Image Processing Project - MATH 4491
3/28/2022
Due Date: 4/29/2022

This is your chance to apply the PDEs we have discussed in class to actual images. You will work in groups of 3 or 4 and turn in one completed report per group.

Project Questions

1. Work with the pictures of the tile and daisy.
   - Apply the heat equation to the images to blur them. Select three different time values to correspond to slight, significant and severe blurring.
   - Apply the shock filter equation to each of the 3 images (for both pictures) to try to sharpen your edges in an attempt to approximate deblurring.
2. Work with the image of the peanut, shapes, boundaries, curved boundary and I love math.
   - Apply the level set equation to the images. Select 5 different values of time that demonstrate the evolution of the image for each image. They should represent the dissipation of the edges, the formation of circular regions, and finally the shrinking of the circular regions to a point for the first two images, the curve edge straightening out for the second two images and a combination of both for the final image.
3. Work with the happy face image with light noise, the happy face picture with medium noise, and the happy face picture with heavy noise. To each of these 3 images do the following.
   - Apply the level set equation and find the values of time that you think make the images look the best.
   - Apply the modified level set equation (to the original images) and find the values of α that you think make the images look best.
4. Work with the Stockton osprey picture that is blurred and then had some noise added.
   - Apply either the level set equation or the modified level set equation to remove the noise, and then apply the shock filter equation to the resulting image. Use values of time (or α) for both equations that lead to the best image you can produce. Make sure to list the value of time (or α) that you used.
5. Extra Credit: Choose one of your own photos (of the face) and apply the shock filter equation to it. (Note that you may need to rescale the image if it is too large and convert it to grayscale.)

Project Report

Your report should be well organized and include the following:

1. Printouts of the following images:
   Question 1: The three blurred images for both pictures (labeled with their corresponding time values) and the three images after shock filtering for both pictures (also labeled with the corresponding blurring time values).
   Question 2: The twenty five images demonstrating the image evolution (with their time values).
   Question 3: The three images processed with the level set equation (with the time values you selected) and the three images processed with the modified level set equation (with the α values you selected).
   Question 4: The image after you've applied the level set or modified level set equation (along with the time/α value you selected) before shock filtering, and the image after shock filtering (along with the time value where you stopped the shock filter equation).
   Question 5: The shock filtered image.

2. Discussion of the following questions:
   Question 1: How well did the shock filter "deblur" the images?
   Question 2: Did the level set equation affect the images in the manner you expected?
   Question 3: Evaluate the ability of the level set equation and the modified level set equation to remove noise, but preserve the underlying image for each of the three happy faces.
   Question 4: Is the combination of level set/modified level set followed by shock filtering an effective way of retrieving an underlying image? What are the limitations of this method? (i.e. For what cases would you recommend using it? For what cases would you not recommend using it?)
   Question 5: How did the shock filter equation modify the picture of the face? Did it do what you expected?

3. Both a printout of your report (with images) and a flash drive (that I will return to you on the day of the final) containing all the images that you generated as well as your code for each program.