DIP END SEM SOLUTIONS

Q.1) A - 3, B - 4, C - 1, D - 2
Q.2) A
Q.3) D
Q.4) D
Q.5) A
Q.6) 2^k - 1 - I(r,c)
Q.7) B
Q.8) C
Q.9) B
Q.10) C
Q.11) A

Q.12)
Part a)
Take log(Product of Pixels in Nghd ^ 1/mn) = 1/mn (sum over log of all pixels in Nghd)
Hence pass AMV(log(Image), m,n)
Final Image = exp(AMV(log(Img)+1), m, n);
Derivation of above 10 marks (if no derivation the correct code has 20 marks**)**
Correct code 10 marks
Part b) log(0) is not defined. Assuming standard images i.e. 8 bit representation for pixels.
Convert 0->255 to 1-> 266 and then do the computation(as in part 1) and then postprocess(normalize) to bring the pixel values into 8 bits
5 marks for finding the log(0) error
5 marks for re/writing the modified code.

Q.13)
Part a)
Simple 2 nested 'for' loops from a->c and b->d while adding the intensity values
Matlab types code also accepted (but if sum function is used then its parameters/function signature need to be taken care of as well)
5 marks for correct code
Part b)
J(b,d) - J(a-1,d) - J(b, c-1) + J(b,d)
5 marks for each term (if indexes are wrong marks are struck off) = 20 marks
5 marks for code and handling of edge cases

Q.15)

15. (a) $$\begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \begin{bmatrix} 1/2 & \sqrt{3}/2 & 0 \\ -\sqrt{3}/2 & 1/2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x+4 \\ y+2 \\ 1 \end{bmatrix}$$

OR

$$\begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \begin{bmatrix} 1/2 & \sqrt{3}/2 & 0 \\ -\sqrt{3}/2 & 1/2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 4 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

(b) Let $M = \begin{bmatrix} 1/2 & \sqrt{3}/2 & 0 \\ -\sqrt{3}/2 & 1/2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 4 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix}$

then,
$$\begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = M^{-1} \begin{bmatrix} u \\ v \\ 1 \end{bmatrix}$$

Q17)

Use median filter to remove the salt and pepper noise.

<u>Pseudo Code</u>

for every pixel in image **do**

    sort values in the mask
    pick the middle one in the sorted list
    replace the pixel with the median

Q18)

- Binarize the image using any prefered method (e.g. Otsu)
- Find histogram of image along the rows (will have values only along the lines and zero in gaps)
- Cut the images between the gaps of histogram
- Exclude the first cut belongs to circle.

<u>Alternative</u>

- Dilate the binary image to connect the gaps between characters
- Find the connected components and its boundary
- Cut the image along the boundary with some gap
- Use any method to crop the circle (0nly image processing technique and not manual crop)

Q.19)

Background - (H*W)

Foreground - (1.25H*0.75W)

(1.) Steps for placing the Leaning Tower of Pisa on the Background -

- Fg - Foreground, Bg - Background, mask - Foreground Mask, out - Output Image
- Clip .25H/2 from the Top and Bottom to get Fg' and mask'
- out = Bg*(1-mask) + Fg'*(mask) (Here for Bg consider the columns after 0.25/2 W)
- Apply alpha-blending on the border of mask on Fg' and Bg.

(5 marks given only if all steps correct, otherwise marks awarded partially)

(2.) order of transformations - Scaling, Rotation, Translation

Fg' = [1 0 t; 0 0 0; 0 0 1]* [cosθ -sinθ 0; sinθ cosθ 0; 0 0 1] * [Sx 0 0; 0 Sy 0; 0 0 1] * Fg

Same transformation on the Foreground Mask.

[$S_x$cosθ -$S_y$sinθ t; $S_x$sinθ $S_y$cosθ 0; 0 0 1]

Dimensions of Foreground image would be - max(X coordinate of all 4 corners) = Height, max(Y coordinate of all 4 corners) = Width.

