Skull R-CNN: A CNN-based network for the skull fracture detection

MIDL 2020

ZHUO KUANG¹; XIANBO DENG²; LI YU¹; HANG ZHANG²; XIAN LIN¹; HUI MA²

1 HUAZHONG UNIVERSITY OF SCIENCE AND TECHNOLOGY, CHINA

2 UNION HOSPITAL AFFILIATED WITH TONGJI MEDICAL COLLEGE OF HUAZHONG UNIVERSITY OF SCIENCE AND TECHNOLOGY. CHINA

Content

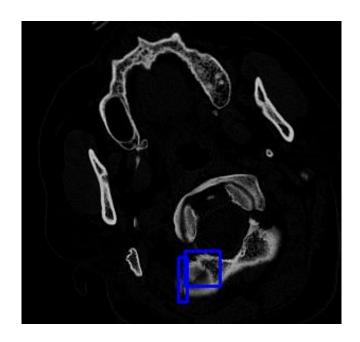
Background

Method

Experiment results

Background

Background



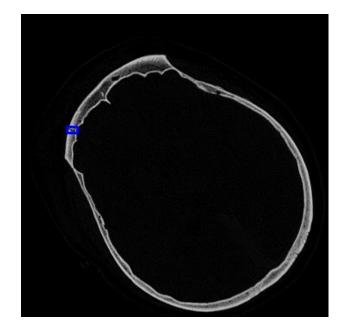
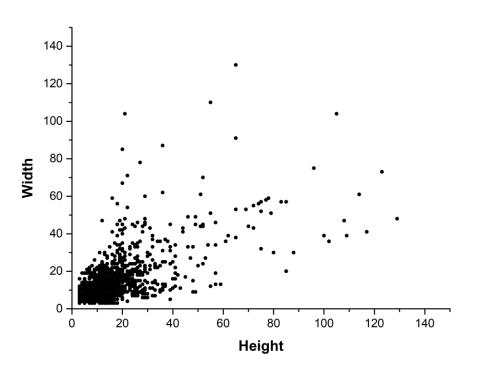


Figure. 1. The skull fractures annotated by the radiologist. The blue boxes are the ground truth annotated by the radiologists, which contain the fractures.

Background



The fractures usually present as narrow slits;

The locations and the length of fractures are diverse;

A considerable percentage of the fractures have very small sizes;

Figure. 2. The distribution of the width and length of the object boxes.

Method

Skull R-CNN

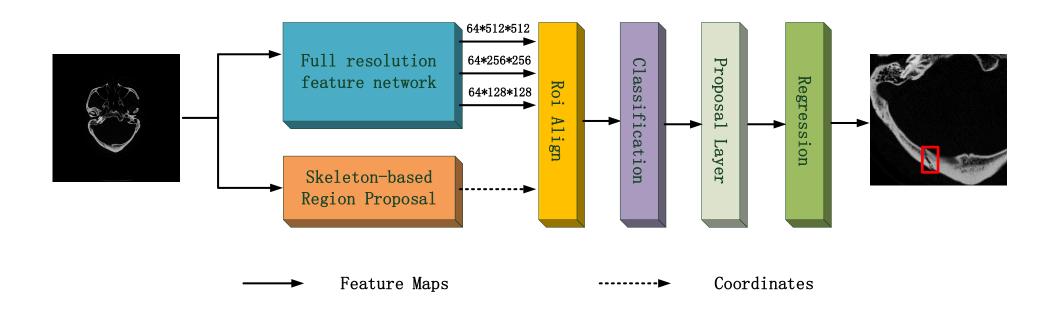


Figure. 3. The architecture of the Skull R-CNN

Skeleton-based region proposal

Based on the feature map with low resolution

Based on the origin CT image

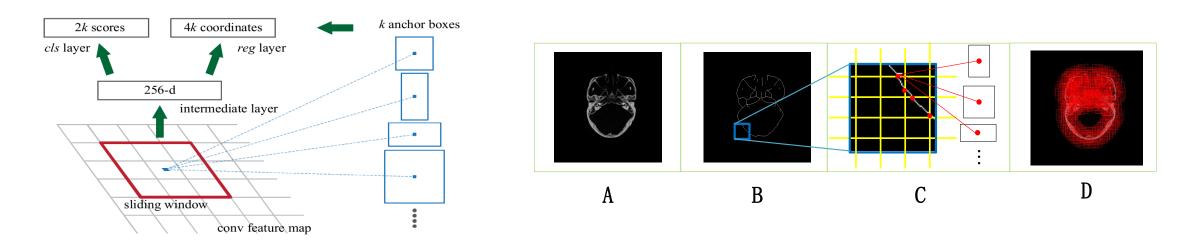


Figure. 4. Left: Region proposal network(RPN)[1]; Right: Skeleton-based region proposal

The candidate boxes are much less than RPN, while keeping enough boxes containing fractures.

