

# Introduction to Multimedia

## hw3\_Report

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程式說明:

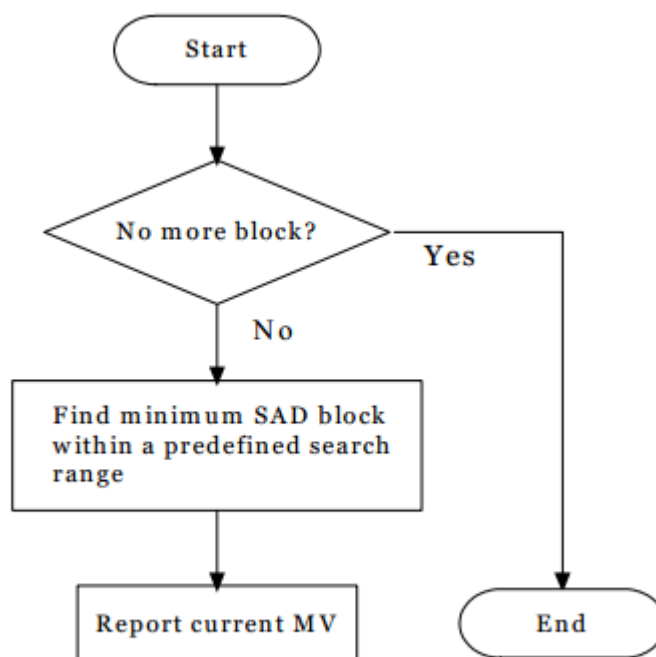
先將T和F先轉成double type做運算，並用 $[h\ w\ c] = \text{size}(R)$ 得image的長h、寬w，並初始化三個array

$p(h/8, w/8)$ 、 $q(h/8, w/8)$  和 $\text{SAD}(h/8, w/8)$ 。p 用來儲存每個Microblock 的Y-component of motion vector；

q 用來儲存每個Microblock的X-component of motion vector；SAD 用來儲存每個Microblock的SAD值。

初始化完之後接著分別做ME：

### 1. Full Search ME



利用雙層for迴圈將frame 分為 $(h/8) \times (w/8)$ 個Microblock, 每換一個新的block 都要Initial此block 的

SAD 為T 這個block 中和R 相對位置的block 中每個pixel 的差的總和。之後以search range =

-15~15 從最左上角開始逐一搜尋R 中和T 最相似的block，一樣是算出T 和目前R 這個block 的

SAD，和上一輪找到的最小的SAD 比較，若新的SAD較小表示這個block 和T 的block 更相近，

將新的SAD 存起來供下一輪比較，並儲存R這個block 和原T 的block 的新motion vector 在p 和 q 中。依此類推在search range 內一個一個block 看，找到新的就把舊的直接覆蓋掉，等到整個 range 都search 完後即可得到這個block 最終的motion vector 和SAD。再往T 的下一個block 推進，依照上述的做法即可找出每一個block 的motion vector 和SAD 存入array 中。在做ME 時其中要注意的是因為search range = -16~16 or -8~8，所以要判斷掉R 的block 超出整張image 的範圍的部分不做。



## 2. 2D Log Search ME



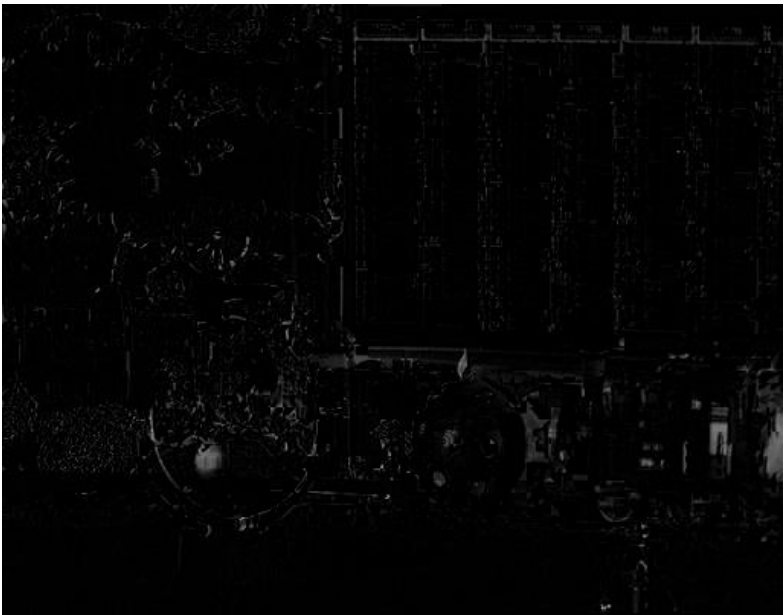
和Full Search一樣，利用雙層for 迴圈將frame 分為 $(h/8) \times (w/8)$ 個microblocks，每換一個新的block 都要initial 這個block 的SAD。另外還要先initial center，我用的是這個block 的最邊界的兩個pixel 位置相加除以二後取floor 為這個block 的center，由於之後R 的center 可能會一直更改，所以初始化完成後將這個center 再存起來做為original center 以固定T 的center。再來由於search range根據題目需求，可根據投影片上algorithm 寫的初始化step size 為 $d = \max(2, 2^{d\_plum-1})$ ;


