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DIP

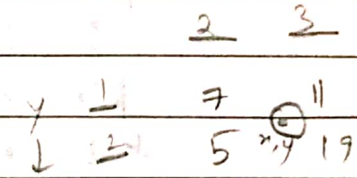
Assignment 2

9/9/20

Q1.

Y/X	0	1	2	3
0	10	10	13	17
1	11	12	7	11
2	10	13	5	19
3	23	17	9	8

for (x, y) pair $\rightarrow$ $(x, y) = (2.7, 1.8)$



Nearest 4 neighbours =
- (2, 1)
- (3, 1)
- (3, 2)
- (2, 2)

For bilinear interpolation, we need 4 neighbours and pixel value at the point to be interpolated can be found using the eq $\rightarrow$

$$v(x,y) = ax + by + cxy + d$$

$$\Rightarrow \begin{bmatrix} x & y & xy & 1 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} = \begin{bmatrix} v(x,y) \end{bmatrix}$$

We can extend this logic to 4 neighbours for which pixel values are known and hence calculate the coeffs. a, b, c, d

P.T.O.

$$\begin{bmatrix} x_1 & y_1 & x_1y_1 & 1 \\ x_2 & y_2 & x_2y_2 & 1 \\ x_3 & y_3 & x_3y_3 & 1 \\ x_4 & y_4 & x_4y_4 & 1 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} = \begin{bmatrix} v(x_1, y_1) \\ v(x_2, y_2) \\ v(x_3, y_3) \\ v(x_4, y_4) \end{bmatrix}$$

Substituting values,

$$\begin{bmatrix} 2 & 1 & 2 & 1 \\ 3 & 1 & 3 & 1 \\ 3 & 2 & 6 & 1 \\ 2 & 2 & 4 & 1 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} = \begin{bmatrix} 7 \\ 11 \\ 19 \\ 5 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} = \begin{bmatrix} 2 & 1 & 2 & 1 \\ 3 & 1 & 3 & 1 \\ 3 & 2 & 6 & 1 \\ 2 & 2 & 4 & 1 \end{bmatrix}^{-1} \begin{bmatrix} 7 \\ 11 \\ 19 \\ 5 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} = \begin{bmatrix} -2 & 2 & -1 & 1 \\ -3 & 2 & -2 & 3 \\ 1 & -1 & 1 & -1 \\ 6 & -4 & 2 & -3 \end{bmatrix} \begin{bmatrix} 7 \\ 11 \\ 19 \\ 5 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} = \begin{bmatrix} -6 \\ -22 \\ -10 \\ 21 \end{bmatrix}$$

for our given $(x, y) = (2.4, 1.8)$

$$v(x,y) = \begin{bmatrix} 2.4 & 1.8 & 4.32 & 1 \end{bmatrix} \begin{bmatrix} -6 \\ -22 \\ -10 \\ 21 \end{bmatrix}$$

$V(x,y) = \underline{10.2}$

i.e. pixel value at $(x,y) = (1.4, 1.8)$ is $\boxed{10.2}$. Depending on application we can also round off this value to the nearest integer value (i.e. 10)

Q2.

(I have applying all these operations to cameraman image <u>only</u>, as clarified by Sir in the lecture).

Here, my scaling matrix →
$$\begin{bmatrix} \overset{S_x}{2} & 0 & 0 \\ 0 & \overset{S_y}{2} & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

i.e. it scales image by 2 times on the x axis and 2 times on the y axis

⇒ if my input image has dimensions 256 x 256, my output image will have dimensions <u>512 x 512</u>

(inverse mapping with bilinear interpolation)
Parts b) c) d) have been applied to the cameraman image straightaway, with comments put up to explain the code step by step.

(Move to the matlab code).

Q3.

unregistered img   reference img

we use

cpselect('cameraman.tif', 'referenceIm.jpg');

Tool

movingPoints   fixedPoints

appended   appended

$$\begin{bmatrix} m_{x_1} & m_{y_1} & 1 \\ m_{x_2} & m_{y_2} & 1 \\ m_{x_3} & m_{y_3} & 1 \end{bmatrix} \qquad \begin{bmatrix} f_{x_1} & f_{y_1} & 1 \\ f_{x_2} & f_{y_2} & 1 \\ f_{x_3} & f_{y_3} & 1 \end{bmatrix}$$

So, for our problem

$$\begin{bmatrix} f_{x_1} & f_{y_1} & 1 \\ f_{x_2} & f_{y_2} & 1 \\ f_{x_3} & f_{y_3} & 1 \end{bmatrix} \times T\_dash = \begin{bmatrix} m_{x_1} & m_{y_1} & 1 \\ m_{x_2} & m_{y_2} & 1 \\ m_{x_3} & m_{y_3} & 1 \end{bmatrix}$$

$$T\_dash = \begin{bmatrix} f_{x_1} & f_{y_1} & 1 \\ f_{x_2} & f_{y_2} & 1 \\ f_{x_3} & f_{y_3} & 1 \end{bmatrix}^{-1} \begin{bmatrix} m_{x_1} & m_{y_1} & 1 \\ m_{x_2} & m_{y_2} & 1 \\ m_{x_3} & m_{y_3} & 1 \end{bmatrix}$$

$$T = (T\_dash)^{-1}$$

Now, we need to apply this transformation T to our unregistered image and then compare the output image with our reference image.

~~We~~ I have applied the transformation using inverse mapping and used bilinear interpolation to ~~find~~ pixel values.

(Move to the Matlab code)