Image Background Segmentation

February 21, 2023

1 Introduction

The segmentation of image backgrounds is a crucial pre-processing step for many computer vision applications, particularly in the context of training data for machine learning models. A review of the literature reveals numerous methods [4], [6] that have been proposed for background segmentation, including thresholding, edge detection, morphological operations, region-based segmentation, and deep learning approaches. While each method has its own strengths and weaknesses, a combination of techniques can often be effective. In this work, we investigate the performance of a hybrid method that combines edge detection and morphological operations for background segmentation in our dataset.

2 Existing Methods

Thresholding [8], one of the simplest methods, involves classifying each pixel in the image as either foreground or background based on whether its intensity is above or below a certain threshold. Edge detection [1], on the other hand, involves detecting edges in the image using various edge detection algorithms, and using them to segment the foreground from the background. Morphological operations [2], such as erosion and dilation, are commonly used for separating the foreground and background in an image with relatively uniform and smooth backgrounds. Region-based segmentation [5] involves grouping pixels into regions based on some criteria, such as color or texture, and classifying them as foreground or background. Finally, deep learning-based segmentation utilizes models to learn how to segment the foreground and background in an image. These models are trained on a large dataset of annotated images and learn to extract features from the images to perform the segmentation task.

3 Used Methods

In the initial stage of our investigation, we applied thresholding techniques to distinguish the foreground from the background. Regrettably, we encountered difficulties in segmenting the image due to the negligible dissimilarities between the pixels in the image. This was mainly attributed to the thickness of the section or the staining methods employed, resulting in the erroneous classification of some regions of the background as belonging to the foreground.

The edge detection approach proved to be a promising solution to the challenges encountered with the thresholding method. In our study, we employed the Canny Edge Detector [3], which is a well-known edge detection algorithm available in the opencv [7] module. Specifically, we detected the edges in the image and extracted the largest contour, thereby effectively separating the foreground from the background. However, we observed that the proposed algorithm's performance

was less satisfactory in cases where the images had lower quality or the brain slices had stroke lesions. In other words, the changes in pixel intensity may not be significant enough to be detected as edges, or the edges may be blurred or obscured by noise or other factors in the image. In addition, edges may not be continuous or smooth, which can make it difficult for edge detection algorithms to accurately locate the edges. These factors can make it challenging to detect the outer boundaries of objects using edge detection alone, especially in images with complex backgrounds or low contrast between the object and background.

4 Our approach

We realized that the solution to the problem would be a combination of methods. In order to tackle the problem of background segmentation, a combined approach is proposed, which leverages the advantages of both edge detection and morphological operations to achieve more accurate results.

The main steps of the algorithm are:

- Image loading and conversion to grayscale
- Application of the Canny Egde Detector
- Image dilation to thicken the edges and create a more complete boundary of the object
- Find the contours of the object
- Find the largest contour, the outer boundary
- Mask creation of the object by drawing the largest contour onto a new image
- Application of the mask to the original image

These steps effectively identify the object in the image by first detecting its edges, then creating a mask of the object, and finally applying the mask to the original image to isolate the object.

Our experimental results demonstrate that the proposed method achieves superior performance in terms of accuracy and robustness compared to the approaches mentioned above.

5 Results

In the Figure 1 we see the results of the method in the **good sections**. We can conclude that the method is **accurate in the 100% of the used instances.**

On the contrast, the method doesn't respond well in **bad sections** (Figure 2). It is **accurate only in the 3 out of 10 images or in the 30%**.

6 Conclusion

Our approach achieved high accuracy on a number of good sections. However, we note that our method struggled to achieve good results in certain cases, where the brain slices were not well cut. The method did not perform optimally on these sections, as the images contained significant noise, which led to inaccuracies in the background segmentation. We recognize that further investigation is required to improve the method's robustness and generalizability to a variety of image conditions.

