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Motion Estimation for Video Compression

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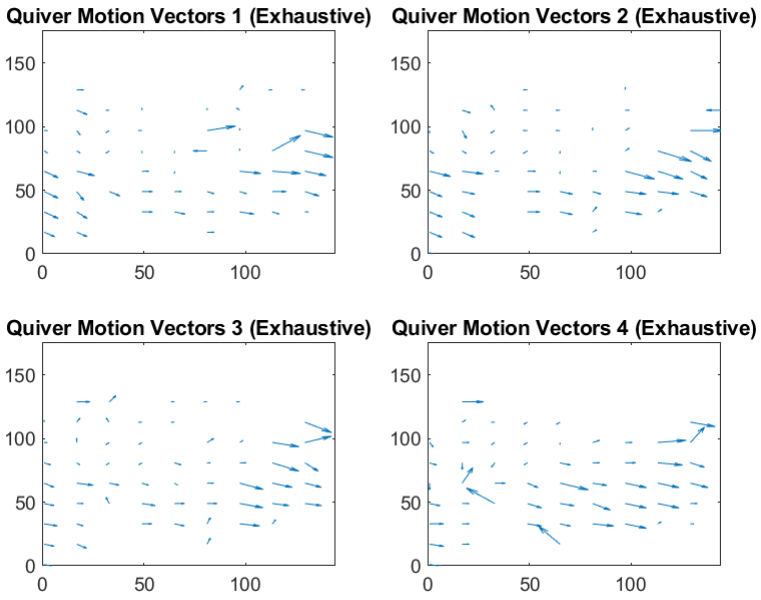

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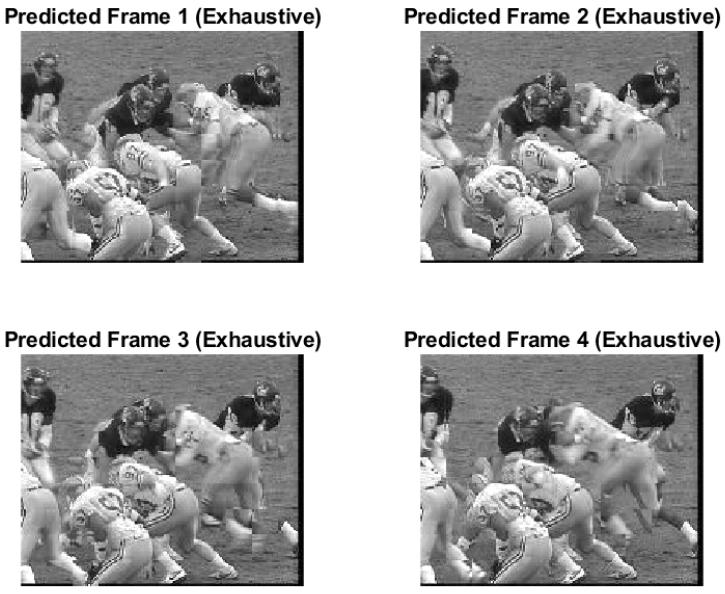

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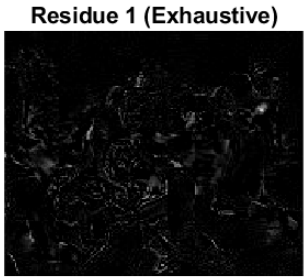

