FlowerPhenoNet: Automated Flower Detection from Multi-view Image Sequences using Deep Neural Networks for Temporal Plant Phenotyping Analysis

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FlowerPhenoNet: Novelties

- A novel approach to flower detection from a multi-view image sequence using deep learning for plant phenotyping.
- A set of new temporal flower phenotypes and their significance in plant science.
- A publicly available benchmark dataset to facilitate research advancement in flower-based plant phenotyping.

FlowerPhenoNet: Steps

- *Image labeling*: The flowers in the training set are manually enclosed by rectangular boxes.
- *Data augmentation*: Application of geometric and photometric transformation to the labelled training set to increase its size.
- *Neural network architecture and training*: You Only Look Once (YOLO) object detector is used for flower detection.
- *Testing*: Image sequences consisting of images of all days for available views are used to test the performance of the detector.
- *Phenotype computation*: Computed phenotypes fall in two broad categories-
  - Trajectory-based: Denoted by graphical representation of $[p_1, p_2, ..., p_n]$, where p_i represents flower size (for flower growth trajectory) or total flower count (for blooming trajectory) for the i-th image of the plant.
  - Event-based: Timing of emergence of the first flower, the total number of flowers present at any time in the image sequence, and the size of each flower at any time.

Fig 2: Data augmentation

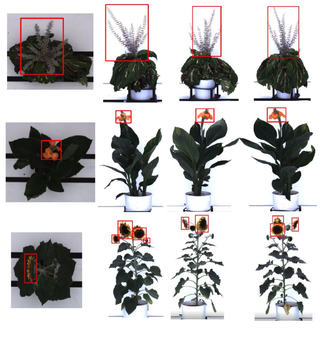

Fig 3: Sample labelled images from FlowerPheno dataset

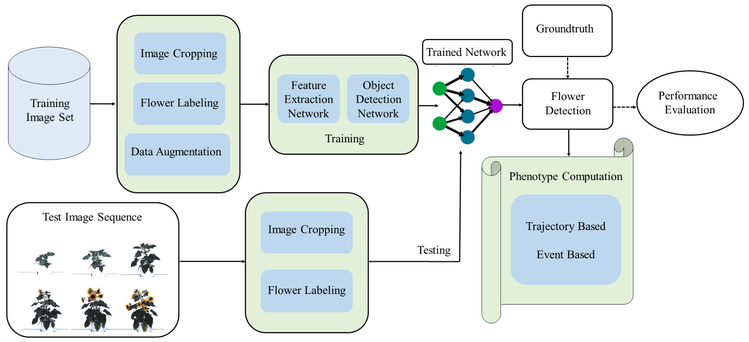

Fig. 1: Block diagram of FlowerPhenoNet

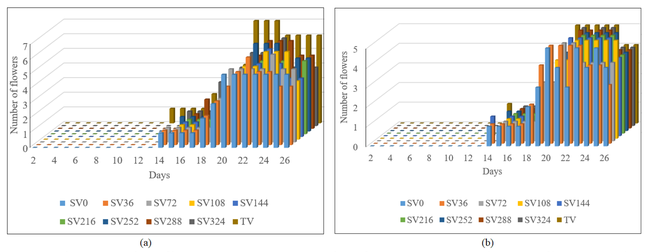

Fig. 4: The flower status graphs for two sample sunflower plants

Flower status report provides the following important information:

- The emergence day of the flower in each view
- The total number of flowers present for a given view on any day
- The highest number of flowers bloomed in the plant

Fig 5: Illustration of growth of canna flower over time

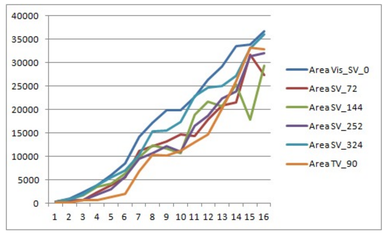

Fig 6: Growth trajectory of a canna flower in multiple views

Acknowledgement

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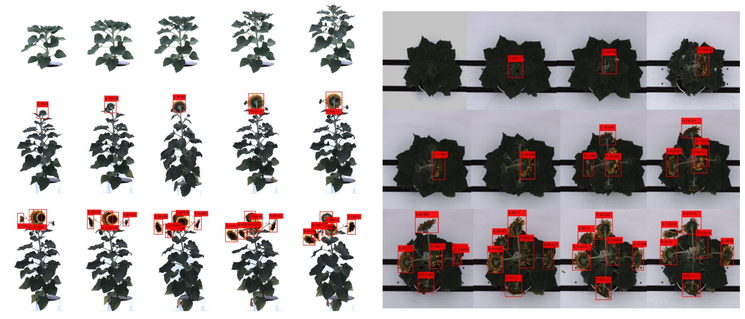
Temporal Phenotypes



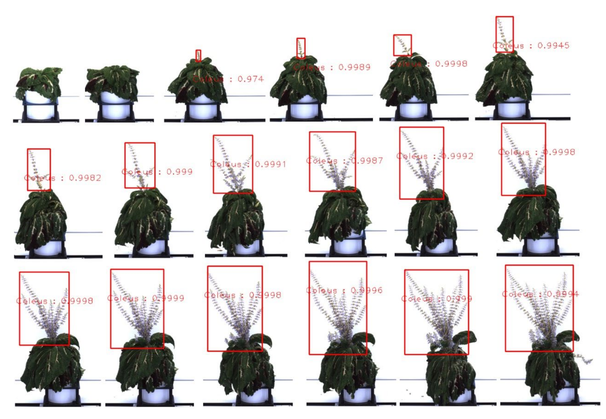


Fig. 7: Illustration of flower emergence timing detection using sample sunflower and coleus image sequences

FlowerPheno Dataset

- Consists of RGB image sequences
- Three flowering plant species: sunflower (*Helianthus annuus*), canna (*Canna generalis*) and coleus (*Plectranthus scutellarioides*)
- Total number of plants for each category: 20
- Number of days: 24 to 35
- Number of views: 10
- Download from https://plantvision.unl.edu/dataset

Fig 8: Sample images from the dataset