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A Quantitative Analysis of Severity Grading of Knee Osteoarthritis

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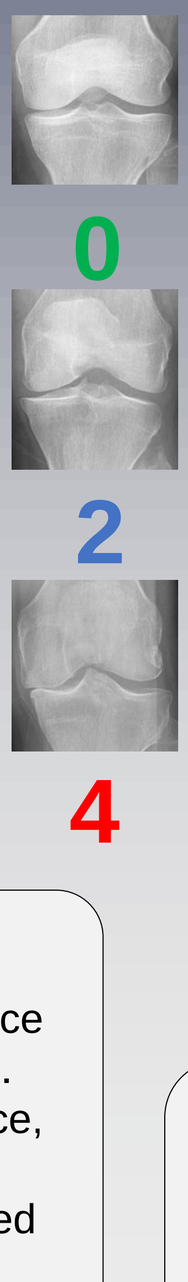
Abstract

This research introduces a novel quantitative approach to address challenges in assessing knee osteoarthritis (OA) severity. By employing image processing and medical data analysis, the proposed method detects and quantifies crucial factors from knee joint X-ray images, surpassing the limitations of qualitative grading systems.
This advancement enhances the accuracy of knee OA diagnosis, offering clinicians a precise tool for tailored treatment decisions and contributing to orthopedic advancements.



Background/ Motivation

The assessment of knee osteoarthritis (OA) severity [5] is crucial for effective clinical management, but existing methods, primarily rely on the qualitative Kellgren-Lawrence (KL) grading system [1], KOOS [3]. Existing system suffers from limited accuracy and the precision of quantitative assessment.
Current literature underscores the need for precise and quantitative approaches to evaluate OA progression [4]. This research addresses this gap by proposing a novel methodology that employs computer vision and image processing techniques to quantify critical features, such as knee joint space and osteophyte count, shape, length, deformity of bone from X-ray images which were previously unexplored.

Objectives

1. To develop algorithms to accurately identify the existence of narrow knee joint spaces, osteophytes in X-ray images.
2. To quantify the features associated with knee joint space, osteophytes from X-ray images.
3. To construct a predictive model that utilizes the extracted features to quantitatively assess the severity of knee osteoarthritis by providing a more precise evaluation method.
4. To provide a comparative study between the newly developed quantitative approach and the traditional qualitative OA grading system.

Research outcome

1. Development of a framework for detecting knee joint space narrowing, osteophytes in X-ray images.
2. Quantitative features related to knee joint space and osteophytes from segmented X-ray images.
3. A predictive model that integrates the extracted features to enable accurate and standardized quantitative evaluation of knee osteoarthritis severity.
4. A comprehensive analysis of quantitative features' value of the newly developed approach, the possible mapping from the perspective of the traditional OA severity grading system and a new measurement.

Methodology

1. **Detection of Knee Joint Space, Osteophytes:**
   a. Data Collection and Preprocessing
   b. Unsupervised Learning (Clustering)

2. **Quantitative Feature Extraction:**
   a. Segmentation of Identified Regions
   b. Feature Extraction

3. **Development of Predictive Model:**
   a. Dimensionality Reduction
   b. Clustering-Based Labeling
   c. Model Training

4. **Comparative Analysis:**
   a. Data Collection for Comparative Study
   b. Model Application
   c. Performance Evaluation

References

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[3] Ewa M Roos and L Stefan Lohmander The Knee injury and Osteoarthritis Outcome Score (KOOS): from joint injury to osteoarthritis

[4] D. Hayashi a, F.W. Roemer a,b, A. Guermazi a Imaging for osteoarthritis
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