

3. (a) A block of  $2 \times 2$  pixels in the current frame is shown in Figure 4 and its co-located block in the reference frame is shown by the shaded area in Figure 5. Given a search window of  $\pm 1$  pixels, find the best-matched motion vector and the corresponding block in Figure 5, if the distortion criterion is Mean Square Error (MSE).

70	85
60	75

**Figure 4**

80	70	50	60
60	55	70	80
60	60	70	60
70	85	70	60

**Figure 5**

(10 Marks)

- (b) In motion estimation, explain the main reason why half-pel accurate motion estimation could achieve better prediction performance than integer-pel accurate motion estimation. With the help of a simple diagram, explain the bilinear interpolation method used to obtain half-pel values in a  $2 \times 2$  image block.

21-81-Q3

Q(a) MSE best match? Fig 4 → Fig 5

70	85
60	75

	1	2	3	4
1	80	70	50	60
2	60	55	70	80
3	60	60	70	60
4	70	85	70	60

Solution ① Calculation

we denote Block as the top-left coordinate

Block MSE

$$(1,1) \frac{1}{4} \times [(80-70)^2 + (70-85)^2 + (60-60)^2 + (55-75)^2] = 181.25$$

$$(1,2) \quad 38.75$$

$$(1,3) \quad 287.5$$

$$(2,1) \quad 306.25$$

$$(2,2) \quad 118.75$$

$$(2,3) \quad 87.5$$

$$(3,1) \quad 231.25$$

$$(3,2) \quad 243.75$$

$$(3,3) \quad 237.5$$

抄送: Yap Kim Hui (Assoc Prof)

Hi,

This question was set by the previous lecturer.

Just use the MSE as the metric, and then determine which motion vector (MV) gives minimum error.

For the MV, it will depend where is the reference point/axis.

In this question, a reasonable answer would be within the range of -1 to 1 for both x and y axis.

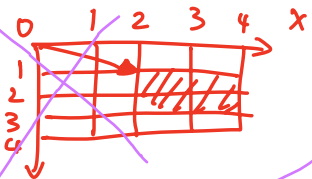
For part (b), your answer seems reasonable.

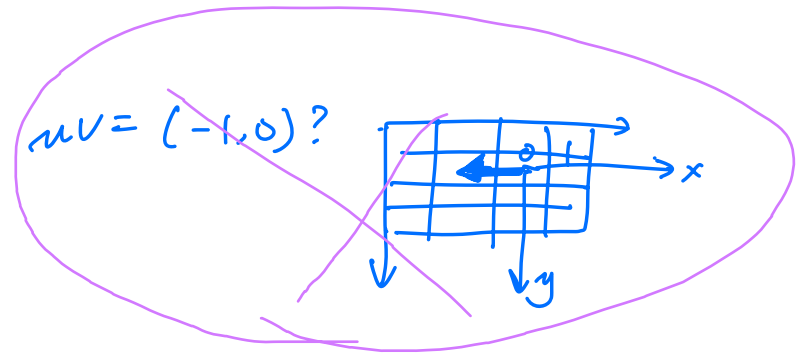
KH

② Motion Vector

$$MV = (dx, dy) = (2-1, 1-1) = (1, 0)$$

MV = (2, 1) ?





(c) Improve?

Solution

- ① more accurately represent the actual motion of object that less than one pixel between frames
- ② improve the matching between blocks.
- ③ Reduce prediction error, such as MSE
- ④ Better prediction means fewer bits required to encode the residual error

Q Bilinear interpolation

Solution : it average the values of surrounding integer-pixel position to estimate half-pixel position

Example 2x2 Block

$P_{00}$  a  $P_{01}$   
 b c d  
 $P_{10}$  e  $P_{11}$

$$a = \frac{P_{00} + P_{01}}{2} \quad b = \frac{P_{00} + P_{10}}{2} \quad d = \frac{P_{01} + P_{11}}{2} \quad e = \frac{P_{10} + P_{11}}{2}$$

$$c = \frac{b + d}{2} = \frac{P_{00} + P_{01} + P_{10} + P_{11}}{4}$$