3. (a) A block of 2×2 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 ± 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 2×2 image block.

21-S1-Q3

Q(a) MSE best match ? Fig4 → Fig5

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) 318.75

(1,3) 287.5

(2,1) 306.25

(2,2) 118.75

(2,3) 87.5 ✓

(3,1) 231.25

(3,2) 243.75

(3,3) 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.

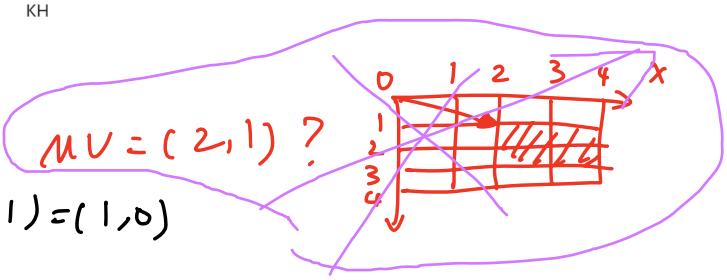
For the MV, it will depend where is the reference point/axis.
In this question, a reasonable answer would be within the range of -1 to 1 for both x and y axis.

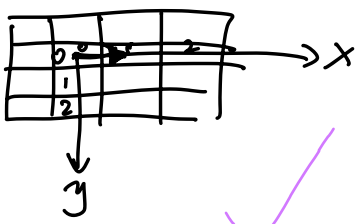
For part (b), your answer seems reasonable.

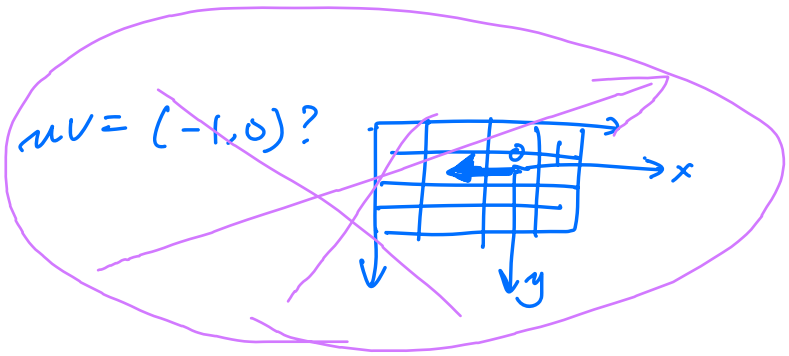
KH

② Motion Vector

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







(c) Improve?

Solution

① more accurately represent the actual motion of object that less than one pixel between frames

② improve the matching between block.

③ Reduce prediction error, such as MSE

④ Better prediction means fewer bits required to encodt the redidual error

Q Biliner interpolation

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

Example 2×2 Block

P_{00} a P_{01}

b c d

P_{10} e P_{11}

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

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