PSQA Module Guide

1.0 Package Installation

First and foremost, download python version 3.9.10 on windows from https://www.python.org/downloads/ . After downloading, click on the .exe file and follow the installation instructions. Adding python to PATH would come in handy to run the program smoothly.

To ensure installation processes are carried out successfully, Pip is needed. To check if Pip exist, open command prompt and type pip. If pip is not installed, Download get-pip.py to a folder on your computer. Next, open command prompt and navigate to the folder containing the get-pip.py installer and run the command 'python get-pip.py'. The best version of pip to use to run the project file is 'pip 21.2.4'.

1) To upgrade pip:
   ```
   python -m pip install --upgrade pip
   ```
2) To downgrade pip:
   ```
   python -m pip install pip==21.2.4
   ```

These modules are needed in order to run the program. This can be done using pip command.

1) numpy=1.23.3 (pip install numpy)
2) opencv-python=4.6.0.66 (pip install opencv-python)
3) tensorflow=2.8.0 (pip install tensorflow)
4) matplotlib=3.4.2 (pip install matplotlib)
5) imutils=0.5.4 (pip install imutils)
6) Pillow=8.3.1 (pip install Pillow)
7) PyQt5=5.15.7 (pip install PyQt5)

2.0 Packages and It's uses

Numpy - Numpy is one of the commonly used packages for scientific computing in Python. It provides a multidimensional array object, as well as variations such as masks and matrices, which can be used for various math operations. Numpy is compatible with, and used by many other popular Python packages, including pandas and matplotlib.

Opencv-python - OpenCV is a great tool for image processing and performing computer vision tasks. It is an open-source library that can be used to perform tasks like face detection, objection tracking, landmark detection, and much more. It supports multiple languages including python, java C++.OpenCV is a Python library that allows you to perform image processing and computer vision tasks. It provides a wide range of features, including object detection, face recognition, and tracking.

Tensorflow - TensorFlow is a Python library for fast numerical computing created and released by Google. It is a foundation library that can be used to create Deep Learning models directly or by using wrapper libraries that simplify the process built on top of TensorFlow**.**

Matplotlib - Matplotlib is a cross-platform, data visualization and graphical plotting library for Python and its numerical extension NumPy. As such, it offers a viable open-source alternative to MATLAB. Developers can also use matplotlib's APIs (Application Programming Interfaces) to embed plots in GUI applications.

Imutils - A series of convenience functions to make basic image processing functions such as translation, rotation, resizing, skeletonization, displaying Matplotlib images, sorting contours, detecting edges, and much easier with OpenCV.

Pillow - The Pillow library contains all the basic image processing functionality. You can do image resizing, rotation and transformation. Pillow module allows you to pull some statistics data out of image using histogram method, which later can be used for statistical analysis and automatic contrast enhancement.

PyQt5 - There are so many options provided by Python to develop GUI application and PyQt5 is one of them. PyQt5 is cross-platform GUI toolkit, a set of python bindings for Qt v5. One can develop an interactive desktop application with so much ease because of the tools and simplicity provided by this library.

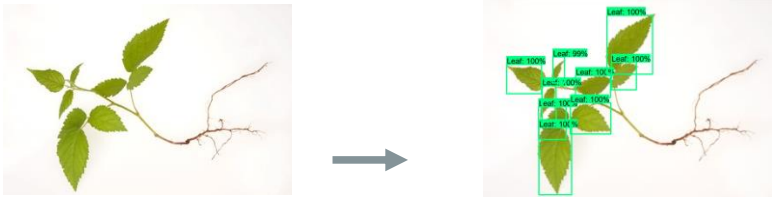
3.0 Functions and Formulas

Load

An image is chosen as followed in the code named ‘Test image.png’ from the path of the image directory. The model is then loaded by passing through ‘saved_model’ from the path inside the ‘inference_graph’ folder. The model is processed and the functions are carried out. Computer vision and image processing is used to calculate the plant’s height, straightness angle of the plant, the existence of white spots, the diameter of the root collars, the colour intensity and the central position of the plant.

