Fractional Interpolation Filtering for HEVC Algorithm

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***Abstrac*t**

Video compression is a combination of image compression and motion compensation. Compressing a video refers to decreasing the amount of data used to represent video. Each video contains of numerous frames which are 2D arrays of pixels. Each frame is regarded as a still image. The process of generating a high resolution image from its low-resolution counterpart is referred to as Image interpolation. Hence this process of interpolation can estimate all the pixel values that are required in a frame. But when the frames are vastly uncorrelated, this process becomes inefficient. One of the important ways for video compression is using motion compression vector. The video coding standards has widely used the motion compensation with fractional motion vector. Fractional interpolation filter produces the fractional samples. That is used is an end to end invertibility driven training scheme. Improvement in-video coding efficiency for low bit rate requirement is possible. Video can be shared in less time without changing its quality.

Keywords*-Fractional-pixel interpolation, Variable filter size, Discrete cosine Fourier transform, High efficiency video coding.*

I. INTRODUCTION

In this paper techniques to compress a video have been discussed. Interpolation filters are widely used and discussed in this project. 'Interpolation' is a process of up sampling which is followed by filtering. An Interpolation filter performs the above phenomenon. Video coding standards which defines a toolkit or a set of tools for compression is a document describing a bit stream structure and decoding method for video compression. The motion compensation with fractional motion vectors has been widely accepted by these video coding standards. Properties of the fractional interpolation [1] such as Inevitability have also been discussed. Fractional samples can be generated from integer samples and integer samples can be recovered from the fractional samples too using the fractional interpolation filters. Inevitability property has been discussed here, which is an important feature.

The integer pixels can be generated from the fractional pixels using the interpolation filter, similarly, the fractional pixels can also be generated from the integer pixels using interpolation filters, and this property of interpolation filters is termed as Invertibility. The fractional interpolation is actually a process to recover the analog signal with several samples and fractional pixels are sampled from that analog signal at certain fractional locations. If the analog signal can be recovered with the integer pixels, it should also be recovered with the fractional pixels. Frame-rate up conversion (FRUC)[3] has been used here to advance the coding efficiency for low bit-rate condition. The original frames are restored after the restoration of the compressed data. According to the phenomenon, before compression, the frame-rate is reduced. Some high order motion models have been considered to give more precise characterization of the complex motion. The modern video coding standards has broadly taken on the state art of high efficiency video coding (HEVC) [2] and block-based hybrid coding framework. These standards have used motion compensated prediction (MCP) [4] to lessen the temporal redundancy. Motion compensated prediction is used to decrease the number of unnecessary bits needed for quantization be the current frame. Both the encoder and decoder consist of a reconstructed copy of previous frame. The present frame is separated into the non- overlapping blocks by block motion compensation and the actual position of the blocks is given by the motion compensation vector. Typically the source blocks overlap within the source frame. Some video compression algorithms [9] unite this current frame out of pieces which are various types of previously-transmitted frames. In MCP, this block to be coded is retrieved within the previously reconstructed pictures and also the location of the reference block is signaled by the motion vector Interpolation filters not only facilitate MCP but also perform anti-aliasing and reduce compression noise. The future frames may be predicting the frame. The expected frames then must be encoded after the long run frames and thus, the real frame order doesn't necessarily match the encoding order.

II. LITERATURE SURVEY

"A Study of assorted Video Compression Techniques", M. Mary Shanthi Rani, P. Chitra and K. Anandharaj, 2017. Various transform based techniques are used by video compression for locating best video compression technique. For efficient storage and transmission, irrelevant information and redundancy could be eliminated using the process of video compression. Targets on transform methods like discrete cosine Transform (DCT), discrete wavelet transforms (DWT) and discrete fractional transform (DFT).

"Inter-Picture Prediction in HEVC, Benjamin Bross", Philipp Helle, Haricharan Lakshman, and Kemal Ugur, 2014 targeting on the H.264/AVC and their coding efficiency. The motion vector prediction was improved with advanced motion vector prediction supported motion vector competition. The block-wise motion data signaling can be significantly simplified by an inter-prediction block merging technique. This technique infers all motion data from the blocks which are already decoded, thus making it simpler.

"Deep Learning-Based Video Coding: A Review and A Case Study" Dong Liu, Yue Li, Jianping Lin, Houqiang Li, Feng Wu. This paper provides us with the information about deep learning for image/video coding. Since the year of 2015, this has been an actively expanding research area, specializing in two categories: Deep network-based coding tools (deep tools) that shall be applied within traditional coding schemes and new coding schemes that are fabricated primarily upon deep networks (deep schemes).
For deep schemes, auto-encoder and pixel probability modeling are the 2 approaches were viewed as transform coding scheme and predictive coding scheme, respectively.

