Monitoring of Diseases Progression by MR

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Abstract — This paper deals with methods for monitoring of development of diseases with using the nuclear magnetic resonance. The paper compares the methods for monitoring the qualitative and quantitative parameters in the NMR images. The main goal is usually comparing the observed images of the human tissues in the time. There are the surfaces, volumes and their changes in the time most often monitored. The typical examples of these objects are several tumors, tubers, polypus or discs of temporomandibular joint. The goal of these methods comparison will be selection of suitable method for monitoring of development of treatment of diseases in the human stomach with using the modern nuclear magnetic resonance tomograph and other approaches. The paper is made as research material for the future work.

1. INTRODUCTION

The advantages of the nuclear magnetic resonance were described in many publications. It is approach to acquisition of spatial data of soft tissues, most often of human organs. The main advantage is absolutely the fact of unproved negative effects of the electromagnetic radiation to human organism subject to prescribed hygienic regulations. The observed images of sensed object can be used for three-dimensional model creation after the application of suitable preprocessing methods. The reconstructed object after that can be useful for example to the better diagnosis in medical sciences, for quantitative or qualitative description of tissues, tumors etc. We can find several evaluations of tissues volumes in many cases. It can be useful for monitoring of used treatment efficiency. The typical example can be a tumor volume reduction etc. This article describes recently published approaches and methods used in medical applications as initial research for forthcoming project witch deals with monitoring of treatment of human stomach efficiency.

2. THE RESEARCH OF RECENTLY PUBLISHED APPROACHES

The common of all published application is a segmentation of MR images. The accuracy of results of tissue volume evaluation is very dependent on the results of segmentation. There are used several approaches of segmentation from simple thresholding to region growing or active contours (snakes). According to publication research it’s clear, that the combination of two-dimensional MR segmentation of tissue slices and following evaluation of volume by number and thickness of slices is the most popular. In many cases we can find a manual tracing of the searched area and following volume evaluation.

2.1. Bone Tumor Segmentation, Neural Networks Classification [1]

Monitoring viable tumor bone area over time is important in the ongoing assessment of the effect of preoperative chemotherapy [1]. In this application, the feed-forward neural network is proposed to classify pixels into viable, non-viable, and healthy tissue. The processing consists of two steps. First, a pharmacokinetic model is used to summarize the temporal information in the perfusion sequence into three main parameters. These parametric images are used to derive multi-scale features, they encode the spatial information not present in the original parametric images.

Figure 1: Segmentation results. Left, pre-contrast images; center, histological mask; right, neural network classification, [1].
2.2. Estimation of Tumor Volume with Fuzzy-connectedness Segmentation [2]
Reproducible measurements of brain tumor volume are helpful in evaluating the response to therapy and the need for changing treatment plans. In this paper [2] there is used an adaptation of the fuzzy-connectedness segmentation to measure tumor volume. Segmentation was performed on axial and coronal gadolinium-enhanced and axial fluid-attenuated inversion recovery (FLAIR) images by using a fuzzy-connectedness algorithm, and tumor volumes were generated. Operator interaction was limited to selecting representative seed points within the tumor and, if necessary, editing the segmented image to include or exclude improperly classified regions.

Figure 2: Images illustrate step 2: Segmentation of FLAIR images. (a), Placement of rectangular VOI around the area of presumed tumor and edema (FLAIR volume) on axial FLAIR images designated IF. (b), Delineated FLAIR volume displayed as green overlay obtained after the deposition of seed points in the VOI [2].

There is some evidence that atrophy of certain medial temporal lobe structures may be present at early stages of cognitive decline, before dementia occurs [3]. There is a presentation of manual/semi-automated tracing method for segmentation of hippocampus of normal and demented subjects.

Figure 3: Hippocampus, entorhinal cortex, and temporal lobe were traced using strict anatomical boundaries. Left, normal; right demented [3].

2.4. Comparison of Tumor Volume Measurement in Subcutaneous Mouse XENOGRAFTS [4]
In animal studies tumor size is used to assess responses to anticancer therapy. Current standard for volumetric measurement of xenografted tumors is by external caliper, a method often affected by error. The aim of the present study [4] was to evaluate if microCT gives more accurate and reproducible measures of tumor size in mice compared with caliper measurements. Furthermore, they evaluated the accuracy of tumor volume determined from 18Ffluorodeoxyglucose (18F-FDG) PET. The tumor volume is there evaluated by the greatest longitudinal diameter (length) and the greatest transverse diameter (width), \( \text{Tumor volume} = \frac{1}{2} \times \text{length} \times \text{width}^2 \).

Figure 4: (a) PET and (b) microCT image of mouse with subcutaneous tumor [4].
2.5. MR Volumetry of Cortices [5]

The occurrence of damage in the entorhinal, perirhinal, and temporopolar cortices in unilateral drug-refractory temporal lobe epilepsy (TLE) was investigated with quantitative MR imaging. There was used an approach that consists of 4 steps. The images were magnified, interpolated, the outlines of each area were traced manually by a trackball-driven cursor and the volumes were evaluated by multiplying the areas by 2 mm thickness of slices [5].

![Figure 5: The example of manual tracing of coronal MR images [5].](image)

3. CONCLUSION

This article shows possibilities of usage of image processing methods in quantitative parameters evaluation of scanned object by tomography methods. These methods are often used for assessment monitoring using volumetry – measuring of tumor volumes in the (human) tissues. This article is taken as initial study of methods and use of these image processing methods for the future work, which deals with an evaluation of treatment efficiency of the human stomach diseases.

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