University of Dayton
Office of Technology Partnerships
937.229.3469

# Frame Decimation through Frame Simplication

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Inventor: Frank Scarpino, et al.

# ***Detailed Description***

## Intent

This invention addresses the issue of reducing video bandwidth requirements and/or improving video quality by increasing spatial resolution. The need for reducing the bandwidth of video information is increasingly significant because of a seemingly limitless growth of multimedia consumption and demand. The less bandwidth that is used the cheaper and quicker a video can be disseminated. Alternatively this method can also be used to improve video quality of a given system.

## Applicability

In general this method can be used in any video compression system that uses predicted frames (P-Frames) as part of the bitstream, where a P-Frame contains the changes that have occurred since the previous frame. Specifically, the following compression schemes can take advantage of this method: MPEG-1, MPEG-2, MPEG-4, H.261, H.263, H.264, DIVX, and XVID. The following are descriptions of 3 different functional uses of the proposed invention:

Use 1 – The video quality is held constant. By decimating a video by a single frame the video bitrate is reduced by the elimination of the content of that particular frame. Increasing the decimation performed on the video stream or video file, will ultimately then yield a greater reduction in the final bitrate.

Use 2 – The bitrate is held constant. Decimating a video by a single frame will result in a quality increase of the video. The more decimation that is performed on the video stream, or video file, then the greater the increase in spatial resolution of the remaining frames.

Use 3 – The video quality and bitrate can both be held constant. A video stream, or file, can be decimated until both the desired video quality and desired bitrate are achieved. This is now possible because this method adds a new degree of freedom to the typical bitrate vs. quality equation.

## Function

The approach is a mechanism which deceives the compression system into decimating frames by merely manipulating the video input sequence. This approach avoids several difficulties associated with video decimation, as well as introduces the novel benefit of remaining backwards compatible with existing encoders.

Prior to explanation of the technical invention, a simplified description of a predictive video coder's architecture is given in Figure 1. First, the system accepts a video frame. If the frame is to be an I-frame, the feedback loop is ignored and the system provides the forward transformation and encoding process. If the selected frame is to be a P-frame, the difference between the reconstructed frame (the reconstructed frame is identical to the reconstructed frame at the decoder output) is subtracted from the input frame. This difference frame is then encoded.

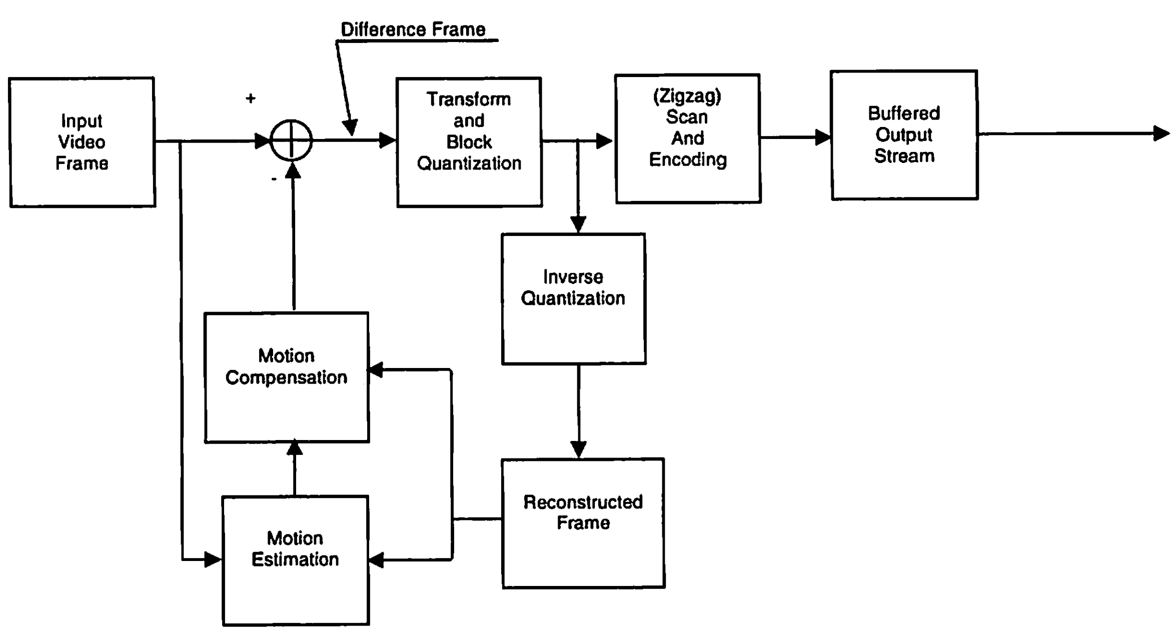


Figure1: Simplified Encoder Architecture

A specific implementation for the decimation approach architecture is as follows: As shown in Figure 2. This architecture induces the system to produce frame decimation each time that the feedback loop is closed in a fashion that injects a *reconstructed* frame into the system as the next frame to be processed. If the feedback loop is closed in this prescribed manner, the difference frame will be a "*zero-frame*" and the encoding system will produce a natural-decimation. In reality any implementation that zeros the difference frame, which includes the sum of differences and the motion vectors, will produce this decimation.

