A Novel Prediction Model For Lossless Video Compression

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We present a novel mathematical model for lossless video compression using Cartesian co-ordinate system. The model is based on our novel approach of explanation to the working principle of Median Edge Detector(MED). Median Edge Detector predicts value of the unknown pixel, x_t, using previously encountered three pixel values (A, B, C), as shown in Fig.(a). This is done using following prediction model.

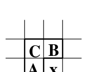
$$\hat{x} = \begin{cases} min(A,B), & \text{if } C \geq max(A,B) \\ max(A,B), & \text{if } C < min(A,B) \\ A+B-C, & \text{otherwise} \end{cases} \qquad (1)$$

We give a novel explanation to this model by arranging the three pixel values in increasing order on a signle dimentional axis as shown in the Fig. (c). We observe that when the point C approaches any one of the two points (A or B), then the point x approaches the other point which explains all the three conditions in (1).

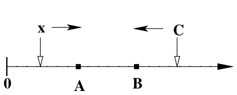
Inspired by the behavior of adjacent pixels of image mapped in single dimension, we applied the similar model for video sequences. For this, we mapped the pixels in two dimensions. In this model, we have considered three causal neighborhood pixels from the current frame and four pixels from the previous frame to determine the context of the pixel to be predicted. This set of pixels is represented in a two dimensional plane with the set of pixels of the present frame taken on Y-axis where as that of previous frame on the X-axis. Now we can have four points in X-Y plane having co-ordinates $\{(a, A), (b, B), (c, C), (x, X)\}$ where X is the pixel to be predicted as shown in Fig.(d). These are joined to form a curve which may be a straight line ($y = mx$ or $y = mx + c$), parabola, etc. The slope of the curve can be obtained in such a way that the prediction error is minimum and then this model can be used for prediction of the unknown pixel. However, in case of the unknown pixel lies on an edge, the model may not give good prediction accuracy. In such cases, propose to take the predicted value equal to the value of the pixel in the previous frame at the same spatial location rather than using any higher order curve model for the same purpose. This choice save computational power associated with estimation of higher order curve parameters. We used following conditions to judge the unknown pixel to be on an edge:

$$Conditions = \begin{cases} C \geq max(A,B) \ \&\& \ C \geq max(a,b) \\ C \leq min(A,B) \ \&\& \ C \leq min(a,b) \end{cases} \qquad (2)$$

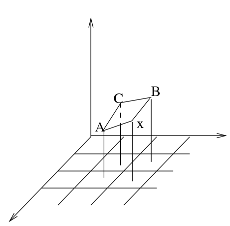
From the experimental results, it was found that the curve with straight line passing through the origin gives the best result with lowest complexity. Although we have an inferior performance of 0.01 bpp as compared to standard motion compensation but our scheme has very low computational complexity, approximately, a decrement of 23% in run time as compared to standard motion compensation method.



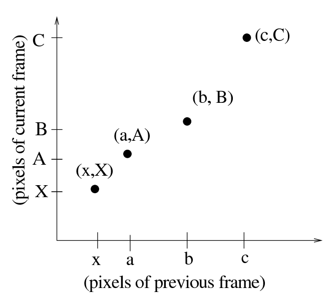
(a)



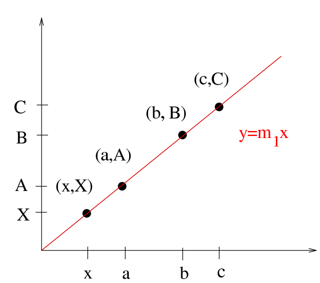
(c)



(b)



(d)



(e)

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