Project 6
Digital Image Processing
CSCE 4240/5225 – Spring 2022
Distributed: Monday, April 25
Due: Thursday, May 5

[Solutions to this assignment must be submitted via the CANVAS web site prior to midnight on the due date. It may be submitted a day late with NO penalty. It may be submitted the second day after the due date but penalized 10 pts. This is an assignment to be performed by individuals, not groups. No one has my permission to copy a solution from another or to allow another to copy from his/her solution. Such behavior will be a grading criterion and, if found, result in a ZERO grade for this assignment.]

Purpose: (1) Examine pseudo-coloring as a medium for visualizing properties of images that are measured on a pixel-by-pixel basis and (2) practice analytical methods in trichromatic color domains.

What to do: Upon reading the image *steel_spheres.png*:

	Action	Result
Step 1	For each RGB pixel in the input image compute the partial derivatives based on use of Sobel operators, organizing them into vectors **u** and **v**. (See eq. 7-50 and eq. 7-51.)	Matrix** D for which each component is a pair: **u** = $\langle \frac{\partial R}{\partial x} \quad \frac{\partial G}{\partial x} \quad \frac{\partial B}{\partial x} \rangle$ **v** = $\langle \frac{\partial R}{\partial y} \quad \frac{\partial G}{\partial y} \quad \frac{\partial B}{\partial y} \rangle$
Step 2	For each component of D compute the magnitude of gradient in each direction. (See eq. 7-52, eq. 7-53, and eq. 7.54.)	Matrix MoG for which each component is the triple: $g_{xx} = \left\lvert\frac{\partial R}{\partial x}\right\rvert^2 + \left\lvert\frac{\partial G}{\partial x}\right\rvert^2 + \left\lvert\frac{\partial B}{\partial x}\right\rvert^2$ $g_{yy} = \left\lvert\frac{\partial R}{\partial y}\right\rvert^2 + \left\lvert\frac{\partial G}{\partial y}\right\rvert^2 + \left\lvert\frac{\partial B}{\partial y}\right\rvert^2$ $g_{xy} = \frac{\partial R}{\partial x}\frac{\partial R}{\partial y} + \frac{\partial G}{\partial x}\frac{\partial G}{\partial y} + \frac{\partial B}{\partial x}\frac{\partial B}{\partial y}$
Step 3	For each component, (x,y), of MoG compute the maximum gradient, $F_\theta(x,y)$. (See eq. 7-56.) Note that a prerequisite is obtaining a value for eq. 7-55, θ.	A 2D matrix, F_θ, for which each component is a scalar yielding the maximum gradient for its locus, (x,y).
Step 4	Rescale $F_\theta(x,y)$ to the range [0, 360].	Call the result H(x,y).
Step 5	From H, construct an HSV image with S = V = 0.5.	myHSV
Step 6	Convert myHSV to an RGB image and print it.	

** The dimensions of matrix D depend on the strategy you choose to use for border pixels.

Hand in: (1) The code for the task, (2) the original image *steel_spheres*, (3) the RGB image derived in Step 6 from myHSV, and (4) an optional report described below.

Report: A report, approximately, one page in length, noting your observations and your hypotheses concerning the effects of each operation. Of interest are thoughts on the effectiveness of the technique in visualizing numeric properties extracted on a pixel-by-pixel basis – e.g., first derivative, second derivative, curvature, kurtosis, … . Also, thoughts on revisions to this assignment increasing its effectiveness as a learning tool would be useful. *The report grade will not be considered in grading the assignment. That is, the report is optional.*

Final Exam
May 12, 2022
10:30am to 12:30pm