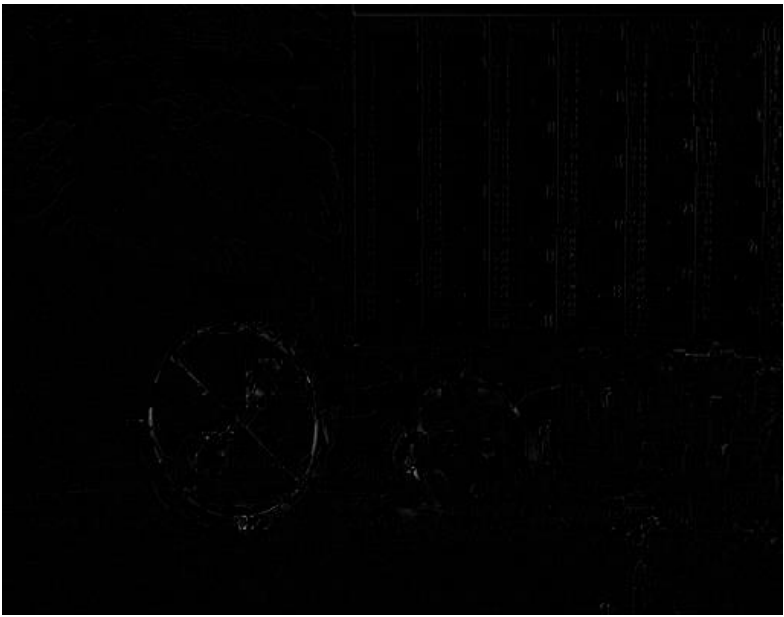

( 其中 $d\_plum = \text{floor}(\log_2(\text{range}))$ , range=8 or 16 )。之後開始比較T 的block 和R 中相對位置的center 上、下、左、右距離step size (d) 以及center 本身的blocks 的SAD 值，如果比上一輪的小則暫時把motion vector 存起來在i\_temp 和j\_temp 中，當這個step size 的五個點都跑過一遍之後將上一輪的motion vector p 和 q 加上j\_temp 和 i\_temp 存回motion vector p 和q，新的center 變成 $x\_center = x\_center + i\_temp$ ;  $y\_center = y\_center + j\_temp$ ;，再以新的center 為R 的center 重複上述步驟繼續找最新似的block。另外step size 的變動在於 $i\_temp = 0$  且  $j\_temp = 0$ 時 ( 也就是當碰到邊界或center 時 )，step size 要除以二取floor 為新的step size。而當step size = 1 的時候，搜尋的blocks 從五個增加為九個，多加了center 左上、右上、左下、右下這四個為中心點的blocks，比較完找到最相似的block 後即結束ME，儲存最後的SAD 值於SAD array 中。

(a.) **Full\_Search ME 's Result:**

(Assume case I & II , Target Frame: caltrain002.bmp,caltrain010.bmp,caltrain012.bmp  
caltrain020.bmp; Range:8&16 )

Full_Search ME			
Target frames	Case (reference)	Range	residual images
caltrain002.bmp	I	8	
		16	