Table:1 Survey of related papers

Sr. No	Paper	Author	Year	Description

1	A study of various video compression techniques.	M. Mary Shanthi Rani, P. Chitra and K.Anandharaj.	2017	The observation of the results shows that the PSNR, compression ratio for effective transmission hybrid , DCT and transform high peak signal noise ratio ,.
2	Inter-Picture Prediction for video compression using low pass and high pass.	Jonas Nilson.	2016	The results are limited to the performances of the low pass filter, LPF, and high pass filters, HPF prototypes. Other filters, with different characteristics and cut off frequencies, could potentially improve the results further.
3	Deep learning based video coding a review and a case study.	Dong Liu, Yue li, Jainping lin, Houqiang Li, Feng Wu.	2018	Most of deep tools have been designed individually but once they are applied jointly they may not collaborate well or may even conflict with each other. The underlying reason is that multiple coding tools are indeed dependent.

III. METHODOLOGY

High efficiency video coding is the next step in evolution. Advanced video coding or AVC is also a type of compression standard for digital video. It is also known as H.264. It helps to set a standard syntax for video formats like mobile TV etc.
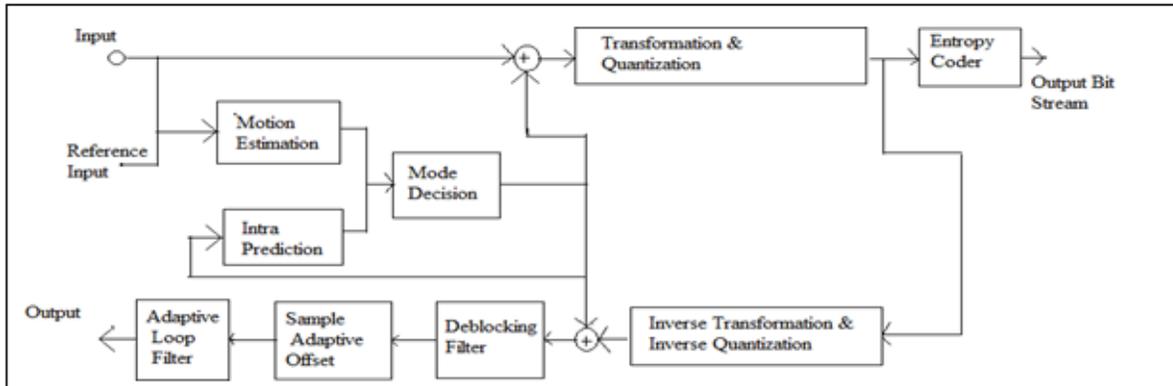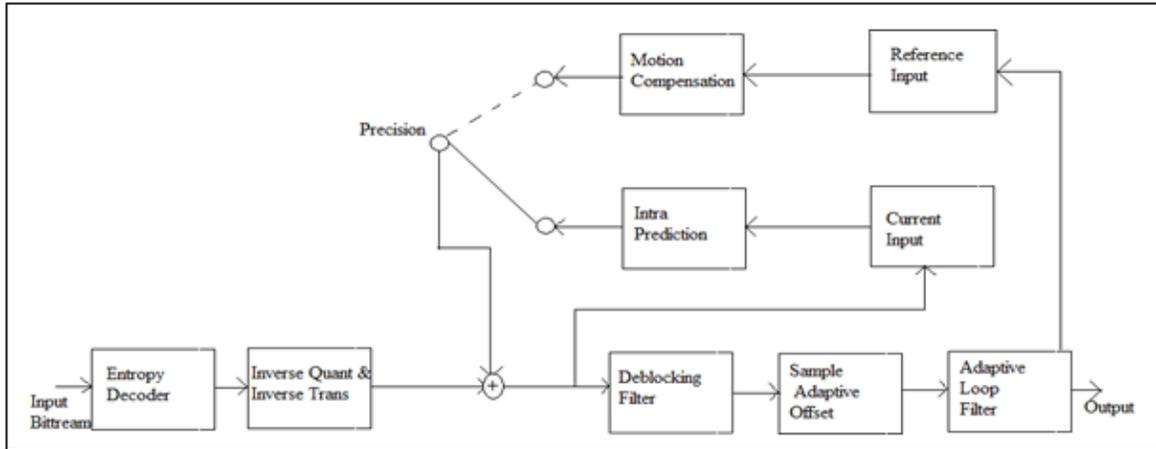

Fig1: HEVC Encoder

Fig2: HEVC Decoder.

