Femur Fracture Detection Based on Deep Learning Model YOLOv8

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Abstract: Femur fracture occurs in various circumstances like car accidents, high-altitude fall incidents, tumour illness, and elderly falls. For better recognition and treatment, physicians need to search the X-ray images for fracture detail. However, some X-ray images were unclear to diagnose, and some were taken from the side position, which is difficult to detect the fracture. This study uses the YOLOv8 model to help physicians with femur fracture detection by utilizing deep-learning models. The performance of YOLOv8 is 42.35% in AP50:95, 84.24% in mAP50, and 25.45% in mAP75 on the private dataset is from Shenzhen University General Hospital. The result shows that the YOLOv8 detection model is competitive and faster on the personal femur fracture dataset than YOLOv3 and YOLOv5 models.

1 INTRODUCTION

Bone fractures are regular in hospitals due to car accidents, high-altitude fall incidents, tumor illness, and elderly falls. Physicians use medical images, for example, X-ray images, to search for the detail of the fracture. However, due to the angle of images taken can vastly alter the fracture info, the deep learning model YOLOv8 is used to detect femur fracture.

YOLOv8 is a multi-scale detection model. It uses three detection heads to classify. According to the basic of the deep learning model, YOLOv8 can learn simple features like straight lines and oblique lines at a low level. At a high level, it can learn more complex features like the femur, femur shaft, and femoral head. Figure 1 shows the anatomy of the femur. The fracture can occur at the femoral shaft, femoral distal, and femoral proximal.

Femoral proximal mainly include the femoral neck, intertrochanteric, and subtrochanteric femoral fractures. Femoral neck fractures occur predominantly in the elderly, typically resulting from low-energy falls, and may be associated with osteoporosis.

Femoral shaft fractures are among the most common fractures seen in orthopedic practice. The femur is the most prominent bone in the body and one of the primary weight-bearing bones of the lower limbs, and unless treated appropriately, fractures can lead to long-term morbidity and disability.

Distal Femur often is unstable and comminuted and tends to have a bimodal distribution, occurring in elderly or younger multiple-injured patients.

Figure 1: The anatomy of the femur.

This research used the YOLOv8 model to detect the fracture for better detection. This deep learning model has three detection heads, which are 8x, 16x, and 32x. Different scales can detect different scales of objects. For instance, if 8x can detect the femur, then 16x can detect the approximate location where

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the femur is, and 32x can use the bounding box to locate the fracture.

The accuracy score obtained from the fracture detection performed by Rashid et al., using a 28-layer dilated CNN and long short-term memory (DCNN-LSTM) on 965 wrist X-ray images, is 88.24% (Rashid, 2023). The result of fracture detection performed by Jia et al. on 1227 sternum fracture X-ray images from the collection of sternal radiographs and hospital diagnostic reports, 0.71 mAP, was obtained using the cascade R- CNN method (Jia, 2022). The AP score of Guan et al. was 62.04% with a two-stage R-CNN method developed for fracture detection based on nearly 4000 arm fracture X-ray images using Resnet backbone.[Guan B, 2020] Wang et al. carried out fracture detection procedures(WrisNet), achieving a 56.6% score of AP, using the model inspired by Faster-RCNN, mainly composed of ResNeXt-TA and FPN for a total of 4346 hairline fractures in hand X-rays images.(WANG W.) Lu et al. developed automated universal fractures detection in X-ray images using a modified Ada-ResNeSt backbone network and the AC-BiFPN detection method based on the part of the MURA dataset. They achieved an AP score of 68.4% on 30000 X-ray images. (LU S, 2022) Guan et al. achieved an AP score of 88.9% using a balanced FPN-ResNeXt model developed for fracture detection in a 3842 thighbone X-ray radiographs dataset. (Guan B, 2022) Yadav et al. used a deep learning model to detect and classify X-ray images of human fracture bone and healthy bone. 5-fold cross-validation was implemented on 4000 augmented datasets and got 92.44 % accuracy for the healthy and the fractured bone. (Xue L, 2021) ParallelNet is proposed by Wang et al. for detection tasks on thigh bone fracture based on multiple backbone networks. The dataset contains 3842 X-way radiographs; the result is 87.8% AP50 and 49.3% AP75. (WANG M, 2021) Chin et al. proposed an Auxiliary Classifier Generative Adversarial Network (AC-GAN) model to label the position of the fracture. The result shows an accuracy of 91.2% (Chiun-Li Chin, 2019).

2 ANOTHER SECTION OF YOUR PAPER

YOLOv8 is the latest deep-learning model in the YOLO series. The structure of this model is shown in Figure 2. The detail of the model will be explained in this section.

