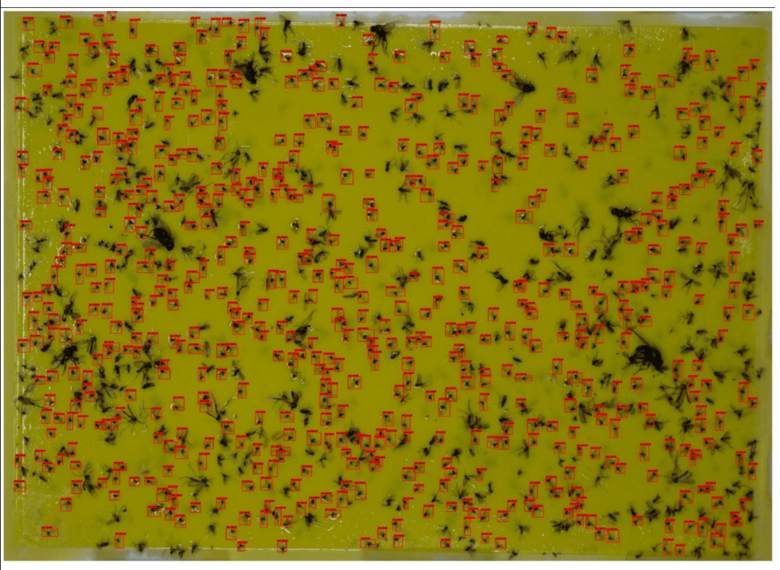
Interactive Image-Based Aphid Counting in Yellow Water Traps under Stirring Actions

Accepted by VAIB (Visual observation and analysis of Vertebrate And Insect Behavior) workshop in the 27th International Conference on Pattern Recognition

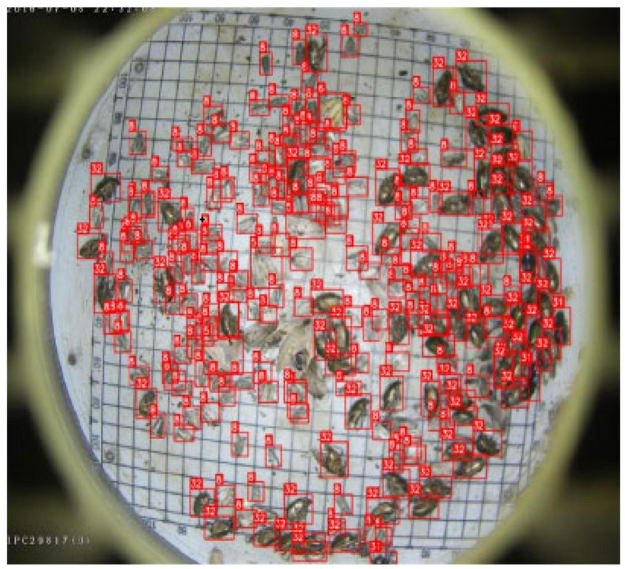
Authors: Xumin Gao, Mark Stevens, Grzegorz Cielniak

Background

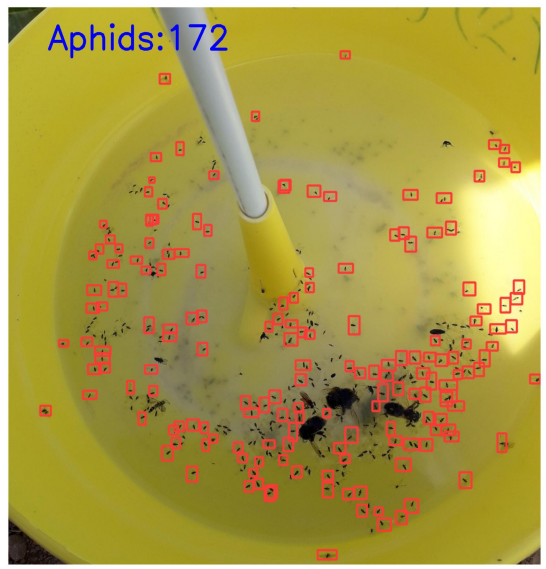


(a)

(b)



(c)



(d)

