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**A Comparative Study of Deep Learning Models for the Classification of Knee Osteoarthritis in X-Ray Images**
(2024) *Proceedings of the 9th International Conference on Mechatronics Engineering, ICOM 2024*, pp. 228-233.

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**Abstract**
Knee osteoarthritis (OA) is a prevalent degenerative j oint disease that causes significant pain and disability. Early and accurate diagnosis is crucial for effective management, traditionally relying on manual assessment of X-ray images by medical experts. This manual approach can be time-consuming and subject to variability. Recent advancements in deep learning offer promising automated solutions for knee OA diagnosis from X-ray images. This study evaluates and compares the performance of three state-of-the-art deep learning models - Convolutional Neural Network (CNN), ResNet-50, and DenseNet-121 - for the classification of knee osteoarthritis using X-ray images. A comprehensive dataset of 10,930 knee X-ray images, labeled as normal or osteoarthritis, was utilized for training and testing the models. Rigorous hyperparameter tuning and optimization were performed to achieve optimal performance. The results demonstrate that the CNN model consistently outperformed the ResNet-50 and DenseNet-121 models across various evaluation metrics, including overall accuracy (97.01%), precision (95.94%), recall (98.97%), specificity (95.85%), and F1 score (96.98%). The CNN model exhibited superior capability in distinguishing between normal and osteoarthritis knees, attributed to its ability to effectively learn hierarchical features and its relatively simpler architecture. © 2024 IEEE.

**Author Keywords**
Convolution Neural Network (CNN);  deep learning;  DenseNet-121;  knee osteoarthritis;  ResNet-50

**Index Keywords**
Arthroplasty, Deep neural networks, Diagnosis; Comparatives studies, Convolution neural network, Deep learning, Densenet-121, Knee osteoarthritis, Learning models, Neural network model, Resnet-50, X-ray image; Joints (anatomy)

**References**
- *Knee Arthritis*,
  Johns Hopkins Medicine. (n.d.),

- Li, X., Zhang, L., Yang, J., Teng, F.
  **Role of artificial intelligence in medical image analysis: A review of current trends and future directions**
  (2024) *Journal of Medical and Biological Engineering*, 44, pp. 231-243.

- Panda, S., Parida, S.K., Khatri, R., Kaur, R.
  **Deep Learning for Medical Image Analysis**
  *Communication and Intelligent Systems. ICCIS 2023. Lecture Notes in Networks and Systems*, 969.
  In: H. Sharma, V. Shrivastava, A. K. Tripathi, L. Wang (eds), Springer, Singapore

- Asnaoui, K.E., Chawki, Y.
  **Using X-ray images and deep learning for automated detection of coronavirus disease**
  (2020) *Journal of Biomolecular Structure and Dynamics*, 39 (10), pp. 3615-3626.

- Guida, C., Zhang, M., Shan, J.
  **Knee osteoarthritis classification using 3D CNN and MRI**
  (2021) *Applied Sciences*, 11 (11), p. 5196.

- Antony, J., McGuinness, K., Moran, K., O'Connor, N.E.
  **Automatic detection of knee joints and quantification of knee osteoarthritis severity using convolutional neural networks**
  (2017) *Machine Learning and Data Mining in Pattern Recognition, Lecture Notes in Computer Science*, pp. 376-390.
  10358

- Sikkandar, M.Y., Begum, S.S., Alkathiry, A.A., Alotaibi, M.S.N., Manzar, M.D.
  **Automatic detection and classification of human knee osteoarthritis using convolutional neural networks**
  (2022) *Computers, Materials & Continua*, 70 (3), pp. 4279-4291.

- Wang, Y., Li, S., Zhao, B., Zhang, J., Yang, Y., Li, B.
  **A Resnetbased approach for accurate radiographic diagnosis of knee osteoarthritis**
  (2022) *CAAI Transactions on Intelligence Technology*, 7 (3), pp. 512-521.

- Abedin, J., Antony, J., McGuinness, K., Moran, K., O'Connor, N.E., Rebholz-Schuhmann, D., Newell, J.
  **Predicting knee osteoarthritis severity: Comparative modeling based on patient's data and plain Xray images**
  (2019) *Scientific Reports*, 9 (1).

- Srinivasan, S., Gunasekaran, S., Mathivanan, S.K., Jayagopal, P., Khan, M.A., Alasiry, A., Marzougui, M., Masood, A.
  **A framework of faster CRNN and VGG16-enhanced region proposal network for detection and grade classification of knee RA**
  (2023) *Diagnostics*, 13 (8), p. 1385.

- Cueva, J.H., Castillo, D., Espinòs-Moratò, H., Duràn, D., Dìaz, P., Lakshminarayanan, V.
  **Detection and classification of knee osteoarthritis**
  (2022) *Diagnostics*, 12 (10), p. 2362.

- Wang, Y., Li, S., Zhao, B., Zhang, J., Yang, Y., Li, B.
  **A Resnetbased approach for accurate radiographic diagnosis of knee osteoarthritis**
  (2020) *CAAI Transactions on Intelligence Technology*, 7 (3), pp. 512-521.

- Huang, G., Liu, Z., Maaten, L.V.D., Weinberger, K.Q.
  **Densely connected Convolutional Networks**
  (2017) *IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*,

- Song, H., Zhao, B., Hu, J., Sun, H., Zhou, Z.
  **Research on improved DenseNets pig cough sound recognition model based on SENets**
  (2022) *Electronics*, 11 (21), p. 3562.

- Tian, Y., Li, E., Liang, Z., Tan, M., He, X.
  **Diagnosis of typical apple diseases: A deep learning method based on multi-scale dense classification network**
  (2021) *Frontiers in Plant Science*, 12, p. 698474.

- Tao, Z., Bingqiang, H., Huiling, L., Zaoli, Y., Hongbin, S.
  **NSCRbased DenseNet for lung tumor recognition using chest CT image**
  (2020) *BioMed Research International*, pp. 1-9.

- Shetty, R., Prasad, S.N., Manjunatha, D.V., Veeraprathap, V., Shahapur, V., Shwetha, M.S.
  **Intermediate learning-based attention regulated densenet for diagnosis of covid-19**
  (2023) *Indian Journal Of Science And Technology*, 16 (6), pp. 427-434.

- Urinbayev, K., Orazbek, Y., Nurambek, Y., Mirzakhmetov, A., Varol, H.A.
  **End-to-end deep diagnosis of X-ray images**

(2020) *42nd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC)*,

- Mahbod, A., Schaefer, G., Wang, C., Ecker, R., Dorffner, G., Ellinger, I.
**Investigating and exploiting image resolution for transfer learning-based skin lesion classification**
(2020) *25th International Conference on Pattern Recognition*,

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