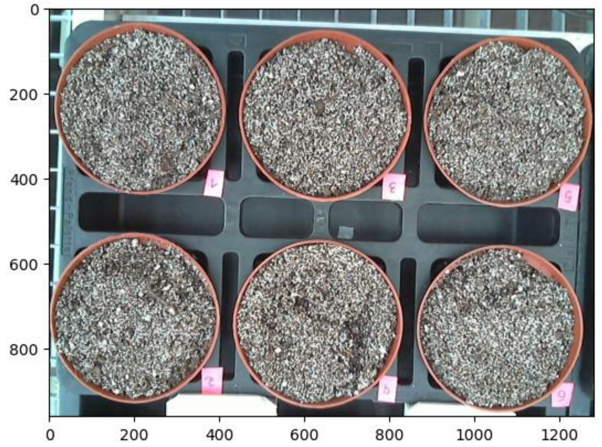
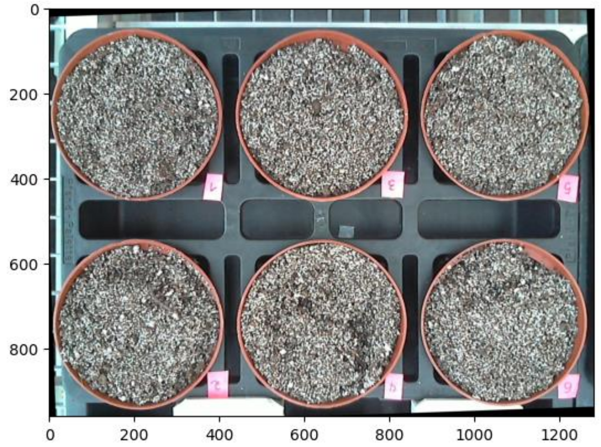
# Class TrayImageProcessor

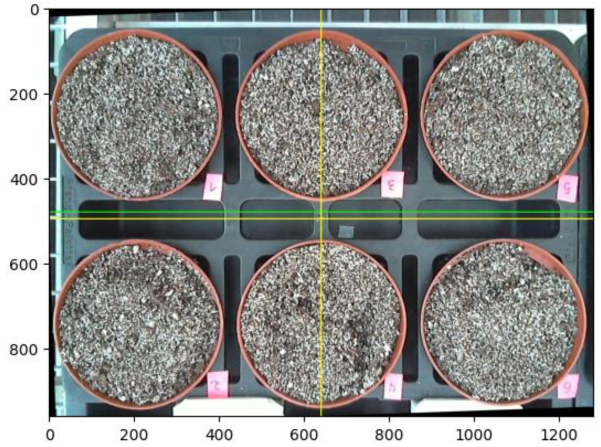
Präsentation des Programmablaufs



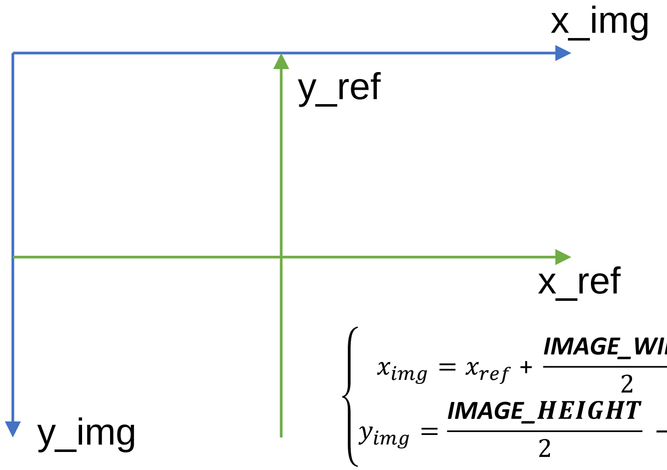
Da die Kamera auf dem Farmbot mit einem gedrehten Winkel montiert ist, muss sie vor der Bildverarbeitung korrigiert werden. Hierzu wird eine Funktion verwendet, bei der die Form des Bildes gleich bleibt, d.h. gleiche Pixelanzahl in Breite und Höhe. Dabei wird ein Teil des Bildes abgeschnitten.



