

## Lab6: Introduction to Video Processing

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### I.Motivation

Considering time-varying imagery, such images may be viewed as three-dimensional signals, with two spatial and one temporal coordinates. These signals are referred as image sequences or video. Virtually all video processing systems sample the imagery along the temporal direction, and process a sequence of images, or frames, taken at a certain rate. We are doing this lab to interpolate images and generate a video sequence from existed images then display the video. And we also use Pyramid decomposition for video compression to see how it can be used for lossless compression. Video processing techniques are used in television sets, VCRs, DVDs, video codecs, video players, video scalers and other devices. It solves problem in systems that have live video or where the video data is so large that loading the entire set into the workspace is inefficient.

### II.Methods

*a. The pseudo-code for part A (linear interpolation)*

for i = 1 to i = 21

for the i'th frame Z,  $Z(i) = X + (X - Y) / 20 * i$ .

end

where X is the first image and Y is the last image.

*b. The pseudo-code for part B (image decimation and interpolation)*

for i = 1 to i = 21

for the i'th frame, if i module 4 = 1

$Z(i) = X(i)$

if i module 4 = 2

$Z(i) = X(i-1) + (X(i+3) - X(i-1)) / 4 * (i-1)$

if i module 4 = 3

$Z(i) = X(i-1) + (X(i+2) - X(i-2)) / 4 * (i-1)$

if i module 4 = 4

$Z(i) = X(i-1) + (X(i+3) - X(i-1)) / 4 * (i-1)$

where X(i) is the i'th image in the original image set.

In part B, the difference between the re-interpolated image and the original image are shown in the averaged MSE. The reason for the existence of the difference is because the re-interpolated

images are created by a linear interpolation instead of the real image; so, there are differences. The difference increased with the large sub-sampling factor, which because the interpolation with larger sub-sampling factor has to substitute more original images then increases the difference. (Q1)

*c. The pseudo-code for part B (Pyramid decomposition):*

*1.Compression*

for the  $i = 2, 4, 6, 8$

$Z(i) = (X(i-1)+X(i+1))/2$  and the difference is  $X(i)-Z(i)$

for the  $i = 3, 7$

$Z(i) = (X(i-2)+X(i+2))/2$  and the difference is  $X(i)-Z(i)$

for the  $i = 1, 5, 9$

$Z(i) = X(i)$

*2.Reconstruction*

for the  $i = 2, 4, 6, 8$

$R(i) = (X(i-1)+X(i+1))/2$  + corresponding difference

for the  $i = 3, 7$

$R(i) = (X(i-2)+X(i+2))/2$  + corresponding difference

for the  $i = 1, 5, 9$

$R(i) = Z(i)$

With a larger number of frames, I will try to only substitute the image whose index module 2 equals to 1. Then I will collect the rest of all the original images and rearrange them. Afterward, I will substitute the images whose index module 2 equals to 1 again in rearranged image set. The "substitution" and the "rearrangement" will be repeated till the number of the original images become even. (Q2)

Addition: there are  $1*6=6$  additions in the interpolation and  $1*6=6$  additions in the difference calculation. The total additions is 12. Multiplication: there are  $1*6$  multiplications inn the interpolation and 0 multiplication in the difference calculation. The total multiplication is 6. (Q3)

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Clearly, the interpolation will cause low cost when the original frames "fade" smoothly (which means the pixels changes averagely between neighbor frames) since the linear interpolation create

even changes between two images. On the contrast, the interpolation will be bad if the original frames "fade" rapidly (the pixels change rapidly between the neighbor frames. (Q5)

### III.Results

For part a, after interpolation, it links the two provided images and make it seems like a video, however, the quality is not good. For part b, after decimation then interpolation, the quality of the video is not as good as the original video. With the increasing in subsample factor, the quality of the final video decreases and the difference between the final video with the original video increases. For part c, the reconstructed video is completely same with the original video. It is a perfect reconstruction. The MSE in part b with subsampled factor 2 is  $e_{MSE} = 60.62$ . The MSE in part b with subsampled factor 4 is  $e_{MSE} = 444.36$ . The MSE in part c is  $e_{MSE} = 0$ . I learned that inappropriate liner interpolation will cause decreasing in quality of the video. Pyramid decomposition in time can be used to compress video under lower complexity to transmit it in good quality. And we can operate at a lower bit rat to contain less information because difference frames typically have low intensities.