INTRODUCTION TO IMAGE PROCESSING AND COMPUTER VISION

LABORATORY PROJECT 1 (LABORATORIES 1 & 2)

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REALIZATION

- algorithms elaborated with OpenCV library
  - OpenCV (C++)
  - SimleCV/OpenCV (Python)
  - EmugCV (C#)
- solution for the laboratory task should contain:
  - source code with description (GUI is not obligatory, source file or Jupyter notebook)
  - folder containing segmentation results (prediction masks) – DO NOT INCLUDE DATASET!!!
  - documentation (report in pdf file)
- solution should be sent up to 20.12.2021
- DO NOT USE ML/DL SOLUTIONS!!!

DOCUMENTATION

- documentation should contain:
  - introduction, problem definition (task description, data set description)
  - literature review
  - description of solution (algorithm, step by step explanation and visualization, proposed imporvements)
  - results:
    - mean results for whole data set
    - mean results in subsets
    - examples of good and bad segmentation results
  - comments and conclusions

LITERATURE REVIEW

Leaf Segmentation under Loosely Controlled Conditions

Simone Buoncompagni[1]
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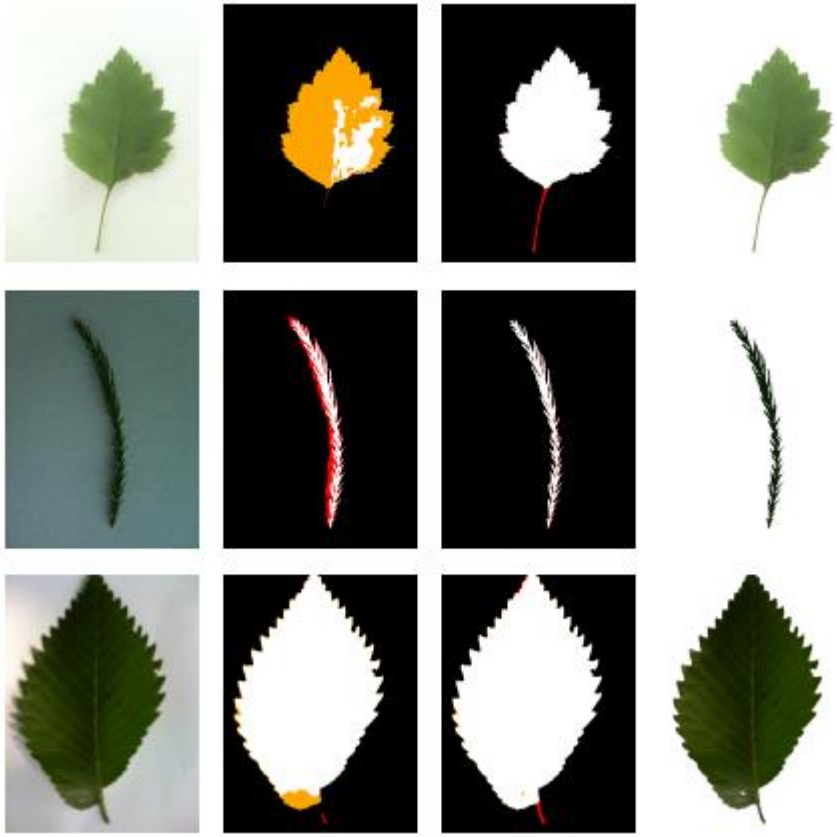
Abstract