Gedrehtes Bild mit dem Winkel <***ROTATION_ANGLE***> (ROTATION_WINKEL)

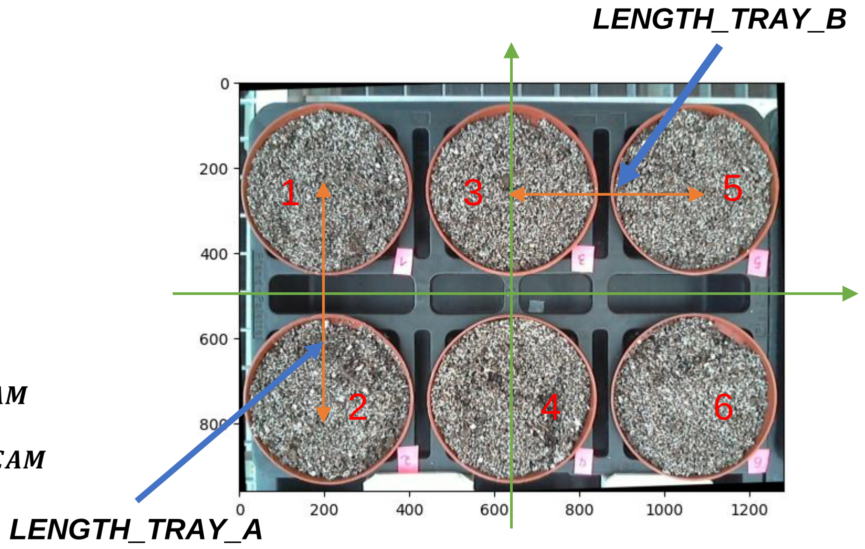


Hier sind zwei Koordinaten dargestellt. Die grüne Koordinate bezieht sich auf die Bildmitte. Die gelbe Koordinate ist in Bezug auf das Zentrum von der Platte (Tray). Hier sieht man, dass die beiden Koordinaten einen Versatz haben. Dieser Versatz ist im <***OFF_SET_CAM***> festgelegt.



$$\begin{cases} x_{img} = x_{ref} + \dfrac{\boldsymbol{IMAGE\_WIDTH}}{2} + \boldsymbol{OFF\_SET\_CAM} \\ y_{img} = \dfrac{\boldsymbol{IMAGE\_HEIGHT}}{2} - y_{ref} + \boldsymbol{OFF\_SET\_CAM} \end{cases}$$

Wie aus der Bildverarbeitung bekannt ist, wird das Koordinatenursprungsystem in einem Bild als links oben mit positiver y-Richtung nach unten definiert. Diese Definition führt jedoch zu Schwierigkeiten bei der späteren Berechnung. Aus diesem Grund wird ein neues Koordinatensystem definiert, das der "normalen" Darstellung entspricht.
Für die Umrechnung gibt es die Funktionen: ***ref2img()*** und ***img2ref()***



Für eine gegebene Geometrie der Palette (Tray), ***LENGTH_TRAY_A*** und ***LENGTH_TRAY_B***, können die Koordinaten des Topfes ermittelt werden:

center_x_1_ref = 0 - LENGTH_TRAY_B * RATIO_MM2PIX
center_y_1_ref = (LENGTH_TRAY_A * RATIO_MM2PIX)/2

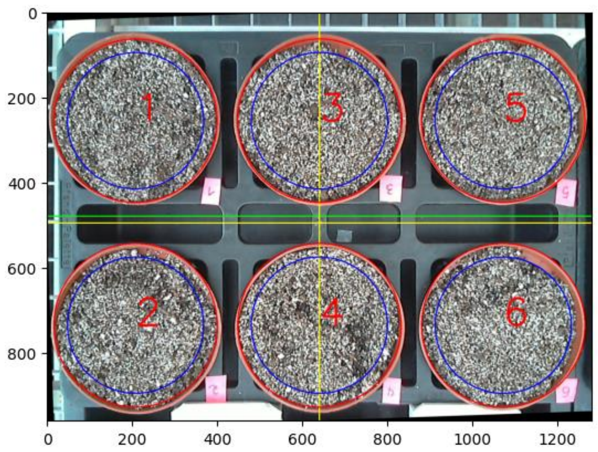
center_x_2_ref = 0 - LENGTH_TRAY_B * RATIO_MM2PIX
center_y_2_ref = -(LENGTH_TRAY_A * RATIO_MM2PIX)/2

