# MEA-Net: Multilayer Edge Attention Network for Medical Image Segmentation

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# Appendix

We tested the proposed baseline with or without decoder 4. As we can see from the Table S1, the experimental results of the baseline structure with the decoder 4 are not satisfactory, especially in the DRIVE dataset, where the results drop substantially. Adding a decoder requires additionally processing the feature information from the encoding path. Moreover, with the addition of D4, the convolution-pooling operation makes the image size smaller, which does not facilitate the decoding path to recover image information. Therefore, this network structure did not add D4.

**Table S1** Ablation studies for baseline on four datasets (mean ± standard deviation)

| Dataset | Network | Accuracy | Sensitivity | Dice | AUC | BF-Score |
|---|---|---|---|---|---|---|
| Tongue | Baseline + D4 | 0.9952±0.0008 | 0.9857±0.0023 | 0.9881±0.0018 | 0.9937±0.0012 | 0.9038±0.0171 |
| | Baseline | 0.9943±0.0059 | 0.9821±0.0262 | 0.9865±0.0156 | 0.9890±0.0128 | 0.8922±0.0946 |
| Drive | Baseline + D4 | 0.9682±0.0071 | 0.7674±0.0429 | 0.7979±0.0138 | 0.8602±0.0210 | 0.6704±0.1014 |
| | Baseline | 0.9725±0.0059 | 0.8289±0.0460 | 0.8331±0.0516 | 0.8773±0.0216 | 0.7056±0.0818 |
| Lung | Baseline + D4 | 0.9919±0.0023 | 0.9777±0.0101 | 0.9826±0.0072 | 0.9911±0.0043 | 0.9099±0.0905 |
| | Baseline | 0.9942±0.0020 | 0.9881±0.0096 | 0.9852±0.0064 | 0.9920±0.0042 | 0.9168±0.0661 |
| Clinical | Baseline + D4 | 0.9985±0.0031 | 0.9028±0.2339 | 0.9067±0.2177 | 0.9512±0.1169 | 0.8959±0.1872 |
| | Baseline | 0.9992±0.0004 | 0.9416±0.0240 | 0.9439±0.0540 | 0.9764±0.0120 | 0.9582 0.0648 |

We experimented with E1 and E2 as an input to the MAG as well. As can be seen from the Table S2, When E2 is also used as an input to the MAG, their segmentation performance for four datasets does not improve, but rather decreases, because it actually causes redundancy of information. E2 needs to be set to the same size and number of channels as E1, and then multiplied with each single attention map for attention weights. The Experimental results show that using E1 alone as the input of MAG obtains better segmentation performance.

**Table S2** Ablation studies for the input of MAG in MEA-Net on four datasets (mean ± standard deviation)

| Dataset | The input of MAG | Accuracy | Sensitivity | Dice | AUC | BF-Score |
|---|---|---|---|---|---|---|
| Tongue | E1+E2 | 0.9940±0.0068 | 0.9821±0.0284 | 0.9859±0.0149 | 0.9898±0.0139 | 0.8975±0.1173 |
| | E1 | 0.9957±0.0010 | 0.9904±0.0015 | 0.9902±0.0022 | 0.9938±0.0010 | 0.9075±0.0841 |
| Drive | E1+E2 | 0.9698±0.0066 | 0.7558±0.0763 | 0.7948±0.0096 | 0.8723±0.0358 | 0.6822±0.0945 |
| | E1 | 0.9736±0.0064 | 0.8349±0.0594 | 0.8377±0.0131 | 0.9113±0.0282 | 0.8064±0.1360 |
| Lung | E1+E2 | 0.9941±0.0017 | 0.9899±0.0087 | 0.9852±0.0056 | 0.9926±0.0037 | 0.9244±0.0387 |
| | E1 | 0.9942±0.0022 | 0.9903±0.0103 | 0.9858±0.0057 | 0.9923±0.0046 | 0.9332±0.0362 |
| Clinical | E1+E2 | 0.9993±0.0004 | 0.9689±0.0432 | 0.9672±0.0238 | 0.9842±0.0216 | 0.9418±0.1037 |
| | E1 | 0.9993±0.0004 | 0.9701±0.0208 | 0.9704±0.0141 | 0.9849±0.0104 | 0.9521±0.0657 |

We conducted an experimental comparison of the two loss functions as shown in Table S3. Loss function 1 is adding dice loss for the final loss, while loss function 2 is the designed loss function in Loss Function Section. Both loss function designs are relatively close, but the experimental results of our proposed loss function are slightly improved, so we continue with the original loss function design.

**Table S3** Ablation studies for loss function in MEA-Net on four datasets (mean ± standard deviation)

| Dataset | Loss function | Accuracy | Sensitivity | Dice | AUC | BF-Score |
|---|---|---|---|---|---|---|
| Tongue | Loss1 | 0.9925±0.0119 | 0.9760±0.0489 | 0.9822±0.0277 | 0.9867±0.0242 | 0.8922±0.1147 |
| | Loss2 | 0.9957±0.0010 | 0.9904±0.0015 | 0.9902±0.0022 | 0.9938±0.0010 | 0.9075±0.0841 |
| Drive | Loss1 | 0.9717±0.0056 | 0.8289 0.0377 | 0.8190 0.0105 | 0.9066±0.0184 | 0.6283±0.1242 |
| | Loss2 | 0.9736±0.0064 | 0.8349±0.0594 | 0.8377±0.0131 | 0.9113±0.0282 | 0.8064±0.1360 |
| Lung | Loss1 | 0.9944±0.0018 | 0.9875 0.0095 | 0.9859 0.0054 | 0.9918±0.0042 | 0.9197±0.0548 |
| | Loss2 | 0.9942±0.0022 | 0.9903±0.0103 | 0.9858±0.0057 | 0.9923±0.0046 | 0.9332±0.0362 |
| Clinical | Loss1 | 0.9993±0.0004 | 0.9681±0.0279 | 0.9675±0.0175 | 0.9838±0.0139 | 0.9054 0.0920 |
| | Loss2 | 0.9993±0.0004 | 0.9701±0.0208 | 0.9704±0.0141 | 0.9849±0.0104 | 0.9521±0.0657 |