Motivation/ Potenzial für Computergesteuerte Textur Analysen:

* PC kann 100 GW diskretisierte während der Mensch nur 100 kann

Bisherige Herangehensweisen dystrophische von gesunden Muskeln zu unterscheiden:

1. Im Zsmhg mit eingelagertem Fett(gewebe)
2. Im Zsmhg mit Verlust der Orientierung der Muskelfasern
3. Im Zsmhg mit Disturbance of Permysium
4. Im Zsmhg mit dem Mittelwert von nekrotischem und regeneriertem Gewebe
5. Im Zsmhg mit dem Anteil von oxidative Microfiber
6. Im Zsmhg mit endomysaler Fibrose
7. Im Zsmhg mit Kollagengehalt
8. Heterogenität der Myofasergröße

Problem: Es gibt eine räumliche Diskrepanz zwischen räumlicher Auflösung von histologischen- und MRT- Bildern

Menschliche Analysten von MRT Bildern können nur Pixel- Ordnungen 1. Und 2. Ordnung erkennen

Neuere Modelle der Textur Analyse gehen davon aus, dass man multiskalen-filterung, statt Pixel Statistiken höherer Ordnungen benutzen sollte

This work was extended by Portilla and Simoncelli [[17](https://link.springer.com/article/10.1140/epjnbp/s40366-015-0017-1#CR17)] by adding second order statistics (joint statistics) of the multi scale responses

The successor of this model demonstrates that a multidimensional set of image statistics results in the capture of texture information that might be lost on the visual representation.

Hence, texture identification is the result of statistical differences.

(The perception of two different textures with the same mean and variance becomes typically difficult for human observers. This can happen for instance if one of the textures is unimodal and the other is bimodal [[18](https://link.springer.com/article/10.1140/epjnbp/s40366-015-0017-1#CR18)].) =?

This limitation results from the fact that texture segmentation involves local statistics instead of global statistics [[19](https://link.springer.com/article/10.1140/epjnbp/s40366-015-0017-1#CR19)].

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for instance, fibrosis, corresponding to an increase of collagen fibers with an increase of associated bound water, decreases the T2; an oedema resulting from an increase of free water induces a T1 increase, etc.

in healthy muscle, it has been established that two spin-spin relaxation times can be separately identified expressing a slow exchange between different water phases [[28](https://link.springer.com/article/10.1140/epjnbp/s40366-015-0017-1#CR28),[29](https://link.springer.com/article/10.1140/epjnbp/s40366-015-0017-1#CR29)].

All these considerations clearly demonstrate that the interpretation of voxel grey level is highly complex and must be prudently related to histological changes. The challenge is therefore to develop a pulse sequence potentially able to differentiate histological changes [[30](https://link.springer.com/article/10.1140/epjnbp/s40366-015-0017-1#CR30)].

Zu den verschiedenen Ordnungen:

The first-order features are based only on the distribution of pixel grey levels and do not consider the relationships between neighboring pixels. They provide knowledge on the most frequent and the least frequently occurring grey levels, on the concentration of the grey levels around their average, or on the degree of asymmetry in their distribution.

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Sikio et al. [[20](https://link.springer.com/article/10.1140/epjnbp/s40366-015-0017-1#CR20)] used co-occurrence matrix parameters on T2 weighted images such as the angular second moment, the inverse difference moment, the entropy and the difference entropy to describe the muscle tissue structure and the effect of different types of exercise

The result showed that large variation in tests significance were observed depending on the muscle, the texture parameter used and the comparison performed.

In pathological cases, texture analysis of MRI data can be a valuable tool to monitor the changes that occur to the muscle tissue. For instance, Skoch et al. [[21](https://link.springer.com/article/10.1140/epjnbp/s40366-015-0017-1#CR21)] were interested in the classification of calf muscle of patients with different pathology.

[…] For dimensionality reduction, the author used Principal Component Analysis (PCA) to extract a group of features that best characterized each muscle.

In opposition, the healthy group and the patients with diabetes mellitus group could be linearly separated.

Following almost the same scheme, a study carried out by Herlidou et al. [[2](https://link.springer.com/article/10.1140/epjnbp/s40366-015-0017-1#CR2)] compared TA techniques to the assessment of several radiologists, on a set of data obtained from patients with muscular dystrophy and healthy volunteers. The texture descriptors such as histogram, co-occurrence matrix, gradient matrix and run length matrix, were extracted from T1 weighted images. In parallel, the radiologists were asked to characterize each ROI by rating the contrast, the texture coarseness, the texture complexity, the strength and the fat infiltration.

How histological changes during GRMD disease modify NMR parameters?

As the histological variations (inflammation, fibrosis, necrosis, fat infiltration…) do not modify relaxation times in the same way, in the same proportion and at the same time, the final result (i.e. the pixel grey level) is rather difficult to be strictly interpreted in terms of histology, especially when two simultaneous tissue changes modify a relaxation time in opposite directions.

Later T1 decreases in relation to fibrosis and fat infiltration. T2 is longer in necrotic but also in fatty and connective tissue. Therefore the distinction between necrosis, fat infiltration or fibrosis cannot be easily performed.

Idee: Erst sehr weit fortgeschrittene Fetteinlagerungen können mit MRT detektiert werden (wegen Auflösung)… Hier vllt ein Ansatz?