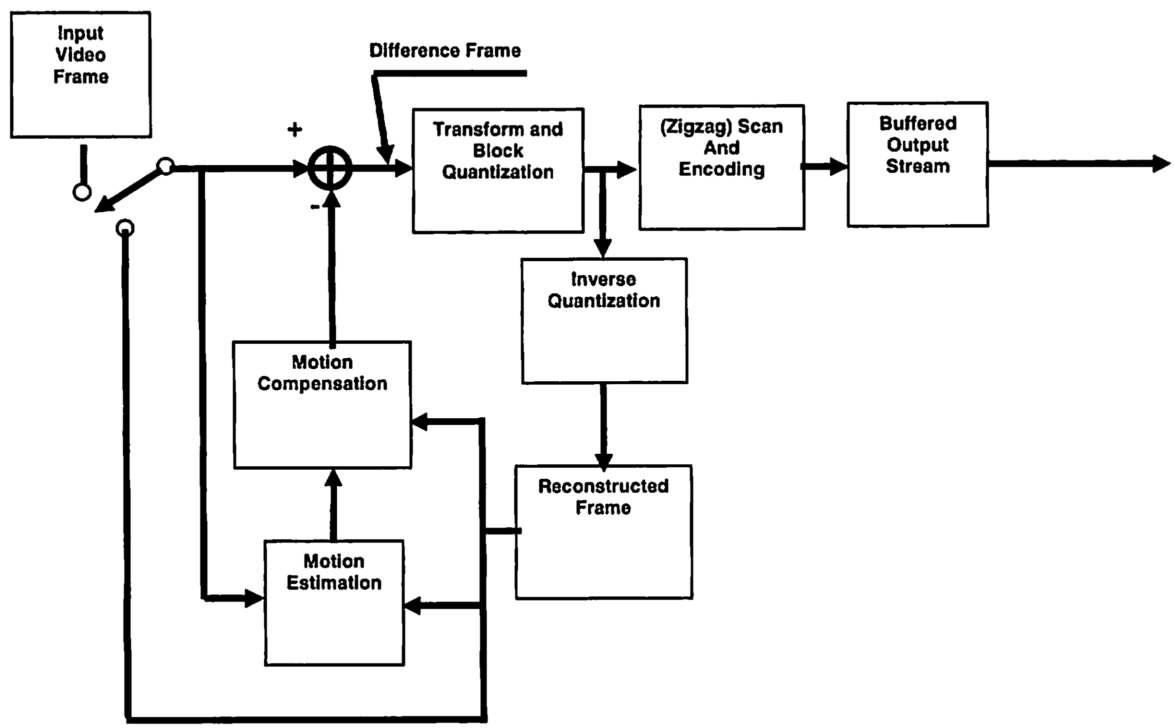


Figure 2: Possible Frame Decimation Architecture

Therefore, the process of frame decimation could proceeds as follows.

1. For frame decimation by a factor of two, the GOP is set to 2 and the (conceptual) switch in figure 2 changes state every other frame.

2. For frame decimation by a factor of four, the GOP is set to 4 and the (conceptual) switch of figure 2 feeds one new video frame and then feeds three reconstructed feedback frames. This process is repeated for the entire video sequence.
3. Decimating a 30 frame per second video to 24 frames per second. Set the GOP to fifteen and the (conceptual) switch of figure 2 feeds in the I-Frame and 11 P-Frames, and then feeds in 3 reconstructed feedback frames. This process is repeated for the entire video sequence. The reconstructed feedback frames can be spaced out over the entire GOP to avoid noticeable jittering.

A major difference between this invention and prior art is the fact that this method removes a portion of the data in the video stream while allowing the video stream to remain standard. Decimation methods that are currently available can be proprietary and inefficient in nature. The ability to improve quality and/or reduce bitrate, while remaining within the given video standard, has significant impact across the entire video industry. In fact the United States Air Force is already working to ensure that this method will go into the upgrade of video systems currently in the field.

The limitations of this method lie in the fact that it is for use only for compression systems which produce P-Frames. If no P-Frames exist then this solution will of course not be feasible. Also a rate controller which is aware of this method would have to be implemented to reap the full benefits of this invention.

<u>Inventors' Roles</u>

Frank A. Scarpino: Contribution was the idea of eliminating predicted frames to in-effect create frame decimation.

Eric J. Balster: Contribution was the addition of more detained information such as the necessity of eliminating motion vectors as well as predicted frames in order to achieve frame decimation.

Thaddeus A. Marrara: Contribution was the feasibility studies, proof-of-concept, and implementation of invention.