INTERPOLATION METHODS IMPACT ON EYE FUNDUS OPTIC DISC AND OPTIC CUP SEGMENTATION

Sandra Virbukaitė, Jolita Bernatavičienė
Institute of Data Science and Digital Technologies, Vilnius University
sandra.virbukaite@mif.vu.lt

INTRODUCTION

The Optic Disc *(OD)* and Optic Cup *(OC)* are the key parameters in eye health assessment which is manual and time-consuming. With the help of computer-aided systems, this assessment can be automated and work as an advisory opinion for doctors. Here, accurate segmentation of the OD and OC is essential as the ratio of these parameters used in various eye diseases such as glaucoma diagnosis. One of the computer-aided systems is a Convolutional Neural Network *(CNN)* U-Net [1] that uses eye fundus images of the same size. The variety of images size caused by different eye fundus cameras [2] is aligned using an image resizing technique where the image interpolation occurs. In this research, we applied the three most common interpolation methods, such as bilinear, nearest neighbour, and bicubic, and evaluated the impact on Optic Disc and Optic Cup segmentation caused by these interpolation methods.

EXPERIMENT AND RESULTS

For this experiment, the publicly available images with their corresponding ground truth of RIM-ONE (159), REFUGE (800) and DRISHTI (101) datasets have been used. By applying image augmentation techniques, such as image rotation by an angle of rotation from 0° to 45°, zooming by 20%, horizontal and vertical flipping, the number of images was increased to 2000 for each dataset. The images were cropped by the area of OD and resized to size of 128 x 128 pixels by three different interpolation methods:

- **Bi-linear** interpolation, which uses the weighted average of the 4 nearest neighbours to produce the output.
- **Nearest Neighbour** interpolation, which selects the value of the nearest point and does not consider the values of neighboring points at all, yielding a piecewise-constant interpolant.
- **Bi-cubic** interpolation, which uses the weighted average of the 16 nearest neighbours to produce the output.

The cropped and resized by different interpolation methods images were used to train a convolutional neural network U-Net. Optic Disc and Optic Cup segmentation results were evaluated by Dice similarity coefficient *(Table 1).*

Table 1. OD and OC segmentation results by Dice score.

Interpolation	RIM-ONE		REFUGE		DRISHTI	
	OD	OC	OD	OC	OD	OC
Bi-linear	0.92	0.82	0.90	0.73	0.93	0.82
Nearest Neighbour	0.94	0.80	0.91	0.76	0.95	0.84
Bi-cubic	0.96	0.84	0.93	0.79	0.96	0.85

The visual examples together with Dice score of the worst and the best Optic Disc and Optic Cup segmentation obtained by training CNN on resized by different interpolation images are shown in Image 1. Here, white circle indicates the ground truth label, blue – segmented Optic Disc and green – segmented Optic Cup.

