Texture Analysis of Human Liver

Final result from MRI of Cirrhotic Patients 2000

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Aim of the Study

- To classify MR images of healthy and disordered liver by TA
- To find features of texture analysis which describe the texture of MR images of the human liver by the most discriminative power
- To test the ability to determine liver using statistical methods (PCA, LDA,…..)

Experiment

- 1.5 T Vision System whole-body MR imager with the commercial dual $^{1}H/^{31}P$ surface coil
- MRI sequences: T2w BH (Breath Hold) transversal slices
  (8 mm, TR/TE=4200/138 ms, 350 FOV)
  1 ACQ (BH), 10 ACQ

Child-Pugh (CP)

Clinical relevance

- **Child-Pugh is a sum of five clinical examinations: ascites, protrombine time, bilirubin level, albumin level (in the blood), degree of hepatic encephalopathy**
- **Each examination is evaluated using a 3 point scale according to liver injury**

Subjects

- 10 healthy volunteers (41.8±14.0 yrs)
- 43 patients (49.7±9.0 yrs) with liver cirrhosis of different etiology

  Category A, B, C

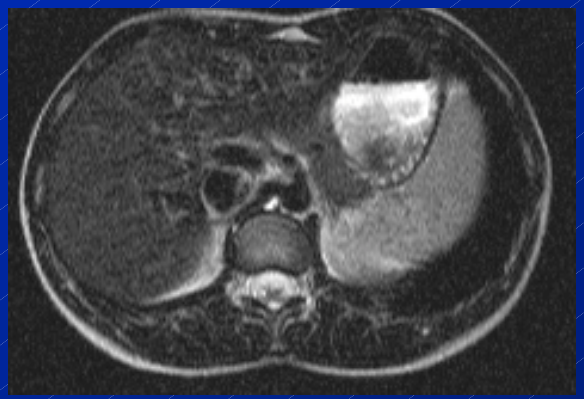
Data

43 patients (we used 161 images)+10 healthy volunteer in each category A,B, C

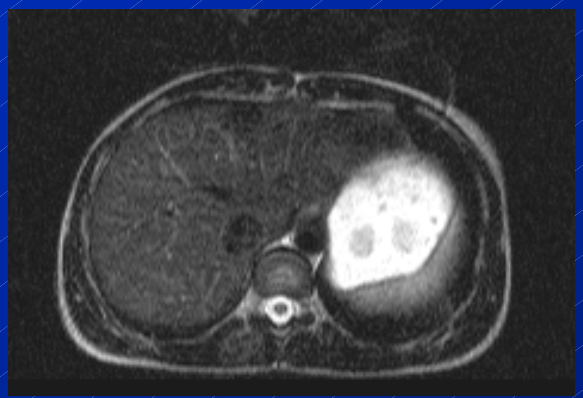
CP	number of patients	number of images
A	4	15
B	13	45
C	22	77
UN	4	24

