



---

## VIDEO PRE-PROCESSING

### Introduction

Noise is the technical definition for various anomalies and variations that get added to a signal. Noise takes many forms and originates from many sources, although the most common type of noise is random noise. Although many studios and head ends have the latest in SDI interfaces, operators still confront content that contains noise. A good example is news items as they frequently contain noisy sequences.

Noise undermines video compression systems in two ways. The most obvious way is the fact that humans see the noise as degradation and are thus less satisfied with the quality of the picture. Secondly, random noise does not compress well and requires substantial bit rate overhead to reproduce the noise present in the signal.

Noise shares the same spectrum as the picture and it is difficult to discriminate between noise and valuable picture detail. Removing random noise, therefore, is the main goal in a compression environment as it is the most prevalent type of noise and the one that is most costly in terms of bit consumption. The objective is to remove the random noise without softening the image or causing motion blur.

This whitepaper outlines why a Video Pre-Processor (VPP) with Motion Compensated Temporal Filtering (MCTF) is the technology that is optimally suited to meet this requirement.

### Pre-Processing Technology

Noise reduction equipment has been available for many years, but there has been widespread distrust of the technology. Many early noise reduction (NR) systems did a poor job and tended to introduce ghosting or blur artifacts while attempting to remove the noise. Consequently, some operators have a negative perception of noise reduction. The challenge is to deliver the benefits while preserving sharpness and eliminating the motion blur or ghosting.

Spatial filtering is the application of two dimensional horizontal and vertical low pass filtering to reduce high frequency components in the signal. This causes loss of both picture detail as well as some noise. Most operators steer clear of spatial filtering as they want to preserve sharpness.

The antidote to random noise is temporal filtering; basically an averaging process applied across video frames. The averaging or filtering process cancels random noise. Temporal filtering works well for still images, but with motion it is liable to cause motion blur. The solution is to use MPEG motion prediction technology to allow the temporal filtering to



---

account for the motion, and so avoid motion blur. This technique is known as MCTF - Motion Compensated Temporal Filtering.

Looking at it in more detail, the motion prediction element (also known as motion estimation) allows temporal filtering to be applied along motion trajectories. This technique prevents the introduction of objectionable motion blur. Motion compensated filtering should not be confused with the more primitive alternative which uses a “motion adaptive” mechanism to reduce the filtering in motion areas. To avoid objectionable motion blurring effects, a motion adaptive temporal filter uses an adaptive mechanism to reduce its strength when motion is detected. This tends to work reasonably well for weak settings, but weaknesses are exposed when stronger filtering is applied. It is especially problematic in a compression environment where you really want the noise reduction to be present at all times, especially in the motion sequences which cause the encoder most stress.

MCTF does not affect impulse noise. Impulse noise is single frame dropouts in video or dust specks seen in movies, but may also be caused by signal interference. Unlike random noise, impulse noise has little effect on bit rate consumption. Most operators are wary of impulse noise reduction as most filters find it difficult to discriminate between, say, a fast moving tennis ball and a spurious impulse.

Some vendors offer more than one filter, but the reality is that the VPP MCTF filter technology is the dominant contributor to compression related noise reduction performance. Random noise is the dominant element in a compression system that impacts efficiency and MCTF is the most effective remedy.

## Alternative Technologies

External pre-processing boxes can be used, but very few external solutions include MCTF. Most external solutions use motion adaptive temporal filters. The integrated VPP offers powerful MCTF filtering and compares very well with the most expensive external solutions, plus offers the benefits of less rack space, lower cost, ease of control, etc.

## Performance

Constant bit rate (CBR) applications benefit dramatically, since removing noise from the signal significantly reduces the chance of overload and the resultant artifacts. An operator can choose to run the channel at a lower bit rate or use the noise reduction capabilities to improve the outgoing picture quality. Content that contains noise will demonstrate the biggest gain. The VPP, using MCTF technology, can powerfully remove noise without the negative effects traditionally associated with NR. The benefits will be most obvious with noisy content, movie material, news feeds and archives.



The VPP is easy to use, with the strength of the individual filters controlled through the UI. Operators will typically use a single setting for most of the content, with perhaps some exceptions for special cases. Operators need to take some care to ensure that the NR is appropriate for the desired application. Some types of content are more sensitive than others to the application of noise reduction; for instance skin tones and complex pictures that contain detail and texture are liable to be the first scenes to highlight that noise reduction is overly strong. Therefore, when selecting a noise reduction strength setting, it is recommended that the operator validates that the setting produces optimum results with sensitive content.

## Summary

Motion Compensated Temporal Filtering as implemented in the Modulus Video encoder is the optimal way to assist delivery of better pictures by removing random noise while preserving sharpness.

## References

[1]. MPEG-2 ref. ISO/IEC 13818-2:2000 - Generic coding of moving pictures and associated audio information.

## Author

Neil Brydon  
Director of Product Marketing  
[nbrydon@modulusvideo.com](mailto:nbrydon@modulusvideo.com)

## Modulus Video

285 Stewart Drive  
Sunnyvale, CA USA 94085  
Tel: 1-408-245-2150  
Fax: 1-408-245-2159  
[info@modulusvideo.com](mailto:info@modulusvideo.com)  
[www.modulusvideo.com](http://www.modulusvideo.com)

Modulus Video and the Modulus Video logo are trademarks of Modulus Video, Inc. All other brand and product names may be trademarks of their respective companies. Copyright © 2005 by Modulus Video, Inc. All rights reserved.

---