# Lab 4: Motion Compensation

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*Abstract*— **This lab explores content based image retrieval and motion vector computation. Both of these topics are significant and they are the basis of how media is retrieved and compressed.**

***macro; entropy; motion vectors; compression;***

## *I.* Introduction

The role of the motion vector compensation is the compression provided to each frame in a video sequence. It takes the current frame (N+1) and looks for the previous frame (N) in order to locate similarities by using a search radius and macroblocks. As soon as a similarity is found among the frames by receiving the lowest mean absolute difference (MAD) a calculation of the motion vector is completed and issued to refer to the macroblock from the current (N+1) to the previous frame (N).

## II. Theory

The process of template matching uses a template from an image or a cropped section from an image and it looks through another image to find the best match of a template within the original image being searched. The point of using a template is to overlay it with numerous candidate locations in the image being searched.

Computation of motion vectors can be compared to the process of template matching. Motion vector calculations use a macroblock from a frame in a video or an image to use the macroblock as a template to look into previous frames. As a result, some candidate locations have to be taken into account from the image being searched or the 2D frame in order to measure similarity with the template used to find the best match of the template within the target image.

Metrics like the Mean Absolute Difference (MAD) and Mean Square Error (MSE) aid in establishing where a match is found in an image by using a template. This is opposite from the vector motion calculation, where only a part of the frame is utilized.

## III. Methodology

The implementation of this lab was done by creating two separate functions. The main function labelled as 'MVC' takes two frames of the provided video file and instead of breaking the image into small macro sized blocks, it provides the starting and ending index of the macro block from frame n+1 and the possible locations to search from frame n. The second function 'findmacro' simply iterates through the provided first and last index and finds the best match and returns a difference and motion vector. The main function keeps a track of this difference vector and constructs a difference image when all macro blocks have been determined.

The main function requires the string title of a video file, a macro block size and a k value for search radius. Note: The program deviates off bounds when the k value is larger than the macro block size.

The function 'findmacro' takes as an input the following parameters (in order): x indices of the macro block in frame n+1, y indices of the macro block in frame n+1, x indices of the possible locations to search in frame n, y indices of the possible locations to search in frame n, search radius size, frame n+1 and frame n. It provides the outputs (in order): the x motion vector, the y motion vector, and the difference between the macro block form frame n+1 and best matching difference block in frame n.

## *IV.* Results

Using the following parameters, macro=32 k=8, the output shows:

```
   352   640     3

total number of macros and total size of frame
   220

   352   640     3

mvector and it size
     0     0
     0    -2
     0    -2
     0    -2
     0    -2
     0    -2
     0    -2
     0    -2
```

| | |
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| 0 | -2 |
| 0 | -2 |
| 0 | -2 |
| 0 | -2 |
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| 0 | -2 |
| 0 | -2 |
| 0 | -2 |
| 0 | -2 |
| 6 | 0 |
| 1 | -2 |
| 0 | -2 |
| 0 | -2 |
| 1 | -2 |
| 4 | -2 |
| 6 | -2 |
| 0 | 5 |
| 0 | 6 |
| 0 | -2 |
| 0 | 0 |
| 0 | 0 |
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| 0 | -2 |
| 0 | -2 |
| 0 | -2 |
| 0 | 0 |
| 0 | -2 |
| 6 | -2 |
| 6 | 0 |
| 4 | -2 |
| 4 | -2 |
| 3 | -2 |
| 3 | -2 |
| 6 | 2 |
| 2 | -2 |
| 4 | 5 |
| 6 | -2 |
| -2 | -2 |
| -2 | 1 |
| -2 | 1 |
| -2 | -2 |
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| -2 | -2 |
| -2 | -2 |
| -2 | -2 |
| 4 | 0 |
| -2 | 6 |
| 1 | -1 |
| 6 | -2 |
| 1 | 2 |
| 6 | -2 |
| -2 | -2 |
| 6 | -2 |

| | |
|---|---|
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| -2 | 0 |
| 0 | -2 |
| 0 | -2 |
| -2 | 6 |
| -2 | -2 |
| -2 | 4 |
| -2 | -1 |
| 0 | 6 |
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| -2 | -2 |
| 0 | 6 |
| -2 | 0 |
| -2 | 6 |
| -2 | 2 |
| 0 | -2 |
| -2 | 3 |
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| -2 | -2 |

220 2

mdif
352 640

2.2792

2.6759

Note: Some of the values in between have been removed, only the first and last quarter of the mvector values are shown.
2.2792 (second last value from the result) is the entropy calculation after applying the mvector difference and 2.6759 (last value from the result) is the entropy calculation

after applying a simple difference calculation. The worst case for the motion vector compensated entropy value is equal to the entropy for the regular difference, and this is because if it doesn't find a better macro match than the one used as default then there will never be a situation where the motion vector compensated entropy will be higher than the regular difference entropy. Although this is a slight increase in compression, the overall effect across the entire video could result in large compression ratios.

When using a macro block size of 32 with an image size of 640x352, we acquire 220 macro blocks. This will function will return 220 mvectors each associated with a difference. The difference macro blocks are then combined to form a reconstructed image shows below:

## V. CONCLUSION

In conclusion, the function worked as designed for. The function does not work, or goes out of bounds, when the size of k is larger than the macro block size, and this is because the indices passed onto the second function only iterate up to twice the macro block size. Therefore, when the edges of the image are referenced, the function tries to pass on non-existent pixel positons resulting in an error. On another note, the mvector values that are shown in the results are not entirely accurate. The repeated occurrence of -2 means that it is associated with the same pixel positon as the macro block, meaning that all the macro block positions are offset by 2. This is true because the most likely to be selected macro block is the one present in the same location in the previous frame.

This lab successfully demonstrated the reduced entropy values as listed in the results. This compression methodology achieved better compression than regular difference encoding.

## REFERENCES


[1] Li, Z., & Drew, M. (2004). Basics of Digital Audio. In *Fundamentals of multimedia* (Second ed.). New Jersey: Pearson Education.

[2] Electrical and Computer Engineering Department, Ryerson University (2014). *Lab 4: Motion Vector Compensation.* Department of Engineering.