

Supplementary Information

A microfluidic microalgae detection system for cellular physiological response based on object detection algorithm

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Table. S1 Detection performance after model optimization.

| Data Aug | Optimizer | Act Func | Loss Func | Architecture | <i>Plat</i> | <i>Chlo</i> | <i>Duna</i> | <i>Sym</i> | <i>Porp</i> | <i>Hae</i> | mAP |
|---------------|------------|------------|-------------------|-----------------------------|-------------|-------------|-------------|------------|-------------|------------|--------------|
| None | SGD | SiLU | CloU | YOLOv8n (baseline) | 0.890 | 0.475 | 0.848 | 0.983 | 0.967 | 0.989 | 0.859 |
| Mosaic | SGD | SiLU | CloU | YOLOv8n | 0.934 | 0.696 | 0.883 | 0.982 | 0.978 | 0.984 | 0.909 |
| MixUp | SGD | SiLU | CloU | YOLOv8n | 0.931 | 0.553 | 0.865 | 0.973 | 0.970 | 0.986 | 0.88 |
| Both | SGD | SiLU | CloU | YOLOv8n | 0.967 | 0.711 | 0.934 | 0.991 | 0.978 | 0.992 | 0.929 |
| Both | Adam | SiLU | CloU | YOLOv8n | 0.946 | 0.653 | 0.923 | 0.987 | 0.980 | 0.991 | 0.913 |
| Both | RMSProp | SiLU | CloU | YOLOv8n | 0.928 | 0.615 | 0.932 | 0.985 | 0.976 | 0.984 | 0.903 |
| Both | SGD | ReLU | CloU | YOLOv8n | 0.945 | 0.719 | 0.941 | 0.990 | 0.969 | 0.987 | 0.925 |
| Both | SGD | Leaky ReLU | CloU | YOLOv8n | 0.946 | 0.717 | 0.942 | 0.981 | 0.979 | 0.991 | 0.926 |
| Both | SGD | ELU | CloU | YOLOv8n | 0.939 | 0.726 | 0.949 | 0.989 | 0.970 | 0.992 | 0.928 |
| Both | SGD | ELU | SloU | YOLOv8n | 0.934 | 0.749 | 0.936 | 0.991 | 0.982 | 0.986 | 0.930 |
| Both | SGD | ELU | Focal_EIoU | YOLOv8n | 0.960 | 0.762 | 0.953 | 0.992 | 0.974 | 0.991 | 0.939 |
| Both | SGD | ELU | GIoU | YOLOv8n | 0.937 | 0.742 | 0.953 | 0.990 | 0.982 | 0.985 | 0.932 |
| Both | SGD | ELU | DIoU | YOLOv8n | 0.956 | 0.752 | 0.942 | 0.991 | 0.982 | 0.990 | 0.936 |
| Both | SGD | ELU | Focal_EIoU | YOLOv8n + p2 | 0.925 | 0.845 | 0.960 | 0.979 | 0.980 | 0.961 | 0.942 |
| Both | SGD | ELU | Focal_EIoU | YOLOv8n + p2 + BiLRA | 0.949 | 0.873 | 0.937 | 0.988 | 0.983 | 0.983 | 0.952 |

The bolded text indicates the way in which the model detection performance is most improved among the various tricks in this column. *Plat*: Platymonas; *Chlo*: Chlorella; *Duna*: Dunaliella salina; *Sym*: Symbiodinium; *Porp*: Porphyridium; *Hae*: Haematococcus; **Both**: Mosaic + MixUp; BiLRA: Bi-Level Routing Attention

