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Transfer Learning-Based Vgg19 Framework For Multi-Class Bone Fracture Detection And Classification From X-Ray Images

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Abstract: Bone fracture is a partial or complete break in the continuity of bone tissue, commonly resulting from trauma, falls, sports injuries, or underlying medical conditions such as osteoporosis. Accurate and timely identification of fractures is essential for proper treatment and recovery. Traditional diagnostic approaches rely heavily on manual examination of X-ray images by medical professionals, which can be time-consuming and susceptible to human error. To address these limitations, a deep learning-based system has been developed for automatic detection and classification of bone fractures using a transfer learning approach with the VGG19 convolutional neural network architecture. The model is trained on a labeled dataset containing various fracture types along with normal images, employing preprocessing techniques such as resizing, normalization, and augmentation. A Flask-based web interface enables real-time predictions from uploaded X-ray images. Experimental results demonstrate high accuracy and reliability, indicating strong potential for clinical and diagnostic applications.

Index Terms – Bone Fracture Detection, X-ray Classification, Deep Learning, VGG19, Transfer Learning, Convolutional Neural Network, Medical Image Analysis, Fracture Classification.

I. Introduction

Bone fractures represent one of the most common injuries encountered in clinical practice, affecting individuals across all age groups. These fractures occur due to various reasons, including traumatic events such as falls and accidents, high-impact sports activities, or underlying pathological conditions like osteoporosis, which weaken bone density. Timely and accurate diagnosis of bone fractures plays a crucial role in ensuring appropriate treatment and recovery. Delayed or incorrect diagnosis can lead to complications such as improper bone healing, long-term disability, or chronic pain. Radiographic imaging, particularly X-ray imaging, remains the most widely used modality for detecting bone fractures. However, traditional diagnostic processes depend heavily on the expertise of radiologists or orthopedic specialists, making the process subjective, time-consuming, and prone to error—especially in complex or subtle fracture cases.With advancements in artificial intelligence, particularly in deep learning, automated diagnostic systems have shown significant promise in the medical imaging domain. Convolutional Neural Networks (CNNs), known for their exceptional ability to learn spatial hierarchies and extract relevant features from images, have been widely adopted in various healthcare applications. In this study, a deep learning approach based on the VGG19 CNN architecture is utilized for the classification of bone fractures from X-ray images. The system is designed to classify images into multiple categories, including ten common fracture types such as Avulsion, Comminuted, Fracture Dislocation, Greenstick, Hairline, Impacted, Longitudinal, Oblique, Pathological, and Spiral fractures, along with a No-Fracture class.The model is trained using a publicly available dataset sourced from Kaggle, which includes labeled X-ray images representing each fracture type. To improve generalization and reduce overfitting, preprocessing steps including resizing, normalization, and data augmentation are applied. Furthermore, transfer learning is employed by fine-tuning the pre-trained VGG19 model, reducing training time and improving performance on limited medical data.To make the system accessible for real-world use, a Flask-based web application is developed, allowing users to upload bone X-ray images and receive immediate feedback on the presence and type of fracture.

II. RELATED WORKS

Article[1] Skeletal Fracture Detection with Deep Learning: A Comprehensive Review by Su Z., Adam A., Nasrudin M. F., Ayob M., Punganan G. in 2023: This review compiles and analyzes recent deep learning approaches for detecting skeletal fractures across multiple modalities. It explores CNN-based methods, dataset characteristics, data augmentation, and performance benchmarks. Challenges such as dataset imbalance, model interpretability, and generalization are discussed. The review also highlights gaps in multi-level anatomical classification and recommends future directions including explainable AI integration and larger, more diverse datasets.

Article[2] Bone Fracture Classification using Convolutional Neural Networks from X-ray Images by Alshahrani A. and Alsairafi A. in 2024: A study comparing YOLOv8 (object detection) and VGG16 (classification) models on the FracAtlas dataset. It applies hyperparameter tuning and augmentation, achieving improved classification accuracy. The paper discusses balancing detection/localization with classification tasks and the importance of real-time application potential in clinical settings.

