MEDICAL IMAGE PROCESSING

Term Project 2021-2022 Fall

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Image Processing

ABSTRACT

In our rapidly developing world, human and machine interaction is increasing. In the medical sector, on the other hand, patient follow-ups come to the forefront for the purpose of creating semi-automated applications and helping doctors to diagnose. In this project, some applications were made by going through the example of kidney image.

INTRODUCTION

Images are very important in the diagnosis and healing processes of the disease in the medical field. Advanced image techniques and analyzes play a major role in the development of the medical field and are widely used.

Nuclear medicine images show characteristic information about the physiological properties of the structures-organs. In order to have high quality medical images for reliable diagnosis, the processing of image is necessary.

MATLAB (matrix laboratory) is a multi-paradigm numerical computing software and fourth generation programming language. MATLAB, a proprietary programming language, is developed by MathWorks. MATLAB allows the user to manipulate matrix, plot functions and data, implement algorithms, create user interfaces, and interface with programs written in other languages such as C, C++, Java, and Fortran (Wikipedia). It enables quantitative analysis and visualisation of nuclear medical images of several modalities, such as Single Photon Emission Computed Tomography (SPECT), Positron Emission Tomography (PET) or a hybrid system (SPECT/CT) where a Computed Tomograph system (CT) is incorporated to the SPECT system.

Image Processing Toolbox™ provides a comprehensive set of reference-standard algorithms and workflow apps for image processing, analysis, visualization, and algorithm development. You can perform image segmentation, image enhancement, noise reduction, geometric transformations, image registration, and 3D image processing.(Mathworks)

RELATED WORK

a)Nuclear Medicine is the section of science that utilises the properties of radiopharmaceuticals in order to derive clinical information of the human physiology and biochemistry. According to the examination needed for each patient, a radionuclide is attached to a pharmaceutical (tracer) and the whole complex is then delivered to the patient intravenously or by swallowing or even by inhalation. The radiopharmaceutical follows its physiological pathway and it is concentrated on specific organs and tissues for short periods of time. Then, the patient is positioned under a nuclear medicine equipment which can detect the radiation emitted by the human body resulting in images of the biodistribution of the radiopharmaceutical. In Nuclear Medicine, there are two main methods of patient imaging, the imaging with Planar Imaging, Dynamic Imaging or SPECT and the PET. [1]

b)Image processing in nuclear medicine serves three major purposes: a) the reconstruction of the images acquired with tomographic (SPECT) techniques. b) the quality improvement of the image for viewing in terms of contrast, uniformity and spatial resolution and, c) the preparation of the image in order to extract useful diagnostic qualitative and quantitative information. Nuclear medicine images are grey scale or true colour images (RGB that is Red, Green and Blue). The greyscale image is the most convenient and preferable type utilised in nuclear medicine image processing. The examples used are mostly come from nuclear medicine renal studies, as kidneys‟ planar images and SPECT slices are simple objects to show the application of image processing MatLab tools. (Nailon, 2010)

METHODOLOGY

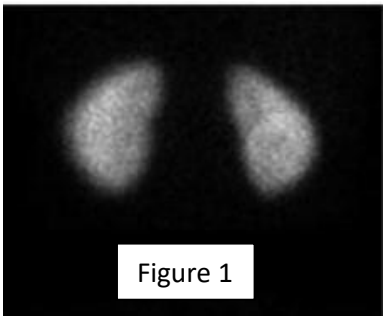
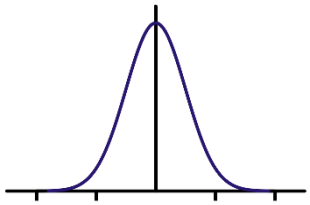


Figure 1

In this project, filtering, segmentation, and background removel issues were addressed on the image shown in figure 1 and corrections were made.

Gaussian Filter:



In electronics and signal processing, a Gaussian filter is a filter whose impulse response is a Gaussian function (or an approximation to it, since a true Gaussian response would have infinite impulse response). Gaussian filters have the properties of having no overshoot to a step function input while minimizing the rise and fall time. This behavior is closely connected to the fact that the Gaussian filter has the minimum possible group delay. It is considered the ideal time domain filter, just as the sinc is the ideal frequency domain filter. These properties are important in areas such as oscilloscopes and digital telecommunication systems.(Wikipedia)

Image Filtering:

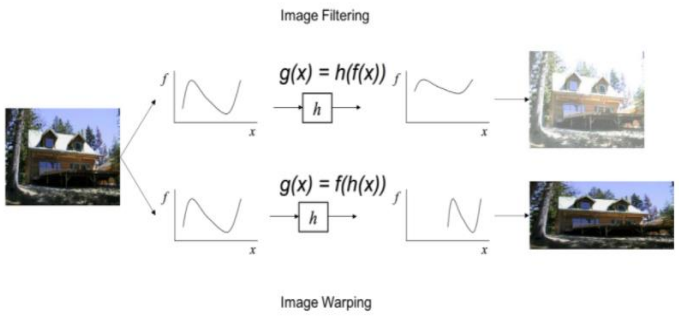
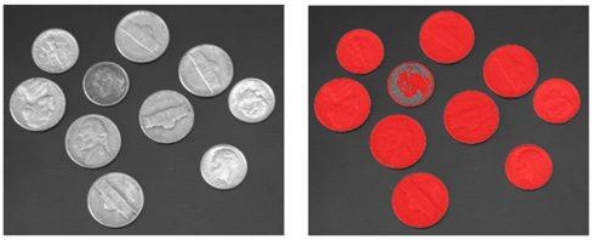


Image filtering is changing the appearance of an image by altering the colors of the pixels. Increasing the contrast as well as adding a variety of special effects to images are some of the results of applying filters. Box filter, Gaussian filter and bilateral filters are kind of well-known filters used in image processing. As we know all these filters are used for de-blurring and smoothing.

Image Segmentation:



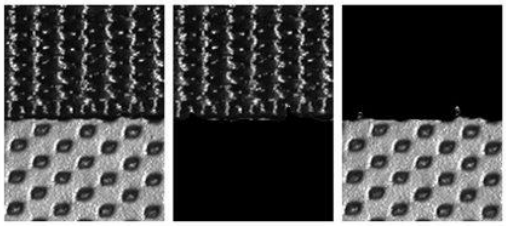
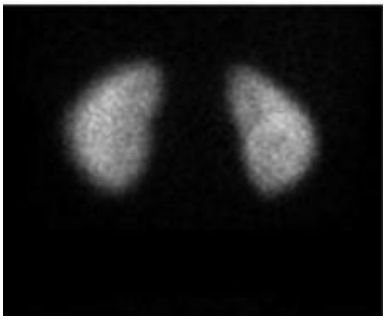


Image segmentation is a method in which a digital image is broken down into various subgroups called Image segments which helps in reducing the complexity of the image to make further processing or analysis of the image simpler. Segmentation in easy words is assigning labels to pixels.

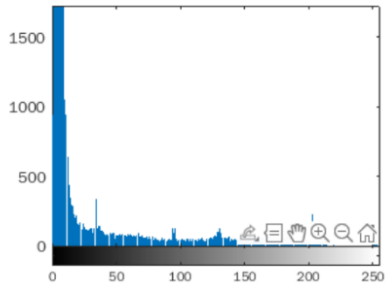
Background Removal:

Background removal is a digital image processing procedure that can be used to classify parts of an image in terms of unwanted and interest regions. Many applications of image processing and computer vision require background removal before further analysis and processing. **[2]**

