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

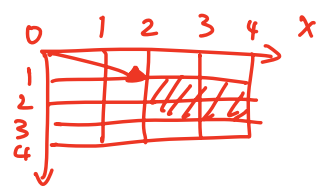
(3,2) 243.75

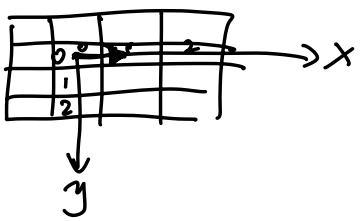
(3,3) 237.5

② Motion Vector

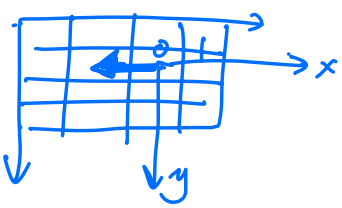
$MV = (dx, dy) = (2-1, 1-1) = (1,0)$

MV = (2,1) ?





$mv = (-1, 0)$?



(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}

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

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