SOME STUDIES IN PARAMETRIC VIDEO AND IMAGE COMPRESSION

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To almighty GOD

Certificate

This is to certify that the thesis titled "**SOME STUDIES IN PARAMETRIC VIDEO AND IMAGE COMPRESSION**" being submitted by **Mr. MITHILESH KUMAR JHA** to the **Department of Electrical Engineering**, **Indian Institute of Technology Delhi**, for the award of the degree of **Doctor of Philosophy**, is a record of bona-fide research work carried out by him under our guidance and supervision. In our opinion, the thesis has reached the standards fulfilling the requirements of the regulations relating to the degree. The results contained in this thesis have not been submitted to any other university or institute for the award of any degree or diploma.

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Abstract

The work presented in this thesis suggests a set of tools and techniques for an efficient representation of texture videos and images using the Parametric Compression framework. The thesis also presents an architecture to integrate these tools with H.264/HEVC to propose an efficient encoder. Further we describes a new motion estimation framework using multi-resolution restricted affine model and a particle filtering based search technique integrated with H.264/HEVC.

First we propose an Statistically Matched Wavelet (SMWT) based pre-processing tool which provides an efficient representation of a texture video frame. We encode the approximation subband coefficients (LL) using a standard image compression scheme like JPEG2000. The detail subband coefficients, that is, HL, LH, and HH are jointly encoded in a compressive sensing (CS) framework and can therefore be represented with fewer measurements resulting in higher compression.

Next we propose a Directional Empirical Mode Decomposition (DEMD) based pre-processing and synthesis technique. The texture video sequence is divided in key frames and $non\text{-}key$ frames. The key frames are encoded using standard JPEG 2000, while

the $non\text{-}key$ frames are reconstructed at the decoder using the DEMD residue and key frame IMF decomposition. Only the very low information DEMD residue is transmitted for $non\text{-}key$ frames. The DEMD residue is encoded using CS in this approach. At the decoder, first the IMF's of the $non\text{-}key$ frames are synthesized from the DEMD representation of key frames using the information present in the residue of the current frame. The IMF's are then combined to synthesize the entire frame. We extended the work by integrating the DEMD-based technique with the standard H.264/HEVC. At the encoder, the input data is pre-processed using DEMD. The DEMD residue images of all $non\text{-}key$ frames (P and B-frames for H.264/HEVC) are encoded using the standard encoder. At the decoder, first the IMF's of all $non\text{-}key$ frames are synthesised using correlation search and patch-based multi-level IMF synthesis from the DEMD representation of key frames (I-frames in H.264/HEVC) and the DEMD residual image of the frame being synthesised. These IMF's are then combined along with the residue of the corresponding frame to synthesize all the $non\text{-}key$ frames.

The final work presented in this thesis is a Restricted Affine Motion Compensation Video Coding scheme that exploits Particle Filtering and Importance Sampling in a multiresolution framework. In this work, We propose three modifications to widely used traditional motion compensation techniques. A higher order linear model is proposed in place of the traditional translational model and the traditional search methods are replaced by an efficient particle filtering-based search, which incorporates information from both spatial and temporal neighbors. The multiscale framework enables efficient parameter estimation while resulting in higher compression due to more accurate motion modeling.

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