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Using Artificial Intelligence to classify osteoarthritis in the knee joint: Review

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Abstract. Knee osteoarthritis (KOA) is a disorder that predominantly affects the cartilage in the human knee joint. In legmovement , cartilage plays a vital function. In osteoarthritis the cartilage's top layer crumbles and impairs causing excruciating agony. A patient with knee discomfort should see a doctor, who will assess the patient's clinical symptoms and recommend that the patient undergo radiographic imaging of the knee. In the therapy of osteoarthritis, clinical symptoms are quite important. Clinical symptoms and radiological criteria are used to do a proper examination of the disease. The breadth of the joint space, osteophytes, and sclerosis are all important radiographic criteria. Based on radiological data, the Kellgren-Lawrence (KL) scoring system is used to evaluate the severity of the condition. The KL system is the most widely used approach for grading Osteoarthritis (OA) in the knee joint into five separate classes, primarily to determine the severity of the illness. (Normal, Doubtful, Mild, Moderate, Severe).
In this review, various medical imaging technologies used to detect and identify knee osteoarthritis have been examined in details. The automated detection of human illness recovery rates and the classification of Osteoarthritis in the knee using medical images utilizing a variety of medical image classification methods have been investigated. This research paper included the many medical imaging procedures used. with a review of the classification methods of knee osteoarthritis (KOA) between2018-2021 using artificial intelligence techniques and showed their methods and results.

Keywords: Knee Osteoarthritis (KOA); Kellgren-Lawrence (KL); Medical Imaging Technologies

1. Introduction

The anatomy of the knee is illustrated in Figure 1. The terms medial side, which refer to the side facing the body's center, and lateral side, refer to the side facing away from the body's center. The construction of the knee joint may be broken down into Four several components, The first component is a bone that is made up of 4 elements: the proximal tibia, distal femur, fibula, and patella. The second component is cartilage, which is made up of the meniscus (medial and lateral), articular cartilage (tibial, femoral, and patellar). The ligaments Figure 2 (cruciate and collateral ligaments) are the joint's third component, holding the other parts of the joint together. The fourth component is called joint capsule, which contains a viscous fluid whose function is to reduce cartilage wear during movement. The biggest joint in the human body is the knee joint. It is made up of two joints: one that connects the tibia to the femur (tibiofemoral joint) and the other which connects the patella to the femur patellofemoral joint).[1] Knee osteoarthritis (KOA) is one of the most common disorders among adults aged 60 and higher. The two most important risk factors for knee OA are age and weight. It is quite difficult for a patient to return to normal once OA has surfaced. As a result, the most significant aspect in preventing knee OA is early detection.[2]

osteoarthritis (OA) is now diagnosed by clinical examination and nearly usually verified with radiography (X-ray imaging), which is a very inexpensive and commonly used imaging modality. The Kellgren–Lawrence (KL) grading system is the gold standard radiographic knee OA severity metric.[3] table 1 shows Kellgren–Lawrence (KL) grading system.

