

CS3570 Introduction to Multimedia

Homework #3

Due: 11:59pm, 05/01/2023

Write a program for motion estimation (ME) using the block matching methods on the given video sequence. You have to implement two search algorithms to find motion vectors, the **full search** and the **2D logarithmic search method**. The search range is $\pm p$ pixels along horizontal and vertical directions. In this implementation, you should apply the ME to all non-overlapping macroblocks to evaluate the motion vectors, and the block matching measure is defined as **sum of absolute differences (SAD)**, which is described in the slide (p.48).

1. **(70%)** Try the two search ranges (**p=8 and p=16**) for two macroblock sizes (**8x8 and 16x16**) by using the **two search methods**. The reference image is **40.jpg**, and the target image is **42.jpg**.
 - a. Show the predicted images by using the block matching with all the above combinations. **(8 images)**
 - b. Show the motion vectors images for all the above combinations. **(8 images)**
 - c. Show the residual images for all the above combinations. **(8 images)**
 - d. Compute the total SAD values and PSNR for all the results. Discuss the motion-based image prediction quality for all the above settings.
2. **(10%)** Try the full search method with search range **p=8** and macroblock sizes = 8x8. The reference image is **40.jpg**, and the target image is **51.jpg**. Show the PSNR of the result. Compare and discuss the PSNR with the result of same search range and macroblock in question 1.
3. **(20%)** Analyze the time complexity
 - a. Measure the execution time required for the two search algorithms with the two different search range sizes (**p=8 and p=16**).
 - b. Compare and discuss the execution time with the theoretical time complexity for the two search algorithms.

Reminder

- You need to implement your own functions for computing SAD and PSNR between two images.
- Your code should work correctly and the generated results must be consistent to your results in report.
- In report, should contain at least all the results (**predicted images, motion vectors images, residual images, total SAD values, PSNR values**) mentioned in the problem, how you implement the methods, the **discussion** to the output results, and reference.
- Please compress your code, input images, result images, report and in a zip file named **HW3_{Student-ID}.zip** and upload it to eeclass.
- Please follow the file structure below:

```
└──HW3_109060000
    ├──hw3.py
    ├──img (3 images)
    │   ├──40.jpg
    │   ├──42.jpg
    │   └──51.jpg
    ├──out (24 images)
    │   ├──full_predicted_r8_b8.jpg
    │   ├──full_predicted_r8_b16.jpg
    │   ├──full_predicted_r16_b8.jpg
    │   ├──full_predicted_r16_b16.jpg
    │   ├──full_motion_vector_r8_b8.jpg
    │   ├──full_motion_vector_r8_b16.jpg
    │   ├──full_motion_vector_r16_b8.jpg
    │   ├──full_motion_vector_r16_b16.jpg
    │   ├──full_residual_r8_b8.jpg
    │   ├──full_residual_r8_b16.jpg
    │   ├──full_residual_r16_b8.jpg
    │   ├──full_residual_r16_b16.jpg
    │   ├──2d_predicted_r8_b8.jpg
    │   ├──2d_predicted_r8_b16.jpg
    │   ├──2d_predicted_r16_b8.jpg
    │   ├──2d_predicted_r16_b16.jpg
    │   ├──2d_motion_vector_r8_b8.jpg
    │   ├──2d_motion_vector_r8_b16.jpg
    │   ├──2d_motion_vector_r16_b8.jpg
    │   ├──2d_motion_vector_r16_b16.jpg
    │   ├──2d_residual_r8_b8.jpg
    │   ├──2d_residual_r8_b16.jpg
    │   ├──2d_residual_r16_b8.jpg
    │   └──2d_residual_r16_b16.jpg
    └──report.pdf
```