OBSS - Analysis of CT images

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1 Abstract

This report includes analysis of computed tomography (CT) images using Canny edge detector. We used this detector to detect contours of human organs in CT images. Program reads an image and detects edges. Then the program displays the original image, the image after detecting edges and the final image after edge linking.

2 Introduction

Our task is to detect contours of human organs in CT images. For this purpose we use the Canny edge detector and a dataset of human organs from Computed Tomography-Magnetic Resonance Imaging Database [1]. The output of the program is a binarized image after edge detection.

3 Methods

Canny edge detector is performed in the following steps:

3.1 Smoothing and intensity gradients

First we read an image and change it into grayscale if needed. Then we perform smoothing of the image in order to remove the noise and compute intesity gradients. For this purpose we use a Gaussian kernel. A way of detecting edges is by analyzing local changes of grayscale levels. Mathematically this means that we are computing image derivatives. In this analysis we use the derivative of a Gaussian kernel. This means that the input image can be first filtered with a Gaussian kernel with respect to y and then filter the result with the derivative of the Gaussian kernel with respect to x. With this, we get partial derivative of the smoothed image with respect to x (denoted Ix) and y (denoted Iy). Then we compute gradient direction/angle (1, see Figure 1, **b)**) for each pixel:

$$Idir(x, y) = atan2(Iy, Ix). \tag{1}$$

We also compute gradient magnitude (2, see Figure 1, **c)**) for each pixel:

$$Imag(x, y) = \sqrt{(Ix(x, y)^2 + Iy(x, y)^2}. \qquad (2)$$

3.2 Non-maxima suppression

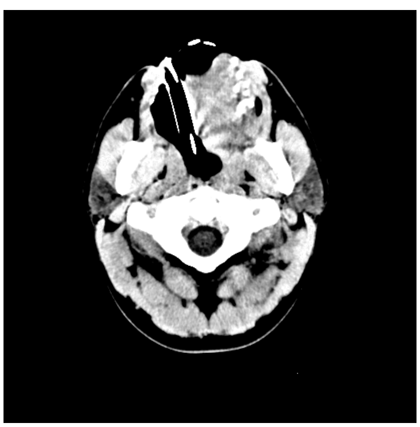
Second we perform non-maxima supression (see Figure 1, **d)**). We check the neighboring pixels parallel to the gradient direction and set the current pixel to 0 if it is not the largest in the neighborhood based on derivative magnitude. This way, we get lines that are at most 1 pixel wide.

3.3 Hysteresis thresholding

Finally, we perform hysteresis thresholding (see Figure 1, **e)**) which uses two thresholds $t_{low} < t_{high}$, keeps all pixels above t_{high} and discards all pixels below t_{low}. The pixels between the thresholds are kept only if they are connected to a pixel above t_{high}. We compute the t_{high} threshold using Otsu's method on the non-maxima suppressed magnitude gradient. And use $t_{low} = \frac{t_{high}}{2}$. The result is a binary image with only strong edges.

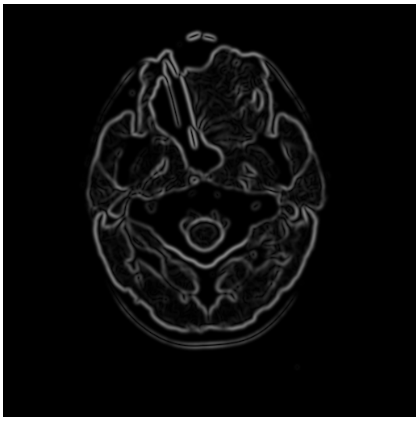
4 Results

Using $\sigma = 2$, as the only parameter of Gaussian kernel with size $3*\sigma$ we get the following results:



(a) Grayscale image of a sample image from the CTMRI DB [1].

(b) Calculated gradient directions as a grayscale image.



(c) Calculated gradient magnitude as a grayscale image.

(d) Result of applying non-maxima suppression on magnitude gradient.

(e) Final image after edge-linking with hysteresis thresholding.

Figure 1: Process of detecting countours of human organs using Canny edge detector.

5 Discussion

We implemented Canny edge detector to detect contours of human organs in CT images. The Canny algorithm is adaptable to various environments. Its parameters allow it to be tailored to recognition of edges of differing characteristics depending on the particular requirements of a given implementation.

Literature

[1] Alessandro Taddei et al. *CT-MRI database*. URL: https://lbcsi.fri.uni-lj.si/OBSS/Data/CTMRI/.