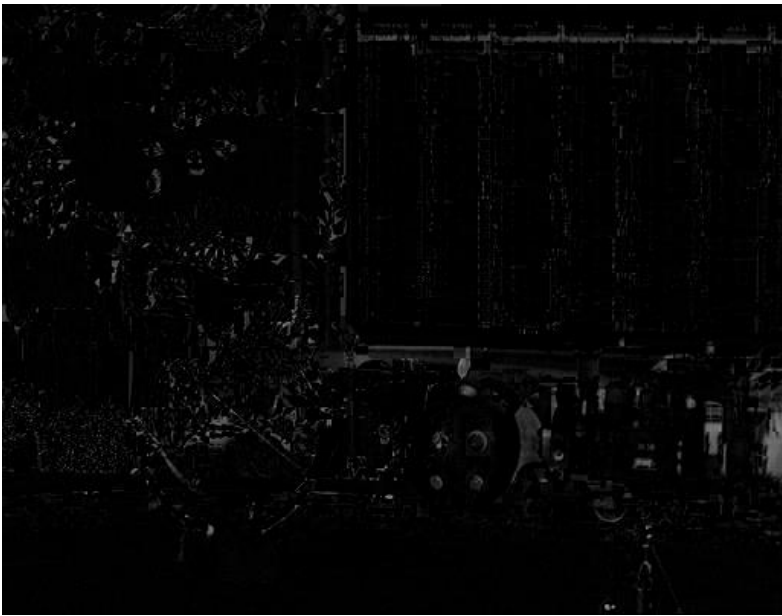
	II	8	
		16	
caltrain010.bmp	I	8	

		16		
	II	8		
		16		

caltrain012.bmp

I

8

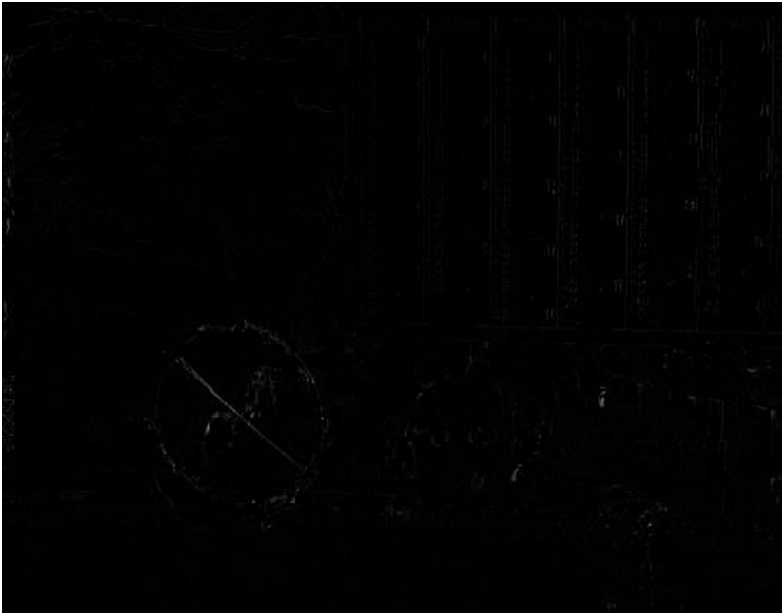


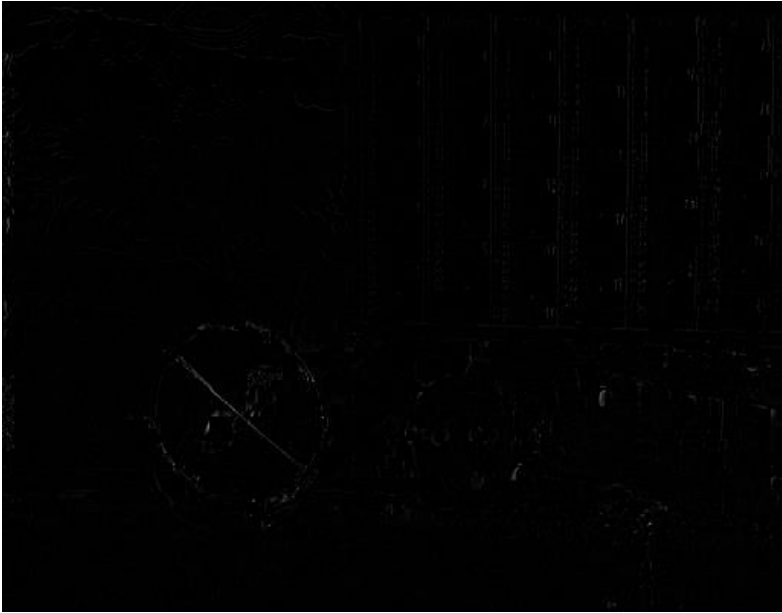


16





II

8



		16	
caltrain020.bmp	I	8	
		16	




	II	8	
		16	

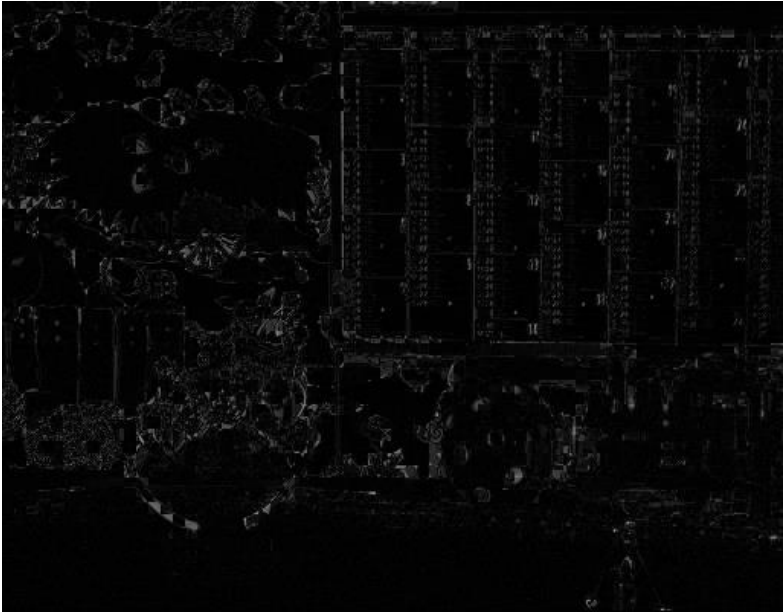

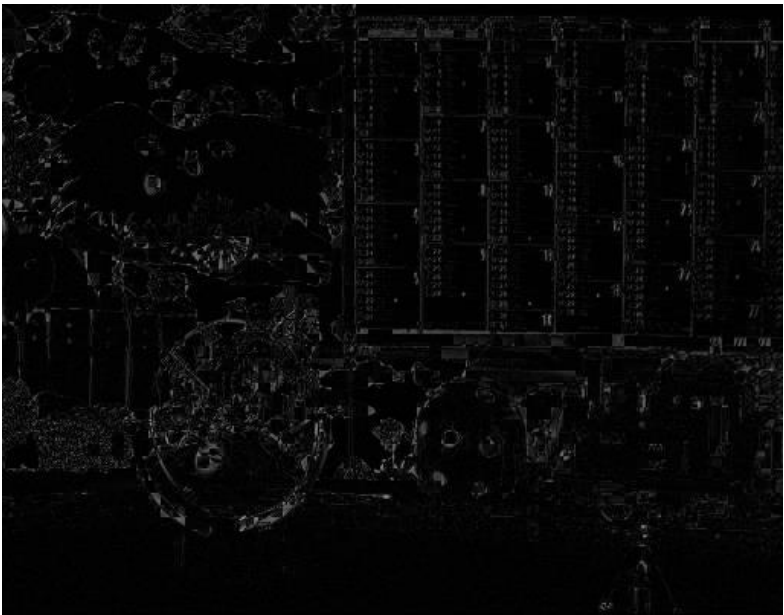
(a.) **2D logarithmic motion estimation ME 's Result:**

