CS3570 Introduction to Multimedia Technology
Homework #3
Due: 11:59pm, 2014/5/12

Write a program for motion estimation using the block matching methods on the caltrain sequence which includes 20 successive images. Two example images are shown below. You should implement two motion estimation (ME) algorithms, the **full search** and **2D logarithmic motion estimation** in this problem. Suppose that the caltrain001.bmp and caltrain002.bmp are used as the reference frame R and target frame T, respectively. In the following problems, you should try two different sizes of the **macroblock** for ME; namely, 8x8 and 16x16. For each marcoblock T(x,y) in the target frame T, a search is performed to find the block within the search region of R(x,y) in the reference image R such that it best matches the macroblock T(x,y). The search region is defined to be a rectangle that is within +/-d pixels along horizontal and vertical directions. The block matching measure is defined as *sum of absolute differences* **(SAD)** given as follows:

$$SAD(i, j) = \sum_{a=0}^{N-1}\sum_{b=0}^{N-1}\left|T(x+a, y+b) - R(x+i+a, y+j+b)\right|$$

where the macroblock is of size N-by-N.

Implement the two motion estimation methods, and apply them to all non-overlapping macroblocks to compute the motion vectors for the search range with d=8 and d=16. Assume (i) caltrain001.bmp is the reference frame, the rest are target frames, (ii) caltrain001.bmp and caltrain011.bmp are reference frames, and the rest are target frames. Then, calculate the prediction errors (SAD) between the target image and the motion compensated prediction image by using the two ME methods.

(a) (40%) Compare the total SAD values by using the two ME methods. Show the residual images (caltrain002.bmp, caltrain010.bmp, caltrain012.bmp, and caltrain020.bmp) in the above two cases for using the two ME methods.

(b) (30%) Compute the PSNR values by plotting the curves of PSNR vs. frame # and discuss the results in the above two cases by using the two ME methods.

(c) (30%) Analyze the time complexity for the two motion estimation algorithms for this problem. Measure the execution time required for the two ME algorithms with the two different search range sizes. Compare and discuss the execution time with the theoretical time complexity.

caltrain001.bmp (reference)   caltrain002.bmp (target)