Digital Signal Processing Summer Seminar
Institute of Information Technology - Vietnam Education Foundation
Image/Video Coding and Processing

Homework Assignment III

July 2006

I Consider a simple 8-bit gray-scale video sequence as shown in Figure 1 where a square black object travels from one corner to another at a constant velocity and a fixed direction across a white uniform background. The size of the object is 4×4; the video frame size is 16×16. Assume also that the macro-block (MB) size is 4×4.

The video frames are encoded as

I B B P B B P B B P B B I

where I stands for Intra-frame, P for Predictive-frame and B for Bidirectional-frame. I frames are coded independently. P frames are predicted from the closest previous P or I frame. B frames are bi-directionally predicted from the nearest two I or P frames, 1 in the past and 1 in the future. B frames are never used as reference frames.

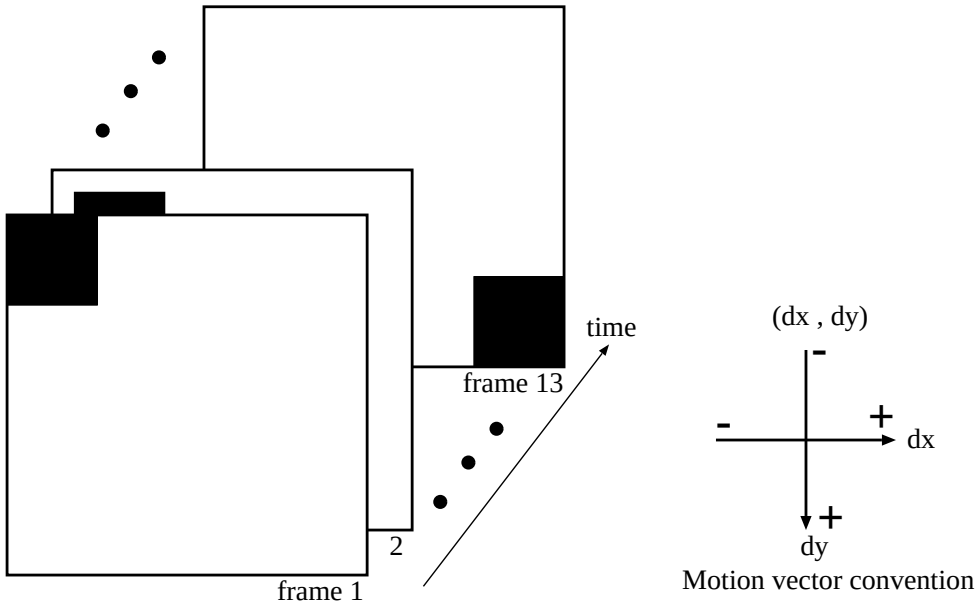

Figure 1: A simple video sequence.

a. Find all relevant motion vectors (dx, dy) (MVs) for frame 2, 4, and 7. Use SAD minimization criterion and a full unrestricted search for your motion estimation. MVs are not allowed to point outside of the video frame.

For B frame, you have to specify a 3-component MV $(dx, dy, p/f)$, where p indicates past (forward prediction) and f indicates future (backward prediction). You are not allowed to use averaging of 2 reference frames.

b. List the encoding and decoding frame order.

c. What frame(s) among 2, 4, and 7 have prediction error?

How many AC DCT coefficients do you have to keep to reconstruct these 3 frames? You can assume that all DC coefficients and side information such as MVs are already encoded separately.

Do B frames help imrove coding efficiency in this case?

d. Suppose that a certain MB (including its headers such as MV) is lost in the transmission process. List all frames that can possibly be corrupted if the missing MB belongs to

- Frame 1
- Frame 2
- Frame 4

e. Devise a simple scheme to replace the lost MB for the following 3 cases

- the missing MB belongs to an I frame
- the missing MB belongs to an P frame
- the missing MB belongs to an B frame