MR Imaging of normal liver

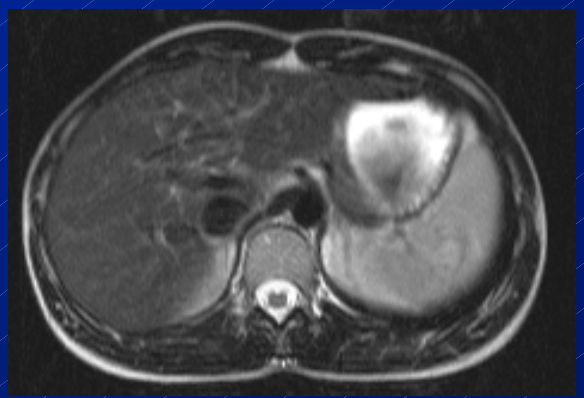
Inspiration, FOV=350



FOV=300, ACQ=1



Exspiration, FOV=350

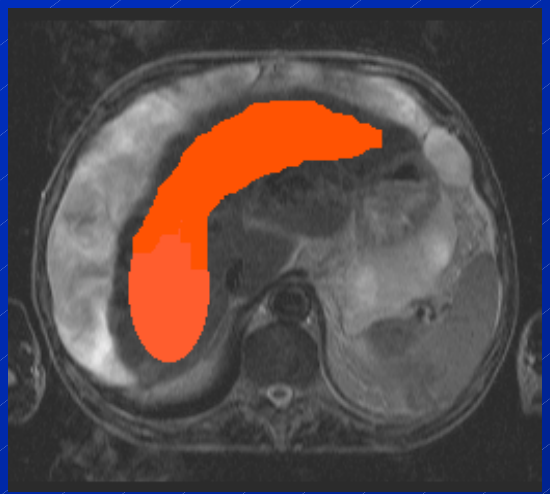


FOV=300, ACQ=10

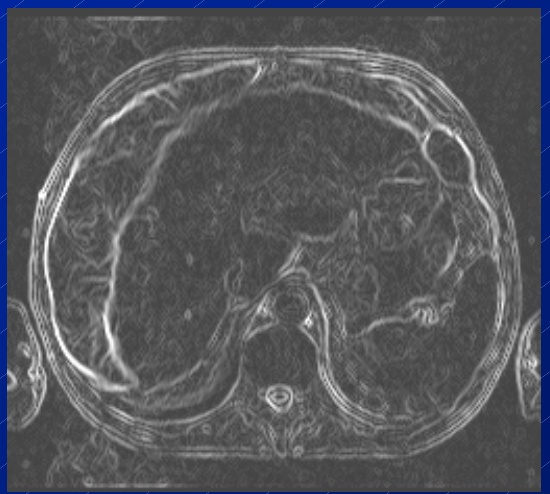
Cirrhotic Patient (CP=11)

Gradient Map from MAZDA

The choice of ROI



Transversal slice



Gradient map

Data evaluation

- Mazda is a computer program for calculation of texture parameters (features) in digital images
- Convert converts data to B11 format and also automaticly selects features for texture analysis
- B11 is made for the quantitative classification of the images according to selected features

MAZDA Parameters

Five sets of TA parameters

- Mean, Skewness, Kurtosis, Gradient Mean, GrKurtosis, Gradient Skewness, Contrast, Correlation, AngScMom, Entropy
- Mean, Skewness, Kurtosis, Gradient Mean, GrKurtosis, Gradient Skewness

MAZDA Parameters

Five sets of TA parameters

- Mean, Skewness, Kurtosis
- Contrast, Correlation, AngScMom, Entropy
- Contrast, Correlation, AngScMom, Entropy, Difference Variance, Sum Of Variance, InvDfMom, Sum Average, Difference Entropy, SumEntrp

Examinations

- Comparison each group (A,B,C) with controls
- Studying all patients altogether and compared them with the controls
- Comparison each group patients among them

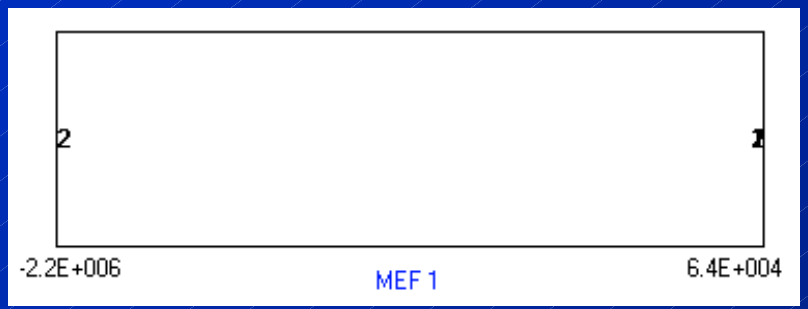
Examinations

- Examination ”unknown” data by comparison other patients and controls
- Dividing patients onto three groups according to their bilirubin level
- Testing all chosen features (16) in singles

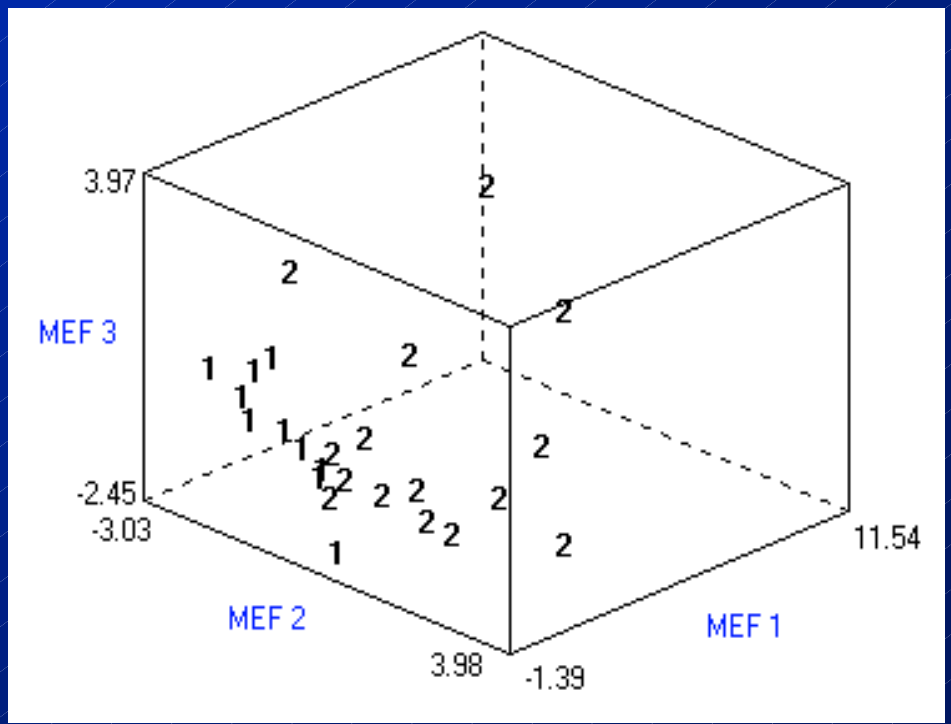
Results

Group A, first set of TA parameters

PCA (non standart.data)