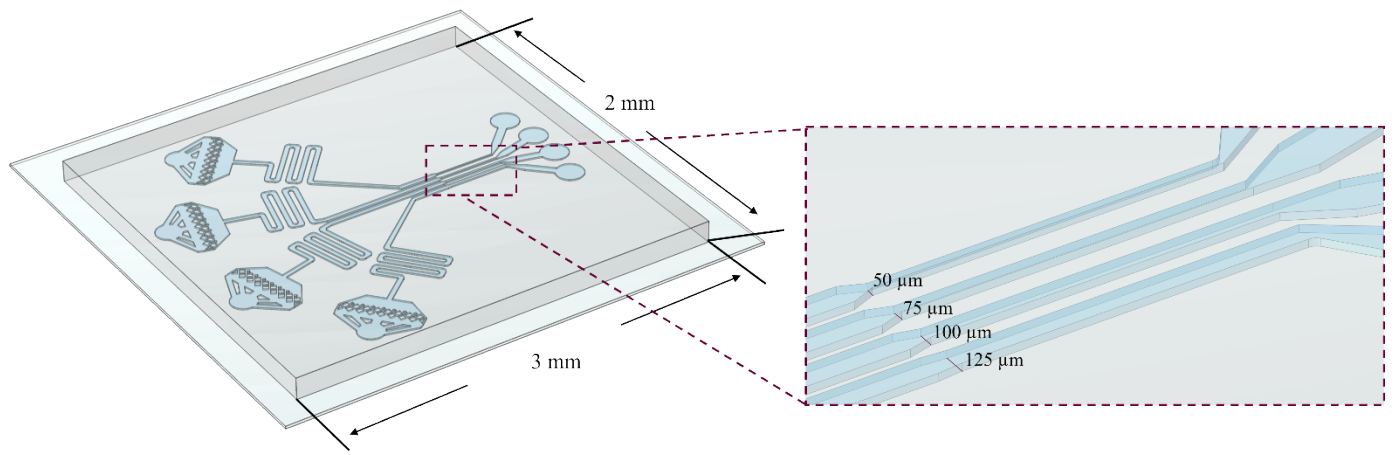


Fig. S1 The microfluidic chip schematic diagram

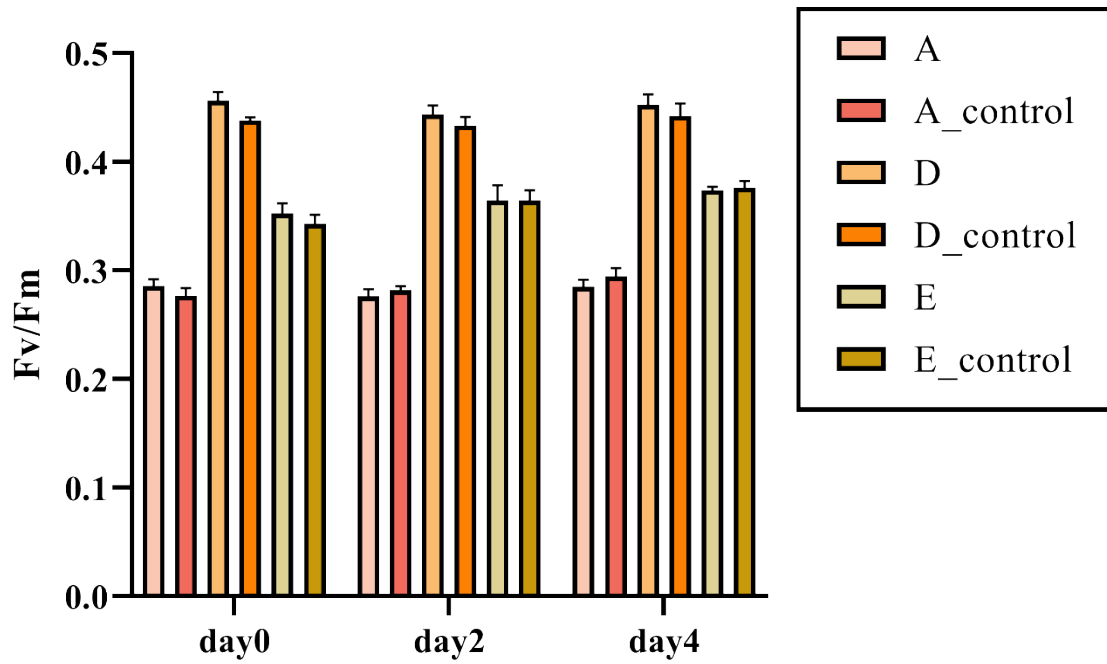


Fig. S2 Cell activity after adding sorbitol. the "control" group represents cell samples treated with sorbitol. Under the same culture conditions, the measurements of maximum photosynthetic efficiency in samples with added sorbitol are nearly identical to the original samples. Moreover, after 4 days, there is a slight increase in activity.