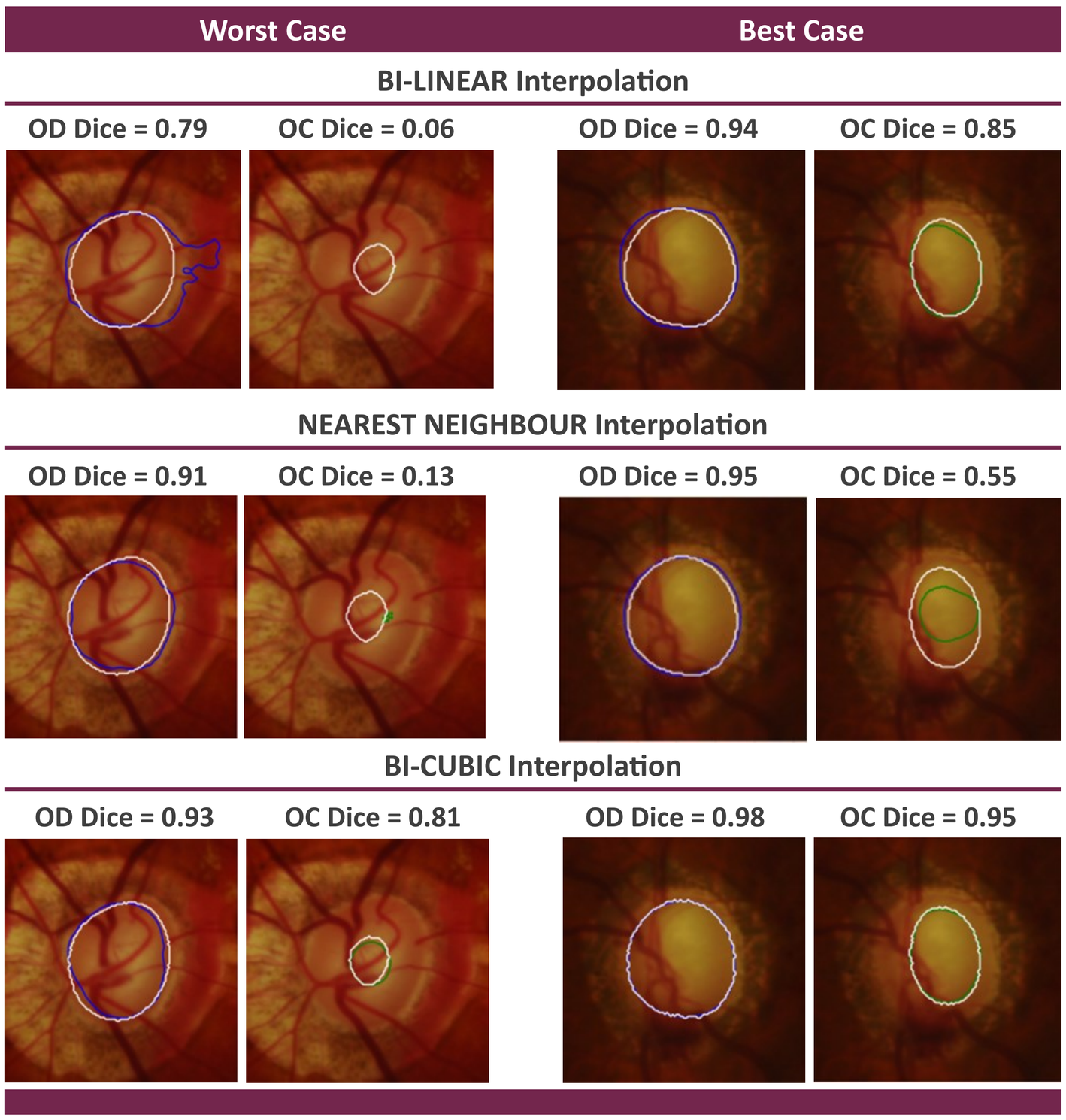

Image 1. Visual examples of OD and OC segmentation

CONCLUSIONS

The experiment has shown that applied interpolation method has an impact on OD and OC segmentation. In OD segmentation case, applying Bi-cubic interpolation for image resizing, a Dice score above 0.95 is achieved for 80% of test images out of 50, applying Nearest Neighbour and Bi-linear interpolation methods - for 56% and for 26% of images respectively. In OC segmentation case, applying Bi-cubic interpolation for image resizing, a Dice score above 0.75 is achieved for 64% of test images out of 50, applying Nearest Neighbour and Bi-linear interpolation methods - for 34% and for 22% of images respectively.

REFERENCES

[1] Ronneberger, O., Fischer, P., Brox, T.: U-Net: convolutional networks for biomedical image segmentation. In: Medical Image Computing and Computer-Assisted Intervention—MICCAI 2015, pp. 234–241. Springer International Publishing (2015). [2] Zhu, Q., Chen, X., Meng, Q., Song, J., Luo, G., Wang, M., Shi, F, Chen, Z., Xiang, D., Pan, L., Li, Z., Zhu, W., "GDCSeg-Net: general optic disc and cup segmentation network for multi-device fundus images," Biomed. Opt. Express 12, 6529-6544 (2021).