VC employs SPME for the same reason as H.264. SPME, which offers sub-pixel accurate MV refinement, is carried out in order to widen the performance of integer pixel motion estimation. However, H.264 SPME is not as computationally complex as HEVC SPME. SPME is heavily utilized in an HEVC encoder. In HEVC video encoder, SPME can take up to 49% of the total encoding time. For sub-pixel interpolation, HEVC standard applies three different 8-tap FIR filters and up to 64x64 PU sizes. Numerous HEVC SPME hardware is proposed. All probable 48 sub-pixel search locations can be searched by SPME hardware. However, only square shaped PU sizes is supported. SPME hardware supports all PU sizes but 8x4, 4x8 and 8x8. Also, it searches 12 sub-pixel search locations. For quarter-pixel interpolation, it uses bilinear filter. SPME hardware uses a scalable search pattern and supports all PU sizes. The necessary sub-pixels for sub-pixel search locations are initially interpolated by three different 8-tap FIR filters by HEVC SPME. In the first stage, sub-pixel search locations round the best integer pixel search location are found. The second stage searches the 8 sub-pixel search locations round the best sub-pixel search location of the primary stage. In Figure, using the closest integer pixels, half-pixels a, b, c and d, h, n are interpolated in vertical and horizontal directions, respectively. Using the closest a and b and c half-pixels, respectively, quarter-pixels e, i, p and f, j, q and g, k, r are interpolated in vertical directions. HEVC SPME can then determine the simplest sub-pixel search location with the lowest SAD value following the computation of the SAD values for each sub-pixel search location.

Intra-prediction:
In intra-coding, the macro blocks are predicted from the current frame only and errors are encoded. This improves intra-coding compression performance significantly. H.264/AVC supports various intra-prediction modes for 8×8, 4×4 and 16x16 pixels.

Inter-prediction:
The H.264 maintains 7 forms of blocks with dimension of 16×16, 16×8, 8×16, 8×8, 8×4, 4×8 and 4×4 pixels for inter-prediction. Prediction can be improved with reduced block size.
Hence, smaller blocks are preferred for a high detail area. Each block has a predicted displacement which is given by motion vectors.

Transform and quantization:
The H.264/AVC supports multiple block size multiplier-free integer transforms for prediction residuals. Various integer transforms are applied depending on the selected transform mode. The H.264/AVC uses scalar quantizer for all transform coefficients. The quantizer value is selected using quantization

parameter (QP) which can have 52 values.

Entropy coding:

The H.264/AVC supports two types of entropy coding schemes: context adaptive variable length coding (CAVLC) and context adaptive binary arithmetic coding (CABAC). For low complexity, CAVLC is selected whereas for higher compression, a more complex encoding scheme, CABAC is employed. CABAC assigns a non-integer number of bits for each variable rather than integer number of bits by variable-length coding.

Structure selection:

The proposed end-to-end training scheme does not restrict the specific form of the InvIF. In principle, any differentiable function can be used as the InvIF in the training scheme. We can select different InvIF forms in practice, considering the requirements. Compression artifact reduction proposed I Variable-filter-size Residue-learning CNN (VRCNN), have been adopted. VRCNN consists of 4 layers, and multi-scale convolutional kernel is utilized in the second and third layers. To adjust to the range of video quality different InvIF for different QPs will be trained. Using other CNN structures will be studied in our future work.
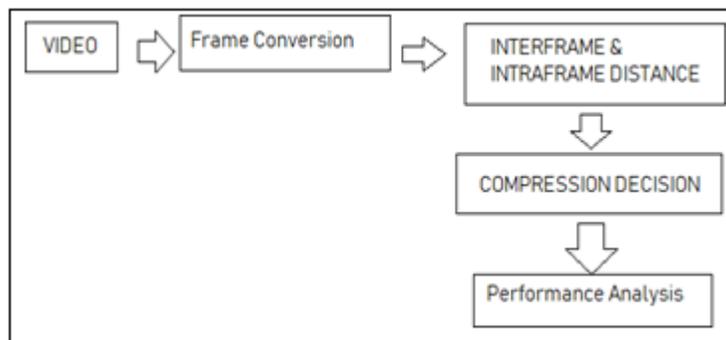

Fig3: InvIF block diagram.

IV. APPLICATIONS

• Videophone.
• Videoconferencing entertainment video.
• Broadcast video interframe JPEG.
• HDTV.

V. CONCLUSION

• In this paper we have conclude that the Video gets compressed without changing original quality and compression for effective transmission.
• Share the video in less time.
• Enhances the efficiency of video coding for reduced bit rate condition.

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