A real-time human bone fracture detection and classification from multi-modal images using deep learning technique

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Abstract

Human bone is an essential structure that allows the body to move. It is a common observation in contemporary society that bone fractures occur frequently. The doctors use X-rays, Computed Tomography scans, and Magnetic Resonance Imaging to determine the location of the broken bone. The previous method of evaluating broken bones in person was inefficient, often leading to errors. However, introducing new, advanced evaluation techniques has obliterated these issues. Consequently, it is essential to develop an automated system for identifying fractured bones. This research uses a new deep-learning model named "You Only Look Once (version 8)" to distinguish between healthy and broken bones from multi-modal images. We utilized a customized dataset named "Human Bone Fractures Multi-modal Image Dataset", which includes 641 images representing ten different classes of bone fractures. The small data set leads to an over-fitting of the model. To increase the amount of data, we utilized a data augmentation technique. Three experiments were conducted to assess the effectiveness of the model. The findings of the experiments show that the proposed study effectively identifies and classifies different types of fractures in this area. Our system attained 95% precision, 93% recall, and 92% of mean average precision. The outcomes demonstrated that the method achieves cutting-edge performance.

Keywords Bone fracture · Fracture detection · Fracture classification · X-ray · MRI · YOLOv8

1 Introduction

Human bone is a diligent framework that supports the whole body [1]. The human skeleton is made up of a total of 206 distinct bones, which differ in length, complexity, and shape. The femur is the largest bone in the human body, while the stapes in the middle ear are the smallest. In most countries, young people, elders, and kids frequently suffer injuries because of falls, collisions, and other occurrences [2]. Therefore, bone fracture is an everyday occurrence, and their frequency is rising steadily. Bone fractures are a common issue caused by stress, accidents, osteogenesis imperfecta, osteoporosis, and cancer. Generally, there are three types of bone fractures: open, closed, and displaced fractures [3]. Figure 1 shows the general fracture types.

Open fracture: An open fracture is a term used to describe a broken bone that has penetrated through the skin. When the injury becomes particularly terrible, the bone might be visible.

Close fracture: Unlike open fractures, closed fractures do not cut through the skin and have a lower chance of infection.

Displaced fracture: A displaced bone fracture exposes a gap between the two ends, meaning the bone edges are no longer straight.

There are more subcategories based on the characteristics of bone fractures besides the above-listed categories [3–5]. Figure 2 shows the subcategories of the bone fracture. These are-

- **Transverse fracture:** The bone is split horizontally.
- **Oblique fracture:** When a fracture splits the bone diagonally.
- **Spiral fracture:** A fracture line that appears spirally or wraps around the bone.

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