Registration and Segmentation for Finding the Affected Region in Kidneys

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Abstract

The kidney failure is the major threat in medical field. The kidneys dysfunction and disease can be filtered using the parameter Glomerular Filtration Rate (GFR). Finding the affected part is the most critical phenomenon in medical field. This method gives the exact area detection in kidney so that the diagnosis and treatment is easily carried out. The aim of the project is to find the Glomerular Filtration Rate (GFR) according to it the affected part in kidney is find out. It deals with renal failure and it applies the concept of Registration and segmentation and classification.
Keywords: registration, segmentation, classification, GFR

I. INPUT IMAGES

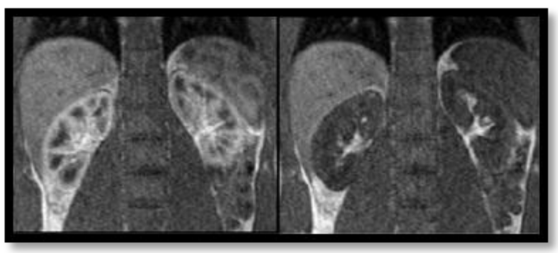


Fig. 1: Input images

II. REGISTRATION

Proper registration is a critical step in the processing chain, as uncorrected voxel displacements will corrupt the voxel time courses. The motion artefacts are caused by respiratory motion, intestinal peristalsis, cardiac pulsations, or patient movement during data collection. In this way, GFR estimates can become strongly biased or even invalidated. To perform motion correction, affine registration has been used.

Affine registration can also be used as an initialization step to a supplementary deformable registration. Clearly, due to respiration there is a significant local affine motion component directed along the head-to-feat axis, as modelled and also observed in our experiments. Still, there is also a deformable motion component due to the elastic properties of the kidney, deforming along with local geometric restrictions in the proximate surroundings. An optimal data term is necessary in order to obtain the best possible registration. Normally, the images contain durable edge information between various tissue types, and also within the kidney after the arrival of contrast agent.

This phenomenon favors the use of a gradient dependent cost functional for registration.

- Step 1: Initialize reference (A) & floating image (B) and set to an identity map.
- Step 2: Collect the seed points based on gradients
- Step 3: The overall goal is to find a minimizer u of a cost functional J

Where J

$$J(u) = \int_T \int_\Omega D(f(x+u,t), f_r(x)) + R(u)dxdt$$

D -> Data term
R -> Regularization

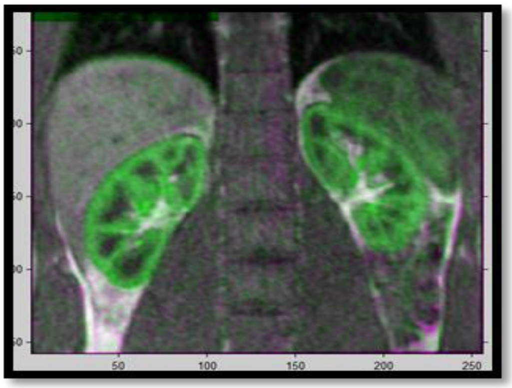


Fig. 2: Registration result

III. SEGMENTATION

Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics.

Active contour model, also called snakes, is a framework for delineating an object outline from a possibly noisy 2D image. This framework attempts to minimize an energy associated to the current contour as a sum of an internal and external energy: The external energy is supposed to be minimal when the snake is at the object boundary position. The most straightforward approach consists in. The internal energy is supposed to be minimal when the snake has a shape which is supposed to be relevant considering the shape of the sought object. The most straightforward approach grants high energy to elongated contours (elastic force) and to bended/high curvature contours (rigid force), considering the shape should be as regular and smooth as possible.