PCA (with standartization data)



healthy volunteer - 1

patient - 2

Results

Group C x controls

Number of misclassification

Set number	*k-NN*		*NDA*		*ANN*	
	Y[%]	N[%]	Y[%]	N[%]	Y[%]	N[%]
1	3,1	6,2	9,3	8,3	8,3	11,3
2	5,2	5,2	11,3	10,3	12,4	12,4
3	3,1	4,1	14,4	14,4	10,3	14,4
4	1,0	11,3	11,3	12,4	14,4	14,4
5	0	3,1	1,0	1,0	2,1	2,1

Results (from B11)

Classification of the „unknown data“, Number of misclassification (clear cases)

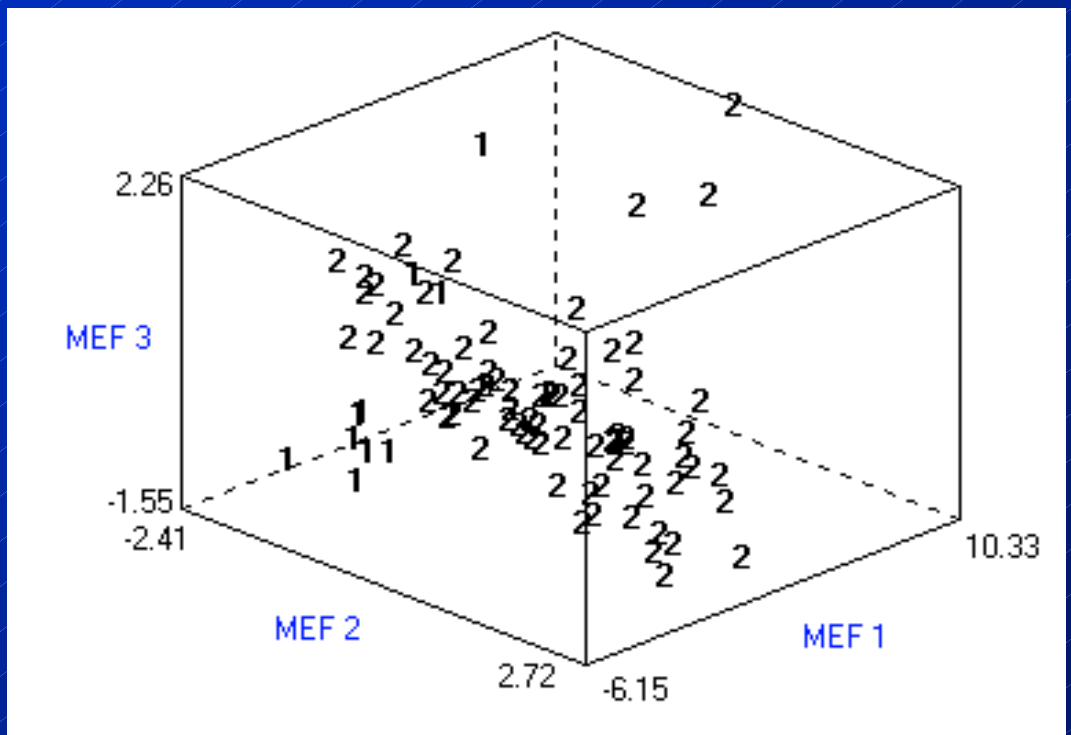
Set of param.	Y [%]	N [%]
MM	0	0
POE	0	0
F	4,2	8,3
1	4,2	0
2	0	0
3	0	0
4	0	8,3
5	0	8,3

Results

- Very good discrimination among patients and controls (error~7%)
- Poor discrimination among patients (error~40%)
- Best features to evaluate human liver are Kurtosis and Difference Entropy
- All used statistical methods had very similar results

What we need for clinical application?

- **The possibility to work with the large database**
- **The posibility to mark data**



PCA-group C
5.set

Conclusion

- The standard sequence was chosen
- Clinical point: to split patients on the three groups is sufficient
- We have sets of TA parameters which can be successfuly applied for TA of cirrhotic patients
- **TA is available to discriminate group of patients and healthy volunteers**