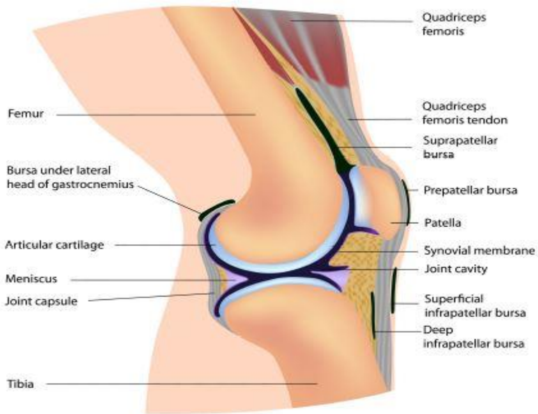

Figure 1 : Knee structure

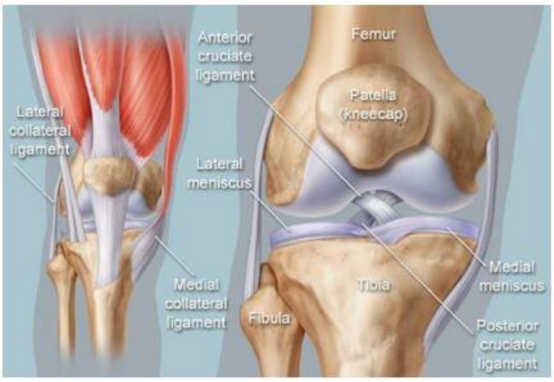

Figure 2: An anatomy of the knee joint with particular emphasis on ligaments (cruciate and collateral ligaments)

table 1 Kellgren–Lawrence (KL) grading system

Grade 0	Normal	No radiological findings of OA.
Grade 1	Doubtful	Narrowing of joint space and possible osteophyte lipping.
Grade 2	Mild	Possible narrowing of joint space and definite osteophytes.
Grade 3	Moderate	Definite narrowing of joint space, Moderate multiple osteophytes, some sclerosis and possible deformity of bone ends.
Grade 4	Severe	Marked narrowing of joint space, large osteophytes, severe sclerosis and definite of bone ends.

This research is organized as follows: Section 2 presents medical imaging techniques. Section 3 provides the medical image classification methods. Section 4 discusses the previous studies of many researchers.

2. Medical Imaging Techniques(MIT's)

(MITs) are non-invasive techniques for peering inside the body without having to open it up physically. It was once utilized to aid in the diagnosis and treatment of a variety of medical problems. Medical imaging techniques come in a variety of forms, each with its own set of risks and advantages. X-ray scan, Computed Tomography (CT scan), and Magnetic Resonance Imaging (MRI scan).

2.1 X-Ray Radiography

A radiography scan is a diagnostic process that uses ionizing magnetic radiation, such as X-rays, to view objects. High-energy electromagnetic radiation with a wavelength of 0.01 to 10 manometers that can penetrate materials and ionize gas is known as an X-ray. When X-rays are sent through the body for medical imaging, they are absorbed or attenuated at different rates depending on the density and the atomic number of the various tissues, resulting in a profile.

X-Ray images advantages

- The procedure is rapid and painless.
- Assist in the planning of medical and surgical treatments.
- It only takes a few minutes to finish the procedure.

X-Ray images risks

- When people are exposed to ionizing radiation, they are more likely to acquire cancer in the future.
- At relatively high levels of radiation exposure, tissues effect like cataracts, skin, and losing hair can occur.[4]

2.2 Computed Tomography (CT scan)

CT is a diagnostic imaging technique that has had a major impact on health judgments and assessments. This is an example of a medical fusion using several modalities. Scans are similar to X-rays in that they provide cross-sectional pictures of the body in a specific location. A CT scan of one's knee, for example, will allow physicians to look at disease or wounds on the knee. The body is encircled by a CT scanner, which sends pictures to a screen.

These pictures are used by the computer to get to the point of view one by one. As a result of this operation, specialists can examine the muscles, ligaments, tendons, lungs, and bones.

CT scan advantages

- CT scans are fast, finishing about 10-20 minutes.

- the results are very quick When compared with other kinds of scans.
- They are considered non-invasive because CT scans are painless.

CT scan risks

- When your body is subjected to a certain level of radiation. Radiation is emitted at a higher rate when the patient's body is scanned more. They're also meant to lower radiation sensitivity.
- The possibility of an allergic response due to the color used.[5]

2.3 Magnetic Resonance Imaging (MRI)

MRI is an entirely new approach for ligament screening because it does not use ionizing radiation, is non-invasive and accurate, and delivers adequate image quality with outstanding resolution and contrast. X-rays provide images in a complex format that may be saved and retrieved, as well as some image acquisition parameters. The device's expensive price (particularly for high field grade magnets), long inspection times, and tendency towards capturing ancient rarities are all drawbacks.[6]

MRI advantages

- Magnetic fields and radio waves have no known detrimental effects on the patient, therefore MRI scans are painless and safe.
- It does not need x-ray exposure, thus it may be used by pregnant women and newborns if necessary.