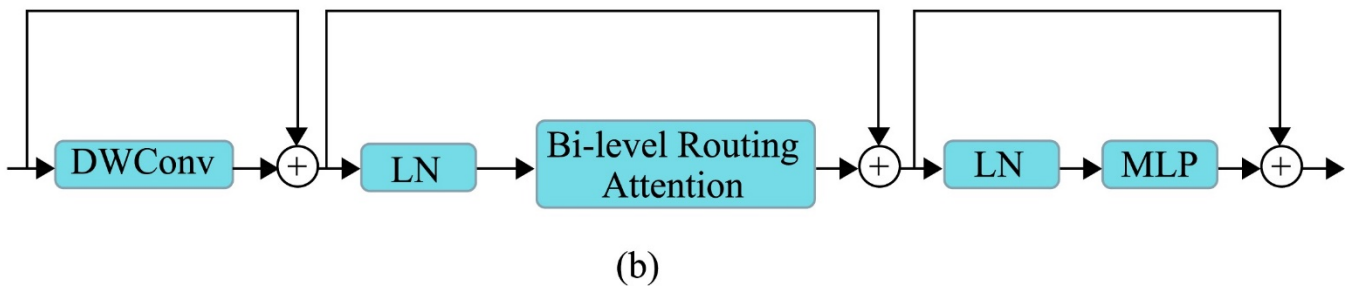
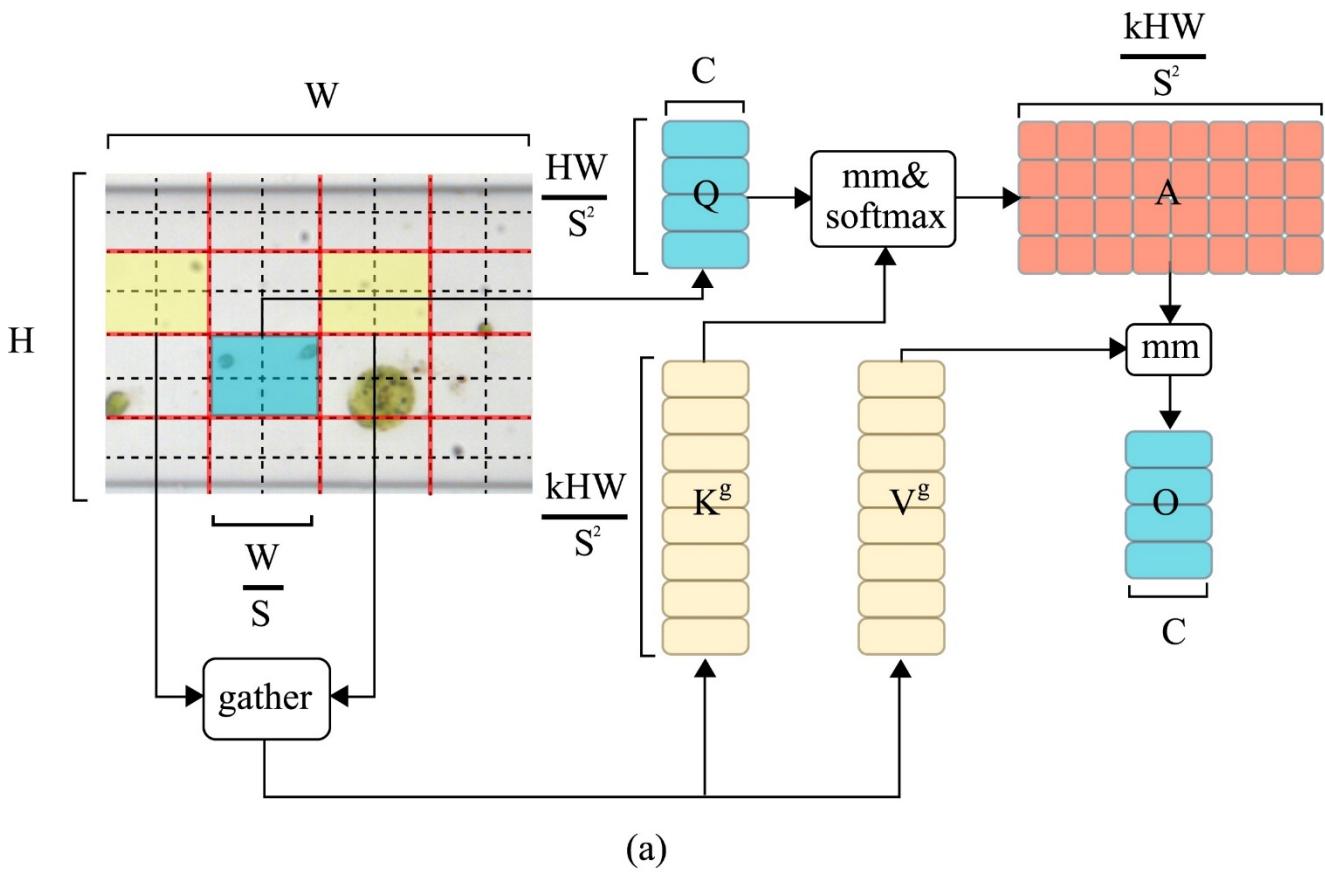


