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A New Rapid Algorithm of Motion Estimation for H.264

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Abstract: *In the past years, there were many fast motion estimation algorithms had been proposed, many of them are very famous, such as TSS, NTSS, FSS, and DS, which has exhibited faster search speed. But the above mentioned algorithms are not based on proper hypothesis, which assumed that a picture changed in the same grade regardless the fact that the change in the horizontal direction is more than that in vertical direction. So a new search algorithm was proposed, named Directional Horizontal Cross Double Diamond Search Method, which performed very well in the experiment.*

Key words: *video encoding, H.264/AVC, motion estimation, fast search algorithm*

1. INTRODUCTION

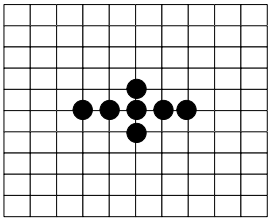
H.264 (or MPEG-4 Part 10) is the most recent digital video coding standard. It was developed by the Joint Video Team (JVT), which represents the cooperation between the ITU-T Video Coding Experts Group (VCEG) and the ISO/IEC Moving Picture Experts Group (MPEG). Although H.264 is better than the old video coding standard, it takes the huge calculation as the cost, and motion estimation takes the most time, which takes about 70 percent in all coding times. So, how to shorten the time in motion estimation is become the more important subject, in the past years, many fast motion estimation had been proposed, and some of than are very useful, such as Three Step search (TTS), New Three Step search (NTTS), Four Step Search (FSS), and Diamond Search (DS) and so on, all of them compare to the full search algorithm saved a big part of time which is taken in the motion estimation, but the decline of PSNR(peak of signal to noise rate) is very small. These fast algorithms give enormous contribution to the H.264 in the real time use. But most of these fast algorithms are both symmetrical regardless in the horizontal way or in the vertical way, the TSS, FSS and so on are all in this way, in the actual motion pictures the move in the horizontal way is more tempestuously than in the vertical way, because the different between forward and afterward frames which are based on the real society video sequences, most come from two aspects, first is the motion of the video object, second is the move of video equipment. The movement of the video object is focus in the horizontal way, such as the car and train, and the walking people; the movement of the cinematograph commonly uses horizontal running and moving as the primary movement, so the motion vector which is in the horizontal way as the most important vector.

It can easily see from the motion vector search process, that the following searches are all based on the former search, every step helps us to find the motion vector by pointing out the approximately position where is the motion vector, and the motion vector in horizontal way is the most important, so in this fast search algorithm we use directional horizontal cross search pattern in the first search step as the search foundation.

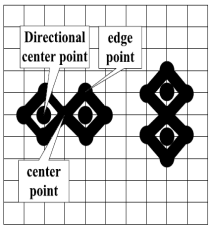
2. FAST MOTION ESTIMATION SEARCH ALGORITHM

Directional Horizontal Cross Double Diamond Search Method (DHCDDS) unites two search patterns, one is the Directional Horizontal Cross search pattern, the other is Directional Double Diamond search pattern, we can use the two search patterns strongpoint, and make sure the best matching point as quickly as possible.

The two search patterns show in Fig. 1:



a
Directional Horizontal Cross search pattern



b
Directional Double Diamond search pattern

Figure 1: The DHCDDS Search Patterns.

Directional Horizontal Cross Double Diamond Search Method's flow chart is show in Fig. 2:

Decision 1: The current best matching point at the center of the search window?

Decision 2: The current best matching point at the center or the directional center of the search window?

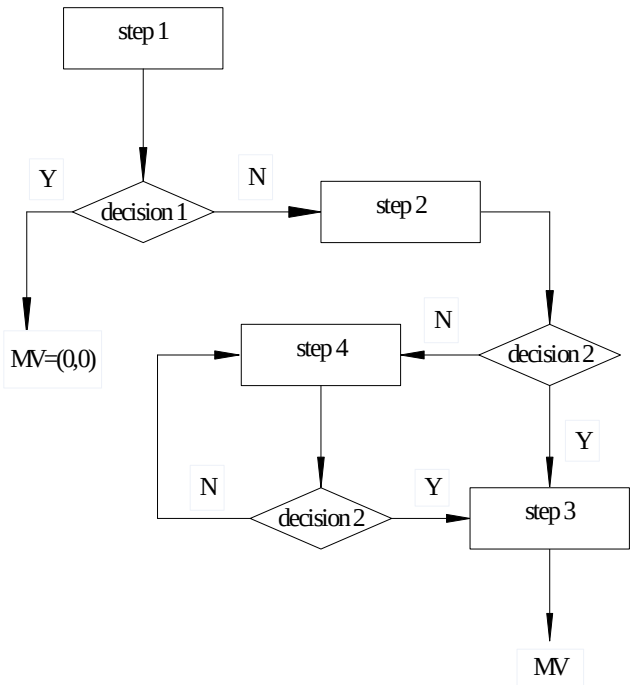


Figure 2: DHCDDS Algorithm's Flow Chart

Directional Horizontal Cross Double Diamond Search Method (DHCDDS) can be described as follows:

Step 1: First of all, using the Directional Horizontal Cross search pattern as the originally search, and finding the current best matching point, if the current best matching point at the center of the Directional Horizontal Cross search pattern, then the current block's motion vector is considered at the center of the search window, in other words we can say that the motion vector mv=(0,0), end of the searching process, otherwise go to Step 2;

Step 2: When the current best matching point not at the center of the current search pattern, so the Directional Horizontal Double Diamond search pattern or the Directional Vertical Double Diamond search pattern will be chose, according to the motion vector, and then find out current best matching point, if the current best matching point at the center or the directional center, then go to Step 3, if the current best matching point on the edge points of the Double Diamond search pattern, go to Step 4;

Step 3: As to the points which are on the top of the center point and the below of the center point, the block matching difference will be computed and then compared to the current best matching point, the one which has the smallest SAD (sum of absolute difference) value is considered as the best matching point, and then end the searching process;

Step 4: If the current best matching point is on the edge points, then the point in the horizontal way the Directional Horizontal Double Diamond search pattern can be used and the point in the Vertical way the Directional Vertical Double Diamond search pattern can be used, according to the center points and the directional center point as the benchmark. So the current best matching point will be got, if the current best matching point is at the center or at the directional center point of the pattern, go to the Step 3, otherwise go to Step 4.

3. SIMULATION RESULT

The Directional Horizontal Cross Double Diamond Search Method (DHCDDS) has been integrated with the H.264 reference software JM86 for the performance evaluation. The test sequences are Silent, foreman and Salesman.

The test conditions are set as follows: 1. MV search range is 16 pixels; 2.Hadamard transform is used; 3. reference frame number equals to 5; 4. CAVLC is used; 5. GOP structure is IPPP; 6. all of them are QCIF format; 7. QP is 28, and the experiment condition is VC++6.0. Experiment results are shown in Table 1:

Table 1
DHCDDS Search Algorithm Compares to Full Search Algorithm

Test sequences		*silent*	*foreman*	*salesman*
Search time(s)	FS	69.528	30.128	15.264
	DHCDDS	22.102	9.842	7.024
SNR (bit)	FS	36.21	35.98	35.67
	DHCDDS	36.02	35.86	35.66
Bit ratios (kbits/s)	FS	232.58	109.15	57.65
	DHCDDS	248.62	110.45	57.76

The results show that the DHCDDS fast search algorithm can get more than 60% coding time reduction versus the full search algorithm, meanwhile the degradation of the video quality and the increase of the bit rate controlled under a reasonable level.

4. CONCLUSIONS

The Directional Horizontal Cross Double Diamond Search Method was proposed by analysis of the video sequences. In the sequences, the changes in the horizontal way are more tempestuously than in the vertical way, so in this fast search algorithm, first of all, using the Directional Horizontal Cross search pattern as the search foundation, then according to the current best matching position to determine whether Directional Horizontal Diamond search pattern or the Directional Vertical Diamond search pattern can be used. From the results, DHCDDS fast search algorithm can get more than 60% coding time reduction versus the full search algorithm, meanwhile the degradation of the video quality and the increase of the bit rate controlled under a reasonable level. Because this fast search algorithm only uses the better

search pattern, it can also unite other methods which can also shorten the searching time, such as halfway-stop technique, and so on. Based on this fast search method the more quickly search method can be got. The motion estimation takes a huge part of the H.264 encoding times, so speeding up the motion estimation search is very important to improve the H.264 encoding efficiency.

REFERENCES

[1] R. Li, B. Zeng, and M. L. Liou, "A New Three-Step Search Algorithm for Block Motion Estimation", *IEEE Trans. Circuits Syst. Video Technol.*, 1994, Vol. 4, pp. 438-442.

[2] L. M. Po, and W. C. Ma, "A Novel Four-Step Search Algorithm for Fast Block Motion Estimation", *IEEE Trans. Circuits Syst. Video Technol.*, 1996, Vol. 6, pp. 313-317.

[3] S. Zhu, and K. K. Ma, "A New Diamond Search Algorithm for Fast Block Matching Motion Estimation", *IEEE Trans. Image Processing*, 2000, Vol. 9, pp. 287-290.

[4] Hongjun Jia, and Li Zhang, "Directional Diamond Search Pattern for Fast Block Motion Estimation", *IEEE Electronics Letters*, 2003, Vol. 39, pp. 1581-1583.

[5] M. Ghanbari, "The Cross-Search Algorithm for Motion Estimation", *IEEE Trans. Commun.*, 1990, Vol. 38, pp. 950-953.