

Bone Fracture Detection Using Image Processing

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Abstract

The image processing technique is extremely helpful for several applications like biomedical, security, satellite imaging, personal image, medicine, etc. The focus of this research is the detection of bone fractures through the application of image processing techniques, aiming to enhance diagnostic precision and support medical decision-making. The proposed system follows a structured approach consisting of preprocessing, segmentation, feature extraction, and fracture detection. In the segmentation phase, the Canny edge detection method is employed, as it provides precise information from bone images. For feature extraction, the system uses the Hough Transform technique to detect lines in the images. The overall effectiveness of the process heavily depends on feature extraction. Experimental results demonstrate that the proposed system is both accurate and efficient for fracture detection.

Keywords: *Biomedical Application; Image Processing; Fracture Identification; Canny Edge Detection; Hough Transform.*

Software: Python.

1. Introduction

Bone fractures have long been a significant concern for humanity, traditionally diagnosed and classified using X-ray images based on human expertise. However, this manual diagnostic process is susceptible to human error. In recent years, Machine Learning (ML) and Artificial Intelligence (AI) have emerged as powerful tools across various domains, including the medical field. In our research, we aim to address the issue of bone fracture classification by leveraging modern AI techniques. Drawing from previous studies and methodologies, we have explored and fine-tuned Convolutional Neural Networks (CNNs) — including architectures such as ResNet, DenseNet, and VGG16 — for the task of fracture identification and classification. Through multiple rounds of model fine-tuning, our classification results initially fell short of the confidence threshold defined later in this paper. Nonetheless, the promising outcomes we obtained suggest that AI-based systems, particularly those using deep learning and advanced techniques like feature extraction, have the potential to surpass traditional diagnostic methods in accuracy and reliability. Bone fractures typically occur due to accidents, falls, or injuries, and are commonly identified through X-ray imaging. Our work seeks to enhance the accuracy and consistency of fracture detection by automating this process through deep learning. But sometimes, it can be difficult to see small cracks, and it takes time for a doctor to check every image carefully. Image processing is a technology that helps computers understand pictures. With this

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technology, we can create a system that looks at X-ray images and helps find broken bones automatically.

2. Literature Review

Deep learning systems have proven effective in accurately identifying fractures across the adult musculoskeletal system [6]. These technologies enable senior medical specialists to extend their expertise to general practitioners working on the front lines, thereby significantly enhancing the quality of patient care. Furthermore, digital pathology has opened new avenues for supporting the triage of complex cases and offers the added benefit of immediate and remote access to diagnostic resources worldwide [2]. It also offers computer-aided diagnostic procedures (CAD) through which systems and experts can focus on highly affected regions of the image [3].

Computerized analysis based on deep learning has shown potential benefits as a diagnostic strategy and has recently become feasible [5]. In emergency departments, missed fractures are the most common diagnostic error and can lead to treatment delays and long-term disability.

In 2016, Geoffrey Hinton, a notable computer scientist often referred to as the “Godfather of Deep Learning,” predicted that radiologists — specialists who diagnose diseases from medical imaging like X-rays, computed tomography (CT) scans, and magnetic resonance imaging (MRI) have long been essential tools in medical diagnostics. However, with the rapid advancement of deep learning, some experts predict a major shift in this field. One such prediction boldly stated, “People should stop training radiologists right now. According to some experts, it is evident that within the next five years, deep learning will surpass human performance in diagnostic tasks [7].

In response to this growing interest, several researchers have reviewed existing bone fracture detection techniques to identify common approaches, highlight the current state of the art, and uncover gaps that could guide future research. For example, Khatik [11] conducted a comprehensive review of various bone fracture detection techniques, while Robert Lindsey et al. [12] specifically focused on the application of deep learning methods for bone fracture identification. Specifically studied bone fracture detection using deep learning techniques.

2.1. Historical Approaches:

- Manual analysis of X-rays and CT scans
- Traditional diagnostic techniques used before automation

2.2. Recent Advances

- Integration of AI and deep learning in medical imaging
- Use of CNNs, object detection models, and hybrid techniques

2.3. Comparative Studies

- Comparison between classical and modern approaches
- Summary of existing research findings and their outcomes

3. Methodology

In this section, the overall system design is described, including image pre-processing, image segmentation and image segmentation and fracture detection. fig1 shows the flow diagram of our developed algorithm. Preprocessing, Image segmentation, Fracture detection, Final result.

