Reduction of Transmission Load in Image Sensor Networks

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The Problem: Transmission loads are characterized by the number of requests and the size of the data requested (typically images have the largest size). In the case of image sensor networks, when there is an increase in the number of requests, then many images are sent over the network. Traffic control centers depend on image sensor networks to provide reliable traffic information in a timely manner. When the number of requests for images increases, then the resulting high transmission load negatively impacts the network’s performance. The nearly continuous transmission of images is expected to lower the network’s overall efficiency. In approaching this problem, we present two approaches that aim to reduce the network’s transmission load.

Previous Work: To improve the network’s performance prior research has focused on data compression and changes in hardware and protocols to transmit data. Compression of images has been accomplished using various methods: contours, discrete cosine transforms, fourier transforms, wavelets and fractals [1, 2]. The main issue with compression methods has been to achieve a high compression ratio and maintain a quality image. We chose to use a contour-based method designed for low bit-rate applications designed by Mizuki [3]. We aim to extend Mizuki’s method to incorporate 3D information and to increase the compression ratio without altering the quality of the images. Preliminary results showed our method has higher Peak-to-Signal Noise Ratios (PSNR) than JPEG at comparable compression ratios. We also present an approach that substitutes text for images to reduce transmission load.

Approach: Both of our approaches use a combination of image sensors, mobile agents and a compression method to reduce transmission loads. Each approach can be used separately or together to improve network performance. Mobile agents control the data flow and compression reduces the size of images sent over the network.

Each image sensor captures and compresses images. The sensor contains a processor that calculates the traffic flow from image sequences. Additionally mobile agents are used to transmit and screen relevant information between the traffic control center and the image sensor.

Mobile agents provide a means of allowing users to specify criteria in which to send traffic information and/or images over the network. Generally when there is traffic congestion or an accident, operators at traffic control centers require quick access to both images and other relevant information (i.e. traffic flow information at different locations). However, there may be times when traffic runs smoothly, and operators only require updates (not including images) in the values of the average speed or traffic flow rate. In these cases fewer images would be transmitted over the network (and in some cases none).

By preserving relevant 3D information, we compress traffic images either to process them at the image sensor or to transmit them to control centers. Our method is content-based and retains contour, color, and depth information. This feature results on average in a higher quality decompressed image than JPEG images with similar compression ratios.

The two approaches to reduce transmission loads are (1) mobile agents sending traffic information and/or images based on preset criteria and (2) compressing images using a content-based method to insure quality and high compression ratios.

The first approach uses mobile agents to control the flow of information over the network. Operators send mobile agents to each image sensor and the mobile agent retrieves traffic flow information and/or images based on its predetermined task. A mobile agent can be set to return an image when traffic flow decreases (increases) by a preset amount. Mobile agents can reduce the transmission load by sending images when the preset criteria is met or sending traffic flow information instead of images.
Compressing images is the focus of our second approach to reducing transmission load. Our compression method begins with a color image and edge depth map. The contour is extracted and a modified chain coding is used to compress the contour. For each contour, a depth and the color to the left and right of the contour are coded with the contour. Figure 1 shows a flow chart of the compression method. The mean coding is optional and improves the image quality by using the mean color of blocks between contours.

Both of our approaches reduce transmission loads. Mobile agents are used to control requests for images versus other information. Additionally we use a content-based compression method to reduce the size of images sent over the network while maintaining image quality.

**Impact:** A decrease in transmission load increases the network efficiency by providing selective access to traffic information and images.

**Future Work:** When considering stationary cameras, as in the case of many traffic monitoring systems, compression of images may be increased by incorporating adaptive background elimination image and encoding the portions of the images which differ from the background.

Our two approaches for reducing transmission load can be extended to the transmission of images over the internet. Mobile agents can be used to transmit a text description of an image versus the actual image.

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**References:**