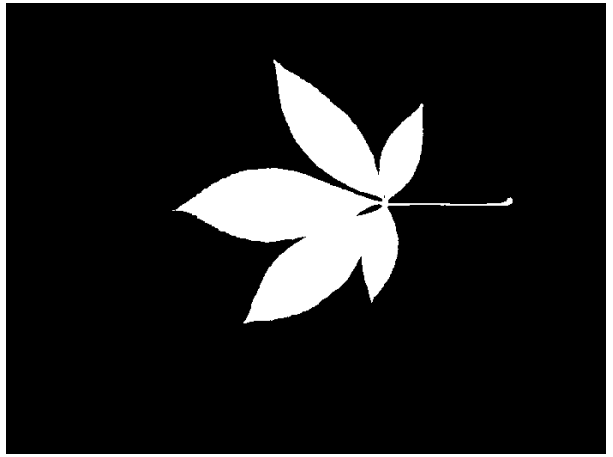
We propose a robust and accurate method for segmenting specular objects acquired under loosely controlled conditions. We focus here on leaves because leaf segmentation plays a crucial role for plant identification, and accurately capturing the local boundary structures is critical for the success of the recognition. Popular techniques are based on Expectation-Maximization and estimate the color distributions of the background and foreground pixels of the input image. As we show, such approaches suffer in presence of shadows and reflections thus leading to inaccurate detected shapes. Classification-based methods are more robust because they can exploit prior information, however they do not adapt to the specific capturing conditions for the input image. Methods with regularization terms are prone to smooth the segments boundaries, which is undesirable. In this paper, we show we can get the best of the EM-based and classification-based methods by first segmenting the pixels around the leaf boundary, and use them to initialize the color distributions of an EM optimization. We show that this simple approach results in a robust and accurate method.



Buoncompagni, Simone, Dario Maio, and Vincent Lepetit. "Leaf Segmentation under Loosely Controlled Conditions." BMVC. 2015.

LEAVES SEGMENTATION AND LABELING

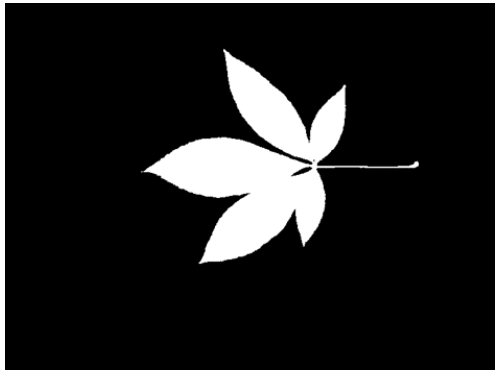
- input: images of leaves
- *Leaf Segmentation under Loosely Controlled Conditions* – **public dataset (part of Leafsnap Field dataset)**
- 300 different leaf images selected from the publicly available Leafsnap Field dataset
  - leaves_testing_set_1: 150 leaf images for which state-of-the-art methods produce already faithful segmentation results
  - leaves_testing_set_2: 150 leaf images for which state-of-the-art methods partially or totally fail



http://smartcity.csr.unibo.it/leaf-segmentation/

LEAVES SEGMENTATION AND LABELING

- output: segmented leaves (leaves masks and bounding boxes optionally)
- binary segmentation, automatic methods are prefered
- assessment according to Intersection over Union metric (IoU, also referred to as the Jaccard index) and Dice coefficient
- mean results for whole data set and in groups/sets

