Beeldverwerken Lab 4

Philip Bouman (10668667) & Jonas van Oenen (10670947)

May 2, 2018

This document contains answers to the theory questions and notes to the exercises belonging to Lab 3.

1 Finding Lines using the Hough Transform

The Hough transform is a feature extraction technique which can be used to detect straight lines in images. Using an edge detector method to obtain points of edges in an image, these points are then transformed to a parameter space, from which object candidates can be selected as local maxima. By transforming the points associated with the local maxima back, they can later be used to draw lines along edges in the image.

The function **hough** performs the transformation of the described method. First it constructs an edge map of the grey scale image using the Canny edge method from lab 2. Next the Hough transform is applied to find lines in the image. For each point in the edge map, all lines that pass through it satisfy the equation:

$$x_i sin(\theta) - y_i cos(\theta) = \rho$$

The formula given in the lecture notes:

$$z_1 cos(\phi) + z_2 sin(\phi) = r$$

Both formulas can be used to describe the same line. The difference is the coordinate system used in Matlab, with the origin in the upper left corner. The distance of the line running from the origin perpendicular to the line passing through point (x_i, y_i) is the value ρ, which can be positive or negative. This depends on the value of θ, which can be between -90 and 90 degrees. If θ is negative ρ can become negative. The Hough transform of the images can be seen in figure 1.

2 Finding the Lines as Local Maxima

The functions **houghlines** and **houghlines2** are used to detect the dominant lines in the image. The **houghlines** function uses labeled regions to find the maxima, the **houghlines2** function uses dilated peak finding and subsequently find the corresponding values for θ and ρ. The results can be seen in figure 2 and 3.

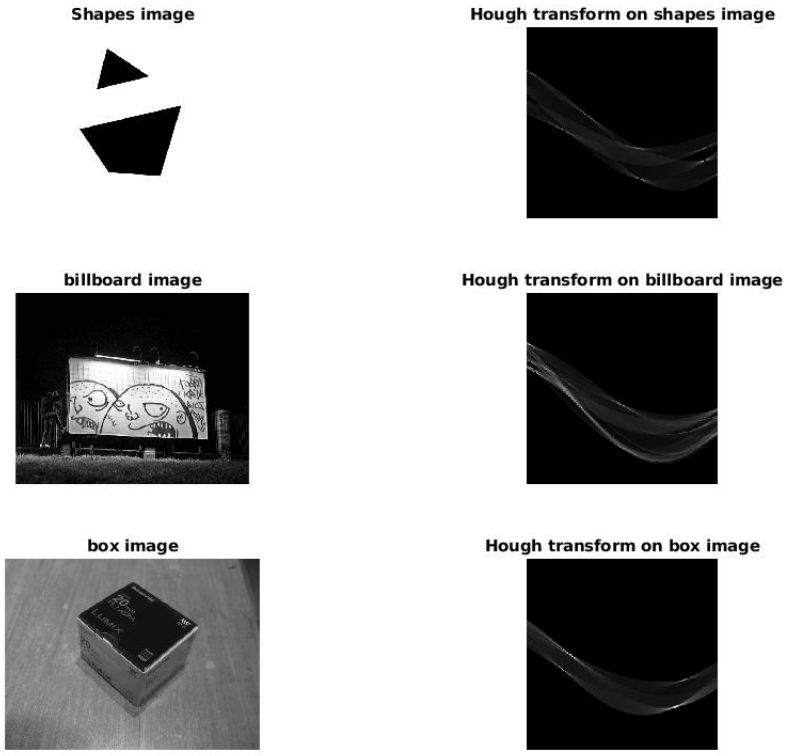

Figure 1: Images (left) and their parameter space (right)

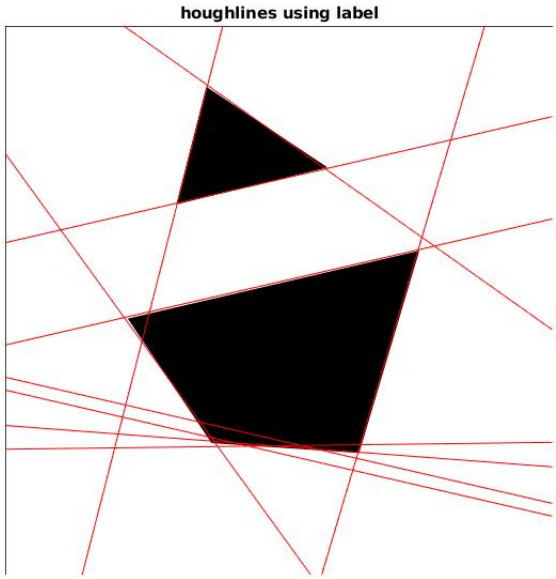

Figure 2: Houghlines using label

3 Using the Lines

We know that the cross product of 2D vectors $a \times b$ equals $||a||||b||sin(\theta)$. Now we are not dealing with two dimensional but three dimensional vectors. In this equation the homogenous weight of the vector is dependent on the other two values. And as we saw in 2D, these are again dependent on $\sin(\theta)$. As such, the weight is proportional to the sin of the angle.

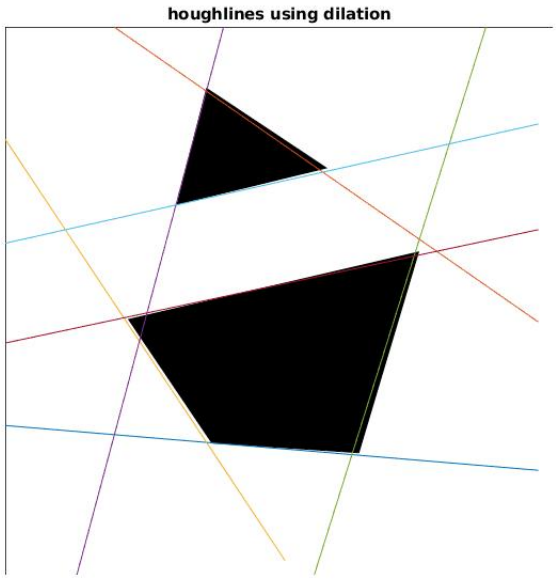

Figure 3: Houghlines using dilation

Figure 4: 4 lines that intersect on the box