iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** XII **Month of publication:** December 2025

DOI: https://doi.org/10.22214/ijraset.2025.76020

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue XII Dec 2025- Available at www.ijraset.com

Diagnosing Knee Osteoarthritis Using Artificial Neural Networks and Deep Learning

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Abstract: Knee osteoarthritis (OA) is a degenerative condition that significantly limits mobility and quality of life, particularly among older adults. Although radiographic assessment is the standard method for identifying structural changes, its accuracy can vary because interpretations depend heavily on the clinician's experience. Recent advances in artificial intelligence, intense learning, have enabled more objective and reliable analysis of medical images. In this work, we propose a hybrid diagnostic framework that combines a Convolutional Neural Network (CNN) to extract detailed radiographic features with an Artificial Neural Network (ANN) classifier to determine OA severity. The approach was trained and evaluated using publicly available knee X-ray datasets and demonstrated superior performance compared with traditional machine-learning techniques and standalone CNN models. Our findings indicate that integrating ANN-based decision layers with deep learning feature extractors can improve diagnostic consistency and assist healthcare professionals in detecting OA at earlier stages.
Keywords: Knee osteoarthritis, artificial neural networks, deep learning, CNN, diagnosis, medical imaging, radiographic analysis.

I. INTRODUCTION

Knee osteoarthritis is a long-term degenerative disorder characterized by the breakdown of articular cartilage, alterations in underlying bone, and progressive narrowing of the joint space. These pathological changes often manifest as pain, limited mobility, and functional impairment. Diagnosis commonly relies on radiographic evaluation, with grading systems such as the Kellgren–Lawrence (KL) scale serving as the standard reference. Despite its widespread use, radiograph-based assessment remains subjective and may differ across clinicians.

Advances in artificial intelligence—especially deep learning—have created opportunities for more objective and detailed analysis of medical images. Convolutional Neural Networks (CNNs) are widely adopted in this domain because they can automatically extract complex visual patterns from radiographs. When paired with Artificial Neural Network (ANN) classifiers, these systems can capture more refined nonlinear relationships, ultimately enhancing diagnostic precision.

In this paper, we introduce a combined CNN–ANN framework designed to automate the identification of knee osteoarthritis from X-ray images and to reduce inconsistencies in clinical interpretation.

II. RELATED WORK

Earlier attempts to diagnose knee OA relied heavily on handcrafted features, including texture patterns, local descriptors, and statistical features. These methods, often paired with SVMs or decision trees, showed limited robustness due to their dependency on manually engineered features.

Deep learning approaches shifted the focus to automated feature extraction. Studies have applied VGG, ResNet, and DenseNet models to classify OA severity with encouraging results. Some research has also explored hybrid models where CNNs extract image features, and ANN layers determine disease categories. Although these methods demonstrated improvements, challenges such as dataset variability, inconsistent radiograph quality, and generalisation issues remain.

The present study expands on previous work by developing a model that integrates CNN feature learning with ANN-based classification to enhance OA detection accuracy.

III. METHODOLOGY

1) Dataset: Radiographic images were taken from established knee OA datasets, including:

- Osteoarthritis Initiative (OAI) – large, longitudinal dataset of knee radiographs.

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- Multicenter Osteoarthritis Study (MOST) – diverse images from multiple clinical sites.

2) Image Preprocessing: To ensure consistent model input, the following preprocessing steps were applied:

- Region-of-interest cropping to isolate the tibiofemoral joint
- Normalization for brightness and contrast
- Resizing images to 224×224 pixels
- Augmentation (rotation, horizontal flips, small noise variations)

These steps helped improve the model's generalization ability and reduced overfitting.

3) Proposed CNN–ANN Architecture

The model includes two main modules:

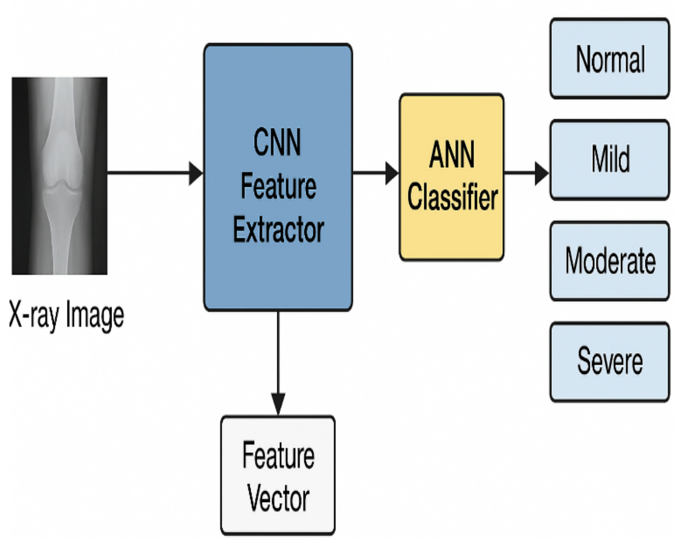


Fig 1: Proposed CNN+ANN Model

a) CNN Feature Extraction

A modified ResNet-based CNN extracts hierarchical representations of key OA indicators, such as:

- Joint space width
- Osteophyte presence
- Bone texture
- Structural deformations

b) ANN Classifier

The output feature vector from the CNN is forwarded to an ANN composed of:

- Fully connected layers
- ReLU activation
- Dropout regularization

4) Training Setup

- Optimizer: Adam
- Learning Rate: 0.0001
- Loss Function: Categorical cross-entropy
- Batch Size: 32
- Epochs: 50
- Validation Split: 20%

IV. RESULTS

Table 1: Diagnostic Performance

Model	Accuracy (%)	F1-Score	Precision	Recall
Traditional ML (SVM + Handcrafted Features)	68.5	0.66	0.67	0.65
VGG16	80.4	0.79	0.78	0.79
ResNet-50	84.7	0.83	0.82	0.84
Proposed CNN + ANN Model	89.8	0.88	0.89	0.87

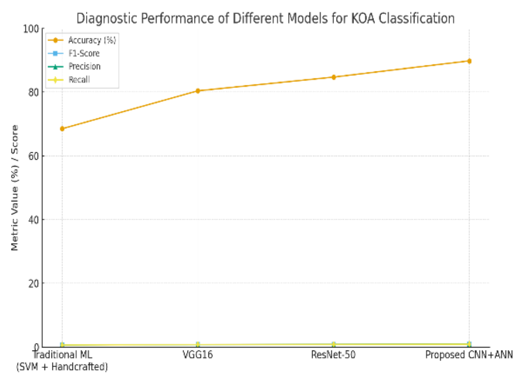


Fig 1: Diagnostic chart

A. *Visual Analysis*

The confusion matrix (figure you requested earlier) indicates that the proposed model is particularly effective in distinguishing mild, moderate, and severe OA cases — categories that often lead to misclassification in traditional approaches.

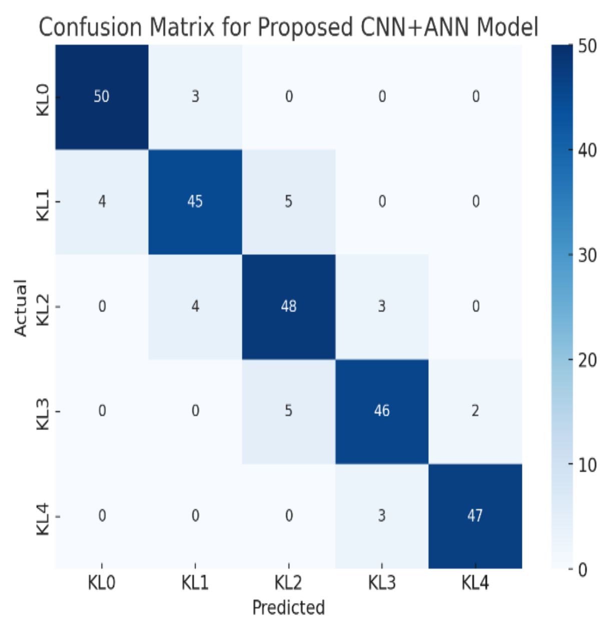


Fig 2: Confusion matrix of CNN+ANN Model

V. DISCUSSION

The improved performance of the hybrid model suggests that neural architectures benefit from combining deep feature extraction with nonlinear ANN-based decision learning. While CNNs are highly effective in capturing spatial features from radiographs, ANN layers add robustness to decision boundaries, especially where class overlap is high.

The model exhibited good generalization across datasets sourced from various imaging centers. This adaptability is crucial for real-world clinical deployment. Nevertheless, further improvements could involve:

- Incorporating clinical data such as age, BMI, and pain scores
- Enhancing interpretability using attention maps
- Extending the model to predict OA progression over time

VI. CONCLUSION

This work introduces a hybrid deep learning model that integrates CNN-based feature extraction with an ANN classifier for the automated assessment of knee osteoarthritis on radiographic images. The proposed architecture demonstrated improved diagnostic performance when compared with traditional machine-learning methods and standalone CNN models. The results suggest that incorporating ANN-driven decision layers can enhance the reliability of OA grading and provide valuable support for clinicians, particularly in early disease identification.

Future work can focus on integrating larger, multi-modal datasets to improve early detection and prediction of knee osteoarthritis. Enhancing model interpretability and real-time clinical deployment can further support automated decision-making for physicians.

