An Optimal-Joint-Coordinate Block Matching Algorithm for Motion-Compensated Coding

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Abstract

Block matching motion estimation/compensation has emerged as an efficient technique in removing temporal redundancies in video signals. Based on a certain distortion function, this technique searches for the best match between a block of pixels in the current picture frame and a number of blocks in close proximity in the previous frame. Most of the published block matching algorithms reduce the search area surrounding the optimum match at each search step. This paper describes a novel methodology to advance the search towards the joint coordinate of the two optimum matches in each step. A new block matching algorithm, namely Optimal Joint Coordinate (OJC) search method, is built on this methodology to avoid redundant searches.

Our algorithm relies on intensive and valid simulation results. The distortion function present in the search region is a convex function with elliptical contours. The basic idea of the OJC is a logarithmic step search. The search does not scan the whole region. The algorithm is described as follows:

Step 1: Initialize the search step size \( p \) to be half of the maximum motion displacement \( w \), i.e., \( p = \frac{w}{2} \). Set the center point \((i, j)\) of the search region at \( i = 0, j = 0 \).

Step 2: Find the optimum point \((i_1, j_1)\) and the second optimum point \((i_2, j_2)\) of the distortion measures \( D(i, j), D(i - p, j), D(i + p, j), D(i, j - p), \) and \( D(i, j + p) \). If \( i_1 \neq i_2 \) and \( j_1 \neq j_2 \), then go to Step 3. Otherwise \( i \leftarrow i_1, j \leftarrow j_1 \) and go to Step 4.

Step 3: Compute \( D(i_1 + i_2 - i, j_1 + j_2 - j) \) and compare it to the minimum distortion measure (i.e., \( D(i_1, j_1) \)) obtained in the previous step. Between two points \((i_1, j_1)\) and \((i_1 + i_2 - i, j_1 + j_2 - j)\), set \((i, j)\) at the point with the less distortion measure. Then, go to Step 4.

Step 4: If \( p = 1 \), stop the search, otherwise set \( p \leftarrow \frac{p}{2} \) and go to Step 2.

The above algorithm is concerned with minimizing the average number of search points. Along with that computed at \((0, 0)\), the total of \( 1 + 5[\log_2 w] \) computations of the distortion function are required to locate the optimum point in the worst case. As opposed to the Modified Motion Estimation (MME) search method that requires \( 1 + 6[\log_2 w] \) computations, the OJC method achieves quicker convergence.