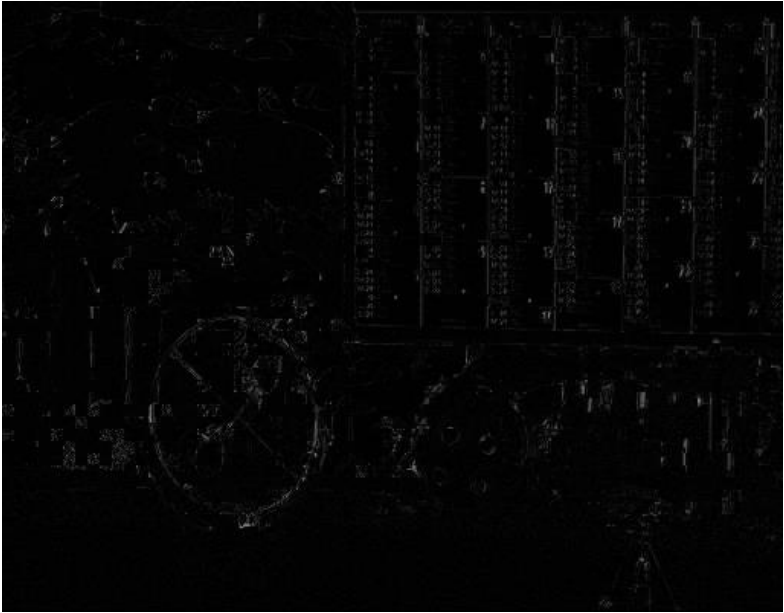

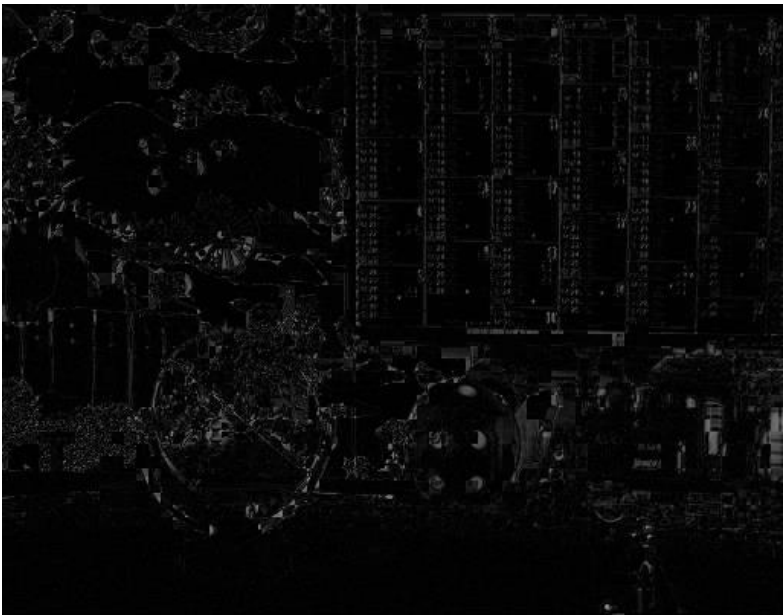
(Assume case I & II , Target Frame: caltrain002.bmp,caltrain010.bmp,caltrain012.bmp caltrain020.bmp;  
Range:8&16 )




<b>2D logarithmic motion estimation ME</b>			
Target frames	Case (reference)	Range	residual images