A simple elastic snake is thus defined by

- a set of n points
- an internal elastic energy term
- an external edge based energy term

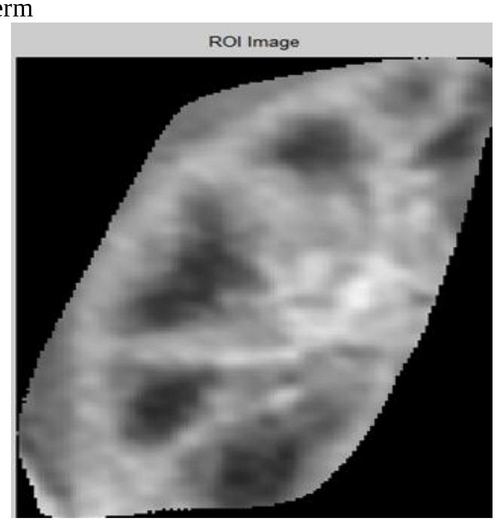


Fig. 3: Segmented kidney

IV. COMPARTMENT MODELING

Renal filtration, mainly taking place in the renal cortex, can be estimated using compartment models within a defined segmentation of the kidney. The compartment time series are then fed into the chosen pharmacokinetic model, producing voxel wise parameters that best match the data. Medical images play vital role in assisting health care providers to access patients for diagnosis and treatment. Studying medical images depends mainly on the visual interpretation of the radiologists.

The contrast in DCE-MRI gadolinium concentration is shown with various time varies with various doses. Average Gadolinium (mmol/L) time curve within left and right kidney for unprocessed data, affine registration, the Sequential model, Reg Seg, and Seg in the breath-hold sequence of subject five. Clearly, the curve evolution is depending on the type of registration.

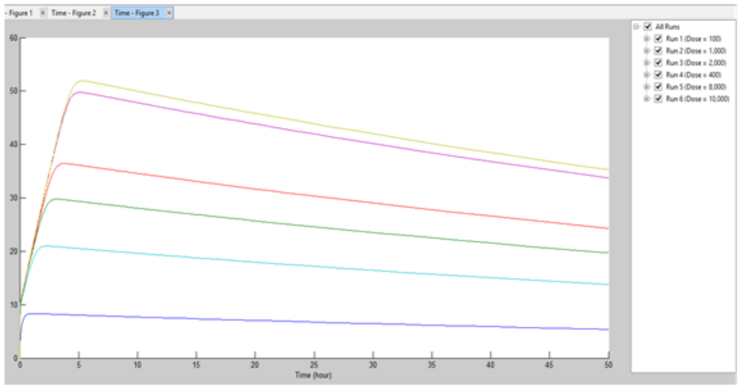


Fig. 4: pharmacokinetic graph

The Features are

- It is used to analyze the contrast agents used in MRI

It will show the drug versus time plots using that intensity of contrast agents can be found out

$$\text{GFR} = \frac{\text{Fluid concentration} * \text{Fluid Flow}}{\text{Plasma concentration}}$$

Dose=C*V
C-> Target concentration
V-> volume of Fluid
The manual calculation of kidneys is

$$\text{GFR} = \frac{60\ ml * 9ml}{6ml} = 90\text{ml/day}$$

- The GFR for the patient is 90 ml. The good kidney GFR rate should be 120 mL/day.

V. FEATURE EXTRACTION

To extract information needed from the image, a feature extraction technique will be carried out. The features are extracted using two feature extraction methods which are co-occurrence matrix approach, known as grey level co-occurrence matrix (GLCM) and also Gabor filters to generate more variation of features are extracted using GLCM (Gray Level Co-occurrence Matrix) features