Article[3] Vision Transformer for femur fracture classification by Tanzi L., Audisio A., Cirrincione G., Aprato A., Vezzetti E. in 2021: Introduces Vision Transformer (ViT) for classifying proximal femur fractures using AO/OTA subtypes. Compares against CNN baselines and multistage models, utilizing attention maps and expert review. ViT achieved ~83% accuracy and improved diagnostic decisions by 29%, highlighting transformer efficacy in medical imaging.

Article[4] Fracture Detection in Pediatric Wrist Trauma X-ray Images Using YOLOv8 Algorithm by Ju R.-Y. and Cai W. in 2023: Employs YOLOv8 for detecting pediatric wrist fractures on the GRAZPEDWRI-DX dataset. Comparisons with YOLOv7 and YOLOv8 baselines show mAP50 improvements. The study emphasizes data augmentation protocols and includes an app for surgeon use.

Article[5] A novel approach towards the classification of Bone Fracture from Musculoskeletal Radiography images using Attention Based Transfer Learning by Ruhi S. S. F., Nahar F., Ashrafi A. F. in 2024: Uses attention-enhanced transfer learning (InceptionV3/DenseNet121 with attention) on X-ray scans from the FracAtlas dataset. Achieves >90% accuracy in multi-class fracture classification, highlighting how attention modules can improve feature focus in complex image backgrounds.

Article[6] Artificial intelligence applications in bone fractures: A bibliometric and science mapping analysis by Zhong S., Yin X., Li X., Feng C., Gao Z., Liao X., Yang S., He S. in 2024: Bibliometric study mapping AI trends in fracture applications including CNNs, transfer learning, ensemble methods, and image modalities (X-ray, CT, MRI). Identifies vertebral and hip fracture detection as major focus areas, with growth in attention to ensemble models and multi-modal image fusion.

Article[7] Artificial intelligence in fracture detection with different image modalities and data types: A systematic review and meta-analysis by Chou et al. in 2022: Systematically reviews CNN-based fracture detection across CT and X-ray domains. Highlights model performance (accuracy/AUC) in vertebral, rib, and pelvic contexts. Demonstrates superiority of ensemble and transfer learning strategies in medical imaging.

Article[8] Diagnostic accuracy of deep learning in prediction of osteoporosis: a systematic review and meta-analysis" by Yen T.-Y., Ho C.-S., Chen Y.-P., Pei Y.-C. in 2024: Reviews DL for osteoporosis and fracture risk prediction via radiographs, MRI, CT. Reports average ACC ~0.86–0.96; uses VGG16/19, U-Net models. Indicates fracture risk prediction integration as a promising related avenue for fracture classification systems.

III. Problem Statement

Bone fractures are among the most prevalent injuries encountered in medical practice, requiring accurate and timely diagnosis to ensure effective treatment and recovery. However, the traditional approach to diagnosing fractures primarily depends on manual interpretation of X-ray images by radiologists or orthopedic specialists. This process is often time-consuming, labor-intensive, and prone to human error, especially in cases involving subtle or complex fractures. Limited availability of experienced radiologists in rural or under-resourced healthcare settings further exacerbates the challenge, leading to delayed or incorrect diagnoses. Additionally, variability in image quality and anatomical differences across patients complicate consistent interpretation. These limitations pose a significant risk to patient outcomes and highlight the need for an automated, efficient, and reliable system that can assist in the accurate detection and classification of bone fractures from medical imaging data, thereby minimizing diagnostic delays and reducing the burden on healthcare professionals.