References

[1] Salem Saleh Al-Amri, NV Kalyankar, and SD Khamitkar. Image segmentation by using edge detection. *International journal on computer science and engineering*, 2(3):804–807, 2010.

[2] Diya Chudasama, Tanvi Patel, Shubham Joshi, and Ghanshyam Prajapati. Image segmentation using morphological operations. *International Journal of Computer Applications*, 117:16–19, 05 2015.

[3] Lijun Ding and Ardeshir Goshtasby. On the canny edge detector. *Pattern Recognition*, 34(3):721–725, 2001.

[4] Osama Dorgham, Mohammad Abu Nasser, Mohammad Hashem Ryalat, and Ammar Almomani. Proposed method for automatic segmentation of medical images. In *2018 International Arab Conference on Information Technology (ACIT)*, pages 1–5. IEEE, 2018.

[5] Stephen Gould, Tianshi Gao, and Daphne Koller. Region-based segmentation and object detection. *Advances in neural information processing systems*, 22, 2009.

[6] Dilpreet Kaur and Yadwinder Kaur. Various image segmentation techniques: a review. *International Journal of Computer Science and Mobile Computing*, 3(5):809–814, 2014.

[7] Naveenkumar Mahamkali and Vadivel Ayyasamy. Opencv for computer vision applications. 03 2015.

[8] Zuodong Niu and Handong Li. Research and analysis of threshold segmentation algorithms in image processing. *J. Phys. Conf. Ser.*, 1237(2):022122, June 2019.

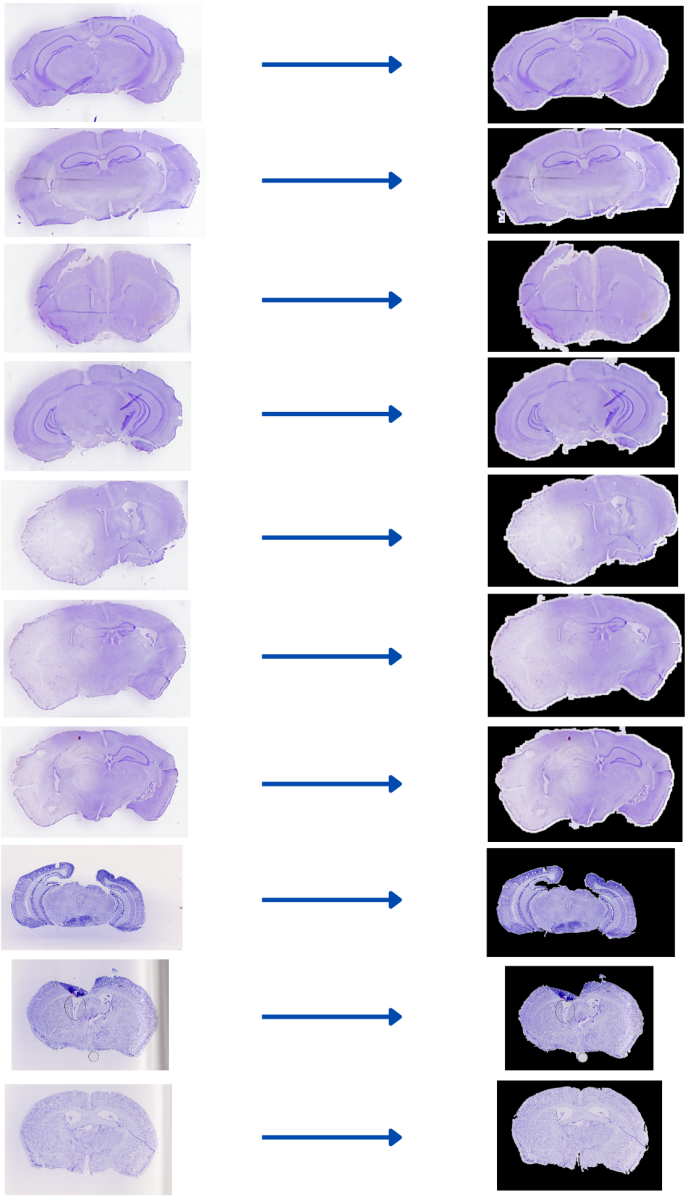

Figure 1: Results of the proposed method for background segmentation of brain slice images. The left column shows the original images, and the right column shows the segmented images using the proposed method.