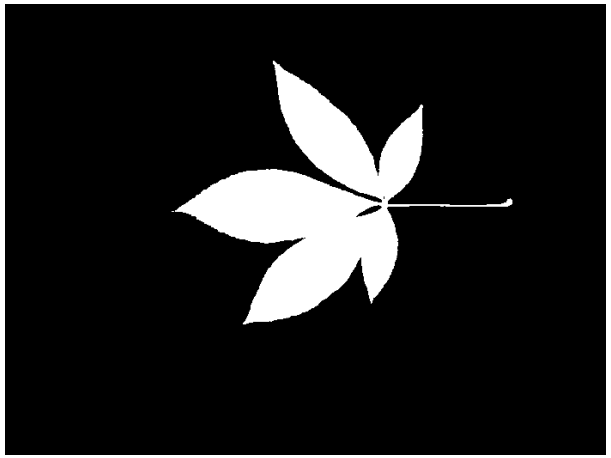


Ground truth (A, target) – binary mask

$$IoU = \frac{target \cap prediction}{target \cup prediction}$$

$$Dice = \frac{2\,|A \cap B|}{|A| + |B|}$$

Original image



Segmentation result (B, prediction) – binary mask

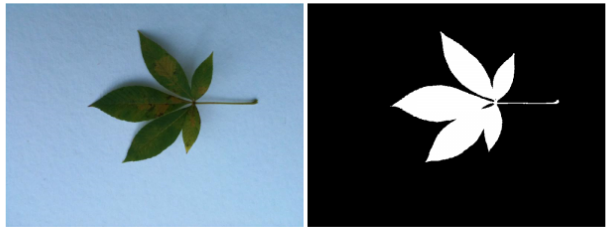
Segmentation result – bounding boxes

ASSESSMENT

- source code with description (idea, meritorical (content-related) assessment) – 10 pts
- documentation – 20 pts
  - introduction, problem definition – 2 pts
  - literature review – 2 pts
  - description of solution (explanation and visualization) – 7 pts
  - results (effectiveness and presentation layer) – 7 pts
  - comments and conclusions – 2 pts

DATA

Leaf Segmentation under Loosely Controlled Conditions



WORK ABSTRACT

We propose a robust and accurate method for segmenting specular objects acquired under loosely controlled conditions. We focus here on leaves because leaf segmentation plays a crucial role for plant identification, and accurately capturing the local boundary structures is critical for the success of the recognition. Popular techniques are based on Expectation-Maximization and estimate the color distributions of the background and foreground pixels of the input image. As we show, such approaches suffer in presence of shadows and reflections thus leading to inaccurate detected shapes. Classification-based methods are more robust because they can exploit prior information, however they do not adapt to the specific capturing conditions for the input image. Methods with regularization terms are prone to smooth the segments boundaries, which is undesirable. In this paper, we show we can get the best of the EM-based and classification-based methods by first segmenting the pixels around the leaf boundary, and use them to initialize the color distributions of an EM optimization. We show that this simple approach results in a robust and accurate method.

DATASET

We release hand-drawn ground truth segmentations for 300 different leaf images selected from the publicly available Leafsnap Field dataset [1].

Ground truth images result to be very useful to determine accuracy of a given segmentation method. In our paper [2] we chose and used Field images since they are taken in loosely controlled and non-uniform conditions, thus producing challenging conditions for automatic segmentation.

In this dataset two different subsets are included:

- leaves_testing_set_1: 150 leaf images for which state-of-the-art methods produce already faithful segmentation results;
- leaves_testing_set_2: 150 leaf images for which state-of-the-art methods partially or totally fail.

http://smartcity.csr.unibo.it/leaf-segmentation/

leafsnap

Home | Species | Dataset | About

Leafsnap Dataset

To promote further research in leaf recognition, we are releasing the **Leafsnap dataset**, which consists of images of leaves taken from two different sources, as well as their automatically-generated segmentations:

1. **23147 Lab** images, consisting of high-quality images taken of pressed leaves, from the Smithsonian collection. These images appear in controlled backlit and front-lit versions, with several samples per species.
2. **7719 Field** images, consisting of "typical" images taken by mobile devices (iPhones mostly) in outdoor environments. These images contain varying amounts of blur, noise, illumination patterns, shadows, etc.

The dataset currently covers all **185** tree species from the Northeastern United States.

If you use this dataset, please cite the following paper:

"Leafsnap: A Computer Vision System for Automatic Plant Species Identification,"
Neeraj Kumar, Peter N. Belhumeur, Arijit Biswas, David W. Jacobs, W. John Kress, Ida C. Lopez, João V. B. Soares,
Proceedings of the 12th European Conference on Computer Vision (ECCV),
October 2012
[paper (pdf)] [slides (pptx)] [bibtex]

NOTE: The dataset released here doesn't exactly match that used to compute results for the paper, nor the currently running version on our servers.

For questions and comments, please contact contact@leafsnap.com.

Downloads

Links	Description	Size	Version	Last updated
Download	Full Leafsnap dataset with original images, segmented images, text index of images, and readme	977MB	1.0	July 11, 2014

Data format

The included leafsnap-dataset-images.txt file contains a listing of all the images, in tab-separated format (tsv). The first line is the header row, which describes each column:

```
file_id    image_path    segmented_path    species    source
```

http://leafsnap.com/dataset/