MRI risks

- MRI tests need a lot of figures, which makes claustrophobia sufferers uneasy.
- Metal cannot be scanned in an MRI scanner, and those with other implants, like pacemakers, are unable to use it.[5]

3. Medical image classification methods

One of the most prevalent methods of knowledge extraction is classification. Many features are typically employed in classification to gather pixels, indicating that multiple images of a particular item are required. The following is the process that will be used to classify the images:

The five key phases in the knee osteoarthritis classification process are image acquisition, pre-processing, feature extraction, classification, and assessment or evaluation. Choosing among a range of images, such as computed tomography (CT), magnetic resonance imaging (MRI), and x-rays, is part of the image acquisition step medical imaging technologies used to detect and identify knee osteoarthritis.[7] Figure 3 shows the process of medical images classification.

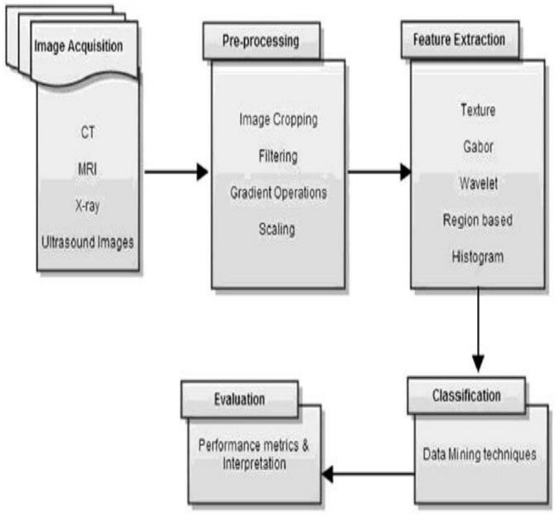

Figure 3: Medical image classification process

Some of the classification methods used to evaluate illness of knee osteoarthritis

3.1 k-Nearest Neighbor (KNN) Classification

The K-Nearest Neighbor (K-NN or KNN) technique is a classification approach based on learning data that is nearest to the object. Data is projected onto a multi-dimensional space, with each dimension representing a data feature. This area is separated into divisions dependent on how learning data is classified. The Euclidean distance is commonly used to determine whether neighbors are close or far apart. The KNN algorithm is an effective training technique for data with a lot of noise.[8]

3.2 Support Vector Machine (SVM) Classification

A Support Vector Machine (SVM) is a flexible Machine Learning model that can perform linear and nonlinear classification, regression, and even outliers identification. It is one of the most widely used Machine Learning models. SVMs are especially well-suited to classifying difficult little or medium-sized datasets.[9]

3.3 Convolutional Neural Network (CNN)

A CNN is a type of Artificial Neural Network that is designed to preserve spatial correlations in data by using just a few different connections between the layers. The input to a CNN is organized in a grid layout and then passed through layers that retain these associations, with each layer action affecting a tiny portion of the previous layers (Figure 4). CNN's are well-suited for image-oriented

applications because they can generate very efficient representations of the input data.
CNN's include three various layers first layer is a convolutional layer, the pooling layer is a second layer, and the Final layer is a fully connected layer that calculates the final outputs.[10]
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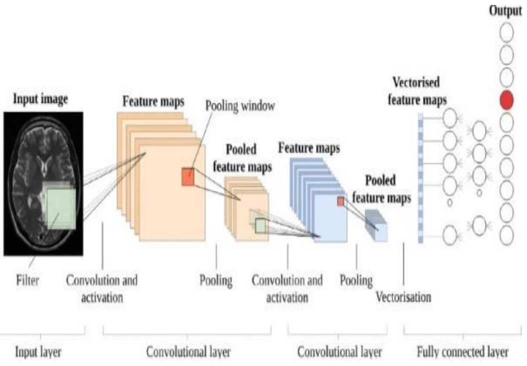