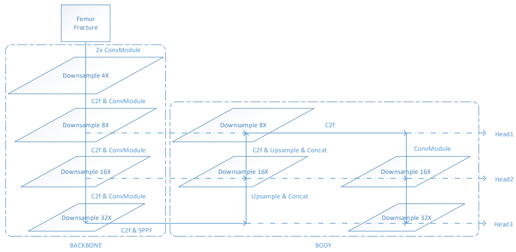

Figure 2: The structure of YOLOv8 model.

2.1 Yolov8 Model

Like YOLOv5, YOLOv8 provides different size of models based on the scaling factor to meet the needs of different scenarios. The Backbone and Neck part of the model refers to the YOLOv7 ELAN design idea. The C3 structure from YOLOv5 has been replaced with a richer C2f structure of gradient flow, and the number of channels has been adjusted for models of different scales. It is a fine-tuning of the model structure. It is no longer a brainless set of parameters to apply to all models, dramatically improving the model's performance. Compared with YOLOv5, the Head part has changed a lot. It has been replaced with the current mainstream decoupling head structure, which separates the classification and detection heads. The TaskAlignedAssigner positive sample allocation strategy is adopted in the calculation, and the data enhancement part of the Distribution Focal Loss training is introduced. The Mosiac enhanced operation can effectively improve the accuracy introduced from YOLOX.

2.2 Study Dataset

The X-ray images of femur fracture include 312 fracture images collected from Shenzhen University General Hospital between 2019 to 2023, ranging from femoral neck fracture to distal femur fracture. The physicians from Shenzhen University General Hospital checked the data labeling of femur X-ray images.

3 EXPERIMENTS

This study used local PC to train the deep-learning model for femur fracture detection. The graphics card of the local PC is 12 GB Nvidia GTX3060.

The following configuration is used in all machine learning models for femur fracture detection: the epoch of data training is 300 times, the initial learning rate is set as 0.01, and the final learning rate is 0.01 of the initial learning rate. Warmup epochs are 3. The parameters used to optimizer weight decay are 5e-4, initial warmup momentum is 0.8.

The bounding box outputs performed with the YOLOv8 model in femur fracture X-ray images are provided as a dataset sample in Figure 3 below.

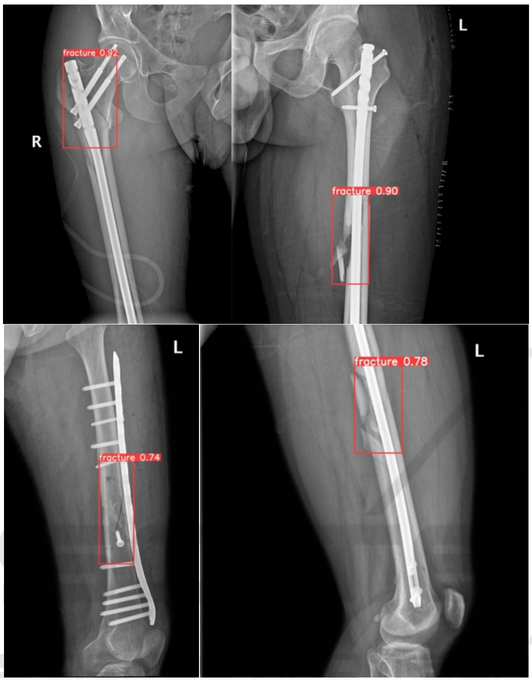

Figure 3: Sample of Detection result of YOLOv8 model.

In order to explain the detection result of YOLOv8, this research adds other deep learning models to compare the result of YOLOv8.

YOLOv3 uses more profound and more accurate Darknet-53 as the backbone and shifts from multi-category to multi-label classification, removing softmax and using binary cross entropy instead.

The network architecture of YOLOv5 consists of three parts: CSPDarknet as the backbone, PANet as the neck, and Yolo Layer Head. The data is first input to CSPDarknet for feature extraction and then input to PANet for feature fusion. Finally, the Yolo layer outputs the detection results.

Based on the same parameters, the detection result of three deep learning models is shown in the table below.

Table 1: Detection result of YOLOv8, YOLOv5, and YOLOv3 models.

Model	mAP50-95	mAP50	mAP75
YOLOv8	0.4235	0.8424	0.2545
YOLOv5	0.3627	0.7578	0.3146
YOLOv3	0.4079	0.8116	0.3666

Table 1 shows that YOLOv8 has better overall detection results than YOLOv5 and YOLOv3 Models on fracture detection. When the results mentioned above are examined, it depicts that YOLOv8 has an improvement in mAP50-95 and mAP50 values. YOLOv8 can be used in femur fracture detection in the private dataset.

4 CONCLUSION

This study aims to support physicians and intern doctors in medical image detection and solve the problem when X-ray images are deficient in clinical needs and require physicians to retake X-rays of femur fractures. In addition, the result shows that the YOLOv8 model can detect femur fracture better than other deep-learning models.

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