Fig. Some typical works of automatic aphid/pest counting

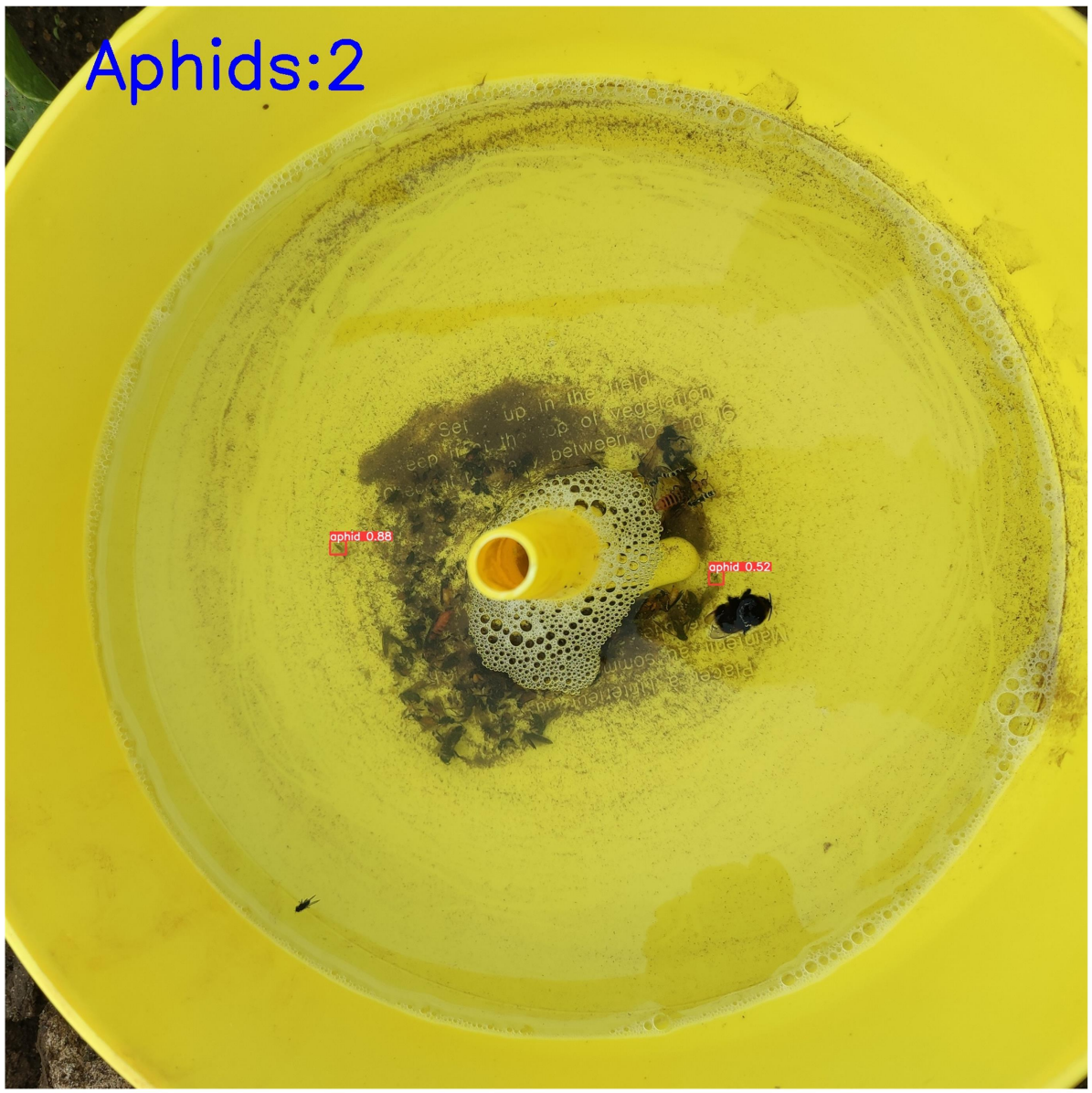
Common Limitations:

