

Dissertation Course Final Work

Paraphrasing exercise

Information of the material in this report:

Jha, D., Smedsrud, P. H., Riegler, M. A., Johansen, D., De Lange, T., Halvorsen, P., & Johansen, H. D. (2019, December). Resunet++: An advanced architecture for medical image segmentation. In 2019 IEEE international symposium on multimedia (ISM) (pp. 225-2255). IEEE.

-Abstract

In order to reduce the risk of polyps developing into cancer, applying a precise computer-assisted detection and segmentation method for polyps during colonoscopy procedures supports a lot while the endoscopists removing abnormal tissue. Debesh Jha and his colleagues proposed a new model based on ResUnet structure which is used for colonoscopic image segmentation, called ResUNet++, this model is for segmenting pixel-wise polyps. They did multiple evaluations that showed an ideal result applying on the public dataset. In figures, the performance of the model proposed in this article surpasses the performance of U-Net and ResUNet models and it works well in two datasets – Kvasir-SEG and CVC-612.

-Introduction

Being the main reason for the death of cancer globally, Colorectal Cancer (CRC) should be discovered as soon as possible. In order to lower the possibility of having CRC, the most common way is to cut off the neoplastic lesions like adenomatous polyps. (Polyps are the predecessors to CRC) In the article of J. C. Van Rijn and his co-workers, they illustrated that a lot of adenomatous polyps have been ignored in diagnosis. Previously, doctors used a Computer-Aided-Detection (CAD) system to highlight the position of polyps. This might reduce the possibility of ignorance of polyps. However, this abnormal detection cannot figure out which exact position exists abnormal situation, so the Debesh Jha and his colleagues hope to create a CAD system with the ability of segmentation.

According to Debesh, the biggest challenge of the design of CAD system for polyps is that it costs too much money in process of collecting and labeling appropriate datasets for training and testing. In the article, Debesh and his colleagues provided some images to present various of polyps with

different shapes, sizes, colors and appearances. Besides, they declared that polyps have a high similarity between types. Polyps are mainly divided into four categories: serrated, hyperplastic, adenoma and mixed polyps which is rare to occur. Also, because some vague backgrounds may increase the similarity among them - for instance, some polyps may form with the background. Indeed, these may cause great challenges for the mission in this article, but by creating a useful system, it can significantly help the applications in clinical situations.

In the articles of Milletari, Ronneberger and Zhang, they all achieved considerably with the help of semantic segmentation analysis method for medical images, which inspired Debash and his colleagues in improving the performance of automated segmentation and detection for polyps by using these tactics. In the cell tracking challenge 1 (ISBI) in 2015, a deep learning structure is applied into semantic segmentation into the biomedical field which is called U-Net and it showed the most advanced performance. Zhang and his colleagues pointed out a structure called ResUNet in their paper, which is a variant of U-Net and it received the best result in image extraction procedure. Then that is why Debash works his model based on this one.

In the article of Debash, he created model and ran on two public datasets to evaluate the ResUNet++ structure proposed in this paper. What showed in the result is that this model performs better than other models like U-Net and ResUNet in terms of efficiency and performance.

In this paper, Debash and his colleagues made achievements as follows:

- (1) First, based on the previous models to present image segmentation, they proposed a brand new semantic deep learning structure called ResUNet++. This model utilizes the idea of squeeze, excitation and residual blocks and some other advantages. ResUNet++ improved the result of doing segmentation for polyps comparing with other models and it performs not bad even with a small number of images.
- (2) They created a new Kvasir-SEG dataset based on the original Kvasir dataset by annotating the classes of polyps with the help of experts. Furthermore, they provided the processed dataset to the researchers around the world to prompt more techniques and further studies.

-Literature review

In the past twenty years, studying on how to detect the diseases of gastrointestinal (GI) tract in colonoscopic videos kept an active study field. Inside these areas, the detection of polyps is the most prevailing one. After these years' studies, Machine Learning models can perform better than ever that those models can reach the level of experts.

Research people also studied the CAD system rather than only algorithm development, the whole process covered data labeling, analysis, evaluation, and professional data visualization. By using techniques ranging from Machine Learning to Deep Convolutional Neural Network (CNN), Thambawita and his colleagues proposed several new models to achieve to give the result of classifying the GI. Likewise, Guo and his colleagues proposed two fully CNN models with different structures in the competition called Gastrointestinal Image Analysis (GIANA) and they won the match in 2017 while also took the second place in the GIANA match in 2018.

In 2015, Long and others proposed Fully Convolutional Network (FCN), which is an image segmentation with perfect performance methods, and it is based on semantic segmentation. FCN trained pixels end-to-end and they do not need any further steps to output the result. Besides, in the work of Ronneberger and his colleagues, it suggested a structure based on FCN and it is spread to U-Net structure. This structure performs with good results with different variants in the works of Milleari, Zhang, Guo, Cicek, Drozdal, Diakogiannis and Zhou whether using nature images or medical images.

Brandao suggested that polyps detection has an ideal result on most of the published datasets, and while doing tests, researchers prefer to train and validate datasets with a smaller size. However, this will directly lead to the problem of lack of robust and universality. Moreover, in some researches, the researchers only care of some specific types of polyps. And as the publication of some more unpublic datasets, it will make the comparison process to be more difficult. Although every researcher wants to avoid this, it is still an untouchable task for machines to reach the level of professional colonoscopists. Nevertheless, it has some possibilities to improve the performance of the system.

-Conclusions (In my case, conclusions are chapter 6: discussion and chapter 7: conclusion)

Discussion

After applying all models on datasets Kvasir-SEG and CVC-612, the ResUNet++ model proposed in this paper reveals the best result among all models, especially in terms of catching shape details in the Kvasir-SEG dataset. It means that it is more similar for the segmentation mask of ResUNet++ model than the other advanced models while the others like ResUNet-mod and U-Net also performed not bad.

Debash and his co-workers decided to utilize dice coefficient loss function as they discovered that ResUNet++ model performs with better dice coefficient value while all the mIoU values of other functions are low. Besides, the results in this experiment also being affected by batch size, optimizer and the amount of filters.

Debesh Jha and his colleagues convince that there are some improvements on the processes to improvement the performance, like increasing the size of dataset by utilizing some more advanced techniques and post-procedures. After these improvements, although the number of parameters increased on the structure, our training model received better performances. They thought that the model mentioned in their paper can not only be used in segmentation tasks for biomedical images but also for nature images and other types of pixels. Although this model has been improved by researchers, some advanced improvements that may have an impact on the performance of structure also exist. In this research, they figured out that the size of images might be changed as they only ran codes on the machine with the GPU of Nvidia-DGX-2. Therefore, some useful information might get lost because of that. Besides, time for training will increase due to more parameters used in ResUNet++ model.

Conclusion

In the article of Debesh Jha and his colleagues, they proposed a new structure that can achieve the needs of segmenting colorectal polyps in the colonoscopy examinations more accurately which is called ResUNet++. It has the strengths of residual units, excitation units, squeeze etc... The proposed model predicted more accurately in terms of semantic questions which performed better than U-Net and ResUNet structures after the

evaluations of applying it to multiple datasets. Furthermore, the proposed model in this article could be a strong baseline in the future study in clinical problems. Afterwards, to have a considerable segmentation result, other processing technologies can also use the model in this article.