(8 Marks for calculating the Transformation matrix fully (partial marks in rare cases given))

(2 Marks for the Final Dimensions)

(3.) Consider an angle of the sun with the Tower.
Find the length of the shadow on the ground.
Use some method of darkening the appropriate region.
(2 marks for finding the length of the Shadow and 3 marks for the steps to create the shadow effect)

Q.20)
(1.) floor((W-w)/(w-p))*floor((H-h)/(h-p))
45/(1)*(90/5) = 45*18 = 810 or 46*19 = 874

(6 Marks for correct General Formula, 4 marks for calculation of steps)

(2.)

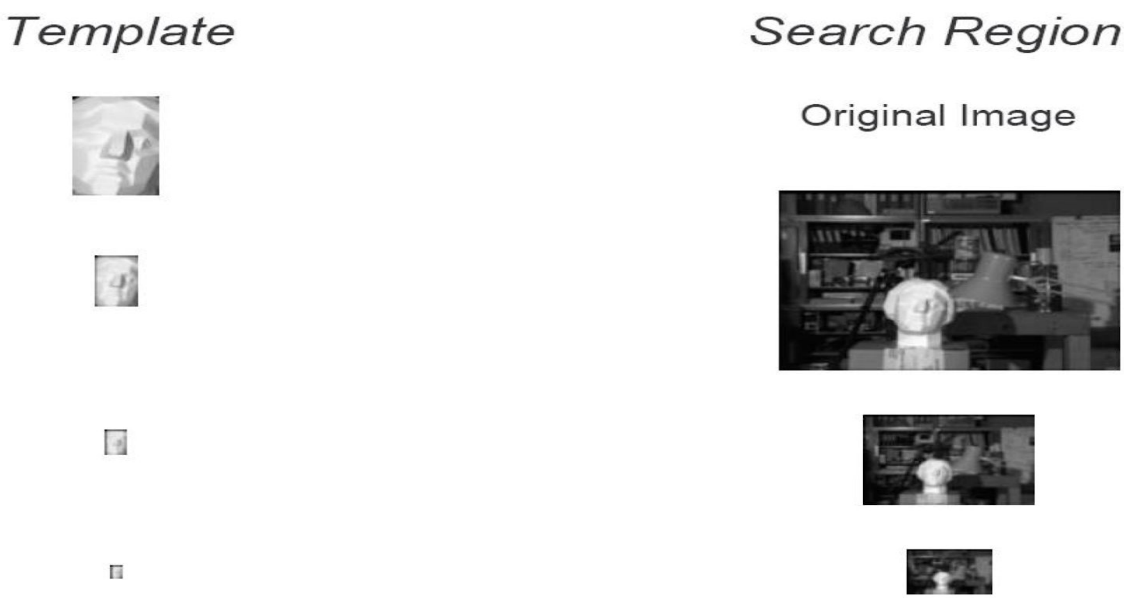
- Select a subsampled window from the input image, of aspect ratio 1:2
- Calculate the Gradient Image
- Orientation Binning - The second step of calculation is creating the cell histograms. Each pixel within the cell casts a weighted vote for an orientation-based histogram channel based on the values found in the gradient computation. The cells themselves can either be rectangular or radial in shape, and the histogram channels are evenly spread over 0 to 180 degrees or 0 to 360 degrees.Use 8x8 cells
- Block Normalization
- Concat to get the HOG features.

(5 Marks only awarded in case of all steps correct. Refer the HOG paper for more details)

(3.) Yes, for the overlapping parts, don’t re-calculate the gradients) **(5 marks awarded if concept is explained clearly)**
(4.) Build a pyramid for the given image and template. (So the lowest level will have the smallest dimensions)

- at the lowest level we search the entire image with correlation template
- constrained to a neighbourhood of high response centers in the previous level
- again constrained based on results at highest level.

(5 marks awarded only if explained how this pyramid saves time by introducing locality)


Template
Search Region
Original Image