Tissue segmentation and quantification in medical color images for semi-automatic hepatic diseases evaluation

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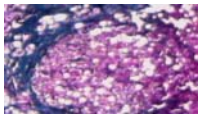
Topic of the project

- Implementation of a software application in C++ Builder which performs the identification and quantification of steatosis, fibrosis and normal hepatic tissue from microscopical color medical images of hepatic biopsies



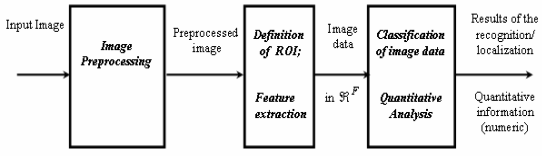
State of the art in medical image segmentation applications

- The recently described methods of digital image analysis of fibrosis in liver biopsy sections have major flaws
- A method based on Adobe Photoshop software proposed by GAMAL M DAHAB and others
- An image analysis application (Fibro*Xact*) proposed by Marc A. Friedenberg

Pixel classification and segmentation

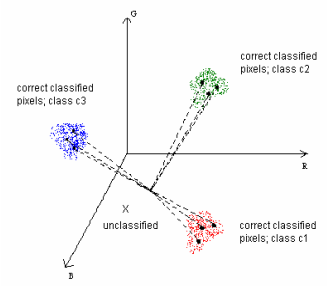
- **Classification** is the process by which an object/observation is associated to a certain category; this association is done based on the specific properties of the object/observation;
- **The label of a class**: simbolically identifies in a unique and simple way a certain class from the set of possible classes;
- **Digital image segmentation** from the classification point of view
  - Purpose: image decomposition in regions which are strongly correlated with the object contained in the image.

The structure of an image analysis system based on classification



K-NN algorithm (K-Neareast Neighbour)

- a supervised algorithm
- the use of training samples for each class
- K – the number of the most important neighbours used in voting



K-NN algorithm (K-Neareast Neighbour)

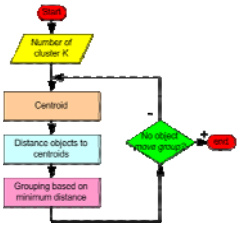
Steps of the alghorithm:

1) Building the training set
2) Computing the Euclidian distance between all the pixels that compose the image and the correctly classified pixels from the training set
3) Sorting in decreasing order of distances and selecting the closest K distances and associated class labels
4) Determine the category to which the currently classified pixel belongs, by using the majority category vote.

K-Means algorithm

The steps of the K-means algorithms :

1) Determine the centroid coordinate
2) Determine the distance of each object to the centroids
3) The objects (pixels) are grouped based on minimum distance
4) The algorithm is repeated if convergence is not reached

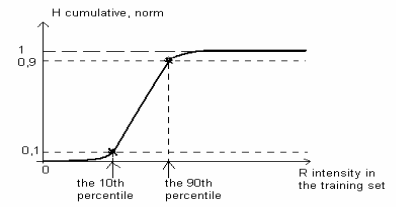


A percentile-based algorithm

- A supervised color segmentation method
- Concept:
  - Since we have the color training samples for: fibrosis, steatosis and healthy tissue represented in the RGB color space, we can use each class data to build color components ranges for each class:
    [Rmin, Rmax]
    [Gmin, Gmax]
    [Bmin, Bmax]
  - However taking strictly the minimun and the maximun is not statistically significant
  - A better statistic estimate is given by the 10th and the 90th percentiles
  - This leads to the color model:
  - [Rx Gx Bx] is in fibrosis if Rx is in [10th percentile of Rfibrosis, 90th percentile of Rfibrosis]
    Gx is in [10th percentile of Gfibrosis, 90th percentile of Gfibrosis]
    Bx is in [10th percentile of Bfibrosis, 90th percentile of Bfibrosis]

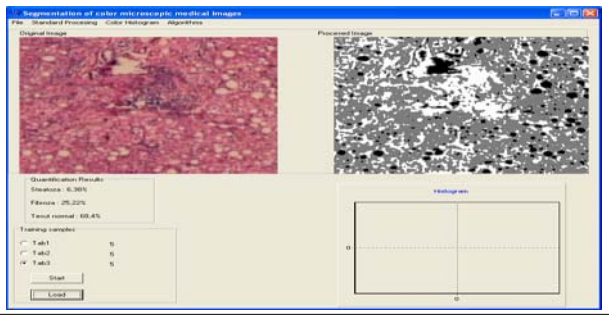
A percentile-based algorithm

- Computation of the 10th and the 90th percentiles:



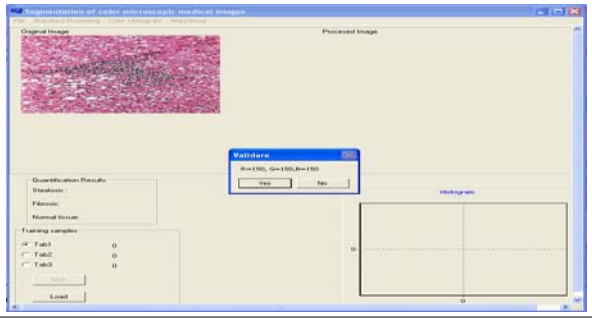
Experimental results

The main application window – K-NN segmentation:



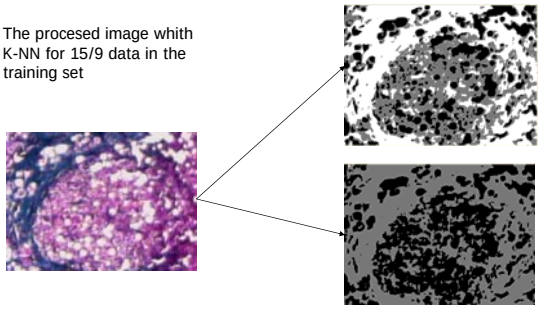
Experimental results

Building the training set for the supervised segmentation:



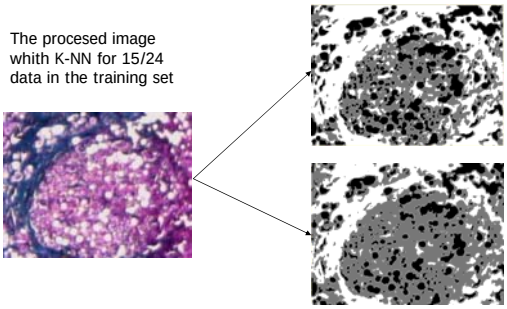
Experimental results

The procesed image whith K-NN for 15/9 data in the training set



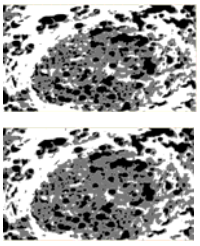
Experimental results

The procesed image whith K-NN for 15/24 data in the training set



Experimental results

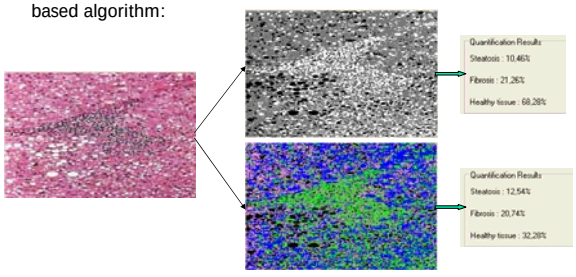
Comparison of the K-NN segmentation results for different training sets:



	K-NN(1)	K-NN(2)
Steatosis:	20,13%	18,98%
Fibrosis:	37,35%	32,71%
Healthy tissue:	42,51%	48,31%

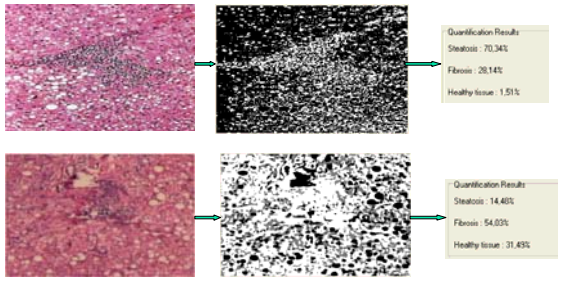
Experimental results

Comparison between k-NN algorithm and percentile based algorithm:



Experimental results

- The results of K-means algorithm:



Conclusions

1) The supervised algorithm K-NN:

- Advantages:
  - A simple implementation; the most difficult problem raised was to find the best method of building the training set
  - Reliable results
- Disadvantage:
  - The result depends a lot on the training samples.

2) K-Means algorithm

- Advantage:
  - One of the most simple means of classification but whith poorer results than K-NN
  - Unsupervised algorithm

3) The percentile-based algorithm

  - The results based on this algorithm are satisfactory but not so good as the results offered by K-NN algorithm.