Figure 4: typical building block of CNN

3.3.1 Convolutional layer

This layer contained some feature maps which are produced by a convolution between input image and kernel. each kernel is a matrix of 3*3 or 5*5. figure 5 shows an example of 2D convolution.[11]

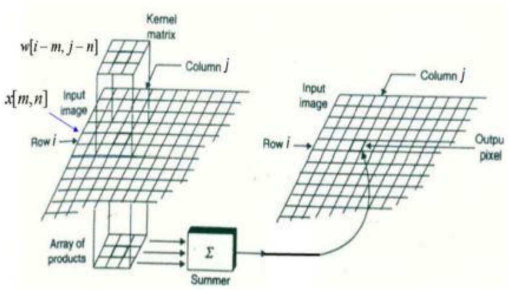

Figure 5: Example of 2D convolution.

3.3.2 Pooling layer

A pooling layer is placed regularly between the convolution layers, to gradually reduce the size of data to minimize some of the parameters in the network and the number of computational resources consumed. The input's invariant properties can also be learned by the pooling layer. Global average pooling and max pooling are two common pooling layer approaches. The pooling layer's input data is usually a feature map created following a convolution. Figure 6 shows the max pooling[12].

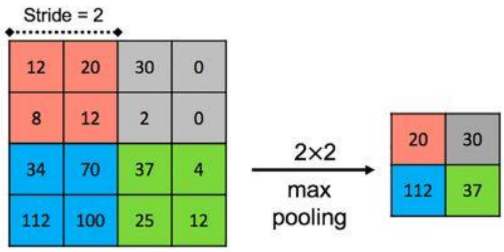

Figure 6: Max pooling

3.3.3 Fully connected layer

The image's feature map is obtained after a sequence of convolution and pooling layers, and all of the neurons in the feature map are changed into a fully connected layer. Finally, the soft-max layer may classify the output. The fully connected layer's purpose is to incorporate local information with class differentiation in both the convolution layer and the pooling layer to enhance the overall performance of the CNN.[10]

4. Previous Studies

In this section, a review of some previous studies has been carried out , which include data, methods, and the results

In 2018 Aleksei Tiulpin et al provided a novel transparent computer-aided diagnostic technique for assessing knee OA illness based on the KL scoring system and the Deep Siamese Convolutional Neural Network, using the Kellgren-Lawrence grading system. They score a 66.71 % multiclass accuracy.[13]

In 2018 RUOPING LI built a deep neural network to predict knee osteoarthritis severity automatically. Due to their differing initial sizes, he had to manually detect and chop out knee joints from knee X-Ray photographs as input to the network.

The ResNet-34 has been fine-tuned to access the knee joint's K&L grade. He also has a 63.5 percent multiclass accuracy. [14]

In 2018 Abdelbasset Brahima used a circular Fourier filter to preprocess the X-ray in the Fourier domain. The data is then subjected to a unique normalization approach based on modeling that predicts with multivariate linear regression (MLR) to decrease the variations in OA and healthy persons.

To reduce dimensionality, an independent component analysis (ICA) technique is applied at the feature selection/extraction step. Finally, for the classification challenge, Naive Bayes and random forest classifiers are utilized. On 1024 X-ray scans of the knee, this innovative image-based technique is used. The findings demonstrate that the suggested approach has an 82.98 % predictive classification performance for OA detection.[15]

In 2019 Pingjun Chen et al employed 2 deep convolutional neural networks (CNN) to predict the severity of knee OA using the Kellgren-Lawrence rating scale. To begin, they use a customized one-stage YOLOv2 network to recognize knee joints based on dimensions of the Knee joint scattered in X-ray. Second, they used a new adjustable ordinal loss to fine-tune the common prevalent CNN models, including Res-Net and VGG and Dense-Net versions in addition InceptionV3 to evaluate the identified knee joint images.

