Abstract

Efficient compression of picture signals is very essential for transmission over communication channels and for storage purposes. Keeping the importance of low complexity in view, this thesis presents some efficient predictive coding methods for both - images and video.

The conventional LS based predictive coding methods are computationally very complex due to requirement of matrix inversion. Besides the problem of the complexity, the matrix inversion may fail and in that case the required prediction coefficients can not be obtained.

The state-of-art lossless coding methods such as Context-based Adaptive Lossless Image Coding (CALIC) and JPEG-Lossless (JPEG-LS) are based on switched adaptive prediction. For this purpose, CALIC uses Gradient Adjusted Predictor (GAP) while JPEG-LS uses MED.

GAP consists of seven slope bins and a predictor is associated with each of the bins. The slope bin boundaries and the associated predictors are fixed for all class of images while these could be image dependent.

In our work, we have explored some possible alternatives for the LS based predictor keeping its high complexity in view. In order to achieve an improvement in the performance of GAP, we propose class dependent optimal slope bins and statistically optimal predictor for each of the bins. The concept of obtaining optimal bins and associated predictors are extended for video.

As stated earlier, the LS based methods are computationally very expensive and for the same reason, we derive two lattice methods for images. The major difficulty faced during the derivation was unavailability of the Toeplitze property in the autocorrelation matrix and due to the same reason we derived two sub-optimal

lattice algorithms for lossless compression of images.

The proposed lattice methods use a full quarter or asymmetrical half plane space and generate one forward and one backward prediction error field at each of its stages. However, for compression purposes the backward prediction error field is not necessary. Keeping this in view, we propose a ladder method of prediction that uses cascaded structure of separate one-dimensional predictors. Reduction in the prediction performance is negligibly small since the predictor is operated on an error frame obtained from the previous stage. Because the proposed ladder method uses only first order predictor at each of its stages, the method is much simpler than the proposed lattice methods.

In order to achieve a better performance than the prediction method used in CALIC, we propose a hybrid method consisting of GAP or MED at the first stage and the ladder method at the second stage. From the simulation results we found that the proposed hybrid method results in better performance than that is used GAP with bias cancellation technique.

In order to improve the performance of GAP, optimal slope bins and optimal predictors are proposed for natural, medical and high-resolution image class. The improved GAP can be used in the proposed hybrid method.

The optimal slope bins are found in such a way that requires minimum bits in coding of prediction errors. Using this criterion function we propose seven numbers of optimal slope bins for natural, medical and high resolution images.

After finding the bins, we propose two different criteria functions for finding statistically optimal predictor to be associated with each of the bins. The predictor based on one of the criteria results in the minimum average value of entropies while predictor based on the second criterion results in the minimum average value of the prediction error energies.

The proposed method is applied to image of natural, medical and high resolution class and observed a significant improvement in the performance as compared to GAP.

We also present an efficient method to find LS based switched predictors for a

given image. The estimated set of the predictors can be store as header information with the image. Using the header information, the image can be compressed and uncompressed as fast as a method based on GAP. From our simulation results, we have shown that the proposed method results in similar performance as that of EDP which is computationally much more complex than the proposed method.

We also observed the performance of hybrid-method using the optimal GAP (with optimal bins and optimal predictors) and the ladder predictor. However, we found that application of ladder predictor on this GAP results in a low improvement over the one obtained using GAP and ladder combination. The reason for low improvement is that the first stage has removed a good amount of redundancy from the input image and the second stage has only a little to offer in terms of redundancy removal.

The concept of slope bin classification and finding associated predictors for images is extended to propose a switched adaptive method for lossless compression of video. For this purpose we propose a very simple method for estimation of slope that contains spatial as well as temporal information. Using a large number of video sequences, we optimally classify the slope to obtain generalized slope bins. As in case of image, we find that seven numbers of slope bins are sufficient. After finding the slope bins, associated predictor is found for each of the bins. Our simulation results show that the proposed method results in much better performance as compared to the LOPT - the recently proposed best method in terms of achievable compression ratio. At the same time, the decoder based on our method is as fast as a method based on GAP while decoder as well as encoder based on LOPT is computationally much more complex. Coding time of our method and LOPT is almost the same.