Abstract

In current video coding standards, like H.264 and HEVC, to exploit inter frame redundancy, motion estimation is done at the encoder which makes encoder 5 to 10 times more complex than the decoder. This strategy is suitable for applications like broadcasting or video on demand systems, where video is coded once and decoded many times. However in many applications like video surveillance, multimedia sensor networks, disposal camera etc., require less encoder complexity possibly at the expense of increased decoder complexity. For this purpose, distributed video coding (DVC) is considered as a suitable solution. Most of the DVC codecs in literature use Low density parity check and accumulate (LDPCA) or Turbo codes and make use of the available feedback channel for effective compression. In these codecs, the complexity of the LDPCA decoder is very high and it uses feedback channel multiple times which makes it unacceptable for practical applications. Feedback-free DVC codecs are also proposed in literature and have more applications compared to DVC codecs with feedback channel. However, feedback-free codecs suffer from difficult tradeoff between encoder complexity and rate-distortion (RD) performance. A local rank transform (LRT) based DVC codec with feedback channel is proposed in literature and has less complexity both at the encoder and decoder compared LDPCA based DVC codecs, but the RD performance is relatively poor. In this thesis, several LRT based DVC codecs have been proposed to improve the RD performance keeping both the encoder and decoder complexity low.

The first work in this thesis is aimed at improving the RD performance of the LRT based DVC codec and also to eliminate the need for a feedback channel, which makes

the codec suitable for real time application. This is done my modifying different computational modules of the base LRT based DVC codec. These include an LRT variant to reduce bit rate, a probability based rank merging, coding rank positions instead of their values, a mean assisted motion estimation and compensation, an adaptive reconstruction algorithm and a post processing step. Detailed simulations show that the proposed codec performs near to LDPCA based schemes with feedback channel, and consumes less power both at the encoder and decoder which makes it suitable for low power applications.

In all the state-of-the-art DVC codecs, each input frame is divided into either intra frame or Wyner-Ziv (WZ) frame. Intra frames are coded using H.264 intra encoder and WZ frames are coded using LDPCA or Turbo codes. In LRT based DVC codec, LRT along with arithmetic coder is used for coding WZ frames. In the second work of this thesis, only 50% pixels of WZ frame are encoded to decreases the bitrate. At the decoder, a convolutional neural network (CNN) is used which is trained to do upsampling from 50% noisy pixels. The proposed codec shows significant improvement in the RD performance at the expense of increased decoder complexity.

Finally, in the LRT based DVC codec, an approach of limited use of feedback channel is proposed. It is found to improve the RD performance compared to its feedback free version. The codec processes the WZ frame blockwise and mode decision to code a block is taken at the decoder. Feedback channel is used here to send this mode decision map. The complexity of both the encoder and decoder is less compared to conventional DVC codecs. The RD performance of the codec is found to be poorer compared to DISCOVER but is close at some data rates.

Keywords: Distributed video coding (DVC), Low density parity check and accumulate (LDPCA), Local rank transform (LRT), Wyner-Ziv (WZ), Convolutional neural network (CNN)