The greatest classification accuracy of 69.7% is achieved by the fine-tuned VGG19 model with the recommended ordinal loss. [16]

In 2019 Anil Kumar Chaudhary et al aimed to use Deep Features to detect and classify Osteoarthritis in the knee using medical images (MRI). The model they're constructing in this research is trained on the two types of MRI images: healthy knee MRI and OA knee MRI.

Deep learning was utilized to tackle the object detection issue to pinpoint the exact location of the OA in a knee MRI.

they trained to process and evaluate an SSD (Single Shot Multi-box Detector) with Mobile net-model utilizing Tensor Flow Object detection. Osteoarthritis knee MRI images are used to test the model as pre-trained and with fine-tuning.

the result of images classification is 95.61% validation accuracy.[17]

In 2019 Kevin A. Thomas et al used the KL scale for each X-ray was predicted using a 169 layer CNN with a dense convolutional network design. The last layer was changed to contain 5 outputs one for each of the five KL classes. Weights pre-trained on ImageNet (a huge dataset used to train the models) were utilized to establish the network's weights. The suggested model is 71 % accurate.[18]

In 2019 Rima Tri Wahyuningrum et al employed preprocessing input images and feature extraction using a CNN and using LSTM (Long Short Term Memory) for classification. A manually cropping region on the knee joint with 400 × 100 pixels is used for preprocessing. They use VGG-16, which is one of the CNN models. For feature extraction, a model is pre-trained on the ImageNet. These characteristics are then employed as the LSTM's input signal. Finally, the severity of knee osteoarthritis is classified using the LSTM model. This strategy yields a 75.28 % success.[19]

In 2019 Marc Gorriz et al offered a new end-to-end CNN (Convolutional Neural Network) for autonomously quantifying the degree of osteoarthritis in the knee using X-ray that contains trainable attention modules that act as fine-grained detectors of the ROI (Region Of Interest) without being supervised. The suggested attention module may be used at various scales and levels in any Convolutional Neural Network (such as VGG 16) pipeline, allowing the model to know important patterns of attention across the most informative sections of the x-ray at various resolutions. This strategy yielded the greatest results, with a 64.3 % accuracy rate.[20]

In 2019 Bin Liu et al introduced a model for automated diagnosis of knee OA based on a DL (deep learning) strategy. They employed Faster R-CNN as a baseline which comprises of RPN (Region Proposal Network) and Fast R-CNN, to analyze the input x-ray with location and classification at the same time. The RPN is taught to create region recommendations that include the knee joint, which are subsequently classified using Fast R-CNN. This model is 74.3 % accuracy.[21]

In 2019 Abdelbasset Brahim et al used knee X-ray imaging and spectral analysis to improve the diagnosis of Osteoarthritis (OA) disease is given in this research.

The suggested technique uses the Power Spectral Density (PSD) of a picture in various orientations as a feature for classification. The necessary PSD coefficients for OA identification are then selected using Independent Component Analysis (ICA). Finally, 688 knee X-ray pictures are classified using a logistic regression classifier. The suggested diagnosis method produces categorization findings with an accuracy of up to 78.92 %.[22]

In 2020 Bofei Zhang et al used Res-Net (Residual Neural Network) to recognize the joint of the knee from x-ray and then combined Res-Net with CBAM (Convolutional Block Attention Module) to generate an automatic evaluation of the KL score. A multiclass accuracy is 74.81 % was reached by the suggested model.[23]

In 2020 Soon Bin Kwon et al created a model for classification KOA automatically utilizing X-ray imaging and analysis of gait data based on the KL scoring system. An SVM (Support Vector Machine) was used for multi-classification in addition to radiograph characteristics acquired from a deep learning network specifically Inception Res-Net v2. The suggested method outperformed a widely used deep learning strategy that relied solely on x-ray images as input data. This finding suggests that x-ray images and gait data are complementary in terms of KOA categorization and that combining the two can increase the automated diagnosis' accuracy.