Fig. S2 The structure of Bi-Level Routing Attention ¹. (a) The schematic diagram of Bi-Level Routing Attention; (b) Details of the BiFormer block

Reference

1. L. Zhu, X. Wang, Z. Ke, W. Zhang and R. Lau, *Journal*, 2023, DOI: 10.48550/arXiv.2303.08810, arXiv:2303.08810.

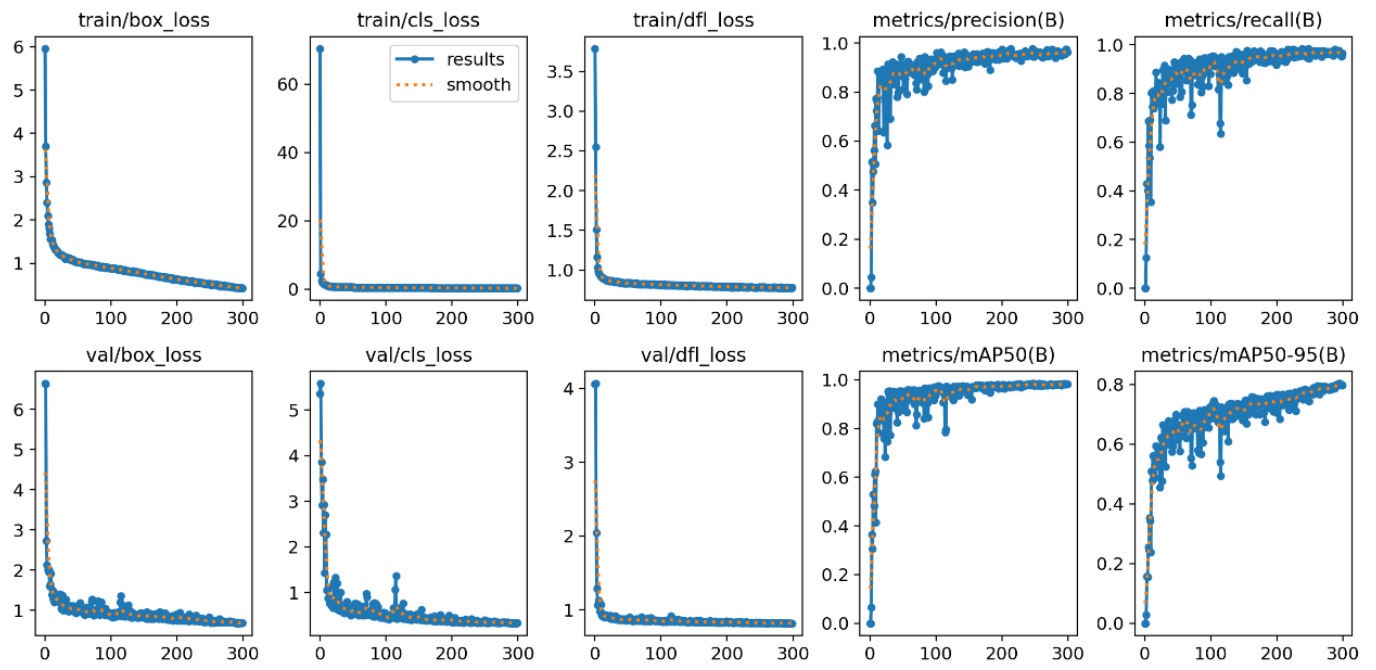


Fig. S3 The training and validation loss of the optimized model

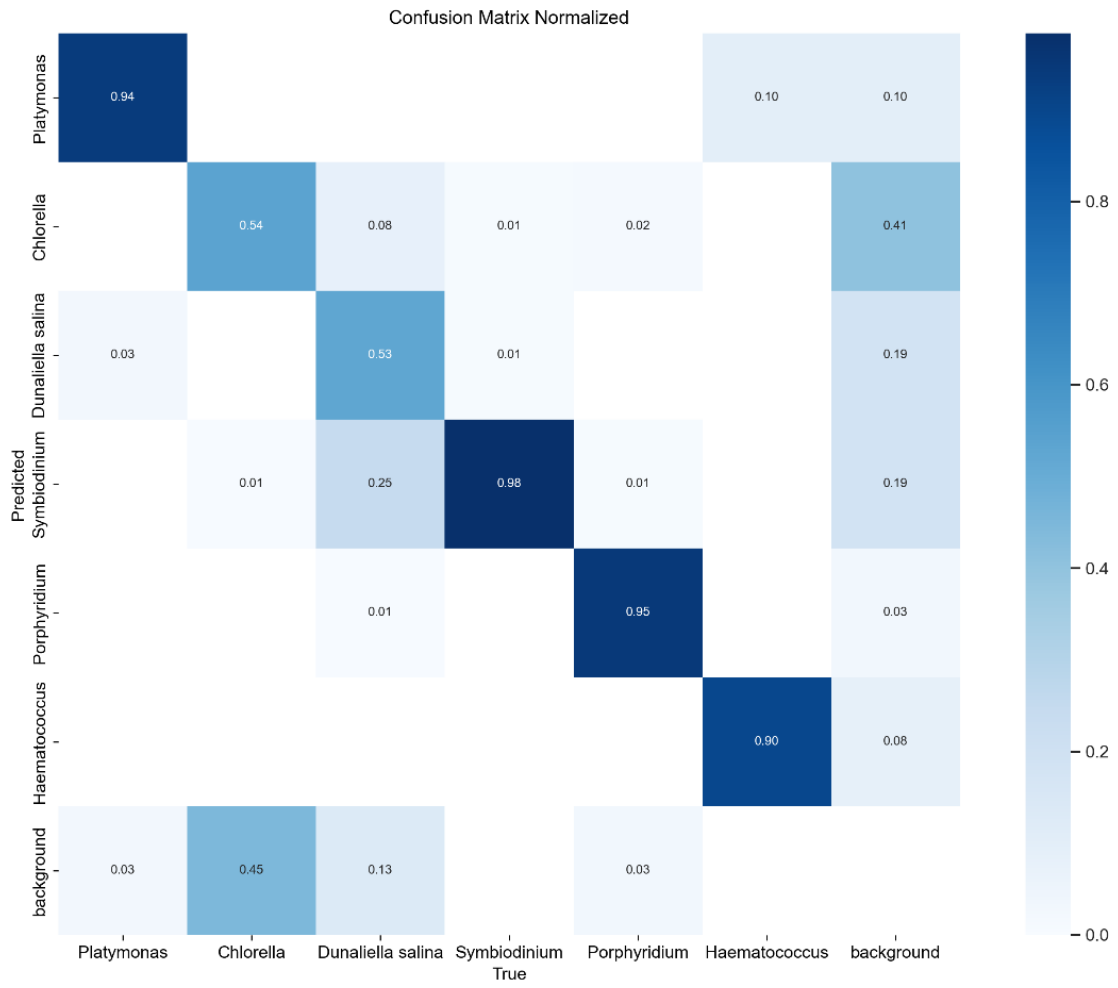


Fig. S4 The confusion matrix of the baseline model