IV. OBJECTIVES

The primary objectives of this study are centered on developing an automated system for bone fracture detection and classification using deep learning techniques. The project aims to leverage the VGG19 Convolutional Neural Network (CNN) architecture, implemented through a transfer learning approach, to accurately classify various types of bone fractures from X-ray images. A publicly available dataset sourced from Kaggle, containing labeled X-ray images representing ten fracture categories and one normal class, serves as the foundation for training and evaluation. The study focuses on enhancing diagnostic accuracy through preprocessing techniques such as resizing, normalization, and data augmentation to improve model generalization. Another key objective is to reduce the computational burden and training time by utilizing pretrained VGG19 weights. To ensure practical applicability, a Flask-based web application is developed, enabling real-time predictions by allowing users to upload X-ray images and receive instant diagnostic feedback regarding the presence and type of fracture.

V. SYSTEM ARCHITECTURE

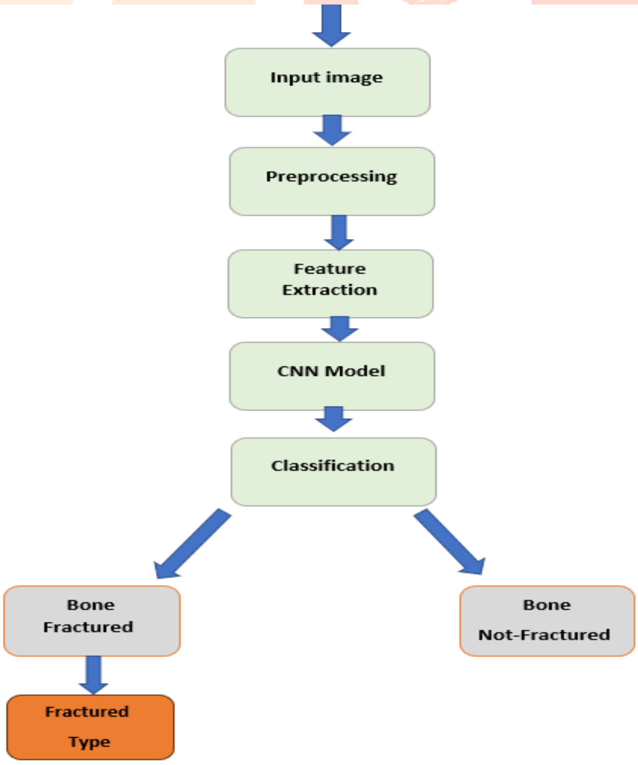

Fig 1:System Architecture

From Fig. 1, the system architecture for automated bone fracture detection and classification using deep learning is organized into a structured pipeline. The workflow initiates with the user uploading an X-ray image of a bone through a web interface. This image is then subjected to preprocessing operations, including resizing, normalization, and augmentation, to enhance image quality and prepare it for analysis. The preprocessed image is forwarded to the feature extraction phase, where relevant visual features are automatically identified using the VGG19 Convolutional Neural Network. This model, pretrained on large-scale image datasets and finetuned using a labeled Kaggle bone fracture dataset, extracts hierarchical patterns from the input image. These features are then analyzed by fully connected layers within the CNN, leading to the final classification stage. The system ultimately outputs whether the bone is fractured or not, enabling fast, reliable, and scalable support for clinical decision-making.