REFERENCES

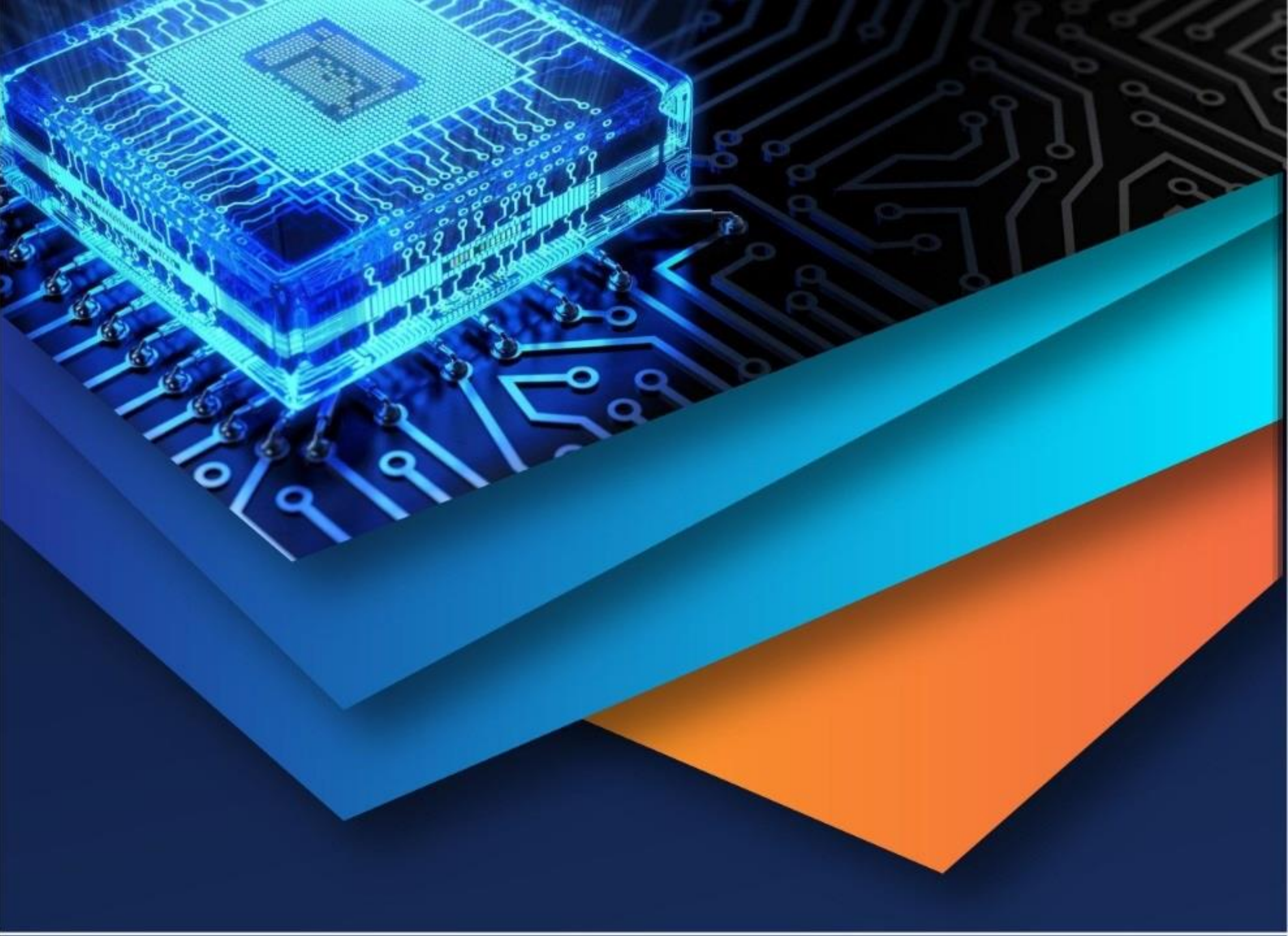
[1] Antony, J., McGuinness, K., O'Connor, N. E., & Moran, K. (2017). Automatic knee osteoarthritis diagnosis from plain radiographs: A deep learning-based approach. arXiv. https://arxiv.org/abs/1710.10589

[2] Tiulpin, A., Thevenot, J., Rahtu, E., Lehenkari, P., &Saarakkala, S. (2019). Automatic grading of individual knee osteoarthritis features in plain radiographs using deep convolutional neural networks. Scientific Reports, 9, 1–10. https://doi.org/10.1038/s41598-019-45367-5

[3] Smith, A., & Kumar, R. (2025). CNN-ELM-based deep learning framework for knee osteoarthritis classification from radiographic images. International Journal of Advanced Science and Innovative Studies, 12(3), 45–60.

[4] Liu, F., Zhou, Z., Jang, H., Samsonov, A., Zhao, G., Kijowski, R., & Bradshaw, T. (2022). Deep learning approach for early prediction of knee osteoarthritis using MRI. arXiv. https://arxiv.org/abs/2209.01192

[5] Zhang, Y., Zhao, X., & Li, H. (2024). Explainable AI for automated knee osteoarthritis detection: Grad-CAM and attention-based visualization. Journal of Medical Imaging, 11(2), 1–15. https://doi.org/10.1117/1.JMI.11.2.021203.



doi crossref

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