a) Static counting

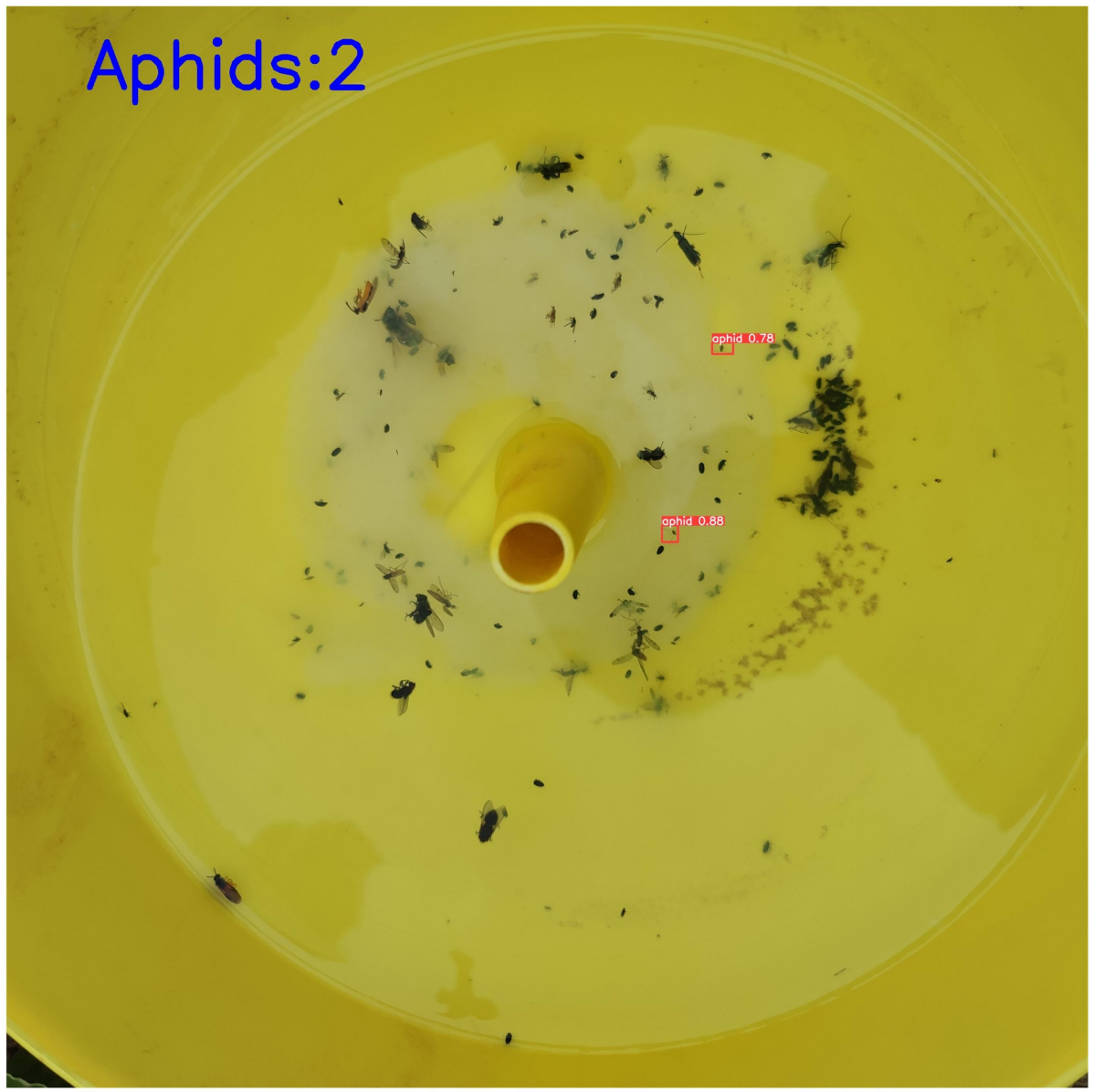
b) Inaccurate (severity of undercounting)