RESULTS



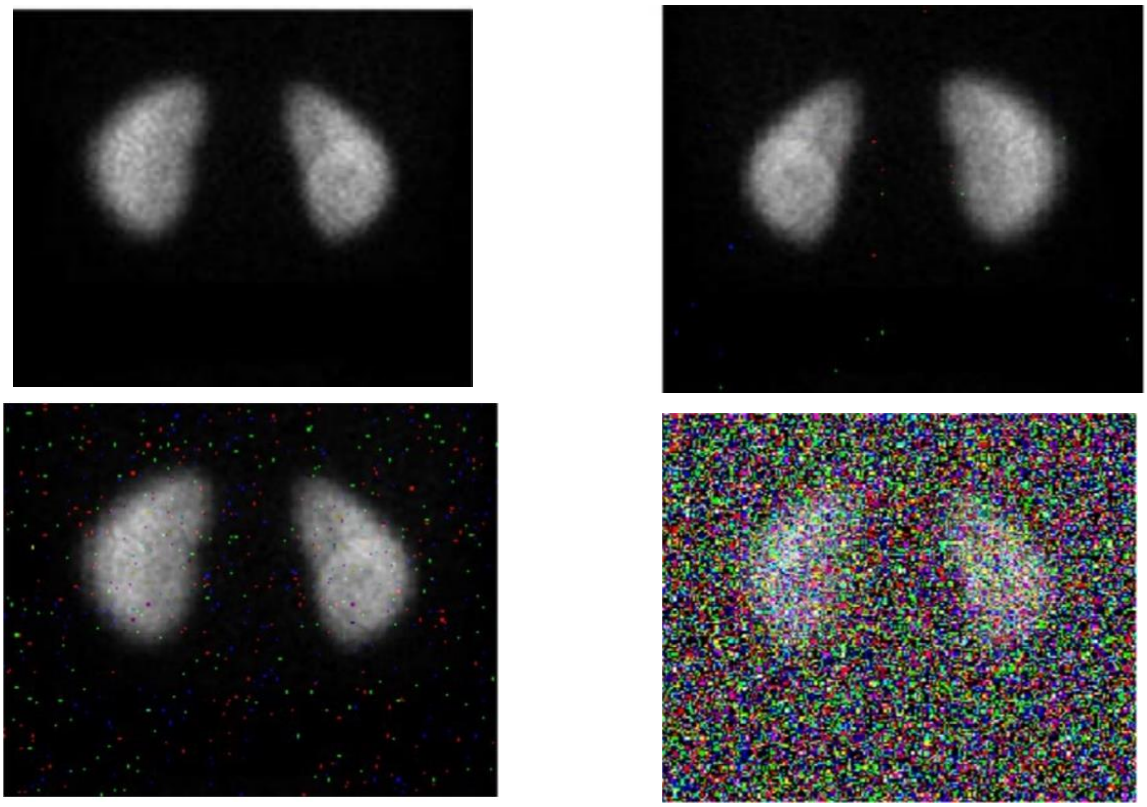
(a) Original Test Image



(b) Greyscale graphic of a

```
imhist(rgh2gray(kidneys));
```

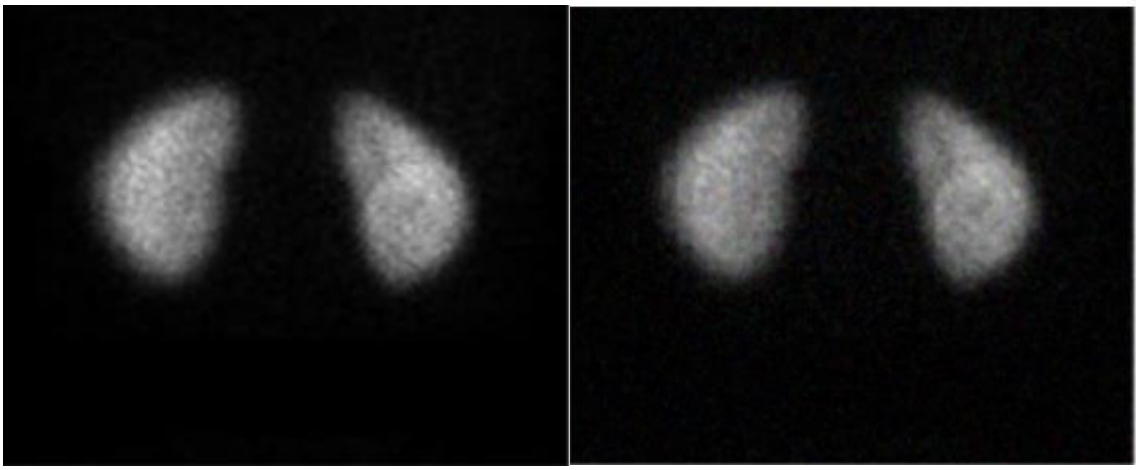
Filtering:



(a) Original kidneys image, (b) salt & pepper filter implemented image with value 0.0003,(c) salt & pepper filter implemented image with value 0.01,(d) salt & pepper filter implemented image with value 0.55

Our citation codes

```
I = imread('kidneys.tif');
figure, imshow(I);
J = imnoise(I,'salt & pepper',0.55);
figure, imshow(J);
I = imread('kidneys.tif');
figure, imshow(I);
J = imnoise(I,'salt & pepper',0.003);
figure, imshow(J);
I = imread('kidneys.tif');
figure, imshow(I);
J = imnoise(I,'salt & pepper',0.01);
figure, imshow(J);
```



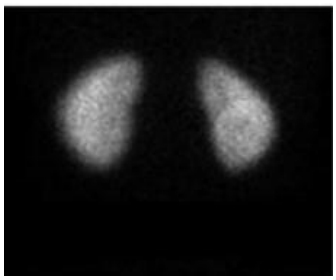
(a) Original kidneys image, (b) Gauissan Filter implemented image with T value 120 and frequence 10

