

Chapter 5

Low Level Representation of Data for Visual Sensor Network

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ABSTRACT

Wireless Sensor Network future direction is going towards more complex sensor such as camera sensor. Therefore, a very active research field is Visual Sensor Network. This type of network brings new challenges such as processing and transmitting a massive amount of data generated by the camera sensor. The efforts into decreasing the amount of data to be transmitted are going towards two directions: data encoding and data filtering. This chapter introduces an algorithm for each direction. Visual data encoding is performed by means of Predictive Video Encoding using Phase-Only Correlation function to achieve motion estimation. Visual data filtering is done at the lowest level of abstraction and is performed in three phases: pixel classification, background update and detection. The algorithms involved in each phase are light in terms of complexity and memory resources.

INTRODUCTION

Wireless Sensor Network (WSN) have been in study for the last 20 years; therefore, there are already some network deployed such as ZebraNet, a network to monitor wild life in Africa (Juang, 2002) or Great Duck Island Network (Mainwaring, 2002). However, most of the research has been

focused on sensors that collect scalar data such as temperature, humidity, vibration and acoustic. However, these types of sensors do not provide enough information for some applications such as distributed surveillance systems, traffic monitoring or health care for elderly people. Therefore, a new research direction is been focused in Visual Sensor Network. Visual Sensor Network (VSN) is a large set of camera nodes, where each node is capable of processing images locally and

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extracting important information. Moreover, VSN collaborates with other camera nodes to achieve and specific application task as well as provide high-level descriptors of the capture images. Imaging technology has advance notably, producing small, low power, and low cost image sensor devices making VSN attainable in the near future. VSN provide a more complete set of information since a camera sensor is involved (Charfi, 2009). VSN have several applications such as distributed video surveillance, elderly health care assistance, traffic control, environmental and structural monitoring within others. Distributed video surveillance uses networked smart camera nodes that cooperatively process the information to prevent crime, locate missing persons, identify criminals or prevent potentially harmful activities. The smart camera nodes must use computer vision techniques as well as image processing algorithm to achieve its mission. Traffic control and monitoring network may provide rerouting traffic to avoid congestion points as well as assist efficient parking detection. While telemedicine sensor network integrates body sensing lectures with images of the elderly people inside their own environments to allows remote health care assistance. The structural stress may be detected with a network of camera sensor distributed along the building or bridge to provide a 24 hrs monitoring (Akyildiz, 2002).

VSN represents new challenges with respect to scalar WSN, such as how to manage the amount of information generated by the cameras, how to integrate highly complex vision algorithms into a limited embedded system, what are the best way to represent visual data, how can the data be fused to obtained only the important information out, how to efficiently scale VSN with respect of bandwidth management, transmission power, etc. Let's take a look into some of these challenges.

The amount of information generated by this type of sensor is large because represents the scene with a two-dimensional set of data points (Soro, 2009). Consider a low resolution 352×288 pixels camera using a RGB format produces 72 Mbps.

$$\left(\frac{352 \times 288}{frames} \right) \left(\frac{30 frames}{sec} \right) \left(\frac{3 colors}{pixel} \right) \left(\frac{8bits}{colors} \right) = \frac{72Mb}{s}$$

However, WSN are bandwidth limited in nature. WSN are densely populated; consequently bandwidth is a scarce resource. Moreover, a node is energy-constrained and transmission is one of the most expensive operations in terms of energy. For that reason, data must be process within the node to decrease the amount of data before its send to the base station. VSN bring new challenges to the WSN research such as camera coverage, network architecture to guarantee the ability to communicate a massive amount of data over a limited bandwidth network, and data processing to accomplish a data representation suitable for VSN environment.

A camera sensor provides information of distant objects and scenes from certain direction. Therefore, these sensors have directional sensing mode. In a scalar WSN the sensing mode is omnidirectional; therefore the fusion algorithms developed for WSN consider the vicinity of the nodes to fuse data. VSN must consider the area that is cover by the camera; also it must developed algorithm to establish the overlap of such areas to be considered within the fusion algorithm. The representation of the data obtained by the camera node must also be considered in developing the fusion algorithm.

The focus of this work is data processing to efficiently communicate visual nodes.VSN as well as WSN collect the data and processed it to stream only the relevant data to the Base Station (BS). Since a low-resolution camera may produce a 72 Mbps data stream is impractical to stream all data due to bandwidth constraint and energy limited nodes. Since processing cost is more economical than communication cost in terms of energy, it makes more sense to process the data and send only the relevant information to BS. There are two approaches to eliminate redundant

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