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A Deep Learning Model for Classifying Histological Types of Colorectal Polyps

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Abstract. In this study a deep learning architecture based on a convolutional neural network has been evaluated for the classification of white light images of colorectal polyps acquired during the process of a colonoscopy, to estimate the accuracy of the optical recognition of histologic types of polyps. Convolutional neural networks (CNNs), a subclass of artificial neural networks that have gained dominance in several computer vision tasks, are gaining popularity in many medical fields, including endoscopy. The TensorFlow framework was used for implementing EfficientNetB7, which was trained with 924 images, drawn from 86 patients. 55% of the polyps were adenomas, 22% were hyperplastic, and 17% were lesions with sessile serrations. The validation loss, accuracy, and AUC ROC were 0.4845, 0.7778, and 0.8881 respectively.

Keywords. Deep learning, convolutional neural networks, polyps, endoscopy

1. Introduction and Background

It is accepted that optical biopsy, which avoids histological investigation, It is important during colonoscopy because it enables the endoscopist to make a rapid and direct choice regarding the risk level of the lesion and, as a result, whether excision is necessary. For any healthcare system based on constrained human and financial resources, this strategy seeks to reduce complications while also saving money, time, and effort [1].

It is thought that artificial intelligence could act as an adjunct even to novice endoscopists who are less experienced to perform an optical determination of colorectal polyps in routine clinical practice and furthermore relieve the tremendous overload on laboratory and human resources [2-3].

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This study aims to evaluate a convolutional neural network used for the discrimination between adenomatous and hyperplastic colorectal polyps acquired by white light endoscopy during everyday practice.

2. Methods and Materials

This study was approved by the corresponding Institutional Review Board. The patients that were self-referred for screening or submitted for colonoscopy due to various indications were prospectively included in this study during which any polyp detected was photographed and then resected for histological interpretation that was a priori used as the gold standard for this analysis. The research includes the training process of the EfficientNetB7 [4], a Convolutional Neural Network (CNN), which was provided with polyp images of 2-classes, neoplastic (adenomas with low and high-grade dysplasia) and non-neoplastic (hyperplastic) polyps. Any polyp that was discovered was photographed using high-definition imaging under white light endoscopy (WLE) with as much clarity as possible avoiding bubbles, feces, blur vision, etc., and stored with a resolution of 720X576 pixels.

Convolutional neural networks (CNNs), a subclass of artificial neural networks that have gained dominance in several computer vision tasks, are gaining popularity in many medical fields, including endoscopy. Using a variety of building blocks, including convolution layers, pooling layers, and fully connected layers, a CNN is intended to automatically and adaptively learn spatial hierarchies of features through backpropagation. The performance of the CNNs on the histological classification process was evaluated based on Accuracy, Loss as well as the areas under the curves (AUC/ROC curves). EfficientNetB7 is among the most advanced architectures in convolutional neural networks (CNNs).

The TensorFlow framework [5] was used for implementing EfficientNetB7, which was trained with 924 collected images, drawn from 86 patients after their pre-processing based on the ImageNet database through a transfer learning process. The data being used for training and testing was split on a 90:10 ratio and the proportion of the three categories based on their histologic type in the dataset was 60% adenomas, 24% hyperplastic, and 16% polyps with sessile serrations.

3. Results

We collected data on 86 patients, with a median age of 64 years (in the 24-92 age range). The total number of polyps was 191 with a size ranging between 6-10mm (1st-3rd interquartile) and their histologic type included 55% adenomas, 22% hyperplastic, and 17% polyps with sessile serrations. Without any further augmentation, 924 pictures were captured and kept for analysis.

The validation loss, accuracy, and AUC ROC were 0.4845, 0.7778, and 0.8881 respectively. The accuracy and AUC ROC values on validation and training datasets during the training of 100 epochs can be seen in Figure 1 below.

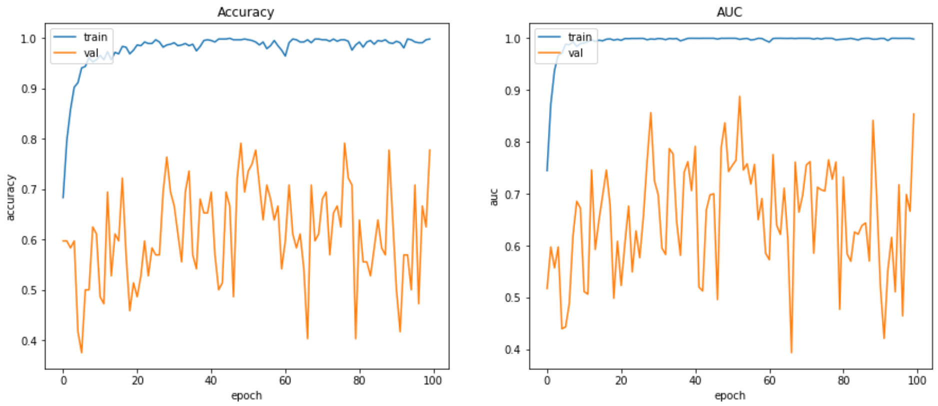

Figure 1. The epoch versus accuracy and AUC ROC plots of the EfficientNetB7 model on train and validation datasets.

4. Discussion

There exists a wide range of accuracy of CNNs (mean 80.85%) [6-9] concerning the optical classification of colorectal polyps that seems to be comparable to the optical discrimination provided by expert endoscopists using image-enhanced endoscopic systems like NBI or BLI. We have demonstrated that the EfficientNetB7 upon WLE during typical clinical practice situations to select neoplastic lesions had a satisfactory validation accuracy of 77.78%. With an AUC of 0.8881 and an acceptable amount of error gradient, this model appears to be satisfactory.

In our study, the images have been prospectively collected restricting any selection bias and we particularly stress the point that neither sophisticated endoscopic techniques nor image augmentation were used to accomplish our results.

Our study has some limitations being in the initial phase of training the model that further needs validation and including WLE images which although inferior in quality are under widespread use in the endoscopy units worldwide.

5. Conclusion

Convolutional neural networks can provide acceptable accuracy but still needs further improvement and validation to ensure reliability. Artificial intelligence could be used in routine clinical practice to lessen the impact of disease and the human effort required to treat it if these findings are supported by the development of this study or other research. Artificial intelligence could be used in routine clinical practice to mitigate the impact of disease and the human effort required to treat it if these findings are supported by the development of this study or other research.

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