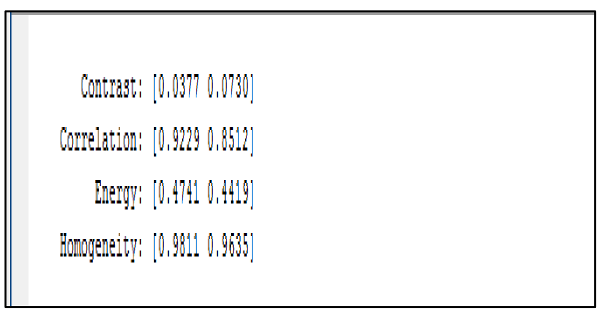


Fig. 5: features

- Contrast = $\sum(|i-j|^2\,(p,j)$
- Energy = $\sum p(i,j)^2$
- Homogeneity=$\frac{\sum p(i,j)^2}{1+|i-j|}$
- Correlation= $\sum(i-\mu\text{i})(j-\mu j)\,\frac{p(i,j)}{[\sigma_{i-}\sigma_{j]}}$

i->mean(elements)
j->standard deviation

VI. CLUSTERING

Renal filtration mainly taking place in Renal cortex. Finds no of clusters. Find data points and number if coordinates M * N using grade f membership. At each iteration objective function is minimized to find best location for clusters. The iteration count stops when the Pfcm value gets minimized
PFCM(x,c,m,e)
X-> Unlabeled data set

C->No of clusters
M->Parameters in objective function
E->A threshold

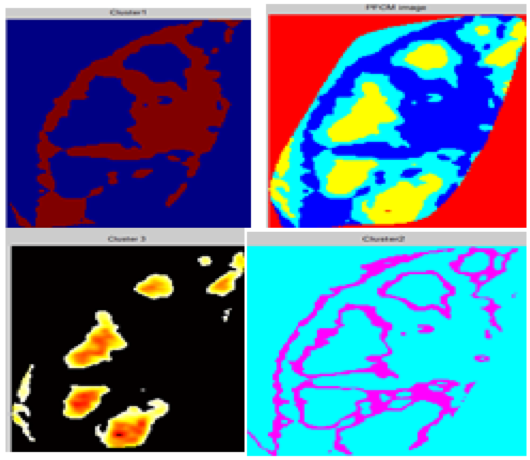
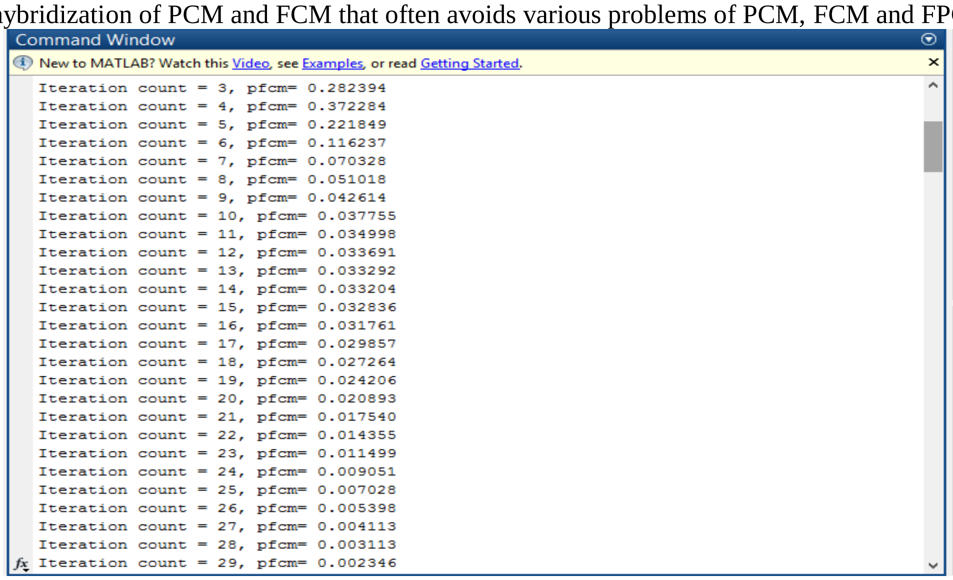


Fig. 6: clusters

The PFCM (Possiblistic Fuzzy C-Means clustering) of whole kidney compartments are shown. The PFCM is a good clustering algorithm to perform classification tests because it possesses capabilities to give more importance to typicality's or membership values. PFCM is a hybridization of PCM and FCM that often avoids various problems of PCM, FCM and FPCM



