Çağrı Erciyes:

I searched a Computer Vision System for automatic plant species identification whose name is “Leafsnap” and read the article about that application [1].

Leafsnap is the first mobile app for identifying plant species using automatic visual recognition. Computer vision is used to significantly simplify the plant species identification problem. The main parts of recognition process;

Classifying: Decide whether the image is of a valid leaf by using binary (leaf/non-leaf) classifier. That classifier can be trained on manually labelled images. That part is essential because of the severe lighting and blur artifacts, and also many users take photos of other objects (not leaf) .

Segmenting: Separate the leaf from background by obtaining binary image. The method is estimating foreground and background colour distributions in HSV colorspace (expectation- maximization). That part is crucial in order to obtain shape descriptions being accurate for recognition. It challenges shadows, blur, fine structures on leaves, removing false positive regions from the binary image and removing the stem from the image to standardize the shape.

Extracting: Obtain curvature features that representing the shape of the leaf. The method is computing histograms of curvature over multiple scales using integral measures. Curvatures are computed using different techniques such as ‘the area measure’ and ‘the arc length measure’.

Comparing: Search labelled database of leaf images and return the specifies with the closest matches. The method is simple nearest neighbour approach with histogram values intersection and it uses the extracting results of image.

In particular, the use of a pre-filter on input images, numerous speedups and additional post-processing within the segmentation algorithm, the use of a simpler and more efficient curvature-based recognition algorithm provides that all computation is completed in about 5 seconds (for one image recognition) . Also, the search database consists of features extracted from 23.915 ‘clean’ lab images of pressed leaves and 5192 field images taken by mobile devices.

***The first note is that, some species of leaves are compound (consisting of small leaflets); others are found grouped into clusters (e.g., pine needles)) . This gives rise to complex segmentation boundaries that are difficult to handle for edge-based or region-based methods. Colour-based pixel wise approach works well to achieve that (in segmentation part).

***The second note is that, in ‘extracting’ part, for constructing a feature vector suitable for classification, histograms of the curvature values at each scale are computed and concatenated together to form the Histograms of Curvature over Scale (HoCS).

***The third note, general main complications are;

- Field images contain varying amounts of blur and are photographed with different viewpoints and illumination.
- The often small inter-species variation against the large inter-species variation is considerable.

-->My main mission in that project is ‘Image Processing’ part which consists of classifying, segmentation, extracting features of leaf image and also creating labelled parameters for database search of leaves. For ‘Vision Recognition’ part, I will provide data which will be used for training of images and sometimes I might get involved in working of recognition part :)

-->Before anything else, I will talk with Turk botanists and biologists about to get basic shape classification characteristics about leaves and ask my other questions such as which leaves should we start from capturing (i.e. tree or flower) and how we will choose our labelled leaves in database.

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İlke Çuğu:

I examined “MobileFlora” a large-scale flower recognition mobile app. According to their paper “Development and Deployment of a Large-Scale Flower Recognition Mobile App” [1]:

- App collects flower images taken by users and classifies them into a set of flower categories
- They created the biggest flower dataset which consists of 250,000+ images of 578 different flower species, and they will continue to collect images from future users.
- Top 5 choices of possible flower classes returned and they are sorted by possibility. If user wants, at most 10 choices are given in order to avoid showing too many irrelevant results.
- If top 10 do not provide satisfactory choice, users can give a name to the flower, if they like. Otherwise, it saved as “unknown”.
- One of the discriminating characteristics of MobileFlora is that it can generalize within a class and can ignore irrelevant characteristics, such as colour.
- They proudly give a particular experiment result in order to show how powerful their recognition algorithm is in which their app gives fairly accurate results than Google Image Based Search Engine.

- App can handle user-generated images which may significantly vary in quality and will differ from the images of flowers that are encountered on web search engines.
- They used “fine-grained classification” technique.
- Only restriction about the usage is that full image of the desired flower must be within the boundaries of the image. Interestingly, multiple flowers (cluster flowers) are not a problem.
- They have expert biologists in their team in order to label the flowers accurately.
- In recognition part: they used near-duplicate detection to get rid of images very similar (nearly identical, but modified in some way e.g. by rescaling, compression, by adding noise or logo)
- Their recognition algorithm in general as follows:
  1) Extract HOG [2] features at 4 different levels.
  2) Encode them in 8196-dimensional global feature dictionary using the Local Linear Coding method of Wang [3].
  3) A global max pooling of the encoded features in the image done, as well as, max poolings in a 3x3 grid of the image [4].
  4) Then classified into individual 578 classes by a multiclass classification algorithm such as Support Vector Machines. Since their dataset is large, they used 1-vs-all strategy of linear classification and a Stochastic Gradient Descent version of SVM [4].
- They tested their recognition on Oxford 102 flowers dataset.
- The recognition algorithm part does not mean much for now. It is clear that a serious research and experimental work is needed. The workload of a large flower, in our case leaf, image database is emphasized and the term “multi-machine parallel computations” is also mentioned throughout the paper.

- My part in our project will be about Parallel Computing and Machine Learning. Since parallelization mostly requires a working serial algorithm, I will focus on machine learning strategies for tree identification at the beginning.

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Eren Şener:

Firstly, I tried to gather what kind of trees we have in Turkey. I came up with a list of tree names [1] from this site. (The names in the list are not the exact ones. After deciding which species we are going to use, I will find the exact names. And, it is not stated that these trees grow in Turkey but if we have Turkish names for them, we may grow them too.) Then, I looked for images of trees from the list. However, not having answers for some questions such as "How many images do we need for each class?, Does it matter having background of leaf images cluttered?, What kind of image should we use for species of coniferous evergreen trees (iğne yapraklı) just a leaf or a bunch of leaves?", I didn't continue to gather them.

