Chapter 87
Data Processing and Exchange Challenges in Video-Based Wireless Sensor Networks

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ABSTRACT

This chapter presents the main challenges in developing complex systems built around the core concept of Video-Based Wireless Sensor Networks. It summarizes some innovative solutions proposed in scientific literature on this field. Besides discussion on various issues related to such systems, the authors focus on two crucial aspects: video data processing and data exchange. A special attention is paid to localization algorithms in case of random deployment of nodes having no specific localization hardware installed. Solutions for data exchange are presented by highlighting the data compression and communication efficiency in terms of energy saving. In the end, some open research topics related with Video-Based Wireless Sensor Networks are identified and explained.

INTRODUCTION

Wireless Sensor Networks (WSNs) technology is nowadays widely used in various domains. It has applications in fields such as emergency rescue, environmental monitoring, military operations, at-home medical care or industrial systems. A wireless sensor network consists in a set of network nodes capable of sensing and wireless communication. It operates in the absence of a pre-deployed infrastructure and can work in hostile environments. Nodes are self-configurable, low power, low cost, and can be rapidly deployed in emergency situations. Their sensors interact with the physical environment by monitoring and measuring light, heat, position, movement, chemical presence, etc. The information from sensors is then delivered to the other nodes over the wireless network. In many applications one more powerful node, known as central point (CP), gathers the information from sensor nodes, processes it, and interprets the results.

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Special kinds of WSNs are represented by Video-based Wireless Sensor Networks (VWSNs), in which case large amounts of video data are sensed, processed in real-time and then transferred over the wireless networks (Sánchez, 2012). Among traditional applications, video monitoring for environment surveillance covers an area that focus attention nowadays due to more frequent threats posed by hurricanes, earthquakes or terrorist attacks.

One important problem in this context is related with data storage and exchange. Indeed, acquisition of a video sequence with reasonable frame rate implies significant amount of data that needs to be stored and transferred.

Handling video data usually required large storage buffers. These buffers help multi-frames video encoding/decoding process but also ensure temporary storage for multi-hop data transfer. Several hardware platforms where developed to provide large data buffers for such intensive data flows as eCAM (Chulsung, 2006), Cyclops (Mohammad, 2005) and RISE (Zeinalipour, 2005).

The wireless communication is characterized by noise, path loss, channel fading and interference. The result is a wireless channel having much lesser capacity than a wired one. Moreover, WSN multi-hop routing tends to generate more interference, delay, packet loss and higher number of errors during transmission. High packet loss rate on the path affects the bandwidth and delay values of transmission. Consequences depend on the application domain and on the kind of implemented system. All application has specific service requirements from the network usually expressed through a parameter named Quality of Service (QoS). Video surveillance using VWSNs in particular have a more constrained set of QoS requirements, aimed to sustain transmission of high quality data at a high bit-rate. Many of them require strict end-to-end delay, bandwidth and jitter guarantees. These parameters are hard to be satisfied not only due to mentioned communication issues but also because video encoding/decoding algorithms that involve significant processing time.

The aim of the chapter is to debate various solutions for data processing and exchange in video-based wireless sensor networks and to point out some open issues in this field.

VIDEO-BASED WIRELESS SENSOR NETWORKS

Combining video surveillance with wireless sensor networks brings important advantages in many fields. Resulting video-based wireless sensor networks have a large applicability especially in surveillance of critical zones to detect suspect activities. Beside obvious military applications, a lot of systems were developed for surveillance in subway and train stations, airports, hospitals, parking zones, stores, and other public places (Fernandez, 2013). Along common intrusion detection tasks, these systems can be used also to identify persons, vehicles or other kind of targets.

Another class of applications was designed for environmental monitoring in the case of areas subject to earthquakes, flooding or other natural disasters (Dawood, 2013). Sensor nodes can be deployed in the risk area to collect images over a wide surface. A disaster headquarter will use the information to take the best management decisions to overcome the situation.

Despite the fact that object sensed by the camera can be at arbitrary locations, information quality strongly depends on camera's resolution, size of the object and distance between camera and object. Depending on particular application and on the size of the smallest interesting object, we can determine experimentally the medium distance D_q, which provide adequate quality. This distance is known as camera range or depth of view.

Data collection from video sensor assumes a target entering field of view (FoV) coverage area.