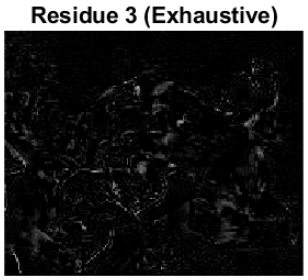

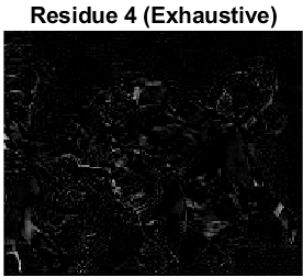

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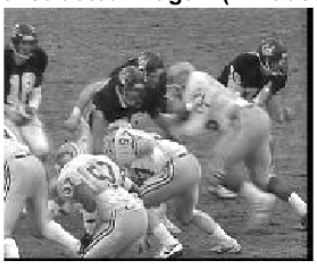
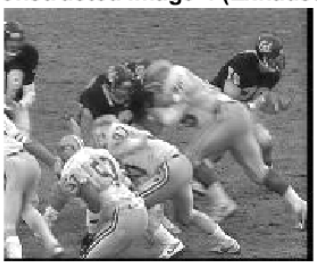
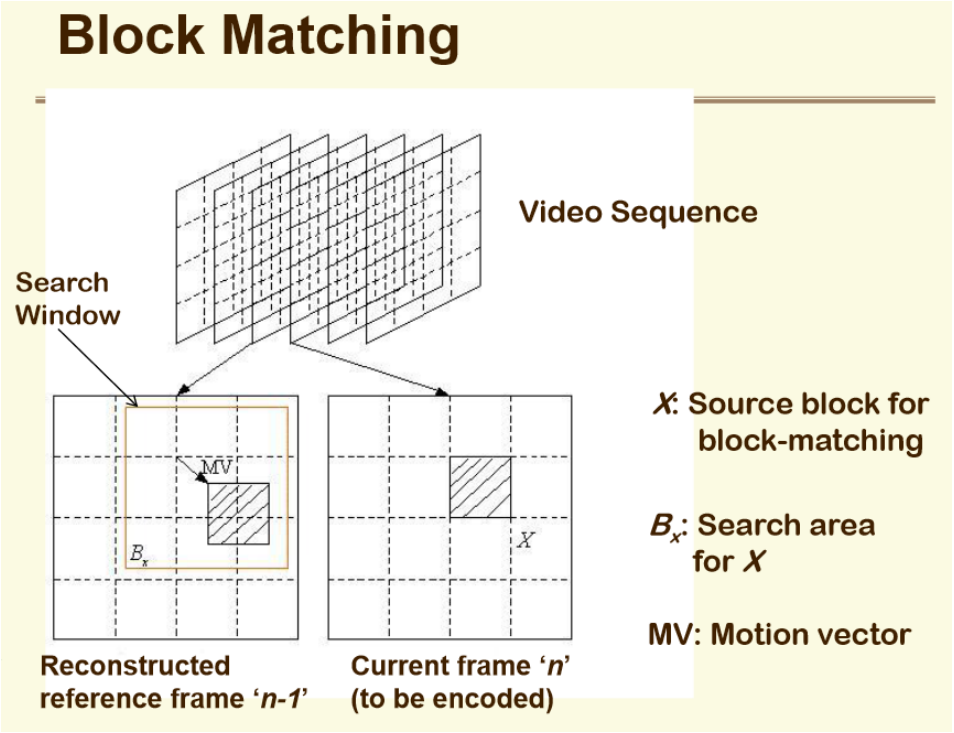




INTRODUCTION

In MPEG and H.26X standards, **block-matching** technique was used for motion estimation/compensation to remove temporal redundancy in order to compress the size of the video file. Motion estimation is the process of determining motion vectors that describe the transformation from one 2D image to another, usually from adjacent frames in a video sequence. "Motion estimation examines the movement of objects in an image sequence to try to obtain vectors representing the estimated motion. Motion compensation uses the knowledge of object motion obtained to achieve data compression."



