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INDIAN INSTITUTE OF TECHNOLOGY JAMMU

NH44, Nagrota, Jagti, Jammu-181221

Programme Name: M. Tech
End Semester Examination

Course Name: Image and Video Processing **Course Code: COL005P1M**
Duration:2.5 Hours **Max. Marks: 50**

Note:
- All the questions are compulsory. You are free to make any assumption by clearly stating the conditions
- Please mention all the steps clearly

Q1: Show that the Laplacian is isotropic (invariant to rotation). Assume continuous quantities. Coordinate rotation by an angle Θ is given by: **10 Marks**

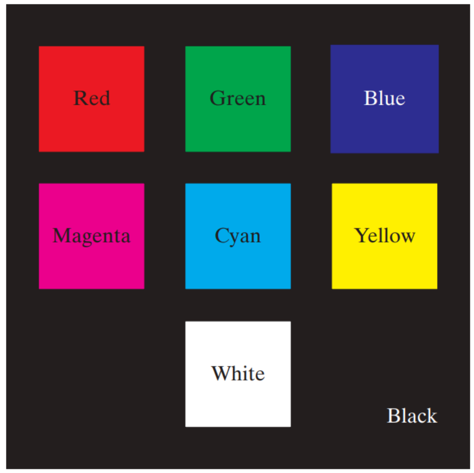
$$x' = x\cos\Theta - y\sin\Theta \text{ and } y' = x\sin\Theta + y\cos\Theta$$

where (x, y) and (x', y') are the unrotated and rotated coordinates, respectively.

Q2: Consider image blurring caused by uniform acceleration in the x-direction. If the image is at rest at the time $t = 0$ and accelerates with a uniform acceleration $x_0(t) = at^2/2$ for a time T, find the blurring function $H(u, v)$. You may assume that shutter opening and closing times are negligible. **10 Marks**

Q3: Consider the following image composed of solid color squares. For discussing your answer, choose a gray scale consisting of eight shades of gray, 0 through 7, where 0 is black and 7 is white. Suppose that the image is converted to HSI color space. In answering the following questions, use specific numbers for the gray shades if using numbers makes sense. Otherwise, the relationships "same as," "lighter than," or "darker than" are sufficient. If you cannot assign a specific gray level or one of these relationships to the image you are discussing, give the reason. **10 Marks[4+3+3]**

(a) Sketch the hue image.
(b) Sketch the saturation image.
(c) Sketch the intensity image.



Q4. The results obtained by a single pass through an image of some 2-D kernels can also be achieved by two passes using 1-D kernels. For example, the same result of using a 3x3 smoothing kernel with coefficients 1/9 can be obtained by a pass of the kernel $[1\ 1\ 1]$ through an image, followed by a pass of the result with the kernel $[1\ 1\ 1]^T$. The final result is then scaled by 1/9. Show that the response of Sobel kernels can be implemented similarly by one pass of the differencing kernel $[1\ 0\ 1]$ (or its vertical counterpart) followed by the smoothing kernel $[1\ 2\ 1]$ (or its vertical counterpart). **10 Marks**

Q5. One often finds in the literature a derivation of the Laplacian of a Gaussian (LoG) that starts with the expression: **10 Marks[7+3]**

$$G(r) = e^{-r^2/\sigma^2}$$

Where $r = x^2 + y^2$. The LoG is then derived by taking the second partial derivative with respect to r:

$$\nabla^2 G(r) = \partial^2 G(r)/\partial r^2$$

Finally, $x^2 + y^2$ is substituted for r^2 to get the final (incorrect) result:

$$\nabla^2 G(x, y) = [(x^2 + y^2 - \sigma^2)/\sigma^4] exp[-(x^2 + y^2)/2\sigma^2]$$

Derive this result and explain the reason for the difference between this expression and the following Eq:

$$\nabla^2 G(x, y) = [(\frac{x^2+y^2-2\sigma^2}{\sigma^4}) e^{-(\frac{x^2+y^2}{2\sigma^2})}]$$

*****Best of Luck*****