c) Occlusions (aggregation, foreign objects) or Submersion

Questions



Sinking to the bottom and clustering

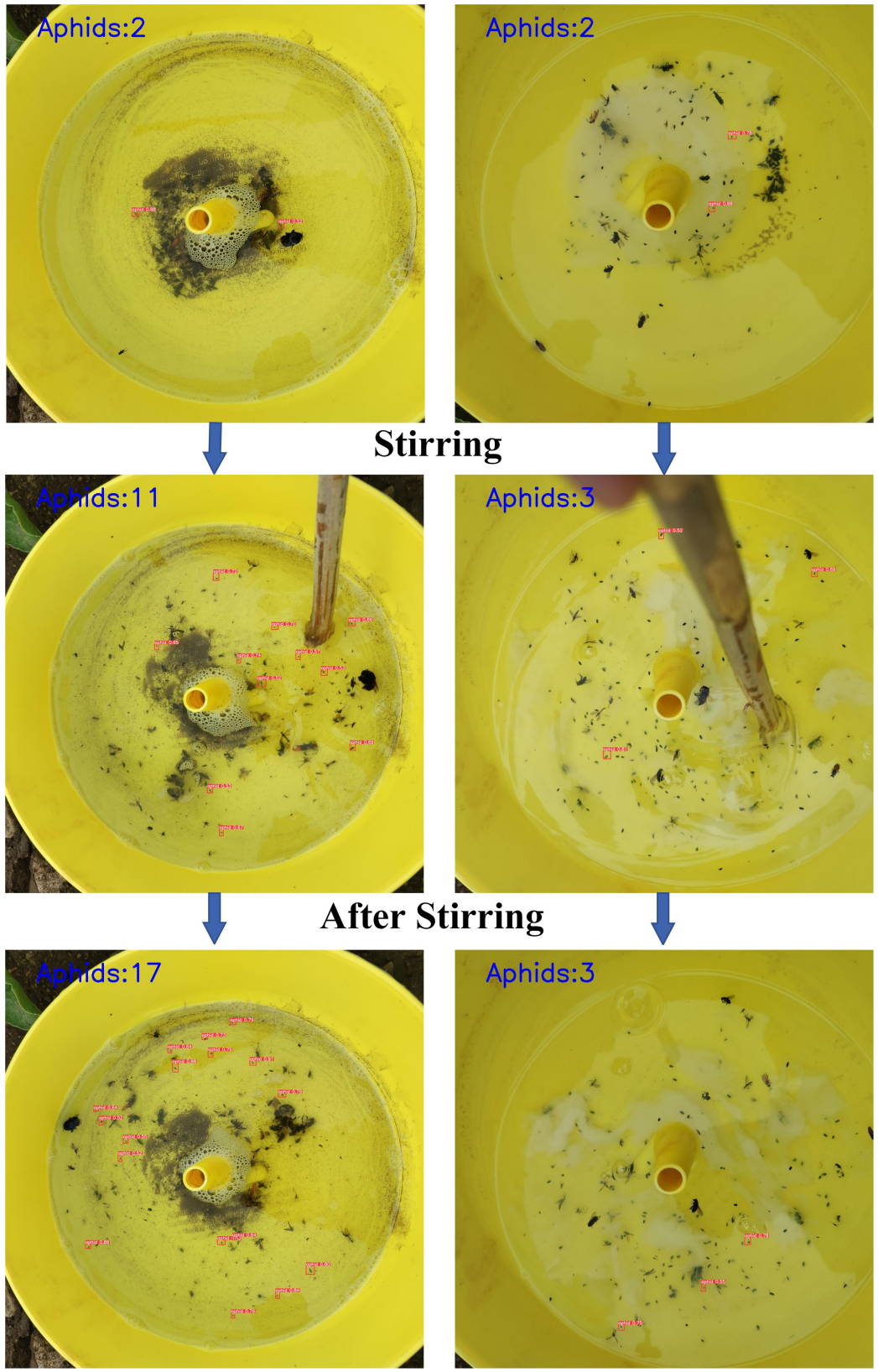


Sinking to the bottom and invisible areas

1) How to count aphids in severely occluded?

2) Are there any aphids in the invisible areas?

Solution



Maximum count = Final count ??

Solution

Maximum count ≠ Final count ??

To what extent can this counting result be trusted? ➡ **counting confidence evaluation**