the combination of gait and radiographic imaging characteristics performed better than compared to the deep learning technique. The combined model had a 75.2 % accuracy, whereas the deep learning technique had a 64.7 % accuracy.[24]

In 2020 Christoph von Tycowicz proposed a novel transductive learning strategy for automated grading of osteophytes from morphometric knee bone data. Deep neural networks for anatomical shape data are used in his method which combines principles from computational anatomy and geometric deep learning. This model's average multi-class accuracy on test sets was 64.64 %.[25]

in 2020 Sudeep Kondal et al offered a unique approach for automatically classifying knee x-ray on the KL scoring system using convolutional neural networks in this research. Their technique is divided into two connected parts: first, a model for object detection separates knees from other image. second, a regression model evaluates each knee individually on the KL grade. They trained a classification model using the DenseNet-121 architecture, which categorized each input knee image as one of five discrete classes. They got a precision of 0.55 and a recall of 0.57 for each class.[26]

In 2020 Kamali C et al employed the U-net model for cartilage segmentation and a few deep learning techniques such as SVM and KNN for OA severity classification. They used KL-grading to train the algorithms to assess the severity of knee osteoarthritis. The SVM classifier produces a more accurate classification result than the KNN classifier, with an accuracy of 73% vs 70.5% for KNN.[27]

In 2020 Rima Tri Wahyuningrum et al explained that radiologists divide the severity of KOA into five stages according to Joint Space Narrowing (JSN) and the presence or absence of osteophytes, ranging from a healthy knee (stage 0) to the greatest damage (stage 4). they designed a method that intends to limit radiologists' subjectivity while speeding up the categorization of KOA severity based on information collected from X-ray images. In this study, they used hyper-parameters and a fine-tuned technique to create Deep Convolutional Neural Networks DCNN to identify the severity of KOA based on X-ray images. The average result performance evaluation accuracy rate is 77.24 %.[28]

In 2021 Albert Swiecicki et al created a method for an automated deep learning that assesses knee osteoarthritis severity according to the KL grading system by combining the Lateral (LAT) and Posterior-Anterior (PA) views of knee x-ray. For the assessment of OA in the knee, a unique deep learning-based technique was used in two steps : (1) detection joints of the knee in x-ray using faster R-CNN. and (2) classification using the KL scoring system. Both PA and LAT perspectives were used as input to the model in their technique. the result of the model is 71.90 % multi-class accuracy.[29]

In 2021 MD. REZAUL KARIM et al offered the Deep Knee Explainer, a novel explainable approach for KOA diagnosis based on radiographs(x-ray) and magnetic resonance imaging (MRI). To begin, they used the deep-stacked transformation approach to thoroughly preprocess MRIs and radiographs for any noisy and artifacts that might include undiscovered pictures for domain generalization. The ROIs are then extracted using a U-Net design with a Res-Net backbone. They use the generated ROIs to train Dense Net and VGG architectures to categorize the samples. Their method achieveed a classification accuracy of up to 91 %.[30]

In 2021 Carmine Guide et al performed knee OA classification, this work uses a 3D CNN model to assess a series of Magnetic Resonance Images (MRI) knee. The capacity to study the all series of 3D MRI as a one unit as opposed to a standard 2D CNN that analyses one image only at a time, is a benefit of employing 3D CNNs. The Kellgren and Lawrence (KL) severity scale was applied to each knee, with values ranging from 0 to 4. In addition to the 5-category KL class, we evaluated a 2-category classifying that separates non-OA (KL<=1) from OA (KL >=2) knees. They also analyzed traditional x-ray using 2D CNN models such as VGG16, ResNet50, and Dense Net, which were trained to classify x-ray into 5 KL categories and 2 categories (OA or Non-OA). They also carried out a comparison study between MRI and X-ray. The proposed 3D model with MR images outperformed a CNN model trained on X-ray only for the same patients in both the 5-category classification (54.0 % vs. 50.0 %) and the 2-category classification (83.0 % vs. 77.0 %). The results show that MRI when combined with a 3D CNN model, has a better chance of improving clinical diagnostic accuracy for knee OA than the currently employed X-ray approaches. [31]

