MUNICIPAL SOLID WASTE MANAGEMENT

Towards automatic enumeration of Black Soldier Fly Larvae offspring

eawag
aquatic research

Sandec
Sanitation, Water and
Solid Waste for Development

Motivation

Dosing of a defined number of young larvae (typically five to seven days old) per unit of biowaste and/or larvero (treatment crate) volume and area ensures efficient and reliable black soldier fly larvae biowaste treatment. Such dosing requires a reliable estimate on the number of larval offspring, which previously was determined by laborious manual counting of young larvae (Figure 1). This factsheet summarises our attempts to make larvae enumeration more efficient and accurate using computer vision. We hope this factsheet encourages the uptake and further development of the counter, tailored to the possibilities at treatment facilities in low- and middle-income countries.

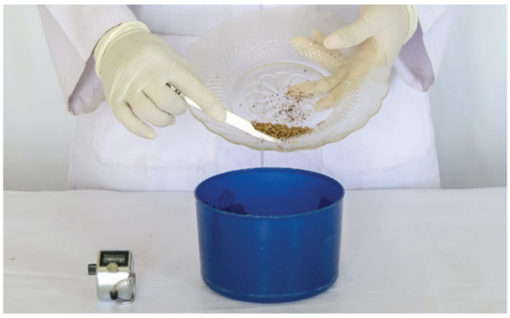

Figure 1: Manual counting of young black soldier fly larvae.

HistoNet

Automatic counting of black soldier fly larvae by computer vision is challenging because they are small and similarly-looking. Our counter uses the novel HistoNet deep learning architecture that predicts object size distributions and total counts in cluttered scenes directly from an input image. Details on the development and validation of HistoNet are included in Sharma et al. (2020). The counter can be downloaded from ERIC/open (https://opendata.eawag.ch), the Eawag Research Data Institutional Repository.

Computer system requirements

HistoNet operates in Python. Therefore, the first step is to install a Python software (here: Anaconda) and install libraries required by HistoNet. Furthermore, running the model requires a computer with system memory exceeding 32 GB RAM.

- Install Anaconda (> version 3.7, www.anaconda.com)
- Install opencv (https://opencv-python-tutroals.readthedocs.io/en/latest/index.html)
- Install Theano (https://theano.readthedocs.io/en/0.8.x/index.html)
- Install Lasagne (https://lasagne.readthedocs.io/en/latest/user/installation.html)

Input image requirements

To ensure reliable estimation of larval counts, the approach requires an input image taken under the same conditions as used for model calibration. As shown in Figure 2 and 3, the model was calibrated with images of larvae on a black background taken from 28 cm distance with a Sony WX350 (18.2 Mio. Megapixel) without zoom.

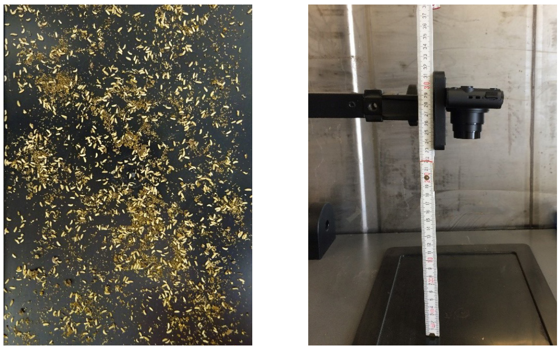

Figure 2: Input images of HIstoNet are young larvae on a black tray (left) and current HistoNet model set up calibrated for images from 28 cm with a Sony WX350 without zoom (right).

Estimation of larval number and size distribution

Following installation of the Python environment and recording of an input image, the larval number ± 2 larvae (Sharma et al., 2020) and size distribution can be estimated using the graphical user interface (GUI) by running python gui.py. As shown in Figure 4, the GUI has two buttons: One for upload of the input image and one for running the HistoNet model using the input image to predict the larval number and size distribution. The model can be altered by assigning changing the path to a different model in predict_gui.py.

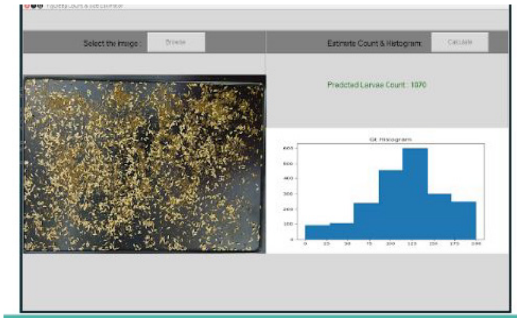

Figure 4: HistoNet graphical user interface (GUI).

Next steps

Shortcomings of the current version of the larval counter is knowledge on Python and high requirements on computer system memory and image quality. The model can be downloaded from ERIC/open (https://opendata.eawag.ch). We hope that sharing the model and code will encourage take-up. The model also required further development considering knowledge and computer systems available at black soldier fly treatment facilities in low- and middle-income countries. Specifically, reducing model size to allow smart phone operation, increased robustness to allow use under variable image collection conditions and a mode allowing continuous training of the model by the user. Users and developers of the model are obliged to cite HistoNet (Sharma et al., 2020).

Further reading

Sharma, K., Gold, M., Zurbrügg, C., Leal-Taixé, L., & Wegner, J. D. (2020). HistoNet: Predicting size histograms of object instances. In The IEEE Winter Conference on Applications of Computer Vision, 3637-3645.