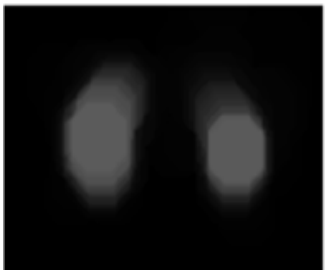
Our citation codes

```
kidneys = double(imread('kidneys.r.jpg'));
noise = 10*randn(size(kidneys ));
kidneys Noisy10 = kidneys  + noise;
figure;imshow(kidneysNoisy10/max(kidneysNoisy10(:)))
figure;histogram(kidneysNoisy10)

kidneysSegmented = imbinarize(kidneys Noisy10,120);
figure;imshow(kidneysSegmented)
```

Image Segmentation:





Gradient Magnitude process: (a) Original image, (b) image after masking of foreground objects [(a) to (b) from left to right]

```
Example

I = imread('kidneys.jpg');
Figure, imshow(I)
hy = fspecial('sobel');
hx = hy';
Iy = imfilter(double(I), hy, 'replicate');
Ix = imfilter(double(I), hx, 'replicate');
gradmag = sqrt(Ix.^2 + Iy.^2);
figure, imshow(gradmag,[])
se = strel('disk', 20);
K = imopen(I, se);
figure, imshow(K)
```

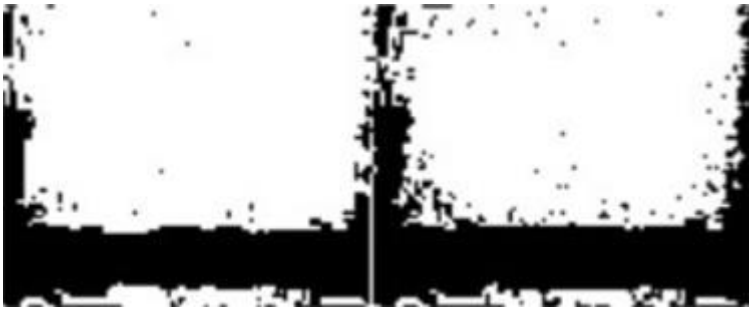
Our citation codes

(a) Original kidneys image, (b) edge detection with canny method (c) edge detection with prewitt method

Our citation codes

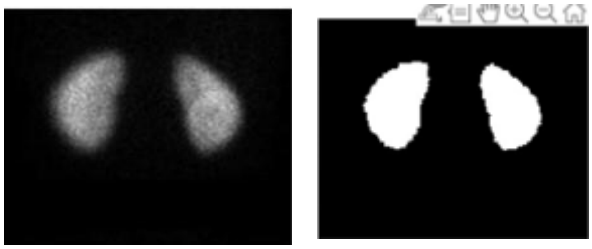
```
I = imread('kidneys.jpg');
figure, imshow(I)
J = edge(I,'canny', 0.048);
figure, imshow(J)
```

(a) Original kidneys image, (b) binarized with 'montage' and later with 'adaptive' methods



```
imshowpair(I, BW, 'montage')
imshowpair(I, BW, 'adaptive')
```

Background Activity Removal



(a) Original image, (b) segmented binary segmented binary image after thresholding depicting only sharp organ boundaries and the value of the threshold is calculated: ans = 0.2667

```
I = imread('kidneys.jpg');
figure, imshow(I)
I2 = im2bw(I, 0.2667)
```

CONCLUSIONS

As technology develops, medical related topics will always be in a change, maybe for better maybe for worst. Through this change, doctors and scientists should be working together for the greater change in this industry as Image Processing will be a topic of interest for researchers. Image processing and analysis applied to nuclear medicine images for diagnosis advanced the acquired image qualitatively as well as offer important information of data which is useful in patient's therapy and care. Even through not all the determined images were 100% accurate, the application proved to be very useful to doctors. The responsibility of the engineers and the researchers should take in this field is to work side by side with the doctors who provides consistent data. MatLab and Image Processing Toolbox enable both quantitative analysis and visualization of Nuclear Medicine images acquired as planar or angle projected images to reconstruct tomographic (SPECT, PET) slices and 3D volume surface rendering images which will be needed from the engineers perspective.

References

[1] MATLAB – A UBIQUITOUS TOOL FOR THE PRACTICAL ENGINEER Edited by Clara M. Ionescu

[2] Single-image Background Removal with Entropy Filtering - Chang-Chieh Cheng