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YOLOv8-Assisted Bone Fracture Detection Assessment from X-ray Images

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Abstract:

Bone fracture are among the most common orthopedic injuries and pose a significant healthcare challenge due to their impact on patient mobility,quality of life,and recovery. Accurate and timely detection of fractures from radiography X-ray images is essential for effective diagnosis,treatment planning,and prevention of complications.However,many existing deep learning approaches focus primarily on image-level classification using conventional convolution neural networks (CNNS) and lack precise localization of fracture regions,which is critical for clinical interpretation.Moreover only a limited number of studies have explored unified object detection models capable of simultaneously localizing and identifying fractures within a single framework.To address these limitations,this study proposes a YOLOV8-based deep learning framework for automated bone fracture detection using publicly available radiographic X-ray datasets.The dataset was annotated using Label Studio by marking fracture regions with bounding boxes to enable accurate object detection.The proposed model was trained with GPU acceleration to improve computational efficiency and support real-time inference.Performance was evaluated using standard metrics including precision,Recall,F1-Score,Accuracy and Mean Average Precision (mAP).Experimental results showed that the proposed YOLOV8 model achieved an overall detection accuracy of 72.3% demonstrating its capability for reliable fracture localization and automated detection.The developed system can be integrated into clinical decision support systems,radiology departments,hospitals,emergency care units,diagnostic imaging centres,and telemedicine platforms to support rapid fracture screening.it can also assist radiologists,orthropedic surgeons,emergency physicians,and healthcare professionals by providing an automated second opinion,reducing diagnostic time ,minimizing human error,improving clinical decision-making and ultimately enhancing patient care and treatment outcomes.

Keywords—Bone Fracture Detection, YOLOV8, Deep Learning, X-ray Image Analysis, Medical Image Processing, Object Detection, Fracture Localization, Clinical Decision Supports System.

I. INTRODUCTION

Bone fractures are among the most common musculoskeletal injuries worldwide, affecting millions of people each year due to road traffic accidents, falls, sports injuries, workplace hazards, and age-related conditions such as osteoporosis. Accurate and timely fracture diagnosis is essential because delayed or missed detection can result in improper treatment, prolonged recovery, permanent disability, and increased healthcare costs. In modern clinical practice, fracture diagnosis primarily depends on the visual interpretation of X-ray images by radiologists and orthopedic specialists. Although this approach has been widely adopted, it is often challenged by subtle fracture patterns, poor image quality, overlapping anatomical structures, and the increasing workload of medical professionals. These factors may lead to diagnostic variability and occasional missed fractures, particularly in emergency settings where repaid decision-making is critical. Consequently, the integration of Artificial Intelligence (AI) and deep learning into medical imaging has emerged as a promising solution for improving diagnostic accuracy and reducing the burden on healthcare professionals. Recent advances in computer vision have enabled automated analysis of radiographic images, allowing intelligent systems are increasingly being explored to support clinical decision-making and enhance patient care.

Among the various deep learning techniques, the You Only Look Once (YOLO) object detection framework has gained significant attention become of its ability to perform object localization and classification simultaneously in real time. Compared with conventional multi-stage detection methods, YOLO offers an excellent balance between detection accuracy and computational efficiency, making it highly suitable for medical image analysis. Recent studies have demonstrated the effectiveness of YOLO-based models in detecting fracture from X-ray images; however, several challenges remain, including limited dataset diversity, variations in fracture appearance, annotation quality, and model generalization across different clinical environments. Addressing these limitations is essential for developing reliable computer-aided diagnostic systems that can be efficiently integrated into healthcare practice. Motivated by these challenges, this study presents a YOLO-based bone fracture detection approach for identifying fracture regions in X-ray images with improved efficiency and reliability. The proposed system aims to assist healthcare professionals by providing rapid and accurate fracture localization while supporting timely clinical decision-making. By combining advances in deep learning with medical image analysis, this work contributes to the ongoing development of intelligent diagnostic technologies that have the potential to improve patient outcomes and strengthen the future of AI-assisted orthopedic healthcare.

The main contributions made by this study are outlined below:

- Uses YOLOv8 for automated bone fracture detection.
- Uses X-ray images for identifying fracture regions.
- Supports seven fracture related classes in the project dataset.
- Uses bounding – box annotations for object detection.
- Uses GPU acceleration to reduce training time.
- Evaluates the model using Precision,Recall,F1-score,mAP@0.5 and mAP@0.5:0.95.

II. RELATED WORKS

Table 1. Comparative summary of existing approaches for bone fracture detection

Author	Method	Accuracy	Limitations
Ju & Cai [1]	YOLOv8+ Data Augmentation	mAP@0.5:63.8%	Mainly focused on pediatric wrist fractures
Chein et al. [2]	YOLOv8-AM+Attention	mAP@0.5:65.8%	Mainly evaluated on pediatric wrist X-rays
Ju et al. [3]	YOLOv8+ Global Context	mAP@0.5:66.32%	Focused on a specific wrist-fracture dataset
Ju et al. [4]	FCE-YOLOv8	mAP@0.5:67.07%	Additional modules increase model complexity
Agarwal & Kumar [5]	YOLOv8	High detection performance reported	Dataset and evaluation scope are limited
Vidhya Shree [6]	YOLOv8	YOLOv8-based fracture detection	Focused on X-ray fracture detection with limited scope
Srinivasu et al. [7]	YOLOv10	Improved fracture detection	Uses YOLOv10 rather than YOLOv8
Chen et al. [8]	Deep learning + X-ray	Automated fracture detection	Different detection framework from YOLO
Zhang et al. [9]	Deep learning + Window loss	Bone fracture localization	Point-based annotation approach
Ashwin & Nasreen Taj [10]	YOLOv8 + ResNet50	Comparative deep learning approach	Review/comparative study rather than the same implementation

Based on these existing approaches, there is a need for systems that can detect multiple types of fractures, rather than concentrating only on one anatomical region such as the wrist. The proposed work therefore applies YOLOv8 to a multi-class bone-fracture dataset containing seven fracture-related categories.

