Intermediate report

Self learning software to identify illegally traded orchid material



Figure 1 *Cypripedium calceolus* [1]

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# Introduction

## CITES

There are thousands of different orchid species known all over the world [2]. None of these are allowed to be imported into the Netherlands without CITES permits.

Since 1973 orchids are primarily protected by the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), which is signed by over 120 nations [3]. Despite this convention many orchids are illegally traded. To trade species that are protected by CITES, a licence or certificate is required. Each nation who signed the Convention must designate one or more Management Authorities. They are in charge of administrating that licensing system. All the nations have to designate one or more Scientific Authorities. They advise the Management Authorities about the effects of trade on the status of the species.

It is difficult to monitor the illegal trade of orchids because some orchids look very similar to non-protected plants. Because they look very similar it can be difficult to know if the imported species is an orchid or not. To improve identification, software that can identify orchids from pictures of tubers, leaves or flowers can be useful.

## Study group

During this project the focus is on slipper orchids and orchids from which *salep* is produced.

In Europe and Asia the slipper orchids (*Cypripedioideae*) are widely distributed between sea level up to 2000 m altitude. Species prefer to live in calcareous environments and are found in deciduous or mixed deciduous and coniferous woods. They grow best in light to deep shade. The slipper orchid is an herbaceous perennial plant species that can live very long. It can grow up to 60 cm and each season the slipper orchid will produce new growths. Each stem of the orchid can contain 3 to 4 leaves that often have upcurved sides. The flower stalk can be one-flowered or two-flowered with leaf-like bracts. The sepals and petals are rarely green but commonly brightly coloured. They are also often twisted [4]. Slipper orchids are highly desired ornamentals.

Ground orchid bulbs of the *Orchidoideae*, also known as *salep,* are very popular in Turkey. They are used to produce ice creams in summer and drinks during winter. *Salep* is also used as medicine. In the early 1990s the trade of *salep* increased strongly. The official statistics from the Turkish State Institute of Statistics show that the export between 1995 and 1999 was 282.000 kg annually. It is unknown if this information is related to pure *salep*, substitutes or mixtures. To achieve this amount of *salep* 9.825.000 – 19.650.000 bulbs are required. This is far too much so there are some laws established to protect these orchids. In Turkey there are three laws that would protect them. The first law is the Turkish Forest Law. This law regulates the use of non-wood forest products. In short this law states that it is forbidden to collect and remove any form of forest vegetation. The second law, the Turkish Law of Natural Parks states that “The production of forest products, hunting and disturbing the natural balance is prohibited.” Since collecting *salep* is classified as production of forest products, it is prohibited in all protected areas. The last law in Turkey is The Regulation on Collection, Production and Export of Bulbs of Wildflowers. As the title of this law reveals, this law regulates the production and the export of bulbs, roots and tubers of flowers. It also holds a list with species that may not be taken away from the wild for export [5].

## How a web application can improve control in illegal orchid trade

To make it easier to follow the trade routes of orchid smuggling, a web application that can identify different orchid species would be handy. This application can be used on laptops/desktops and smartphones/tablets by taking pictures of flowers, leaves and underground tubers and upload the pictures to the website. A simple workflow of the application can be found in figure 2. In this project the focus is on creating the website and integrate the identification application. This application is already available at Naturalis, and is not developed during this internship.

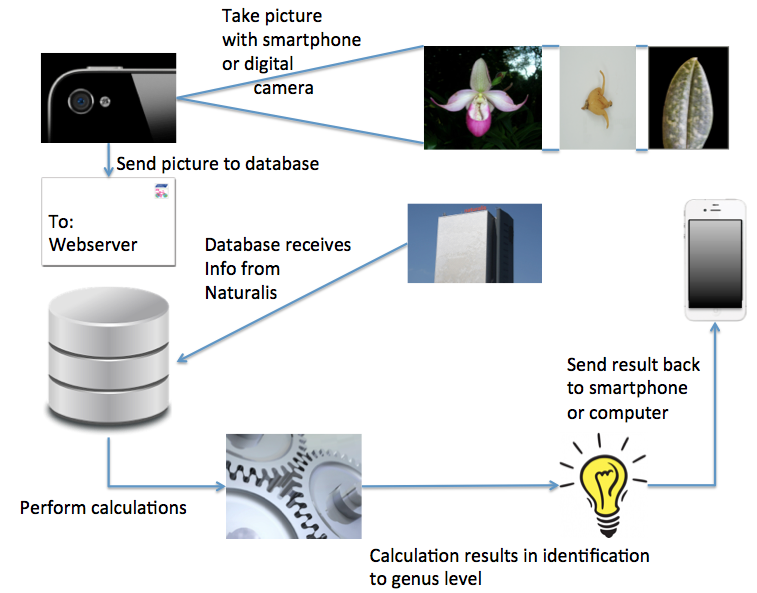


Figure 2 A simple workflow of the application made during this project. Resources of the pictures: [7-16]

## Comparable software

There is software available that can identify a person using face recognition. One example of software like this is KeyLemon [20]. This software could be used to unlock a computer.

The overall operation of software like this is to take a picture or series of pictures of your face. When it takes a series of pictures it is almost always required to move your head up and down and / or left and right. The software saves this picture / these pictures. When you use the software to unlock your computer the software takes a picture / a series of pictures of your face and compares this picture / these pictures with the saved picture(s). When it finds a match you will be logged-in to your own account.

