

Image Processing for the Diagnosis of Osteoarthritis (OA) Progression

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Abstract:

Joint disease of the knee called osteoarthritis may affect one or both knee joints at the same time. osteoarthritis is frequently called 'wear and tear' arthritis because of the dynamic degradation of articular cartilage it causes. Cartilage is a tough, flexible layer that protects the joints from injury while still allowing them to move freely. Osteoarthritis causes cartilage to stiffen and crack, increasing the risk of rupture. In our studies, we're trying to figure out whether osteoarthritis (OA) develops at any age. Around 27 million Americans are living with OA, according to government health officials. We devised a new method for detecting osteoarthritis (OA) in images by using machine learning techniques in image processing. This method is more accurate in identifying the degree of knee OA than existing approaches, which fall short in terms of accuracy.

Keywords— Osteoarthritis, X-ray, Kellgren Lawrence (KL) Classification, SVM algorithm.

1. Introduction

A frequent type of arthritis that mostly affects women, overweight people, and the elderly is osteoarthritis. Arthritis that primarily affects cartilage is known as osteoarthritis (OA). A joint's cartilage is the tissue that connects the bones at their ends. In a normal or healthy joint, cartilage enables bones to move freely without grinding against one another. Osteoarthritis occurs when the cartilage on the top of the joint wears away, allowing the bones to rub against one another and cause excruciating agony. When it comes to the joints, osteoarthritis most frequently affects the knees, hips, spine, and feet. Osteoarthritis is divided into two categories: primary and secondary. Primary OA may develop in the elderly for a variety of reasons, including heredity or natural ageing. OA due to an injury, obesity, sports, or rheumatoid arthritis may appear early in life. Osteoarthritis (OA) is most often characterised by joint pain and stiffness, as well as reduced function and participation restrictions, and stiffness in the morning or after a long time of resting. Patient-reported symptoms and X-rays are currently the main diagnostic tools for osteoarthritis right now. However, until symptoms occur and patients are referred to a specialised surgeon for assistance, an MRI is the only other option. However, this test is expensive and seldom performed. Radiography (X-ray) has historically been used despite the advent of many imaging techniques for improved OA diagnosis including as MRI, OCT, and ultrasound.

preferred. It's the "gold standard" for diagnosing knee OA since it's so readily accessible. X-ray images show the formation of bony spurs in osteoarthritis patients who have lost cartilage in their joints, as well as decreased joint space between them.



Fig. 1. Normal Knee Image



Fig. 2. Osteoarthritis Knee Image

It is the goal of this research to create a novel OA detection method based on machine learning techniques that is more accurate in determining the severity of knee OA than existing approaches. Examining the OA [2] An OA analysis goes through

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the following stages: To begin, here are a variety of X-ray knee scans taken from different people. After creating a filter, extract the feature vector as a dataset and classify it according to the KL-grade system. The linear regression in a Support vector machine was used to solve nonlinearity problems in osteoarthritis research (SVM). As a result, researchers will look at samples with varying degrees of OA severity, from mild to severe.

Approaches Under Consideration

Preprocessing, Euclidean distance feature extraction, and categorization of calculated features are the four main stages in the proposed method. The following subsections go into detail about each step. Image Acquisition is step one.

To acquire an image, one must get it from a source and then process it to create a new and improved image. Compilation of Information: We used 125 X-ray pictures of knees from various hospitals and diagnostic centres as an input data set. Age, gender, and occupation were all taken into consideration while selecting the pictures.

B. Pre-processing

During pre-processing, some of the most critical aspects of the X-ray image are brought to light. Pre-processing techniques differ depending on the application after the acquisition of X-ray images of the knee. The pre-processing operation reduces the image's size to 515x408 pixels and scales it down to 200x200 pixels for further examination.

C. Retouching of Photographs

Image quality may be improved to a large extent using image enhancement techniques. This research makes use of contrast modulation to improve the sharpness of X-ray pictures of the knee joint.

D. Euclidean distance-based feature extraction

The inner product, a logically straightforward mathematical method, is used to illustrate feature matching. The feature matching technique is readily extended to the subspace method in terms of mathematical structure.

A knee X-ray is used to locate the right and left knees by downscaling it by a factor of 40, i.e. $x' = \text{round}(x/m)$ and $y' = \text{round}(y/m)$. $m=40$ represents the image's enlargement factor; x' and y' represent the enlarged image's width and height, respectively. If you have a problem with your right

knee, scan from $x'=1$ to $x'=18$, and then scan again from $y'=1$ to 20. Then scan the left knee, and do the same thing again from $y'=1$ to 20. For each of the 4057 pixels, the Euclidean distances between them are computed as follows:

Assume that $W_{x,y}$ is an image's intensity while I 's is an image's pixel intensity while d_i is a distance in Euclidean coordinates between joint image I and the 4057 shifted window W .

Every picture in the collection may have its right and left knees located using this quick and simple method. As a last step, the scaling factor is used to determine the location's value.

x is equal to the square of $(x'*m)$ and y is equal to the square of

The rescaled feature's centre of mass coordinates are then calculated as follows: $x_c = M_{1,0}/M_{0,0}$ and $y_c = M_{0,1}/M_{0,0}$, where $M_{i,j}$ is the moment of order i,j . a graph showing the sum of the rows

Once the knees have been located, we use row sum graphs to determine the junction area. The sum graph represents the row- wise summation of gray values.

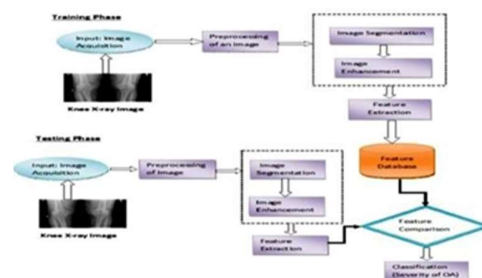


Fig. 1. Training and testing phase

E. Classification

The above-mentioned method produced a dataset with characteristics that will be used for further classification. Classification of knee joints in a database is accomplished via the use of the support Vector machine (SVM). When it comes to machine learning, SVM surpasses every other technique available. The recovered characteristics are fed into a Support Vector Machine (SVM) to assess the severity of osteoarthritis. [5] Two phases make up SVM: training and testing (or validation). Feature matrices and class labels are required in order to train the SVM. The decision mechanism for assigning a class to an input database has been put in place.

Analysis of KL Grade

Kellgren-Lawrence Individuals' knee OA severity is classified using the Grading System, the most accurate approach. The KL grading system divides students into four groups.

It doesn't seem like there is any OA in the knee, but there is a risk of osteophyte lipping and a reduction in joint volume. There are osteophytes and evident restriction of joint space, some sclerosis and probable distortion of bone shape in Grade 2. There are significant numerous osteophytes and evident restriction of joint space, some sclerosis and probable distortion of bone shape in Grade 3 (moderate to severe).

There are enormous osteophytes, substantial joint space limitation, severe sclerosis, and visible deformities of the bone contour in grade 4. There are three criteria used to classify osteoarthritis: the presence of osteophytes (bony growths adjacent to the joint space), constriction of the tibial–femoral joint space, and subchondral bone sclerosis.

Conclusion

We described an automated method for assessing the severity of OA based on X-ray images of the knee in this study. This is a data-driven method for detecting osteoarthritis that makes use of several different data sets. According to research, about 65% of OA patients have been identified. OA in knee and hand joints will be the focus of future study, which will also incorporate regression modelling to better predict OA. We will also evaluate models created in longitudinal and prospective investigations.

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