

Resource Allocation and Performance Limit Analysis of Wireless Video Sensors

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Abstract

Wireless video sensor networks (WVSN) have been envisioned for a wide range of important applications, including battlefield intelligence, security monitoring, emergency response, and environmental tracking. Compared to the traditional communication system, the WVSN operates under a set of unique resource constraints, including limited energy supply, on-board computational capability, and transmission bandwidth. The objective of this work is to study the resource utilization behavior of a wireless video sensor and explore its performance limit under the resource constraints. More specifically, we will develop an analytic power-rate-distortion (P-R-D) model to characterize the inherent relationship between the power consumption of a video encoder and its rate-distortion performance. Based on the P-R-D analysis and a simplified model for wireless transmission power, we study the optimum power allocation between the video encoding and the wireless transmission, and introduce a measure called *achievable minimum distortion* (AMD) to quantify the distortion under the total power constraint. We consider two scenarios for wireless video sensing: small-delay wireless video monitoring and large-delay wireless video surveillance. Based on the AMD concept, the power consumption analysis for the wireless transmission, and an analytic model for transmission distortion, we obtain the performance limit of the wireless video sensors in each scenario. The analysis and results obtained in this paper will provide an important guideline for practical wireless video sensor design.

Keywords: wireless sensor network, rate-distortion, wireless video compression, resource allocation, power consumption.

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