In 2021 Simon Olsson et al wanted to see how effectively an AI could classify the severity of knee OA in this investigation. The dataset included 6103 x-rays from 2002 to 2016, which were manually classified using the KL grading scale and fed into a Res-Net CNN. For all KL grades, the CNN overall AUC was more than 0.87, except KL grade 2, which had an AUC of 0.8.[32]

In 2021 Yifan Wang et al described a deep learning-based highly automated technique for diagnosing osteoarthritis. Transfer learning from the object detection domain was effectively applied to the segmentation of the knee joint region. They used Yolo for object detection to extract ROI knee, then used ResNet50 CNN backbone to extract feature maps from cropped knee x-ray, the extracted feature maps were flattened and recomposed as a series, and they used a visual transformer to exploit correlations between different local regions for the final classification. The accuracy of the proposed method's outcome is 69.18 %.[33]

In 2021 Christos Kokkotis et al classified the KL scale prediction task in this study as a binary categorization of NON-KOA (KL<=1) and KOA (KL>=2). The suggested fuzzy ensemble feature selection approach combines the results of multiple fuzzy logic-based FS algorithms (filter, wrapper, and embedding). An elaborate experimental setup was used to assess the performance of the suggested technique, which included numerous competing (Feature Selection) FS algorithms and several well-known ML (Machine Learning) models. The top-performing model has a classification accuracy of 73.55 % (Random Forest classifier).[34]

In 2021 Rohit Kumar Jain et al described OsteoHRNet, a deep learning-based system that uses X-rays to automatically evaluate the severity of Knee OA in terms of KL score classification. To capture the multi-scale properties of knee X-rays, the suggested technique is based on one of the most current deep models, the High-Resolution Network (HRNet) used as a backbone in addition to Convolutional Block Attention Module (CBAM) to filter out any unproductive features and increase performance even further. The best multiclass accuracy of 71.74 % was attained by our suggested model. [35]

In 2021 Mohammed Bany Muhammad and Mohammed Yeasin created a three-module convolutional neural network (CNN) ensemble that is easy to understand. To find Knee joints, they first constructed a scale-invariant and aspect ratio protecting model. Second, they built an ensemble scoring method using "hyper-parameter optimized" CNN models with diversity to grade the seriousness of KOA using the KL scale. Third, they gave a visual explanation of the ensemble model's predictions. The average accuracy is 87 %.[36]

In 2021 D. R. Sarvamangala and Raghavendra V. Kulkarni introduced a method for automatically classifying and evaluating knee OA that uses MCBCNN "Multiscale Convolutional Blocks in a Convolutional Neural Network". Pre-trained CNNs (Convolutional Neural Networks) and multiscale convolutional filters are used to create the suggested model. MCBCNN was implemented using three pre-trained CNN models namely Mobile-Net2, Res-Net50, and Inception-Netv3. The three proposed models have been subjected to a thorough performance investigation. The results of the KOA scale provided by each of the three planned MCBCNNs were compared. The results reveal that MCBCNNs outperform pre-trained CNNs in terms of performance. The MCB Res-Net50 outperforms the other two MCBCNNs in average accuracy, with a score of above 95 %.[37]

In 2021 Alexey Mikhaylichenko and Yana Demyanenko evaluated densely connected convolutional networks and their application to the issue of assessing knee osteoarthritis seriousness on the KL scale, which has a five-point scale. To begin, they utilize a Single Shot Detector (SSD) that they trained model from scratch to locate knee joint locations in radiographs. The researchers then use Dense-Nets to assess OA score in the x-ray of identified knee joints. The accuracy of the categorization result is 71%.[38]