III. PROPOSED WORK

The proposed system uses YOLOv8 to automatically detect and classify bone fractures from X-ray images.

The overall workflow is:

Data Collection → Fractured X-ray images → Data Pre-Processing → Annotation (Label Studio) → Model Training (YOLOv8 Model) → Model Output (Detection + Classification) → Evaluation (Precision, Recall, F1-score, mAP@0.5)

The uploaded reference paper similarly uses a workflow in which images are collected, annotated, used for YOLOv8 training, and finally evaluated for detection and classification.

III.A. DATA COLLECTION

The project dataset contains approximately 8,000 X-ray images.

The dataset contains seven classes:

Class No.	Class Name
0	Elbow Positive
1	Fingers Positive
2	Forearm Fracture
3	Humerus Fracture
4	Humerus
5	Shoulder Fracture
6	Wrist Fracture

The images are divided into training and validation sets according to the dataset configuration.

III.B. DATA PRE-PROCESSING

Before training the YOLOv8 model, the X-ray images are prepared in a suitable format.

1. Collection of X-ray images.
2. Removal or execution of unsuitable images.
3. Conversion/preparation into YOLO-compatible format.
4. Images resizing to 640 x 640 pixels.
5. Preparation of corresponding labels files.
6. Organization into training and validation folders.

Image resizing can be represented as: I resised = Resizing(I,640,640)

The reference paper also uses 640 x 640 input images for YOLOv8 training.

III.C. DATA ANNOTATION

Each fracture region is represented using a bounding box.

A bounding box can be represented as: $B_i = (x_i, y_i, w_i, h_i)$

where,

xi = x-coordinate

yi = y-coordinate

wi = width

hi = height

Each bounding box is associated with one of the seven fracture classes. This allows YOLOV8 to learn both where the fracture is located and which fracture category it belongs to.

III.D. YOLOV8 MODEL ARCHITECTURE

YOLOv8 is a single-stage object-detection model. Its major components can be described as:

1. Back bone — Extracts important visual features from x-ray images.

2. Neck — Combines features at different scales so that the model can detect both relatively large and small fracture regions.

3. Detection Head — Predicts bounding-box coordinates, confidence score, and class probabilities.

The reference paper similarly describes YOLOv8 in terms of Backbone, Neck and Detection Head, with an anchor-free detection approach.

III.E. MODEL TRAINING

For this project the YOLOv8m pretrained model is used.

Parameter	Value
Model	YOLOv8m
Image size	640 × 640
Epochs	120
Batch size	8
Device	NVIDIA T4 GPU
Number of classes	7
Dataset	Bone fracture X-ray dataset

The model learns from the training images and corresponding bounding-box labels. During training, the model gradually improves its ability to recognize fracture patterns.

IV. MODEL EVALUATION

The trained model is evaluated using standard object-detection metrics.

Precision

Precision measures how many predicted detections are actually correct

Precision = TP / (TP + FP)

Recall

Recall measures how much actual fracture instances are successfully detected.

Recall = TP / (TP + FN)

F1-Score

*F1 = 2*PRECz*

mAP@0.5

mAP@0.5 represents mean Average Precision when the IoU threshold is 0.5.

mAP@0.5:0.95

This provides a stricter overall evaluation across multiple IoU thresholds.

The reference paper also evaluates YOLOv8 using Precision, Recall, F1-score and Map metrics.

V. CONCLUSION

In conclusion, the proposed Bone Fracture Detection system using YOLOv8 demonstrates the remarkable potential of Artificial Intelligence and Deep Learning in transforming conventional medical image analysis into an intelligent, efficient, and automated process. The system is designed to identify and localize suspected fracture regions from X-ray images, thereby providing a rapid and consistent approach to preliminary fracture assessment. By exploiting the advanced object-detection architecture of YOLOv8, the proposed methodology achieves an efficient balance between detection accuracy, computational efficiency, and real-time processing capability. Unlike conventional manual examination, which can be time-consuming and influenced by variation in interpretation, the proposed system offers an automated framework that can assist in minimizing diagnostic delays and improving the consistency of fracture identification. Furthermore, the integration of image preprocessing, feature extraction, deep-learning-based detection, and precise localization establishes a robust foundation for computer-aided diagnosis in the healthcare domain. The system can potentially support medical professionals by highlighting suspicious fracture regions and providing an additional layer of analytical assistance during radiographic evaluation. Although the proposed model is not intended to replace qualified radiologists or clinical expertise, it can function as a supportive technological tool for preliminary screening and decision assistance. Future development can focus on incorporating larger and more diverse datasets, advanced augmentation strategies, attention mechanisms, transfer learning, and model optimization to enhance generalization and reliability across different anatomical regions and fracture patterns. Overall, this project emphasizes the transformative capability of YOLOv8-based deep learning to contribute towards faster, scalable, reliable, and intelligent fracture detection, ultimately supporting the advancement of AI-assisted medical diagnosis and modern healthcare systems.

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