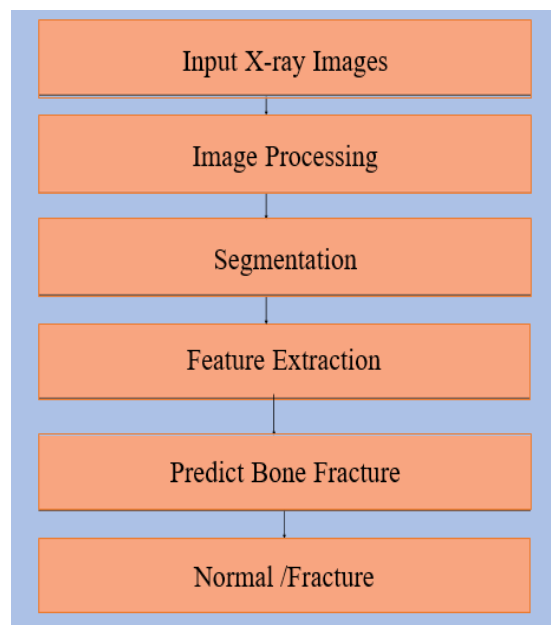


FIG.3.1. System Flow Diagram

3.1.Input X-ray Images

- The system receives X-ray images of bones as input.

3.2.Image Processing

- Enhances the image quality by removing noise and adjusting contrast to prepare for analysis.

3.3.Segmentation

- Separates the region of interest (such as the bone) from the rest of the image for focused analysis.

3.4.Feature Extraction

- Identifies and extracts important visual features such as edges, shapes, and textures relevant to bone structure.

3.5.Predict Bone Fracture

- A machine learning or deep learning model uses the extracted features to determine whether a fracture is present.

3.6.Normal / Fracture Output

- The system outputs the result: either the bone is normal or it has a fracture.

4. Machine Learning Model**4.1.Supervised Learning**

- Classification models: SVM, Random Forest, CNN.
- Training with labeled datasets.

4.2.Unsupervised Learning

- Clustering techniques (K-means, DBSCAN).
- Use in anomaly detection or feature learning.

4.3.Data Sets and Evaluation Metrics

- Overview of training/testing datasets.
- Metrics: Accuracy, Precision.

5. Datasets And Evaluation Metrics

5.1.Available Datasets

- Public datasets: MURA, etc.
- Challenges with dataset diversity and labelling

5.2.Performance Metrics

- Sensitivity, specificity
- Confusion matrix analysis

5.3.Validation Techniques

- Cross-validation, holdout method
- Overfitting prevention

6. Implementation Framework

6.1.Software Tools

- Python
- Libraries: OpenCV, TensorFlow, Keras, PyTorch, numpy, pandas, PyAutoGUI.

7. Case Studies

7.1.Case Study 1: X-ray Analysis

- Detection of fractures using edge-based techniques and CNN.

7.2.Case Study 2: MRI Scan

- Application in detecting bone and soft-tissue injuries.

7.3.Case Study 3: CT Scan

- High-resolution fracture detection using CT imaging.

8. Challenges And Limitations

8.1.Algorithmic Limitations

- Difficulty in handling overlapping bones or artifacts

8.2.Data Limitations

- Insufficient annotated data
- Imbalanced datasets

8.3.Clinical Implementation Barriers

- Acceptance by radiologists
- Regulatory and ethical concerns

9. Future Directions

Artificial Intelligence and Deep Learning must continue to expand for clinical applications like bone fractures. As shown in the study, more work will increase the accuracy and aid the expert to correctly diagnose the hidden fracture. A study should be performed on different bones in detail for different datasets. Mixing different methods and designing a new algorithm can improve the performance on fracture detection on radiographs, and it can also support fracture classification and treatment.

10. Conclusion

Bone fracture detection using image processing has significantly transformed the field of medical diagnostics by offering a faster, more accurate, and cost-effective method for identifying fractures. Through the application of advanced image processing techniques—such as preprocessing, segmentation, and feature extraction—combined with machine learning and deep learning algorithms, it is now possible to automate the diagnostic process with a high degree of reliability.

11. Conflict of Interest

The authors declare that they have no conflict of interest.

12. Funding Declaration

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About Author



Ms. Sakshi Rajaram Bodare is currently pursuing a Bachelor's Degree in Electronics and Telecommunication Engineering at Dr. Babasaheb Ambedkar Technological University. Her academic and research interests include image processing, artificial intelligence, and healthcare technologies.

Sakshi has hands-on experience in Python programming and is skilled in libraries such as NumPy, Pyautogui, customtkinter, pygetwindow, filedialog and PIL which she has utilized to develop algorithmic models for medical imaging applications. Her work reflects a strong passion for integrating engineering with medical diagnostics.