

Figure 3. Comparison of the proposed mitosis detection system results with the best results of other methods in Mitos-ICPR2012 contest

Conclusion: The detailed experimental results demonstrated the promising performance of the proposed fully automated method for mitosis detection with F-measure (91.49%).

Keywords: Breast Cancer Grading; Mitosis Detection; Histopathology Image; Gaussian Mixture Model; Feature Extraction

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• 10.5812/IRANJRADIOL.99145

Automatic Bone Age Determination Using Wrist MRI Based on FIFA Grading System for Athletes: A Deep Learning Approach

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Abstract

Background: Young athletes need to comply with fair play principles including age-specific rules for each category of matches (1). Although birth certificates are considered the main document indicating the age of players, in some regions of the world, the registration of birth is subject to variation, which makes the certificates unreliable. Therefore, FIFA has tried to use imaging methods without ionizing radiation to find out the bone age as the basis for fair play confirmation. FIFA has developed a grading system consisting of I - VI levels, which can be used in teenage athletes (2). The grading system is currently used as the standard bone age determination method in football players (3,4). All national and club matches are obliged to follow screening procedures strictly like anti-doping procedures.

Objectives: The purpose of this study was to evaluate the performance of a deep learning-based automatic system that provides FIFA grades upon receiving DICOM images of the MRI study to facilitate and speed up the bone age determination.

Methods: The FIFA bone age determination system consists of six grades starting from a totally unfused epiphyseal plate (Grade I) to a completely fused plate (Grade VI) where variable progressive degrees of fusion are considered the basis for Grade II to V. The protocol includes nine slices in the coronal plane with 3 mm gaps between the slices. The recommended MR sequence is T1. Since the middle image in the nine-picture dataset is considered the most informative slice containing the largest image of the distal radius, the study was done using this single slice as the basic source of grading. Then, another volumetric set of slices 4, 5, and 6 was used as the second group. A convolutional neural network was designed in four convolutional layers including pooling, ReLU, and fully connected layers (Figure 1).

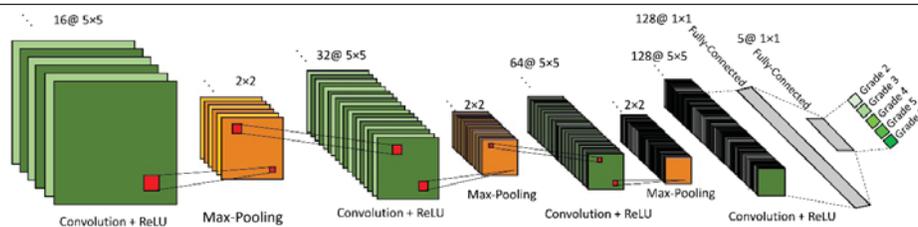


Figure 1. The architecture of the proposed convolutional neural network for bone age determination using wrist MRI

SCIENTIFIC ORAL PRESENTATION ABSTRACTS

Next, 55 teenage football players of the national U17 team were examined using a 1.5 Siemens Avanto Machine. The studies were interpreted by an MSK radiologist member of the AFC panel of radiologists who was aware of the FIFA scoring and grading system, as the ground truth. Thirty-six cases were used for training and 19 cases for testing of the CNN. To increase

the number of training images, augmentation was performed by rotating and moving the original images. Therefore, a total number of 613 images were obtained for training and 267 images for testing. Results: Images introduced to the neural network resulted in sequential layers of meaningful output (Figure 2).

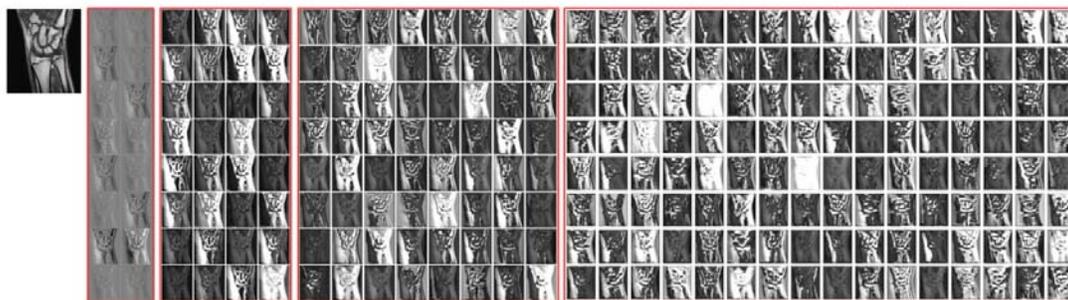


Figure 2. The resultant images in the CNN from the source image to the final FIFA grade

The final outcome of the network, as the FIFA grade of the case, was compared with the interpretation of the radiologist (Table 1). The findings indicated high

accuracy of a single slice dataset while the accuracy approached 100% when the volumetric three slice sets were used.

Table 1 The Final Outcome of the Network ,as the FIFA Grade of the Case ,Compared to the Interpretation of the Radiologist

Group	Accuracy	
	Single Middle Slice, %	Volumetric Three Middle Slices, %
Overall	97.75	99.62
Grade II	90	100
Grade III	98.91	98.91
Grade IV	97.91	100
Grade V	97.43	100
Grade VI	100	100

Conclusion: The findings of this research indicated that CNN could be used for automatic bone age determination and FIFA grading of wrist MRI by reasonably high accuracy.

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• [10.5812/IRANJRADIOL.99134](https://doi.org/10.5812/IRANJRADIOL.99134)

Epilepsy Presurgical Evaluation of Patients with Complex Source Localization by a Novel Component-Based EEG-fMRI Approach

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