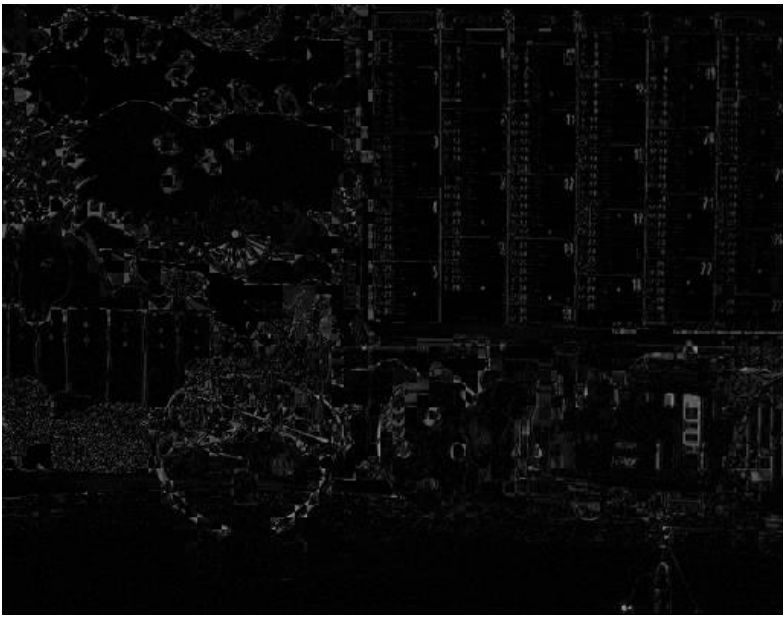



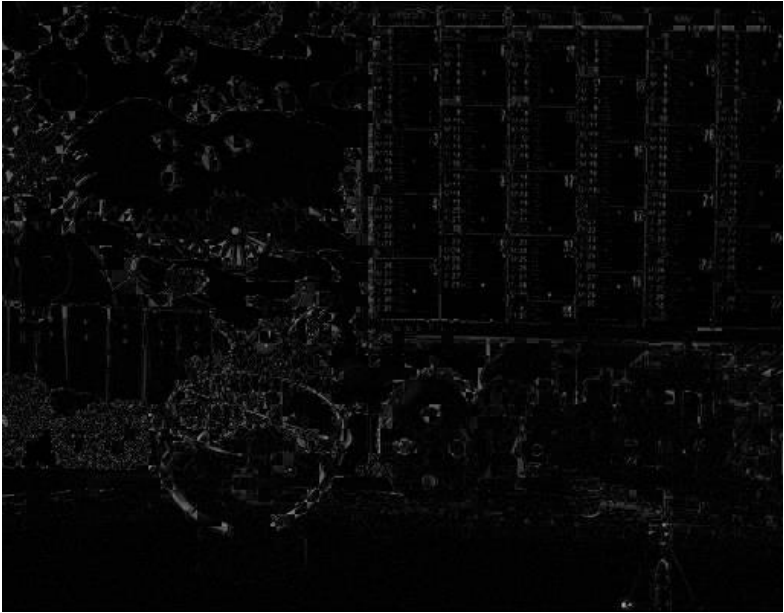
caltrain002.bmp	I	8	
		16	
	II	8	

		16	
caltrain010.bmp	I	8	
		16	

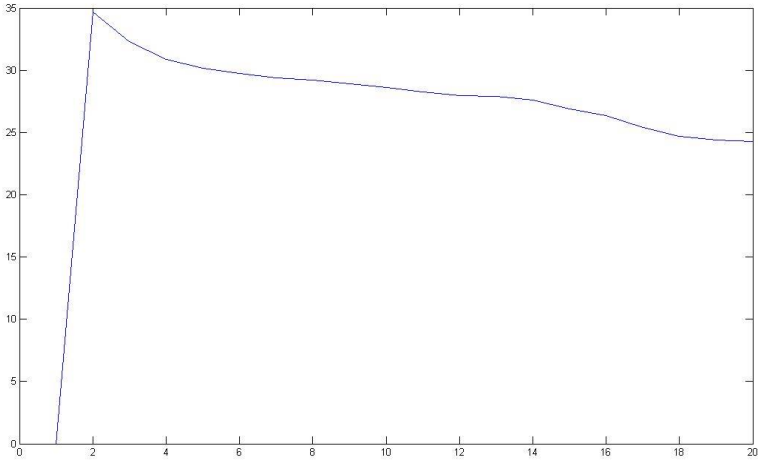
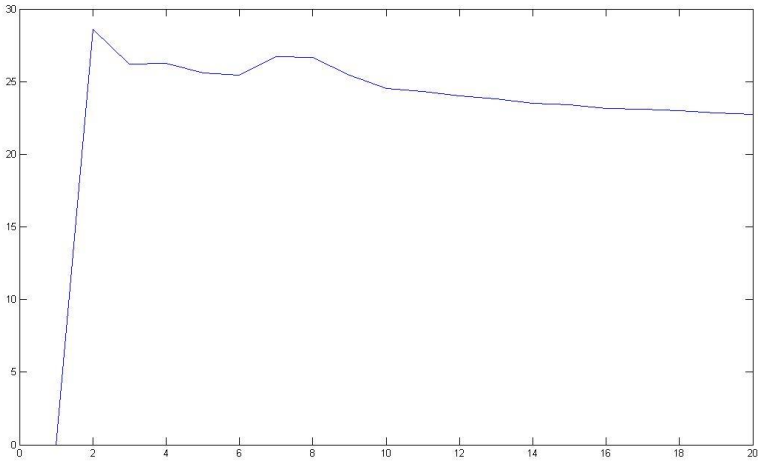
	II	8	
		16	
caltrain012.bmp	I	8	

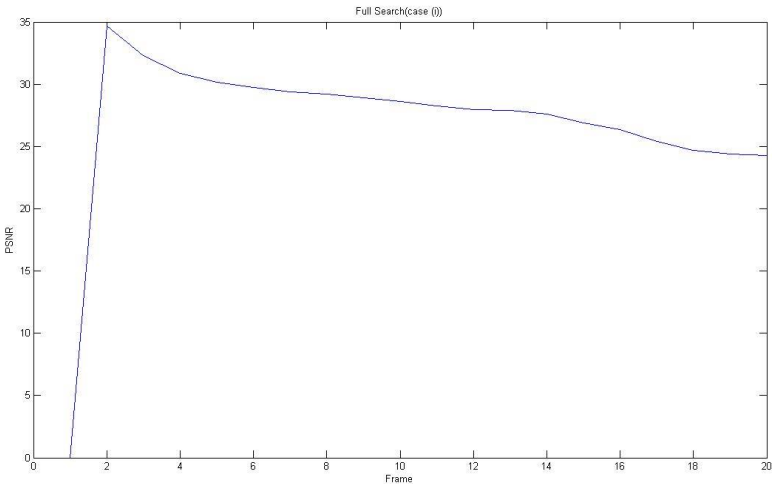
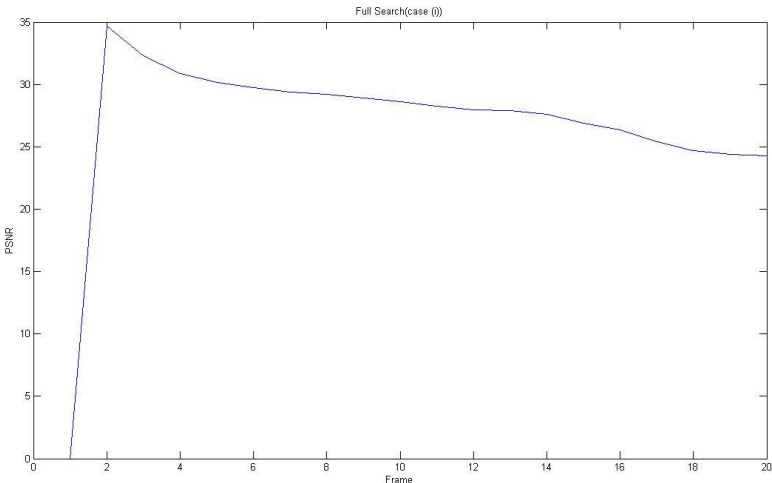
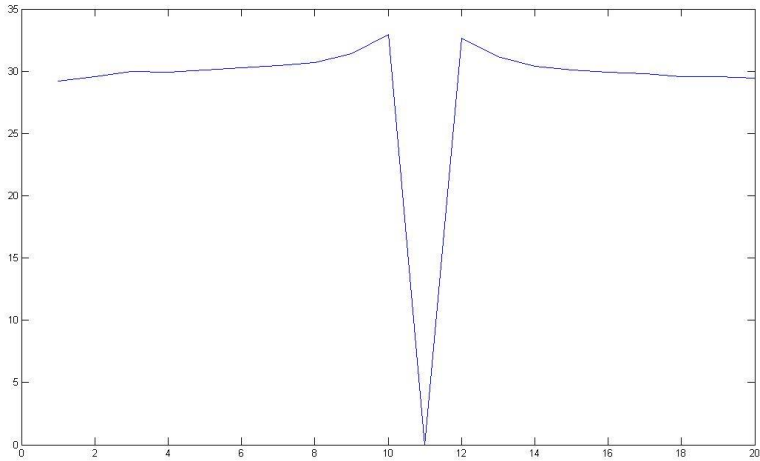
		16	
	II	8	
		16	

caltrain020.bmp	I	8	
		16	
	II	8	

		16	
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(b.)

