Compression Gain Measurements by Using ROI-based Data Reduction

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***Abstract*— For mobile visual communications, the development of more robust and efficient video traffic control and transmission techniques remains one of the most important issues. Foveated video stems from visual entropy reduction by removing undetectable high visual frequencies that occur at a distance from the fixation point. In this paper, compression gain is defined and measured to quantify the enhanced performance when the visual throughput of the regions of interest (ROI) is increased over a capacity-limited channel.**

***Index Terms*— Mobile Visual Communications, Foveated Video, Compression Gain, Regions of Interest (ROI)**

I. Introduction

For real-time mobile visual communications, it is necessary to adapt video traffic to band-limited wireless channels. For efficient video transmission with an insufficient channel capacity, numerous efforts have been made to increase the throughput of visual data by exploiting ROI (regions of interest), objects, human visual characteristics and so on.

Given an ROI, the original video stream may be modified in a manner so as to match the nonuniform sampling of the eye. This may be interpreted as a process of removing undetectable high visual frequencies that occur at a distance from the ROI. When foveation is used, much unessential high frequency DCT information is eliminated, resulting in significant entropy reduction and compressibility with a minimal loss of apparent visual information [1][2][3].

For point-to-point visual communications such as video conferencing, the ROI can be automatically determined by performing face detection, by tracking facial motion or by using other detected human visual parameters. This additional compression can be gained while maintaining compliance with standard compression formats such as MPEG-4, H.264 and their variants [4][5][6]. Hence, visual video compression is particularly appealing for low bitrate video coding / communication applications.

In this paper, we exploit foveation as a tool for exploring methods for measuring the compression gain afforded by increasing the throughput of visually important data. The compression gain afforded by foveation filtering is measured via a rate-quantization model. The amplitude of the spectral density over the frequency domain is assumed to have a Laplacian distribution. Utilizing Parseval's theorem, a decrease in pixel variance can be obtained from the reduction in spectral density energy. Using the cutoff frequency obtained by the human visual characteristics, the volume of traffic that is removed is measured according to the reduced pixel variance.

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II. Facial Information Detection System

For visual communications, the ROI can automatically be determined by using various detected human visual parameters. Fig.1 depicts a block diagram of a visual communication

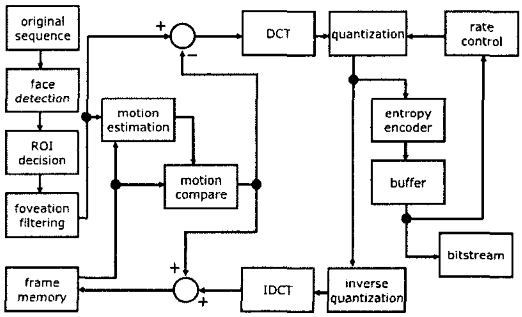

Fig. 1. An example of ROI-based visual communication systems

system using a face detection algorithm. The channel capacity, as like a 'bitrate', is detected in the receiver and transmitted to the encoder. In addition, the encoder monitors the current buffer occupancy in the encoder buffer, determines a target bit rate for the next frames. If the buffer occupancy approaches a threshold and the channel capacity becomes worse, undetectable high frequency components are removed through filtering.

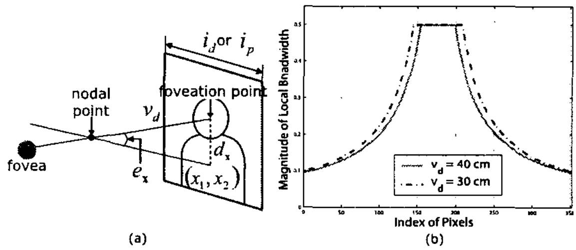

Fig. 2. Human visual modeling. (a) Parameter definition in the viewing geometry, (b) Local bandwidth (in cycles/pixel) which is also used as cutoff frequencies in the filter bank.