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Computer Analysis of Knee by Magnetic Resonance Imaging Data

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Abstract

The examination of knee cartilage degradation by magnetic resonance imaging (MRI) data is essential due to the reduction in physical activity of the population and a rising number of patients with osteoarthritis(OA). The main aim of this publication is to show a new approach for analyzing knee tissue by MRI data. The present paper investigates the problems of relaxation times calculation, medical image segmentation and statistical texture features calculation. Proposed paper describes an approach for medical image segmentation, relaxation times calculation and statistical texture features calculation. An important aspect of analysis of articular cartilage relaxation times changing is illustrated in the experimental part. The experimental part of the publication also describes the dependence between organic structure and relaxation times. The proposed approach the obtained results can be useful for early OA diagnostics.

Keywords: Early diagnosis of osteoarthritis; Magnetic resonance imaging; Medical imaging; Knee joint; Cartilage; Image segmentation; Relaxation time

1. Introduction

Osteoarthritis(OA) is one of the most common knee joint diseases[1]. In America, every tenth adult has OA. Osteoarthritis takes place when the knee joint cartilage wears-out. Magnetic resonance imaging is used to image soft tissue (for example, cartilage is a soft tissue). A doctor who uses simple MRI images can't see all the information which is contained in the MRI image file (usually DICOM formats). For example, he can't see the early stage of

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osteoarthritis. Therefore, computer analysis of knee by magnetic resonance imaging data is very important. The purpose of this analysis is to provide the doctor with the quantitative information about articular cartilage. This information allows the doctor to make early osteoarthritis diagnosis and allows for more precise estimation of the cartilage changes. This paper proposes new methods for knee cartilage OA diagnostics by MRI data.

2. Problem statement

The quantitative information about articular cartilage is very useful, because it provides an opportunity to control the treatment process and examine the effectiveness of medicaments. A doctor, who has quantitative information about articular cartilage state, can estimate the influence of medicaments on cartilage and compare the effectiveness of different medicaments.

Also, the estimation of the articular cartilage changes is very useful, because of early OA diagnostic. A doctor who uses computer analysis for estimating articular cartilage changes has the ability to make early OA diagnosis. At the first OA stage, it is more likely to cure osteoarthritis without any surgical intervention.

Before cartilage analysis it is important to extract cartilage from MRI data[2,3,4,5]. For this purpose, it is useful to perform MRI data segmentation. After that, we can perform segmented object recognition in order to find articular cartilage. So, these are the main problems:
- MRI data segmentation
- Segmented object classification
- Articular cartilage segmentation and recognition
- Articular cartilage analysis
- Early OA stage displaying

3. Proposed approach

Before we can solve the described problems, it is important to know exactly which parameters and features could be used for articular cartilage analysis, recognition and segmentation. This paper proposes to use:
- Physical parameters - relaxation times (T1,T2), proton density and MRI signal[6]
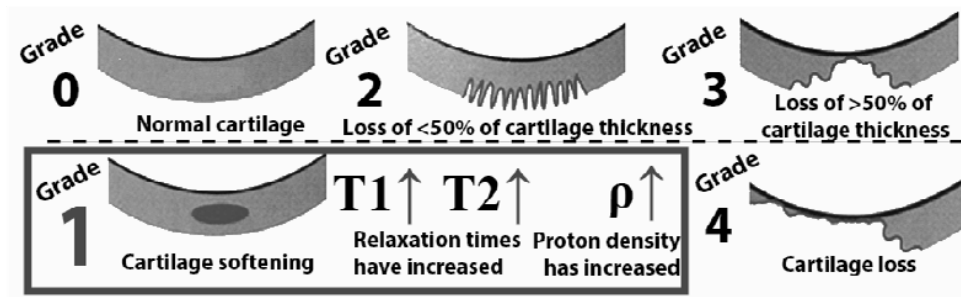- Statistical texture features – contrast, correlation, dissimilarity, energy, entropy and et al.

Fig. 1. Outerbridge classification.

Physical parameters can be useful for first OA grade detection. OA has five grades[7,8] as shown in Fig. 1. The early OA diagnostic is of great importance for people with the early grade of OA. Articular cartilage degeneration is usually recoverable at the first grade of OA. Unfortunately, the first grade of OA is invisible to the doctor who uses usual grayscale MRI images.