Table 2 contain the summary of the previous studied

Table2: Previous Studied

Author	Year	Data	Algorithms	Result
Aleksei et al.	2018	X-ray	Deep Siamese CNN	66.71% accuracy
RUOPING LI	2018	X-ray	CNN ResNet34 with fine tunes	63.5% accuracy
Abdulbasset Brahima	2018	X-ray	Naïve bayes and random forest classifier	82.98% accuracy
Ping Jun Chen et al.	2019	X-ray	CNN (VGG-16)	69.7% accuracy
Anil Kumar Chaudhary et al.	2019	MRI	Single Shot Detector(SSD) for the detect Knee joint and CNN for classification 2 classes	95.61% accuracy
Kevin A. Thomas	2019	X-ray	169-layer CNN with a Dense convolutional network	71% accuracy
Rima Tri Wahyuningrum et al.	2019	X-ray	CNN for feature extraction and Long Short-Term Memory (LSTM) for classification	75.28% accuracy
Marc Gorriz et al.	2019	X-ray	CNN	64.3% accuracy
Bin Liu et al.	2019	X-ray	Fast R-CNN	74.3% accuracy
Abdelbasset Brahim et al.	2019	X-ray	Logistic regression	78.92% accuracy
Bofei Zhang et al.	2020	X-ray	ResNet with Convolutional Block Attention Module (CBAM)	74.81% accuracy
Soon Bin Kwon et al.	2020	X-ray	Support Vector Machine (SVM)	75.2% accuracy
Christoph Von Tycowicz	2020	X-ray	Deep Neural Network CNN	64.64% accuracy
Sudeep Kondal et al.	2020	X-ray	CNN DenseNet-121	Class wise precision 0.55 & mean recall 0.57
Kamali C et al.	2020	X-ray	Support Vector Machine (SVM) & K-Nearest Neighbor (KNN) classifier	SVM – 73%accuracy KNN – 70.5% accuracy
Rima Tri Wahyuningrum et al.	2020	X-ray	Hyperparameters and fine-tuned to create Deep Convolutional Neural Network (DCNN)	77.24% accuracy
Albert Swiecicki et al.	2021	X-ray	CNN	71.90% accuracy
MD.Rezaul Karim et al.	2021	X-ray & MRI	CNN , DenseNet, VGG	91% accuracy
Carmine Guide et al.	2021	X-ray & MRI	2D CNN for X-ray 3D CNN for MRI	X-ray 50% & MRI 54% accuracy for 5 KL grading X-ray 77% & MRI 83% accuracy for Binary classification
Simon Olsson et al.	2021	X-ray	CNN ResNet	AUC more than 0.87
Yifan Wang et al.	2021	X-ray	Yolo for object detection & ResNet50 CNN	69.18% accuracy
Christos Kokkotis	2021	X-ray	Random Forest classifier	73.55% accuracy
Rohit Kumar Jain et al.	2021	X-ray	CNN- High Resolution (HRNet)	71.74% accuracy
Mohammed Bany and Mohammed Yeasin	2021	X-ray	Three module Convolutional Neural Network CNN	87% accuracy
D.R.Sarvamangala and Raghavendra V. Kulkarni	2021	X-ray	Multiscale Convolutional Block in Convolutional Neural Network (MCBCNN)	95% accuracy
Alexey Mikhaylichenko and Yana Demyanenko	2021	X-ray	Dense Nets	71% accuracy

5. Conclusion

various medical imaging methods used to detect and diagnose knee osteoarthritis have been thoroughly explored in this research. The automated detection of human illness recovery rates, as well as the classification of Osteoarthritis, are investigated.

When reviewing previous studies, it has been noticed that X-ray is used as a dataset because it is considered as a gold standard ,accessible , and cheap comparing with MRI because MRI scan high cost.

This paper has provided a serious assessment of osteoarthritis of the knee in clinical imaging with a focus on automatic detection and investigation strategies for human body disorders in which imaging methods are used for each data set. Enhancements in medical image classification procedures for future examination will improve accuracy and efficiency .It can also be used later for automatic diagnosis by computer.

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Competing Interests
The authors should declare that there are no competing interests.

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