بسم الله الرحمن الرحيم

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التوثيق الإلكتروني والميكروفيلم

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قسم

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Computational Intelligence Method for Bones Classification and Abnormality Detection using X-ray Images

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Abstract

Wrong diagnosis for bone abnormalities may lead to serious side effects. Moreover, exhausted, and over loaded doctors may miss some cases. Hence, Computer aided diagnosis systems have a vital role nowadays.

Based on the conducted comparative analysis: 1) There is a lack of published datasets that can be used as benchmark due to the difficulty of collecting data from hospitals; 2) Most of the previous studies consider only one bone due to the high variability in the shape of different bone types and also due to lack of data; 3) Most of the existing studies don't consider the abnormality type; 4) Most of the previous studies apply the traditional methods for feature extraction and classification, except for few new studies that utilize deep learning models (CNN models); 5) The models used in deep learning based studies are of huge depth which increases the training time and computation. Hence, a computer-aided diagnosis (CAD) system based on deep learning approach is proposed to consider the drawbacks of the literature. Bones of the upper extremities: namely, shoulder, humerus, forearm, elbow, wrist, hand, and finger are considered. All experiments have been carried out using the MURA database, the largest public dataset of bone x-ray images.

In this work, three main approaches are proposed and examined: 1) one stage – one task approach; 2) one stage – two tasks approach; and 3) two stage – two tasks approach using state-of-art techniques. In the one stage – one task approach, the model takes the x-ray image as an input and outputs whether the bone is normal or not. While in the one stage – two tasks approach, the model takes the x-ray image as an input and outputs both the bone type and whether the bone is normal or not. Finally, in the two stage – two tasks

approach the classification is done through two stages. The first stage is to classify the bone type and the second stage is to detect whether the classified bone is normal or abnormal. Thus, in the second stage, each bone has its own classifier for abnormality detection. 10 different pretrained models have been examined for the three approaches. The results show the superiority of the two stage – two tasks approach. The best average sensitivity and specificity achieved by the first stage is 95.78% & 99.45% and 83.25% & 83.25% for the second stage, respectively. However, this approach utilizes very deep models which affect the performance and computation time.

Hence, a novel, reliable, hybrid, two-stage method for bone x-ray classification and abnormality detection is introduced. Growing Neural Gas (GNG) network is combined with eight models built from scratch and inspired from VGG model to achieve the best performance and least computations possible. The features extracted from GNG are fed into a two-stage classification step. The first stage classifies a bone X-ray into one of seven types, after which it is directed according to type to one of seven classifiers trained to detect bone abnormality. Hence, the classification step consists of eight different models: one for classification and seven for abnormality detection. The best average sensitivity and specificity obtained for the first stage is 95.86% and 99.63%, respectively. For the second stage, the best average sensitivity and specificity obtained is 92.50% and 92.12%, respectively. These results are superior compared to state of art pretrained models. In addition, the computation and processing time are significantly decreased by the proposed scheme. Furthermore, to the best knowledge of researchers, the proposed method is the first to integrate seven bones together in the same scheme. Finally, the hierarchical nature of the proposed method allows considering two problems together: bone classification and abnormality detection.

List of Publications

1- Hadeer El-Saadawy, Manal Tantawi, Howida A. Shedeed, and Mohamed F. Tolba. “A Hybrid Two-Stage GNG–Modified VGG Method for Bone X-Rays Classification and Abnormality Detection,". IEEE Access, vol. 9, pp. 76649-76661, doi: 10.1109/ACCESS.2021.3081915, 2021. IF: 3.367.

2- Hadeer El-Saadawy, Manal Tantawi, Howida A. Shedeed, and Mohamed F. Tolba. “Hybrid Two-Stage CNN-SVM Model for Bone X-Rays Classification and Abnormality Detection,”. International Journal of Sociotechnology and Knowledge Development (IJSKD), vol. 13, 2021.

3- Hadeer El-Saadawy, Manal Tantawi, Howida A. Shedeed, and Mohamed F. Tolba. “One-Stage vs Two-Stage Deep Learning Method for Bone Abnormality Detection.” In: Hassanien A.E. et al. (eds) Proceedings of the International Conference on Artificial Intelligence and Computer Vision (AICV2021). Advances in Intelligent Systems and Computing, vol 1377. Springer, Cham. https://doi.org/10.1007/978-3-030-76346-6_12, 2021.

4- Hadeer El-Saadawy, Manal Tantawi, Howida A. Shedeed, and Mohamed F. Tolba. “Deep Learning Method for Bone Abnormality Detection Using Multi-View X-rays.” In: Hassanien A.E. et al. (eds) Proceedings of the International Conference on Artificial Intelligence and Computer Vision (AICV2021). Advances in Intelligent Systems and Computing, vol 1377. Springer, Cham. https://doi.org/10.1007/978-3-030-76346-6_5, 2021.

5- Hadeer El-Saadawy, Manal Tantawi, Howida A. Shedeed, and Mohamed F. Tolba. “A Two-Stage Method for Bone X-Rays Abnormality Detection Using MobileNet Network,” In: Hassanien AE., Azar A., Gaber T., Oliva D., Tolba F. (eds) Proceedings of the International Conference on Artificial Intelligence and Computer Vision (AICV2020). Advances in Intelligent Systems and Computing, vol 1153. Springer, Cham. https://doi.org/10.1007/978-3-030-44289-7_35, 2020.

6- Hadeer El-Saadawy, Manal Tantawi, Howida A. Shedeed, and Mohamed F. Tolba. “Bone X-Rays Classification and Abnormality Detection using Xception Network.” International Journal of Intelligent Computing and Information Sciences 21, no. 2 (2021): 82-95.

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