Case	Range		Plot
(i)	8	Full search	
		2D_logarithm_search	

	16	Full search	 <p>Full Search(case 0)</p> <p>PSNR</p> <p>Frame</p>
		2D_logarithm_search	 <p>Full Search(case 0)</p> <p>PSNR</p> <p>Frame</p>
(ii)	8	Full search	 <p>PSNR</p> <p>Frame</p>

		2D_logarithm_search	
16		Full search	
		2D_logarithm_search	

Compare :

1. 在同一個 search range , 同一個 case 中 , Residual image 代表著 matching image(復原圖)及 target 的差異 , 呈現的 pixel=0(black)表示差異越小 , pixel 值越大(接近 white)表示差異越大 , 從上列圖



中,很明顯可以感受到 Full Search 是比較黑的,也就是說和 target 的相似度是 Full Search > 2D Log Search 。

⇒ Full Search 中在 search range  $-range \sim range$  範圍內的每一個 pixel 都作為搜尋 block 的最左上角的點, block 都有搜尋到,所以可以找到最佳的 matching block,進而得到最相似的圖。而 2D Log Search 搜尋的 block 大部分都只有搜尋五個 blocks,只有在 step size 為 1 時是搜尋九個 blocks,之後 step size 才會再縮小;

2. 在同一個演算法,同一個 case 中,不同 Search Range 也明顯造成不同的結果,range 大的 Residual image 白色 pixel 較多,range 小的 Residual image 白色處較少,證明了 range 越小,就能做出越精細、越接近原 target 的圖。
3. 在同一個演算法,同一個 Search Range,不同 case 裡,case I Residual image 明顯比 case II Residual image 還要多黑的 pixel,證明了 case i 的相似度是大於 case ii 的。
4. 比較 Total SAD value(如下表所列),SAD 是 Prediction Error,我們以同一個 case 及同一個 search range 來比較兩種演算法的值,可以發現 2D Log Search > Full Search,因此我們可以知道 2D Log Search 的誤差是大於 Full Search 的,也意味著,在相似度來說,Full Search 是大於 2D Log Search 的。
5. 比較 Total SAD value(如下表所列),SAD 是 Prediction Error,我們以同一個 case 及同一個 search Algorithm 來比較兩種 Range 的值,可以發現 Range 大的 SAD > Range 小的 SAD,因此我們可以知道 Range 越大所造成的誤差是大 Range 小的,也意味著,在相似度來說,Range 小的表現較好。
6. 比較 PSNR(如下表所列),我們以同一個 case 及同一個 search range 來比較兩種演算法的值,可以發現 Full Search > 2D Log Search,表示相似度來說,Full Search 是大於 2D Log Search 的。

7. 比較 PSNR(如下表所列), 我們以同一個 case 及同一個 search Algorithm 來比較兩種 Range 的值 ,  
可以發現 Range 小>Range 大 , 意味著 , 在相似度來說 , Range 小的表現較好。

8. 分析time complexity 並比較execution time

time complexity 的部分 , Full Search 搜尋了完整的search range  $-d \sim d$  , 且microblocks的size 為  $N \times N$  ,  
所以Full Search 的time complexity 為  $O(N^2 d^2)$  ; 2D Log Search 和TSS 的search range 一樣為  $-d \sim d$  , 但因為step size 會取log ( 以2 為底 ) , 所以time complexity皆為  $O(N^2 \lg(d))$  。利用tic ( 計時開始 ) 和toc ( 計時結束 , 並將執行時間顯示在command window 上 ) 得到兩種search ME 的執行時間( 如上表所示 ) , execution time: Full Search > 2DLog Search , Full Search 和2D Log Search 的execution time 其實差不多 ( 只差了0.2秒多 ) 。從前面分析出的time complexity 可看出Full Search 的time complexity 是最複雜的 (  $d^2 > \log_2 d$  ) 。

