Chapter II
Enabling Wireless Multimedia Sensor Networks

Jing Wang
University of Texas at Arlington, USA

Guohua Zhang
University of Texas at Arlington, USA

Yonghe Liu
University of Texas at Arlington, USA

ABSTRACT

Wireless sensor networks have seen a wealth of research efforts and practical implementations in recent years. With the advance of CMOS cameras and microphones, wireless multimedia sensor networks are proposed to be a promising solution to a variety of applications in surveillance and intrusion detection, smart traffic control, automated health care, environmental monitoring, and so forth. It is composed of wirelessly connected small devices, which are able to capture multimedia data from the surrounding environment, besides its capabilities of processing the multimedia data using the embedded CPU and transmitting data to the sink through wireless communication. In this chapter, we firstly address features of WMSNs and challenges facing the realization of WMSNs by introducing two experimental applications of WMSNs. As energy efficient routing and distributed source coding are two critical components for the success of WMSNs, we discuss existing work in these two areas subsequently, in order to reveal details about the challenges and potential solutions to the problems posed by WMSNs. At the end of this chapter, open problems on cross-layer design, quality of information and privacy and security are briefly discussed.

CONCEPT AND EXPERIMENTAL PLATFORMS

Regarded as one of the most promising technologies to extend human presence to interested physical environments, wireless sensor networks (WSNs) have been the subject of a surge of research activities in recent years. Moreover, low-cost, miniaturized image sensors have enabled WSNs to capture multimedia information from the environment. This in turn has introduced a set of new challenges for wireless multimedia sensor networks (WMSNs). Among them, the most critical problems lie on supporting multimedia sensing streaming capability and prolonging the network lifetime using conventional battery and low data rate radio interface. Multimedia sensor networks also demand novel coding scheme, in-network processing strategy, and routing technique in relieving the network bottleneck. In this section we will discuss the key aspects of WMSNs and describe certain experimental platforms.

Key Aspects Of WMSNS

Key aspects of WMSNs include power consumption, bandwidth limits, unreliable wireless link, QoS requirements, multimedia in-network processing, and multimedia source coding. Unique challenges in WMSNs are mainly due to the inherent conflict between the abundant data generated from the sensor nodes and the constraints on bandwidth, power supply and computing capability.

QoS Requirement

Multimedia data delivered by WMSNs present similar QoS requirements as in other multimedia applications. Specifically, the streaming of multimedia data requires consistent connection and has little tolerance toward out-of-order transmission. QoS requirement poses additional challenges to WMSNs since it is mostly application-specific, involving tradeoffs among various metrics like energy consumption, estimation distortion, transmission delay, and so forth.

Bandwidth Demand

Multimedia data usually consumes bandwidth that is orders of magnitude higher than that is supported by normal WSNs. High data rates of the sensor nodes make it almost impossible for the network to transmit the raw data from one node to another. Besides the bandwidth demand, transmitting large amount of multimedia data leads to significant energy consumption compared to transmissions among the traditional scalar sensor nodes.

In-Network Processing

In-network processing has been proposed in WSNs as a powerful methodology to save energy. The application-specific parameter or objectives could be estimated in a distributed way through in-network processing. The most common example is taking average of the sensor data along the route from nodes to the sink. For example, in surveillance WMSNs, the nodes could exchange result of intrusion detection instead of reporting the images or streaming the videos to the sink. As energy efficiency becomes more critical in WMSNs due to high data rate, in-network processing plays a critical role in avoiding transmissions of raw sensor data.

Distributed Source Coding

Compression techniques are indispensable to multimedia applications given abundant redundancy within one frame or among successive frames. However, it is not practical to integrate compression techniques directly in WMSNs because compression algorithms may be too complicated for the resource constrained node platform: distributed source coding, instead, may serve as a desired solution for WMSNs as the complexity of