Compared to RPN, there is no need to be trained and it just costs small amount of computation.

1. Shaoqing Ren, Kaiming He, Ross Girshick, and Jian Sun. Faster r-cnn: Towards real-time object detection with region proposal networks. In Advances in neural information processing systems, pages 91–99, 2015.

Full resolution feature network

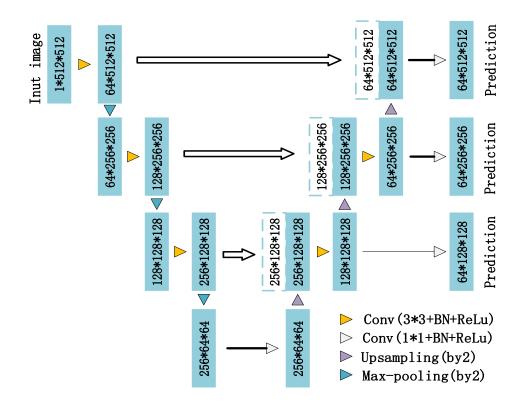


Figure. 5. The structure of the full resolution feature network.

The output feature maps have higher resolutions than the FPN[2], and have more accurate local information;

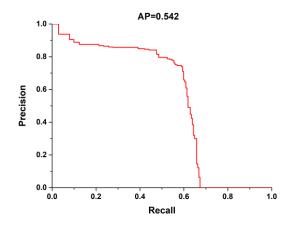
Compared to FPN[2], element-wise addition is replaced by the concatenation to softly merge the feature maps.

Experiment results

Objective indices

Table. 1. The performance of the models.

Methods	AP(×0.01)				Detection time(s\slice)	
	val	test	val(<16*16)	test(<16*16)	val	test
Faster R-CNN + FPN	55.7	54.2	59.4	49.3	0.088	0.087
Skull R-CNN + FPN	62.6	57.9	64.7	58.6	0.058	0.058
Skull R-CNN	65.1	60.0	67.3	63.3	0.035	0.036



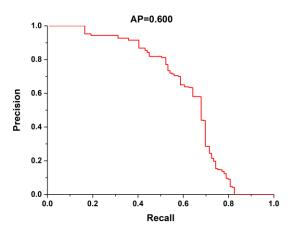


Figure. 6. The PR curves on the test set. Left: Faster R-CNN+FPN; Right: Skull R-CNN

Subjective results

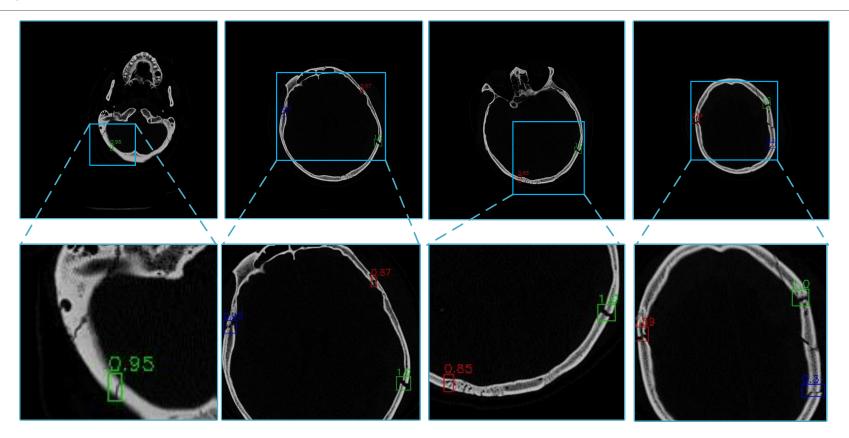


Figure. 7. The detection results of the Skull R-CNN. The images in the second row are the partial magnifications of images in the fist row. In which, the green boxes are TP predictions, the red boxes are FP predictions, and the blue boxes are the FN predictions

Thank you for listening!