Method

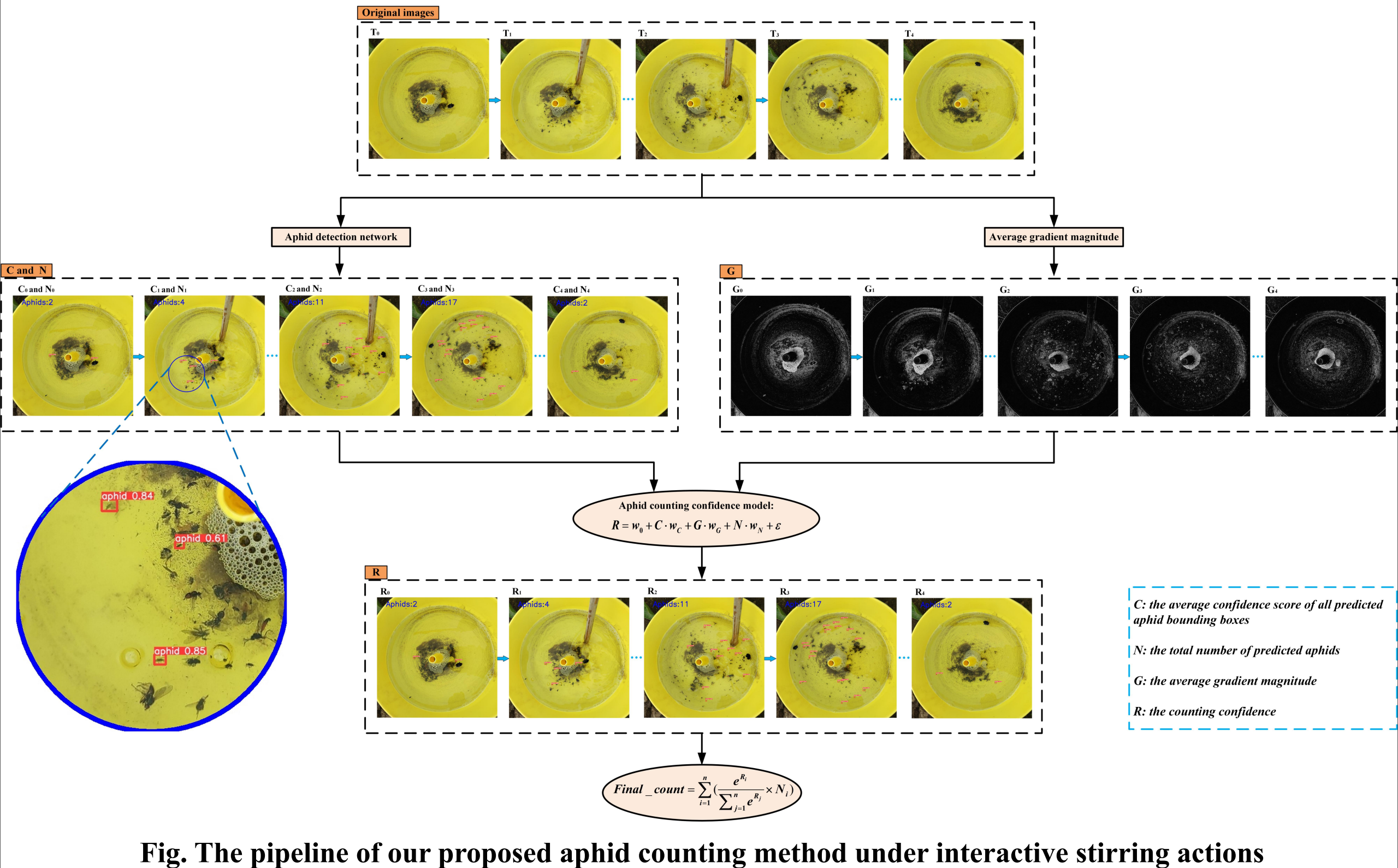


Fig. The pipeline of our proposed aphid counting method under interactive stirring actions