Test Image:

1) Leaf count (object_detection.py)



To calculate leaf count, python uses numpy for detecting the leaves and count using the code :

```
print(detections)
num_detections = int(detections.pop('num_detections'))
detections = {key: value[0, :num_detections].numpy()
                    for key, value in detections.items()}
 #print('I am here #4')
 count = 0
```

```
for i in range(len(detections['detection_scores'])):
    if ((detections['detection_scores'][i] > 0.85) and (detections['detection_scores'][i]
<= 1.0)):
            count +=1
#print('I am here #5')
return count
```

2) (Testui.py)

Plant Height:

To calculate the height of the plant, python uses Pillow library as the first approach and the second approach is by using Open-CV library. PIL is the Python Imaging Library is an important module which is used for image processing. It supports many formats of images such as “jpeg”, “png”, “ppm”, “tiff”, “bmp”, “gif”. It provides many image editing capabilities. The Image module provides a class with the same name which is used to represent a PIL image. PIL.Image.open() is used to open the image and then .width and .height property of Image are used to get the height and width of the image. The same results can be obtained by using **.size** property

Straightness: To calculate the straightness degree of the plant, python uses numpy array to first calculate the midpoint between to points. The formula to calculate the angle is ‘angR = (angle_between(pt1, pt2))-45’

Whitespot: Masking is used in Image Processing to output the Region of Interest, or simply the part of the image that we are interested in. There are three steps in masking;

1. Creating a **black** canvas with the same dimensions as the image, and naming it as mask.
2. Changing the values of the mask by drawing any figure in the image and providing it with a **white** color.
3. Performing the bitwise ADD operation on the image with the mask

Python uses Open-CV function to detect contours and filters on the plant image to determine any whitespot on the plant.

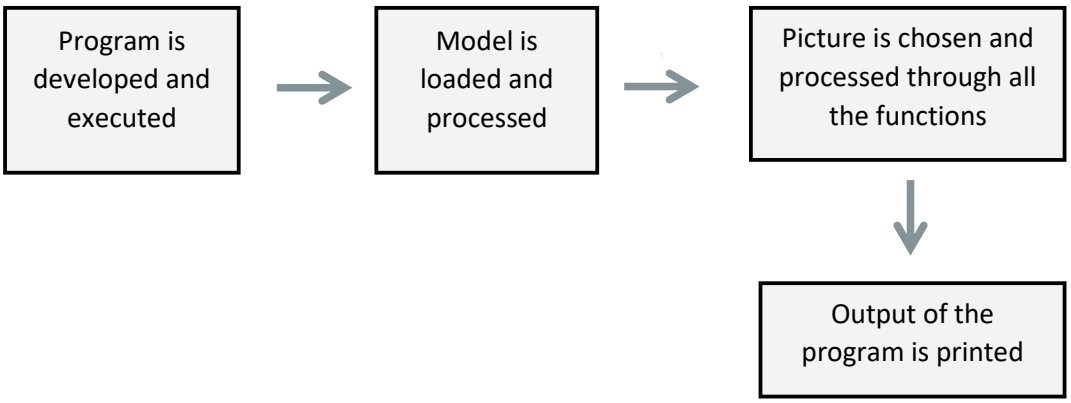
Root Collar Diameter: To calculate the root collar diameter, the code uses same function to calculate the angle as it requires similar calculations of the diameter.

Therefore, python uses numpy array to calculate the diameter using Euclidean method with formula ‘diameter = (round((dist.euclidean(a, b)/54.628),2)) and the diameter is printed in the output.

Colour: Python uses Open-CV to determine the colour of the plant to know if it’s dark or light in colour. Hence, the same method is used to determine the colour as it was used to determine the whitespot on the plant. Masking and filtering is a part of the process used in this function.

Central Position: To determine the central position of the plant, python uses return value using the formula ‘return ((ptA[0] + ptB[0]) * 0.5, (ptA[1] + ptB[1]) * 0.5)’

3) Test image



4) Output