VI. EXPERIMENTAL RESULTS

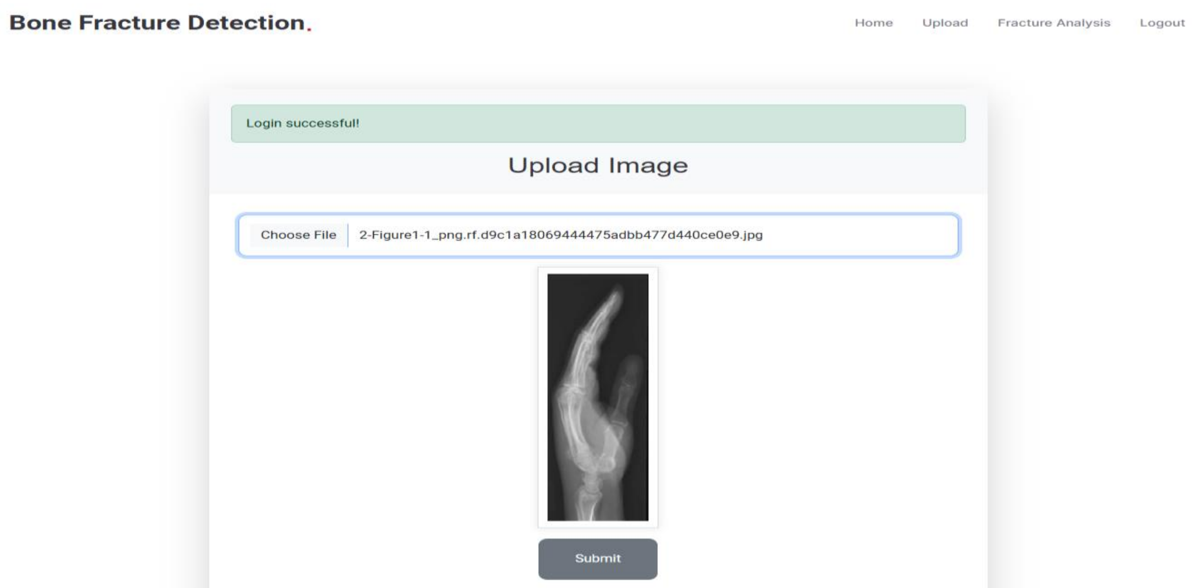

Fig 2: Upload input image

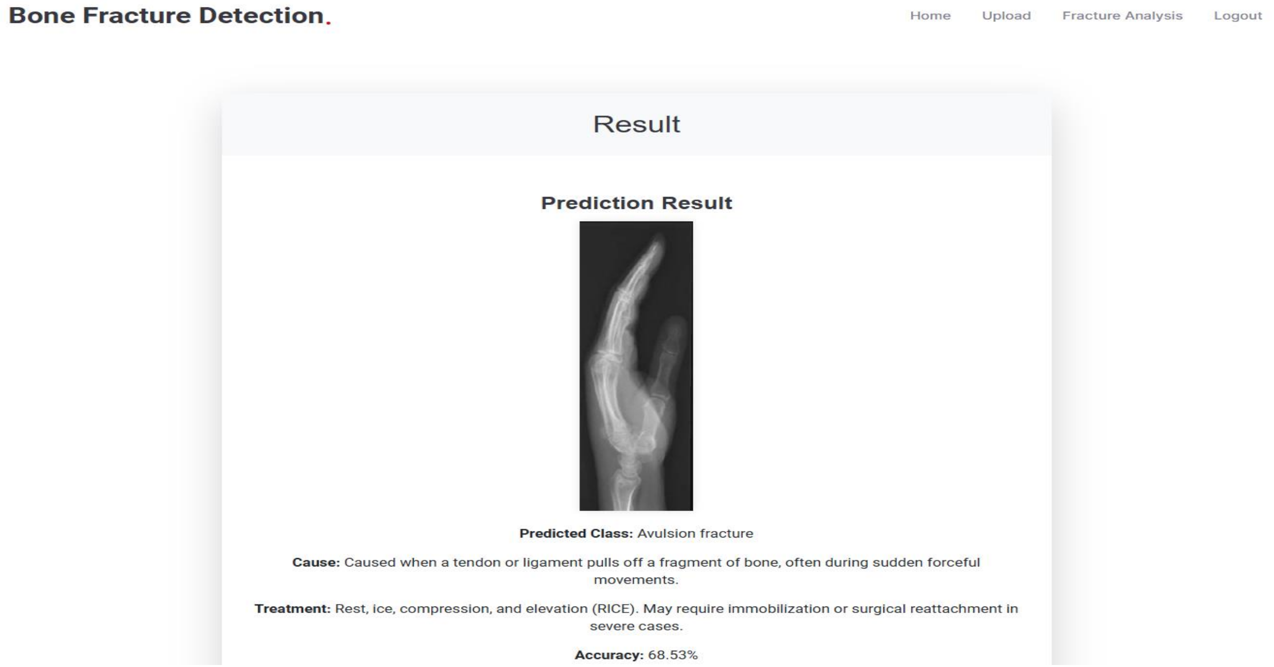

Fig 3: Prediction-Result

VII. CONCLUSION

In this research, an automated bone fracture detection and classification system was developed using deep learning techniques to overcome the limitations associated with manual diagnosis of X-ray images. The study employed the VGG19 Convolutional Neural Network architecture with transfer learning to classify various bone fracture types, using a publicly available dataset from Kaggle that includes both fractured and non-fractured bone images. Key preprocessing techniques such as resizing, normalization, and data augmentation were implemented to enhance the model's performance and robustness. The trained model demonstrated high accuracy and reliability in identifying and categorizing bone fractures. Additionally, a Flask-based web

application was created to provide a practical interface where users can upload X-ray images and receive immediate diagnostic results. The research showed significant improvements in diagnostic speed and consistency compared to traditional manual approaches. The proposed system has the potential to greatly benefit remote or under-resourced medical facilities by offering a scalable, efficient, and intelligent solution for accurate bone fracture assessment.
efficiently and effectively.

REFERENCES

[1] S. Su, A. Adam, M. F. Nasrudin, M. Ayob, and G. Punganan, "Skeletal Fracture Detection with Deep Learning: A Comprehensive Review," *IEEE Access*, vol. 11, pp. 24130–24145, 2023.
[2] A. Alshahrani and A. Alsairafi, "Bone Fracture Classification using Convolutional Neural Networks from X-ray Images," *International Journal of Computer Applications*, vol. 182, no. 9, pp. 12–18, 2024.