Method

Improvements

1. Split-merge strategy
2. Insert ODConv in backbone
3. Insert CoT block in backbone
4. Soft-NMS post-processing

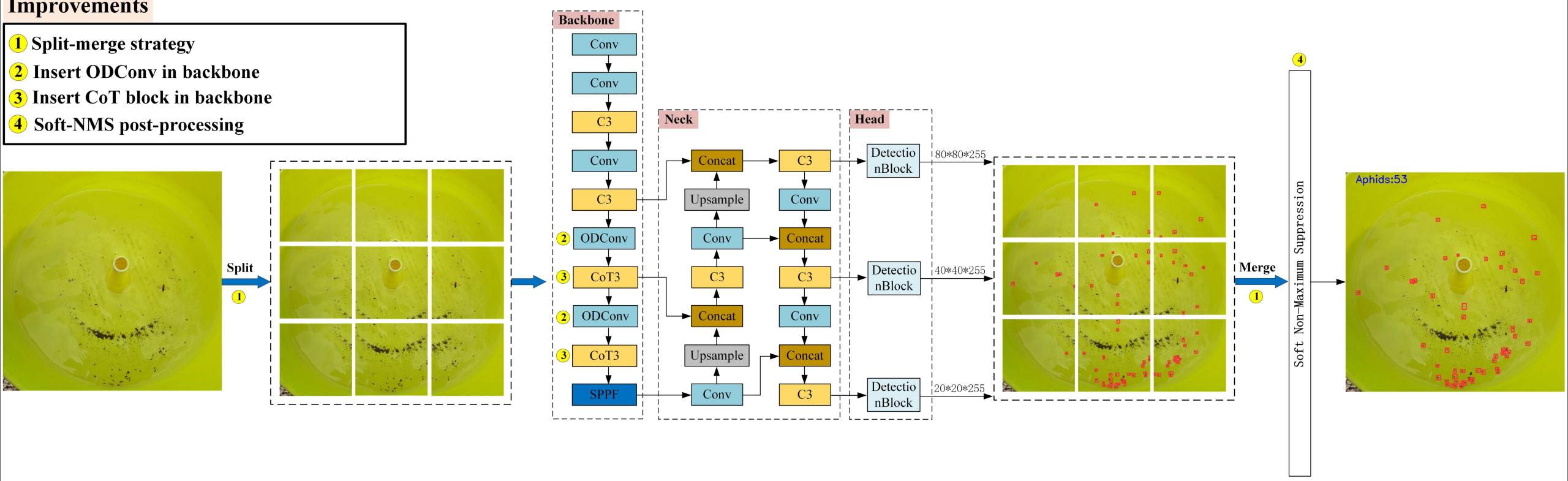


Fig. The pipeline of our proposed aphid detection network

Experimental results

Table. The comparison results of detecting aphids using different networks on the test set

Method	AP @0.5 (%)	AP @[0.5:0.95] (%)
Original Yolov5	40.9	17.2
Ours	74.8	44.1

Table. Ablation study

Yolov5s	ODConv	CoT3	Split-merge	Soft-NMS	AP @.5 (%)	AP @[.5:.95] (%)
√					40.9	17.2
√	√				41.6 (↑ 0.7)	17.4 (↑ 0.2)
√	√	√			43.2 (↑ 1.6)	17.8 (↑ 0.4)
√	√	√	√		73.9 (↑ 30.7)	43.6 (↑ 25.8)
√	√	√	√	√	74.8 (↑ 0.9)	44.1 (↑ 0.5)

Our proposed aphid detection network based on an improved Yolov5 significantly outperforms the original Yolov5, with improvements of **33.9%** in AP@0.5 and **26.9%** in AP@[0.5:0.95] on the aphid test set.

Experimental results

Table. The comparison of aphid counting results using different methods

Group number	Static counting	Maximum count under interactive stirring actions	Ours	Manual counting
1	2	17	9	10
2	15	23	18	21

Our proposed counting method under interactive stirring actions significantly outperforms static counting **and closely matches manual counts**. Additionally, the maximum count tends to be overestimated.

Future work

1) This work is still in progress

2) Collecting more data to improve the counting confidence evaluation system

3) Further investigating the impact of stirring actions on counts, such as the duration and type of stirring

References

[1] Zhang, W., Huang, H., Sun, Y. and Wu, X., 2022. AgriPest-YOLO: A rapid light-trap agricultural pest detection method based on deep learning. Frontiers in Plant Science, 13, p.1079384.

[2] Hong, S.J., Nam, I., Kim, S.Y., Kim, E., Lee, C.H., Ahn, S., Park, I.K. and Kim, G., 2021. Automatic pest counting from pheromone trap images using deep learning object detectors for matsucoccus thunbergianae monitoring. Insects, 12(4), p.342.

[3] Lee, J.H. and Son, C.H., 2023. Trap-based Pest counting: Multiscale and deformable attention centerNet integrating internal lr and hr joint feature learning. Remote Sensing, 15(15), p.3810.

[4] Gao, X., Xue, W., Lennox, C., Stevens, M. and Gao, J., 2024. Developing a hybrid convolutional neural network for automatic aphid counting in sugar beet fields. Computers and Electronics in Agriculture, 220, p.108910.

THANKS

This work was supported by the Engineering and Physical Sciences Research Council [EP/S023917/1], the AgriFoRwArdS CDT, and the BBRO. Thanks to the support of the University of Lincoln.