Answers to questions in Lab 2: Edge detection & Hough transform

Name: ______________________________ Program: ____________________

Instructions: Complete the lab according to the instructions in the notes and respond to the questions stated below. Keep the answers short and focus on what is essential. Illustrate with figures only when explicitly requested.

Good luck!

Question 1: What do you expect the results to look like and why? Compare the size of *dxtools* with the size of *tools*. Why are these sizes different?

Answers: The image *dxtools* show image variations x-wise, and *dytools* variations y-wise. You can use that to detect vertical and horizontal edges. If there are no variations, the image is grey, corresponding to a value 0. The output images change size because the convolutions are only computed for pixels, where the kernel is fully inside the image.

Question 2: Is it easy to find a threshold that results in thin edges? Explain why or why not!

Answers: It's not particularly easy, since it depends very much on the contrasts of the image. Thin edges might be clearly visible to the human eye, but they still have a gradient magnitude lower than the threshold. It's hard to find a threshold such that the width of an edge is just one pixel, since the change in pixel values can be gradual over a number of pixels.

Question 3: Does smoothing the image help to find edges?

Answers: It doesn't really help the problem of finding a good threshold, but it removes noise that could lead to false edges being detected.

Question 4: What can you observe? Provide explanation based on the generated images.

Answers: You see a number of closed contours out of which many are aligned to the edges in the images. For larger scales the contours are fewer, but they are also smoothed, so that the no longer necessarily represent the true shape of objects. . For really small scales the results are very noisy.

Question 5: Assemble the results of the experiment above into an illustrative collage with the *subplot* command. Which are your observations and conclusions?

Answers: The images contain regions that are either black or white, depending on whether *Lvvv* is negative or possible. The white regions cover areas where you have true edges. The regions get smoother, fewer and less exact for increasing scales. For really small scales the results are very noisy.

Question 6: How can you use the response from *Lvv* to detect edges, and how can you improve the result by using *Lvvv*?

Answers: Edges are defined as image points, where the gradient magnitude reaches a local maximum in the gradient direction. *Lvv* detects extremal points in gradient magnitude, but it cannot tell the difference between local maxima and local minima. *Lvvv* is less than zero for those points, where you have a local maximum in gradient magnitude. Thus both *Lvv* and *Lvvv* are needed.

Question 7: Present your best results obtained with *extractedge* for *house* and *tools*.

Answers: Presented.

Question 8: Identify the correspondences between the strongest peaks in the accumulator and line segments in the output image. Doing so convince yourself that the implementation is correct. Summarize the results of in one or more figures.

Answers: Each edge corresponds to a local maximum in Hough space, where each point represents the parameters of a particular line. The values at these points correspond to the number of pixels you have along the line. However, the Hough transform does not ensure that pixels are in fact connected along a line, only that there are enough edge pixels near the line. You could thus have a high concentration of pixels on either side of the image and incorrect lines that are drawn in-between these concentrations.

Question 9: How do the results and computational time depend on the number of cells in the accumulator?

Answers: The computational time increases (linearly) with the resolution in angle. If the resolution is too low, you get too few lines and lines with imprecise positions and orientations. On the other hand, if the resolution is too high, you tend to get many responses for the same line. It's hard to find the perfect balance. In the latter case, you might get somewhat better results by blurring the Hough space, before detecting local maxima.

Question 10: How do you propose to do this? Try out a function that you would suggest and see if it improves the results. Does it?

Answers: The most natural way is to use increments that are proportional to the gradient magnitude, but that rarely leads to visibly improved results. Faint edges just become even harder to detect. Somewhat better results you tend to get if you truncate edge magnitudes, using a relatively low threshold.