完整輸出資訊：

<pre>===== 2D_Logarithm_Search Reference Frame:caltrain001.bmp Target Frame: caltrain002.bmp Range: 16 : Elapsed time is 1.239799 seconds. SAD = 952299.000000 PSNR = 28.514853 ===== =====  2D_Logarithm_Search Reference Frame:caltrain001.bmp Target Frame: caltrain002.bmp Range: 16 : Elapsed time is 47.240093 seconds. SAD = 545739.000000 PSNR = 34.658709 =====</pre>	<pre>===== 2D_Logarithm_Search Reference Frame:caltrain001.bmp Target Frame: caltrain007.bmp Range: 16 : Elapsed time is 1.429798 seconds. SAD = 1556465.000000 PSNR = 24.805032 ===== =====  2D_Logarithm_Search Reference Frame:caltrain001.bmp Target Frame: caltrain007.bmp Range: 16 : Elapsed time is 43.877945 seconds. SAD = 899337.000000 PSNR = 29.410626 =====</pre>
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<div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain001.bmp</div> <div>Target Frame: caltrain003.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 1.368314 seconds.</div> <div>SAD = 1332867.000000</div> <div>PSNR = 25.928714</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain001.bmp</div> <div>Target Frame: caltrain003.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 43.745212 seconds.</div> <div>SAD = 685366.000000</div> <div>PSNR = 32.313189</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain001.bmp</div> <div>Target Frame: caltrain004.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 1.430327 seconds.</div> <div>SAD = 1396779.000000</div> <div>PSNR = 25.518228</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain001.bmp</div> <div>Target Frame: caltrain004.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 44.041624 seconds.</div> <div>SAD = 791590.000000</div> <div>PSNR = 30.886342</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain001.bmp</div> <div>Target Frame: caltrain005.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 1.449469 seconds.</div>	<div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain001.bmp</div> <div>Target Frame: caltrain008.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 1.439820 seconds.</div> <div>SAD = 1520529.000000</div> <div>PSNR = 24.938842</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain001.bmp</div> <div>Target Frame: caltrain008.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 43.828885 seconds.</div> <div>SAD = 914028.000000</div> <div>PSNR = 29.203358</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain001.bmp</div> <div>Target Frame: caltrain009.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 1.446529 seconds.</div> <div>SAD = 1584936.000000</div> <div>PSNR = 24.686550</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain001.bmp</div> <div>Target Frame: caltrain009.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 43.122493 seconds.</div> <div>SAD = 946834.000000</div> <div>PSNR = 28.935876</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain001.bmp</div> <div>Target Frame: caltrain010.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 1.468769 seconds.</div>
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<p>SAD = 1521289.000000</p> <p>PSNR = 24.867966</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p> <p>Target Frame: caltrain005.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 43.734746 seconds.</p> <p>SAD = 834179.000000</p> <p>PSNR = 30.172795</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p> <p>Target Frame: caltrain006.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 1.460565 seconds.</p> <p>SAD = 1595960.000000</p> <p>PSNR = 24.620340</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p> <p>Target Frame: caltrain006.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 43.216467 seconds.</p> <p>SAD = 867997.000000</p> <p>PSNR = 29.753228</p> <p>=====</p>	<p>SAD = 1669131.000000</p> <p>PSNR = 24.383652</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p> <p>Target Frame: caltrain010.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 43.216483 seconds.</p> <p>SAD = 979198.000000</p> <p>PSNR = 28.637646</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p> <p>Target Frame: caltrain011.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 1.477901 seconds.</p> <p>SAD = 1661841.000000</p> <p>PSNR = 24.507762</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p> <p>Target Frame: caltrain011.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 43.869045 seconds.</p> <p>SAD = 1024957.000000</p> <p>PSNR = 28.248342</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p> <p>Target Frame: caltrain012.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 1.479097 seconds.</p> <p>SAD = 1624702.000000</p> <p>PSNR = 24.653381</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p>
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	<p>Target Frame: caltrain012.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 43.258326 seconds.</p> <p>SAD = 1062177.000000</p> <p>PSNR = 27.944549</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p> <p>Target Frame: caltrain013.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 1.512738 seconds.</p> <p>SAD = 1550067.000000</p> <p>PSNR = 24.993309</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p> <p>Target Frame: caltrain013.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 43.138664 seconds.</p> <p>SAD = 1074165.000000</p> <p>PSNR = 27.925560</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p> <p>Target Frame: caltrain014.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 1.460993 seconds.</p> <p>SAD = 1490976.000000</p> <p>PSNR = 25.383570</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p> <p>Target Frame: caltrain014.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 43.020400 seconds.</p> <p>SAD = 1130160.000000</p> <p>PSNR = 27.575337</p> <p>=====</p>
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	<div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain001.bmp</div> <div>Target Frame: caltrain015.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 1.439878 seconds.</div> <div>SAD = 1468637.000000</div> <div>PSNR = 25.578719</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain001.bmp</div> <div>Target Frame: caltrain015.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 42.948582 seconds.</div> <div>SAD = 1225487.000000</div> <div>PSNR = 26.917490</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain001.bmp</div> <div>Target Frame: caltrain016.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 1.443584 seconds.</div> <div>SAD = 1497666.000000</div> <div>PSNR = 25.437686</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain001.bmp</div> <div>Target Frame: caltrain016.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 42.995362 seconds.</div> <div>SAD = 1328229.000000</div> <div>PSNR = 26.341643</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain001.bmp</div> <div>Target Frame: caltrain017.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 1.494888 seconds.</div>
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	<p>SAD = 1633061.000000</p> <p>PSNR = 24.737075</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p> <p>Target Frame: caltrain017.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 43.080772 seconds.</p> <p>SAD = 1503881.000000</p> <p>PSNR = 25.397068</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p> <p>Target Frame: caltrain018.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 1.516481 seconds.</p> <p>SAD = 1696994.000000</p> <p>PSNR = 24.339344</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p> <p>Target Frame: caltrain018.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 42.951050 seconds.</p> <p>SAD = 1644008.000000</p> <p>PSNR = 24.715678</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p> <p>Target Frame: caltrain019.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 1.504244 seconds.</p> <p>SAD = 1746075.000000</p> <p>PSNR = 24.156913</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p>
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	<p>Target Frame: caltrain019.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 43.401983 seconds.</p> <p>SAD = 1703789.000000</p> <p>PSNR = 24.400002</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p> <p>Target Frame: caltrain020.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 1.521310 seconds.</p> <p>SAD = 1790013.000000</p> <p>PSNR = 23.972170</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain001.bmp</p> <p>Target Frame: caltrain020.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 43.630893 seconds.</p> <p>SAD = 1742094.000000</p> <p>PSNR = 24.263861</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain001.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 1.466404 seconds.</p> <p>SAD = 1611457.000000</p> <p>PSNR = 24.704916</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain001.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 42.496846 seconds.</p> <p>SAD = 960122.000000</p> <p>PSNR = 29.184296</p> <p>=====</p>