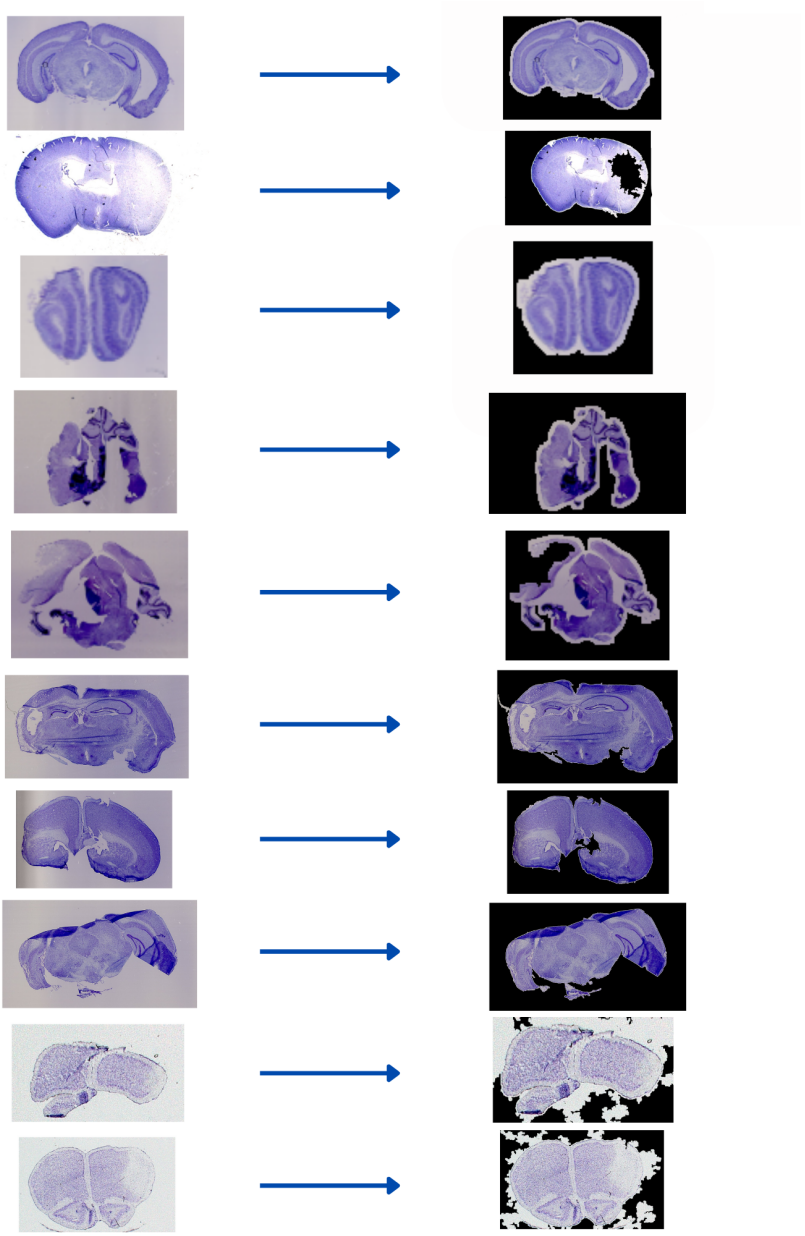

Figure 2: Results of the proposed method for background segmentation of brain slice images. The left column shows the original images, and the right column shows the segmented images using the proposed method.