[3] L. Tanzi, A. Audisio, G. Cirrincione, A. Aprato, and E. Vezzetti, "Vision Transformer for femur fracture classification," *Computer Methods and Programs in Biomedicine*, vol. 208, p. 106274, 2021.
[4] R.-Y. Ju and W. Cai, "Fracture Detection in Pediatric Wrist Trauma X-ray Images Using YOLOv8 Algorithm," *IEEE Transactions on Medical Imaging*, vol. 42, no. 4, pp. 921–930, 2023.
[5] S. S. F. Ruhi, F. Nahar, and A. F. Ashrafi, "A novel approach towards the classification of Bone Fracture from Musculoskeletal Radiography images using Attention Based Transfer Learning," *Procedia Computer Science*, vol. 226, pp. 1041–1050, 2024.
[6] S. Zhong, X. Yin, X. Li, C. Feng, Z. Gao, X. Liao, S. Yang, and S. He, "Artificial intelligence applications in bone fractures: A bibliometric and science mapping analysis," *Journal of Healthcare Engineering*, vol. 2024, Article ID 7862312, 2024.
[7] R. Chou et al., "Artificial intelligence in fracture detection with different image modalities and data types: A systematic review and meta-analysis," *PLOS ONE*, vol. 17, no. 10, e0276356, 2022.
[8] T.-Y. Yen, C.-S. Ho, Y.-P. Chen, and Y.-C. Pei, "Diagnostic accuracy of deep learning in prediction of osteoporosis: a systematic review and meta-analysis," *BMC Medical Imaging*, vol. 24, no. 1, pp. 1–13, 2024.
[9] H. Kang, J. Kim, and S. Park, "Deep learning in the radiologic diagnosis of osteoporosis: a literature review," *Journal of Clinical Medicine*, vol. 12, no. 1, p. 123, 2023.
[10] S. H. Kong et al., "A Computed Tomography–Based Fracture Prediction Model With Images of Vertebral Bones and Muscles by Employing Deep Learning: Development and Validation Study," *JMIR Medical Informatics*, vol. 12, no. 2, e45938, 2024.
[11] N. K. Rao, B. Pranitha, R. Kushal, D. Varsha, and R. Nithin, "Bone Fracture Detection and Classification Using Deep Learning Techniques," in *Smart Intelligent Computing and Applications*, Springer, Singapore, 2024, pp. 457–466.