# Materials and Methods

## Website

During this internship a website is developed. The processes behind this website are written in Python2.7 using the Django package. The layouts of the webpages are written in html, using css style sheets. There are two versions of every html file, one for computers and one for mobile devices. The different python scripts, html files and css style sheets can be found in appendices x-y.

## Training

During this internship the neural network is trained to see the differences between orchid tubers and tuber of orchid look-a-likes. The look-a-likes that are used are *Arum maculatum*, *Asparagus officinalis, Polygonatum verticillatum, Tulipa greigii,* and *Tulipa sp.* [18]. Appendix x contains pictures of these tubers.

The neural network is also trained on pictures of orchids.

Before training of the software is possible there are many steps to prepare the training.

First of all, pictures of the orchid tubers and the tubers of the look-a-likes are required. So in the first few weeks of this internship pictures are taken at the Sylvius lab.

Although the orientation of these tubers is unregulated, it is required that it is the same for all pictures. For instance, if the first picture of a tuber with spurs has the spurs on the right, all other tubers with spurs must have the spurs on the right. The user has to use the same orientation as the trainer, so this can be found in the user guide. The background has to be one colour, like white or black, and this colour must be the same for every picture. The last requirement is that there is only one tuber on the picture.

The pictures are uploaded to a shared Flickr account. On Flickr it is possible to add tags to the pictures. These tags are used later in the preparation process to save the pictures in the correct directory. To download the pictures and the meta data via the command line, a python script written by Hugo Haas, Offlickr, is modified and used (see appendix x) [\*].

Before training of the neural network is possible, a preparation process is needed. The first step in this process is to download de pictures and meta data and search for the tags in the meta data. The next step is to convert the pictures from jpg- to png-format and place the picture to the correct directory (Round, Spur and Oblong for the different orchid tubers, LRound, LSpur and LOblong for the different look-a-like tubers and the correct genus and species for the flowers) using the tags. Finally the trainings data is created as a tab separated value file for every directory.

# Results

## Website

The first design of the website is finished. This website contains a homepage, a page for uploading a picture, a page to show the picture is uploaded correctly and a result page.

On the homepage it is possible to choose to upload a picture or remove the unused files from the server. For the last option it is required to log in with a valid account. After selecting the upload option the user will be send to the upload page. On this page the user can select a picture to upload. On iPhones it is also possible to take a picture after tapping the “select file” button. The website will check if the selected file is a picture. If it is not, the user stay at the upload page and a warning is shown. After uploading the file some modifications of the name of the picture are made behind the scenes. The user will be send to the upload\_succes page. Here the user can see the uploaded picture. The user can choose to see the results or cancel. When the user select the result option a program will be run to generate a result. The output of this program will be send back to the result page, where the user can find the result.

## Preparation script

To automate the preparation process a bash script is developed (see appendix x). The first step in this script is running Offlickr.py to download the pictures as .jpg and the meta data files as .xml. After downloading all these files, the script will run another python script, get\_tags.py (see appendix x), which is developed during this internship, to get the original names and tags from the meta data and save it in .txt files, using the id of the picture as name. So when the picture name is 123456789.jpg the tag file of this picture will be 123456789\_tags.txt. At the end of this step the .xml files will be removed. An example of a tag file of a flower can be found in appendix x. The structure of these files is always the same. For Flower the first line is the original name of the picture, then an empty line, after that the genus, the species and last a tag that tells it is a flower. The first two lines are the same as the flower’s one, after the empty line the kind of tuber (Orchid or Look-a-Like) + shape is represented. The next line holds the kind of tuber. After this line is the shape of the tuber. When the genus and species is known these two lines are after the line with the shape. The last line tells it is a tuber. The knowledge of this structure can be used in the next step.

In this step the pictures will be divided between two directories, Flower and Tuber. Before the pictures and tags are moved to the correct directory, the pictures are converted from .jpg to .png. After converting the pictures, the .jpg files remain in the training directory. So after this step all .jpgs are removed.

After dividing the pictures between Flower and Tuber, the separation goes further. First the Flower pictures are divided between genus and species. After this step there are some directories with genus names in Flower, and every genus directory contains some species directories. After dividing the Flower pictures the Tuber pictures are divide between shape and Look-a-Like or orchid. This step will produce six directories: LOblong, LSpur, LRound, Oblong, Spur and Round. All directories starting with a “L” are for the Look-a-Like tubers.

The last step in the preparation process is splitting the pictures, using a Perl script developed by Ruter Vos (see appendix x). This script modifies the picture so that only the tuber or flower is on the picture, with less as possible background. The background is also normalized to be completely white. Figure x shows a picture before and after splitting.

# Discussion

In every project there are some points of discussion, and this projects is no exception.

Most of the tubers of the orchids are unidentified. During this project they only can be used to train the neural network to see differences between orchid tubers and Look-a-Like tubers. When more of the tubers are identified correctly, it is possible to use the pictures to train the neural network to find different genera or even species.

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# Appendices

## Figures



Figure 3 *Arum maculatum* [16]



Figure 4 *Asparagus officinalis* [16]



Figure 5 *Polygonatum verticillatum* [16]



Figure 6 *Tulipa greigii* [16]



Figure 7 *Tulipa sp.* [16]



Figure 8 A: A picture of a tuber, befor splitting it. B: A picture of the same tuber after splitting it.

## Input and output files

## Codes