, & Akyildiz, 2004), (Bettstetter & Hartmann, 2005). This kind of network can interact with the physical environment and with data processing and wireless communication ability; the sensor nodes in the network can accomplish complex monitoring tasks. The sensor nodes are not traditional simple perception device and transforming the physical signal to digital signal, but a physical unit integrated with perception module, data processing module and wireless communication module. These nodes are expected to be inexpensive and can be deployed in a large number in harsh environments, which implies that the sensors are typically operating unattended without any human intervention for most of the network's lifetime. Each sensor node has its control area to monitor the surrounding environment by perception equipment, optical equipment, chemical analysis equipment, and electromagnetic equipment. Certainly, some special functions can be achieved by setting some functional equipment. WSN has become an important technology with scientific research and practical value in the application of military scouting, industrial production monitoring, city management, ecological monitoring, forest fire monitoring, medical care, disaster rescue, terrorism presentation, and dangerous area domination (Baunach, Kolla, & Mühlberger, 2007).

Figure 1 shows the connecting architecture of Internet and WSNs. It is said that Internet changes the communication method among people while WSNs connect the logical and physical worlds together. By the combination of Internet and WSN, WSNs change the interaction between people and nature. People can appreciate the world directly from the combination of these two networks and extend the current function of network and further explore the world.

After the network is deployed, the sensor nodes monitor and collect various environmental data by distributed computing (Sahoo, Hsieh, & Sheu, 2007), (Shon et al., 2009). The sensory data are transmitted to the sink node by multi-hop method. It can be seen that the sensor node has the double functions of terminal and routing for collecting and processing data. Currently, some crucial technologies in WSNs are poorly developed while the great challenge is the limitation of energy supply, computing capacity, and network communication bandwidth. Therefore, one of the essential research problems is how to effectively utilize limited resources to achieve high performance in data gathering.

Considering the high deployment density of sensor nodes, content redundancy of transmitted sensory data can occur during data gathering process. If all of the redundant packets are transmitted, the energy and bandwidth will be heavily wasted. For the sake of improving the resource utilization, data fusion is employed in WSNs (Ruth et al., 2006), (Li & Mohapatra, 2007), (Pantazis et al., 2008), which brings some benefits: Firstly, the data fusion can save energy consumption. As the monitoring area is overlapped, data fusion process can delete abundant data and save overall transmission energy. Secondly, more accurate data can be obtained. Considering the cost, the accuracy of one sensor node is not high. The correctness cannot be guaranteed only by gathering data from several sensor nodes, some data have to be acquired by monitoring multiple sensor nodes deployed on the same target area. Thirdly, the data fusion is beneficial for improving data gathering efficiency. The reduction of data transmission can enhance the wireless channel efficiency by decreasing the transmission congestion, conflict,