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	<div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain011.bmp</div> <div>Target Frame: caltrain002.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 1.466103 seconds.</div> <div>SAD = 1576157.000000</div> <div>PSNR = 24.799055</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain011.bmp</div> <div>Target Frame: caltrain002.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 42.383784 seconds.</div> <div>SAD = 919547.000000</div> <div>PSNR = 29.570754</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain011.bmp</div> <div>Target Frame: caltrain003.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 1.443507 seconds.</div> <div>SAD = 1490696.000000</div> <div>PSNR = 25.219156</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain011.bmp</div> <div>Target Frame: caltrain003.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 42.301993 seconds.</div> <div>SAD = 884020.000000</div> <div>PSNR = 29.983392</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain011.bmp</div> <div>Target Frame: caltrain004.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 1.455126 seconds.</div>
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	<p>SAD = 1476077.000000</p> <p>PSNR = 25.236533</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain004.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 42.482236 seconds.</p> <p>SAD = 882892.000000</p> <p>PSNR = 29.910736</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain005.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 1.427869 seconds.</p> <p>SAD = 1505749.000000</p> <p>PSNR = 25.055947</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain005.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 42.465983 seconds.</p> <p>SAD = 864680.000000</p> <p>PSNR = 30.102509</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain006.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 1.416933 seconds.</p> <p>SAD = 1585766.000000</p> <p>PSNR = 24.738844</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p>
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	<p>Target Frame: caltrain006.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 43.436460 seconds.</p> <p>SAD = 851366.000000</p> <p>PSNR = 30.294470</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain007.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 1.431886 seconds.</p> <p>SAD = 1551881.000000</p> <p>PSNR = 24.813574</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain007.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 42.372517 seconds.</p> <p>SAD = 839315.000000</p> <p>PSNR = 30.454512</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain008.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 1.405925 seconds.</p> <p>SAD = 1445371.000000</p> <p>PSNR = 25.363928</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain008.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 43.119424 seconds.</p> <p>SAD = 813912.000000</p> <p>PSNR = 30.705054</p> <p>=====</p>
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	<div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain011.bmp</div> <div>Target Frame: caltrain009.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 1.353684 seconds.</div> <div>SAD = 1349092.000000</div> <div>PSNR = 25.926760</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain011.bmp</div> <div>Target Frame: caltrain009.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 42.473968 seconds.</div> <div>SAD = 753652.000000</div> <div>PSNR = 31.376983</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain011.bmp</div> <div>Target Frame: caltrain010.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 1.197127 seconds.</div> <div>SAD = 1012092.000000</div> <div>PSNR = 28.268530</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain011.bmp</div> <div>Target Frame: caltrain010.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 42.389011 seconds.</div> <div>SAD = 654481.000000</div> <div>PSNR = 32.947045</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain011.bmp</div> <div>Target Frame: caltrain012.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 1.204092 seconds.</div>
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	<p>SAD = 1013995.000000</p> <p>PSNR = 28.118113</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain012.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 42.310313 seconds.</p> <p>SAD = 667526.000000</p> <p>PSNR = 32.654880</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain013.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 1.355857 seconds.</p> <p>SAD = 1323242.000000</p> <p>PSNR = 26.098810</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain013.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 43.088649 seconds.</p> <p>SAD = 786446.000000</p> <p>PSNR = 31.142185</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain014.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 1.403704 seconds.</p> <p>SAD = 1443893.000000</p> <p>PSNR = 25.417703</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p>
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	<p>Target Frame: caltrain014.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 42.390777 seconds.</p> <p>SAD = 854442.000000</p> <p>PSNR = 30.422451</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain015.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 1.446020 seconds.</p> <p>SAD = 1524420.000000</p> <p>PSNR = 25.020100</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain015.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 42.483213 seconds.</p> <p>SAD = 863513.000000</p> <p>PSNR = 30.116587</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain016.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 1.430335 seconds.</p> <p>SAD = 1544765.000000</p> <p>PSNR = 24.891571</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain016.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 42.556377 seconds.</p> <p>SAD = 884373.000000</p> <p>PSNR = 29.911557</p> <p>=====</p>
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	<div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain011.bmp</div> <div>Target Frame: caltrain017.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 1.437940 seconds.</div> <div>SAD = 1489605.000000</div> <div>PSNR = 25.184595</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain011.bmp</div> <div>Target Frame: caltrain017.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 42.999662 seconds.</div> <div>SAD = 901525.000000</div> <div>PSNR = 29.788577</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain011.bmp</div> <div>Target Frame: caltrain018.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 1.456323 seconds.</div> <div>SAD = 1519901.000000</div> <div>PSNR = 25.039946</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain011.bmp</div> <div>Target Frame: caltrain018.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 42.413411 seconds.</div> <div>SAD = 911991.000000</div> <div>PSNR = 29.559219</div> <div>=====</div> <div>=====</div> <div>2D_Logarithm_Search</div> <div>Reference Frame:caltrain011.bmp</div> <div>Target Frame: caltrain019.bmp</div> <div>Range: 16 :</div> <div>Elapsed time is 1.428482 seconds.</div>
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	<p>SAD = 1567938.000000</p> <p>PSNR = 24.810580</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain019.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 42.354278 seconds.</p> <p>SAD = 901928.000000</p> <p>PSNR = 29.559510</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain020.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 1.458448 seconds.</p> <p>SAD = 1583636.000000</p> <p>PSNR = 24.744984</p> <p>=====</p> <p>=====</p> <p>2D_Logarithm_Search</p> <p>Reference Frame:caltrain011.bmp</p> <p>Target Frame: caltrain020.bmp</p> <p>Range: 16 :</p> <p>Elapsed time is 42.578011 seconds.</p> <p>SAD = 930302.000000</p> <p>PSNR = 29.419382</p> <p>=====</p>
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