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Command Window
New to MATLAB? Watch this Video, see Examples, or read Getting Started.
Iteration count = 3, pfcm= 0.282394
Iteration count = 4, pfcm= 0.372284
Iteration count = 5, pfcm= 0.221849
Iteration count = 6, pfcm= 0.116237
Iteration count = 7, pfcm= 0.070328
Iteration count = 8, pfcm= 0.051018
Iteration count = 9, pfcm= 0.042614
Iteration count = 10, pfcm= 0.037755
Iteration count = 11, pfcm= 0.034998
Iteration count = 12, pfcm= 0.033691
Iteration count = 13, pfcm= 0.033292
Iteration count = 14, pfcm= 0.033204
Iteration count = 15, pfcm= 0.032836
Iteration count = 16, pfcm= 0.031761
Iteration count = 17, pfcm= 0.029857
Iteration count = 18, pfcm= 0.027264
Iteration count = 19, pfcm= 0.024206
Iteration count = 20, pfcm= 0.020893
Iteration count = 21, pfcm= 0.017540
Iteration count = 22, pfcm= 0.014355
Iteration count = 23, pfcm= 0.011499
Iteration count = 24, pfcm= 0.009051
Iteration count = 25, pfcm= 0.007028
Iteration count = 26, pfcm= 0.005398
Iteration count = 27, pfcm= 0.004113
Iteration count = 28, pfcm= 0.003113
fx Iteration count = 29, pfcm= 0.002346
```

Fig. 7: iteration

VII. CLASSIFICATION

Using neural network(nn training tool).Train the neural network and apply Scaled Conjugate Gradient Algorithm(SCG).Parameters used are epochs, goal, show, mingrad, max fail ,sigma, lambda for performance validation.

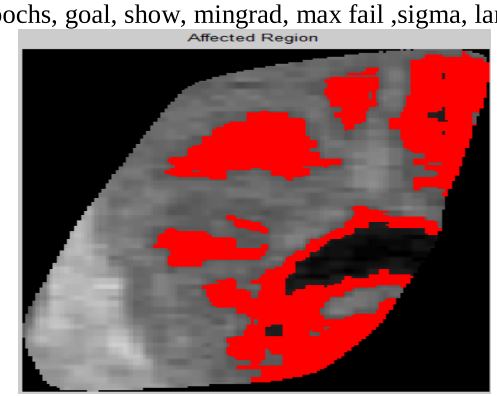

Fig. 8: affected region

The epoch used here is 29 at this stage best validation performance is obtained. It avoids the time consuming line search learning iteration.

VIII. CONCLUSION

The conclusion of the proposed method finds the glomerular filtration rate have presented a novel method for combined registration and segmentation with a good classification to find out the glomerular filtration rate which in turn finds out the renal diseases ,it is applicable to DCE-MRI acquisitions of the moving human kidney.

The segmentation term affects the registration by enforcing time course similarity of voxels inside and outside the kidney. Using time series data from different DCE-MRI examinations we have demonstrated plausible and promising results, in particular related to the smoothness of the voxel time courses and small deviance to Iohexol-measured GFR.

We conclude that our segmentation driven registration approach has a great potential for further development into a full-blown pharmacokinetic GFR model driven segmentation of the kidneys.

We conclude that our segmentation driven registration approach with good classification with pharmacokinetic modeling for finding out the gadolinium concentration has a great potential for finding the GFR rate.

IX. FUTURE WORK

Combined registration and segmentation comes with a good result but the partially blown pharmacokinetic modeling is applied. But in future enhancement Full blown pharmacokinetic modeling based segmentation will bring most plausible and surprising results with the combined effect of segmentation. The sequential segmentation and registration wont give plausible results but the combined one gives plausible results. The comparison of reg seg model and affine unprocessed registration is seen in future .The comparison approaches is not shown in proposed one. The classification approach is used to differentiate between normal and acute rejection patients in kidney. The topology preserving techniques to ensure the diffeomorphic to piece wise constant images with more than two intensities or textured images in future work.

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