Chapter I
An Introduction to Wireless Multimedia Sensor Networks

Elhadi Shakshuki
Acadia University, Canada

Xinyu Xing
Acadia University, Canada

Haroon Malik
Queen's University, Canada

ABSTRACT

Wireless multimedia sensor networks (WMSNs) are a new and emerging type of sensor networks that contain sensor nodes equipped with cameras, microphones, and other sensors producing multimedia content. These networks have the potential to enable a large class of applications, ranging from assisting elderly in public spaces to border protection, that benefit from the use of numerous sensor nodes that deliver multimedia content. In this chapter, we investigate some of the new technology's potential and describe typical characteristics of WMSNs. Then, we introduce the primary challenges in the state-of-the-art in WMSNs. Finally, we discuss the existing solutions and possible future research trends.

INTRODUCTION

Development of microsensor technology immensely funnelled the extent of micro-electro-mechanical systems (MEMS) towards pervasively and ubiquitously capturing multimedia contents. These MEMS consist of a sheer number of wireless multimedia sensors banked with limited power supply, each collaborating towards the common objective. They play an important role in sensing the environmental phenomenon, communicating with the physical world, and retrieving multimedia contents such as video and audio streams, still images, and scalar sensor data. Usually, WSNs are composed of source and sink nodes (Intanagonwiwat, Govindan, & Estrin, 2000;

Krishanamachari, Estrin, & Wicker, 2002). Sources are data generators, which detect events and provide observations or measurements of physical phenomena. Sinks are designed to receive data sent by sources. Therefore, such nodes can monitor and act in the network performing some management functions. Besides, sinks can act as gateways between the WSN and an infrastructure network. Thus, sinks may also provide an interface to the user, allowing a manager to decide and act based on the data provided. This interface can be textual or multimedia, becoming a useful tool to network managers.

Wireless multimedia sensor networks (WMSNs) are a new and emerging type of sensor network that contains sensor nodes equipped with cameras, microphones, and other sensors producing multimedia content; hence, quantified multimedia management is required. Multimedia management faces new challenges in WSNs concerned with provision of scalable quality of service (QoS) through the management of metrics, such as coverage (Tian & Georganas, 2002), exposure (Megerian et al., 2002), energy consumption (Zhao, Govindan, & Estrin, 2002) and application specific metrics (e.g., for target detection, possible metrics are miss detection and false detection ratios). Due to the ad hoc nature of WSNs -- which might be deployed in hostile environments with fairly unpredictable conditions — multimedia management must be scalable, self-configurable and adaptive to handle such challenges. A classic approach is the data-centric design of WMSNs, which aims for the integration of application-level and network-level operations to provide power-efficient solutions. These networks have the potential to enable a large class of applications. The following paragraphs describe some of these applications.

Multimedia surveillance sensor networks. Video-based wireless sensor networks are composed of interconnected, battery-powered miniature video cameras, each video and audio sensor camera packaged with a low-power wireless transceiver that is capable of processing and transmitting sensing video signals. This integration of video technology and sensor networks constitutes the fundamental infrastructure for new generations of multimedia surveillance systems, where many different media streams (audio, video, images, textual data, sensor signals) are concurred to provide an automatic analysis of the controlled environment and a real-time interpretation of the scene. Video and audio sensors are utilized as multimedia facilities to enhance and complement existing surveillance systems against crime and terrorist attacks. Dependable and large-scale video and audio sensor networks, to some extent, extend the ability of law enforcement agencies to monitor areas, public events, private properties, and borders.

Traffic monitoring. Transportation is a sector that is expected to benefit from increased monitoring and surveillance. Traffic in the United States is growing at three times the rate of population growth and causing an estimated $75 billion loss annually due to traffic congestion; therefore, it might be possible to monitor traffic flow in major cities or highways and deploy services that offer traffic routing advice to avoid congestion. Wireless magnetic sensor networks offer a very attractive, low-cost alternative to current technologies such as inductive loops, video cameras and radar for traffic measurement in freeways, urban street intersections, and presence detection in parking lots. In addition, smart parking advice systems (Campbell et al., 2005) WMSNs also allow for monitoring available parking spaces and provide drivers with automated parking advice; thus improving mobility in urban areas. Furthermore, multimedia sensors are installed along major highways; the digital multimedia sensor network gathers lane-by-lane data on travel speeds, lane occupancy, and vehicle counts. Besides, these sensors could also detect violations and autonomously report video streams. These basic data elements

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