Optimizing Camera Frame Rates

Purpose

This application note describes configuration rules needed to obtain optimum frame rate performance from the Lumenera Ethernet camera while receiving high-quality images.

Image Exposure Rates

The exposure rate can cause the imager to create images at a slower rate than the desired frame rate. The inverse of the desired frame rate can be used to determine the maximum exposure rate for each situation.

$$Exposure_{OPTIMUM} = \frac{1}{fps_{Optimum}}$$

Figure 1 – Determining maximum exposure rate for optimum fps.

The Ethernet camera provides an "Auto Exposure" function that will regulate the exposure rate to a desired luminance level. This function can be set to limit the control loop to a maximum exposure rate or to not impact the optimum camera frame rate.

Frame Size

The product of the frame-size and frame-rate will determine the bandwidth used by the camera. The camera will maintain the optimum frame rate until the bandwidth has exceeded the maximum of 1.5MB/s using HTTP. When this rate is exceeded, the camera will lower the frame rate to accommodate for frame-size.

$$Frame - Size_{max} = \frac{1.5MB / s_{HTTP}}{fps_{Optimum}}$$

Figure 2 – Determining maximum JPEG frame-size for optimum fps.

The Ethernet camera varies the frame size with the JPEG quality settings. The parameter can be set as JPEG quality or as maximum frame-size. To maintain high-quality JPEG frames, set the frame-size to 5KB below the maximum.

Network Capacity

The maximum network capacity required for the Lumenera Ethernet camera is 1.5MB/s using HTTP. The MJPEG streaming video from the camera will maintain a constant bandwidth without burst traffic.

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The frame-rate performance will diminish in cases of network congestion. Using HTTP, performance will also degrade with excessive latency.

Design Rules

	fps$_{MAX}$	Exp$_{OPTIMUM}$	File-size$_{MAX}$	Compresion
1600x1200 (UXGA)	17fps	58ms	85KB	1:25
1280x1024 (SXGA)	25fps	40ms	60KB	1:25

Table 1 - Camera Configuration for UXGA and SXGA to obtain optimum framerate.

Frame Rate Control

The camera allows frame-rate control. By default, the camera will capture images at the maximum allowable rate based on the camera type and exposure settings. The camera can be set to capture images consistently at a slower rate by using the "maximum_framerate" variable. This variable is set to zero, by default, which leaves the frame-rate in a free-run mode.

Automated JPEG Control

The camera automatically adjusts the JPEG compression to match a target frame rate or bandwidth usage. The control algorithm is designed to adjust the JPEG compression to match changes in exposure rate and scene complexity.

$$\text{JPEG Size} = \frac{\text{projected\_network\_bandwidth}}{\text{projected\_network\_framerate}}$$

Figure 3 - Auto JPEG Control Algorithm

The user can configure the maximum allowable jpeg size (max_jpeg_size) and imager frame rate (maximum_framerate) to limit the control algorithm.
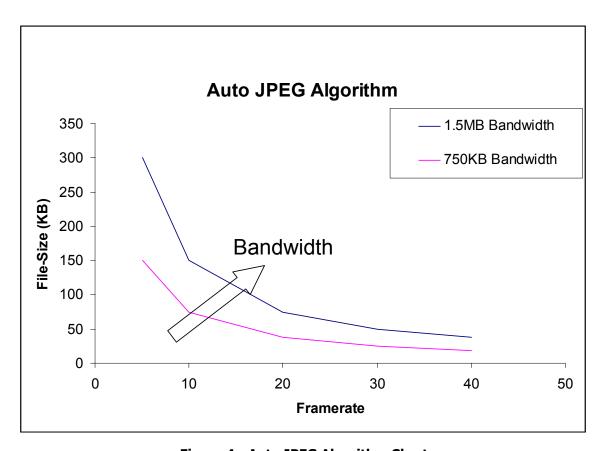
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Auto JPEG Algorithm

Figure 4 - Auto JPEG Algorithm Chart

Troubleshooting Guide

1. How do I control the frame-rate after I have configured the camera?

The camera supports a parameter, "maximum_framerate", that allows the user to set the value to a rate that is below the maximum.

2. How do I initiate an MJPEG stream from the camera?

Use the "nph-video" function with the following syntax:

http://<ip_addr>/cgi-bin/nph-video

3. I am only receiving a fraction of the maximum bandwidth.

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A bottleneck can be found in the camera, the MJPEG receiving computer, or the network in the following ways.

On the camera, check the exposure rate, MJPEG file-size, and the framerate parameter. If more than one video stream is run from the camera, the available bandwidth will be divided between each stream.

If the computer is decompressing the JPEG frames, the CPU will slow down the received video to a rate that it can handle. Turn off the MJPEG decompression to remove a possible framerate bottleneck caused by the computer CPU.

Finally, the network capacity can be tested if the frame-size of each image is set to the maximum allowable frame-rate. On the camera, set the JPEG quality to 99% and the maximum jpeg-size to 500KB. Even though the camera frame-rate will degrade in this configuration, the camera will be forced to use the maximum available bandwidth.

4. Can I pull multiple video streams from the camera?

Yes, the bandwidth of the camera will be divided between the demands of each stream.

5. How can I read the file-size of the images from the camera?

Pull a single image from the camera using the 'image' command. This can be done from a web-browser. The image file-size can be found by reading the image properties.

An image can be pulled from the camera with the following syntax:

<div align="center">

http://<ip_addr>/cgi-bin/nph-image

</div>

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