Then, I focused on datasets that have been used by other researchers. And, I found some useful datasets [2][3][4] that we can extract the images of our own species from them. Also, we said that we will give reference to Wikipedia page of desired tree species for users who are interested in. We found this site [5] which is quite ordered than Wikipedia in terms of information about specific tree species. We may use this site instead of Wikipedia. Example specie from the site: [6]. After we answer questions above and decide on tree species, we can continue to gather leaf images. These sites [7][8][9] and Google Image Search may help us.

I will be working on the part of the project that requires mostly Machine Learning and Pattern Recognition.

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Emre Akın

I have searched an android application called “ApLeafis” which is an android-based plant leaf identification system. Also, I read the paper about this application (In Intelligent Computing Theories pp.106-111). Springer Berlin Heidelberg.

ApLeafis is the first “Android” based plant leaf identification application. Before this app, there was an application named “Leafsnap” which is based on IOS and the Leafsnap could perform the identification only when accessed to the Internet, and the query image must be taken by local camera. However, in ApLeafis, a user can take an image from his camera or upload a digital image to the application. Also, since ApLeafis has its own local database, there is no need an Internet connection to identify the plant leaf.

The dataset used in this application is taken from 126 species in French and the application works well on any device with Android system. However, there should be only one leaf in the picture so that it can be identified by the application.

Process of the application is;

User takes an image from his camera or uploads a digital image to the application.

1. Segmenting this image to binary image by threshold segmentation. (RGB space into grey and then binaries the image)
2. Removing the stem by Tophat (In order to eliminate the influences of noises).
3. Extracting the features of colour, wavelet, phog, IISV and fuse them to form the final feature space and predict the class of the leaf.
4. Comparing the results on local database in the system.
5. Finally, the results, mostly matching with database, are listed order by top matched ones.

Design of the ApLeafis, there is just one Activity on the application and there are three action bars in this activity. They are orderly “Photo”, “Guide” and “Album”. In the Photo, users can use their camera or upload a photo from their gallery. In the Guide side, there is a list view contained an image of the leaf, name of the tree and its Latin name. And, finally in the album side, users can add a leaf which they like or want to see it again in shortcut.

In this project, I will be working on mostly Android side. In the Android, I am going to create a communication channel to the database from Android and show the trees and leaves to the user and also, some features like user can take a picture in the application or can view a Wikipedia site in the application.

Burak Balcı

I researched an application for leaf-based plant identification which is developed within the Pl@ntNet project and presented in the paper "An Android Application for Leaf-based Plant Identification" [1].

1. Plant Identification Process

According to the information obtained from paper, plant identification process consists of these several steps:

- The user captures a leaf image that contains a centered single leaf on a uniform background with an Android device.
- The user has to select one or both of mentioned leaf descriptors. Unlike similar applications, this mobile system enables the user to choose a specific leaf descriptor that will be used as the basis of identification. The descriptors consist of **margin** and **venation points (3. Plant Identification Methods)**.
- The leaf image is sent to a primary intermediate server. There are two kind of server in the system. Primary intermediate server is to store the image in order to broaden the knowledge about the plant species.
- The identification step is performed on the second server using the descriptor previously selected by the user. The descriptors have been embedded in the IKONA content-based image retrieval system [2].

  Content-based Image Retrieval System (CBIR): is the application of computer vision techniques to the image retrieval problem, that is, the problem of searching for digital images in large databases. Content-based means that the search analyzes the contents of the image rather than the metadata such as keywords, tags or descriptions associated with the image.
- Finally, a ranked list of leaf species is returned and displayed on the Android device. A large scale matching algorithm named "**random maximum margin hashing**"[3] returns the most similar images. Then, a **kNN(k-nearest neighbours)** classifier is used to build a list of species.

  Nearest neighbour classifier: locates the nearest neighbour in instance space and labels the unknown instance with the same class label as that of the located (known) neighbour.

2. Knowledge Database (Dataset)

In the project, a knowledge database which will be used to find the most similar images to a query image necessarily exists. The database is a collection of annotated leaf images where a plant species is associated with each leaf image. They use a subset of the training set of ImageCLEF 2012 plant identification task [4] freely available. It contains 6698 images belonging to 122 species.

3. Plant Identification Methods (Descriptors)

Two methods are used in the application:

- A shape based approach that describes the leaf margin using a multiscale triangular representation [6].

- A shape context based descriptor SC2 that represents the salient points of the leaf (essentially venation points) in the context defined by the leaf boundary [5].
- Combination of both by a late fusion algorithm.
  The descriptor was tested on ImageCLEF 2011 leaf dataset.

4. My Part In Project

In the project, i will be mainly working on Image Processing concept related issues. I also will be interested in forming a knowledge database or namely image dataset. I might get involved in pattern recognition related issues with our machine learning guys.

Arboretums

An arboretum is a botanical garden containing living collections of woody plants intended at least partly for scientific study. In our country, there exist four arboretums that contain a lot of endemic and exotic plants [7]. These are:

- Ataturk Arboretum
- Karaca Arboretum
- Cukurova Suleyman Demirel Arboretum
- Koycegiz Yunus Emre Arboretum

We can apply arboretums to form image dataset and a background information about plant related distinctive features or any other needs.

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