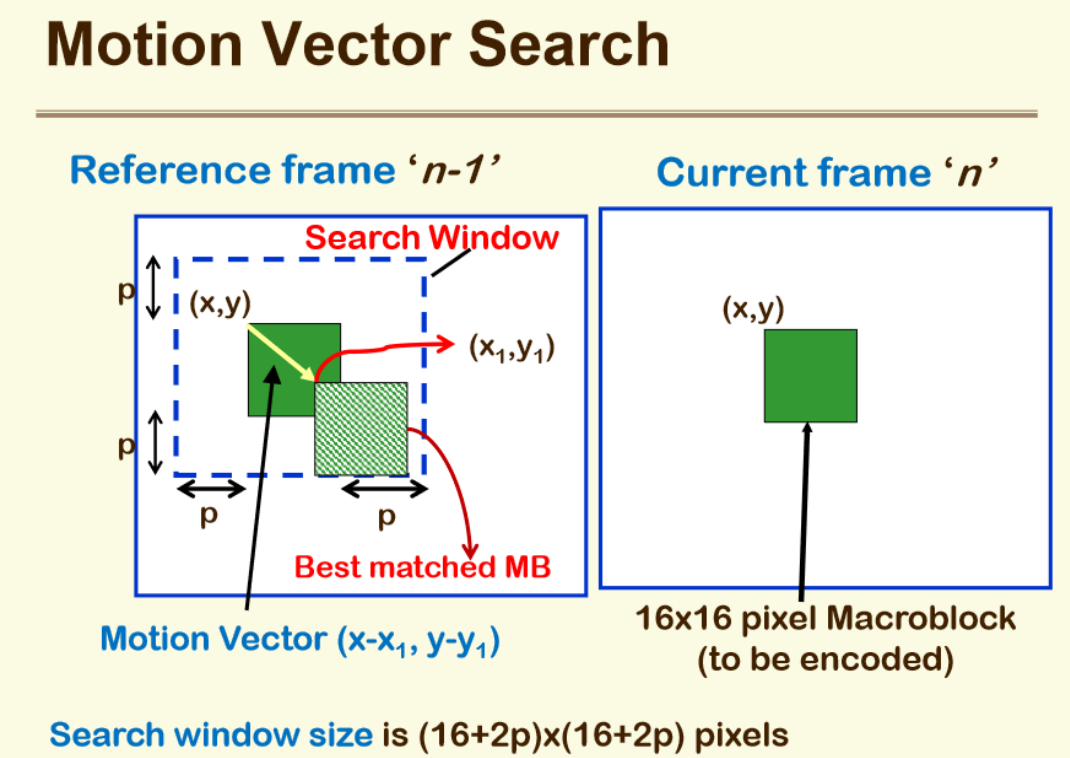
One of the purposes of motion estimation/compensation was to compress the size of the video as much as possible with minimum errors. That means reducing the file size while maintaining the overall quality of the video, at least to the human eyes. Compression can be achieved using different algorithms or techniques to eliminate frame redundancy, some of the redundancies in video are temporal redundancy, spatial redundancy, psychovisual redundancy, and coding redundancy.

How much compression can be achieved depends on the amount of redundancy and structure of the video. A video is broken into different layers:

1. Video sequences

2. Group of pictures (GOPs), which consists of I/P/B frames
3. Pictures
4. Slices
5. Macro Blocks (MB)
6. Blocks

FULL SEARCH (EXHAUSTIVE SEARCH) - is a 'brute force technique' in which every possible candidate block within the search area is compared to the original target block. The distortion function is evaluated a total of (2p+1) * (2p+1) times where p is the maximum displacements in the horizontal and vertical directions. The displacement which produces the minimum distortion is chosen as the motion vector.



ADVANTAGES OF MOTION ESTIMATION:

- Exhaustive/Full search is better when it comes to finding the best match for the motion vectors. The reason behind it is that, in full search, every candidate blocks will be compared with the original block to get the best match candidate.

- Using Full Search could eliminate the risk of missing the best match block which will result in better compressed video quality.

PROCEDURE:

- Read video file, then extract frames 10 – 14.
- Define constants and variables.
- Perform full search motion estimation for Y component.
- Compare current MB to reference MB to get the motion vectors.
- Find the best match block using exhaustive search algorithm (comparing MBs).
- Calculate MAD by adding the difference of the pixel values in the MB.
- Pick and save the best match MB (lowest MAD).
- Calculate the motion vectors (current MB subtracted by best match MB).
- Calculate the residue using the pixel values of the current MB - best match MB.
- Reconstruct the picture (adding the best predicted image with the residue).
- Computational load for exhaustive search is 47978496 additions and 93708 comparisons.

CONCLUSION:

Motion Estimation is a very good technique for video compression. There many block-matching algorithms used in motion estimation, however if resources are not a concern, exhaustive/full search is better since it produces a better-quality video after compression. Sometimes, it is worth to use exhaustive search instead of other faster algorithms when compressing videos to make sure the quality of the videos is high.

References

- PowerPoint Slides
- Display of Difference Image PDF
- MATLAB Help HW3 PDF
- https://www.cmlab.csie.ntu.edu.tw/cml/dsp/training/coding/motion/me1.html