center_x_3_ref = 0
center_y_3_ref = (LENGTH_TRAY_A * RATIO_MM2PIX)/2

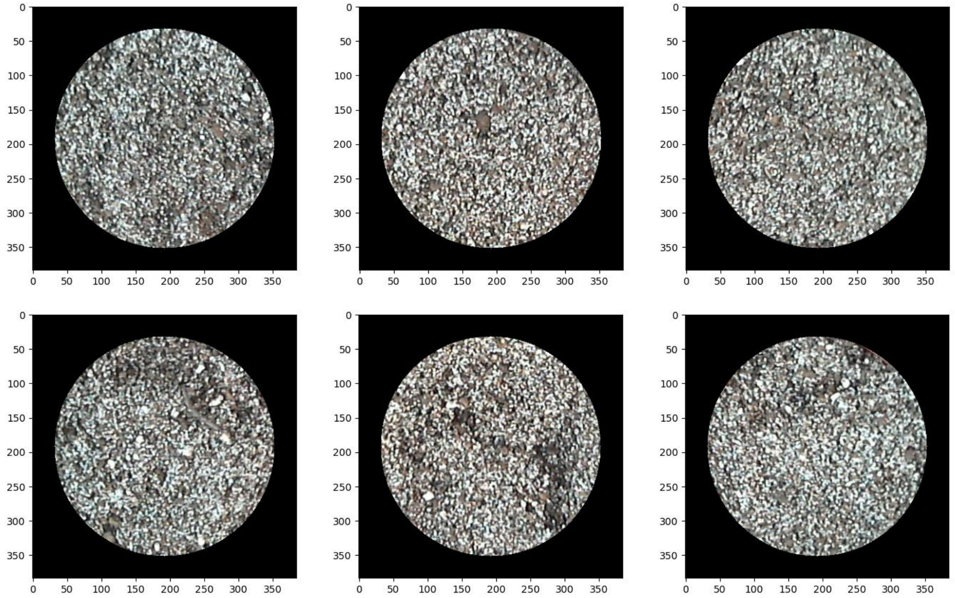
center_x_4_ref = 0
center_y_4_ref = -(LENGTH_TRAY_A * RATIO_MM2PIX)/2

center_x_5_ref = 0 + LENGTH_TRAY_B * RATIO_MM2PIX
center_y_5_ref = (LENGTH_TRAY_A * RATIO_MM2PIX)/2

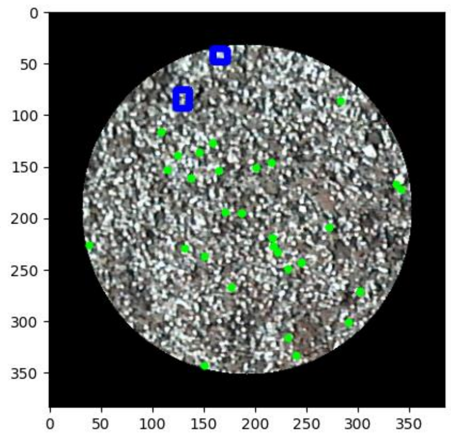
center_x_6_ref = 0 + LENGTH_TRAY_B * RATIO_MM2PIX
center_y_6_ref = - (LENGTH_TRAY_A * RATIO_MM2PIX)/2



Ein Kontrollbild wird erstellt, um die Positionen der Töpfer zu kontrollieren. Der rote Kreis markiert die Positionen der Töpfer und der blaue Kreis die Positionen der ROIs (Region Of Interest). Die ROI ist der Bildbereich, der bei der Verarbeitung berücksichtigt wird.

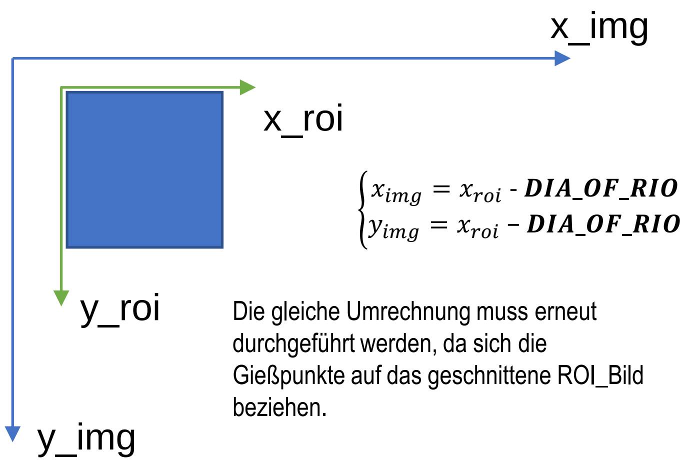


Für jede ROI wird ein neues Schnittbild erzeugt.



Der Algorithmus zur Erzeugung zufälliger Gießpunkte wird auf jedes ROI-Bild angewendet und das Ergebnis dokumentiert (als Kontrollbild und in einer Liste).

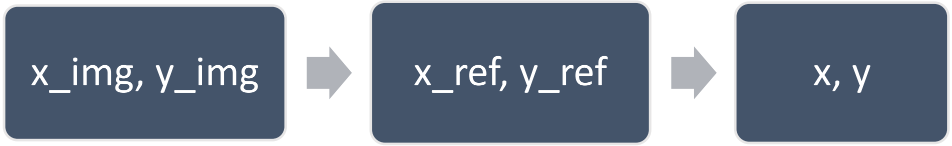
```
prossible watering point: (39, 227)
prossible watering point: (232, 317)
prossible watering point: (240, 334)
prossible watering point: (302, 272)
prossible watering point: (125, 140)
… …
```



$$\begin{cases} x_{img} = x_{roi} \text{ - } \boldsymbol{DIA\_OF\_RIO} + center\_x\_Nr\_img \\ y_{img} = x_{roi} - \boldsymbol{DIA\_OF\_RIO} + center\_x\_Nr\_img \end{cases}$$

Die gleiche Umrechnung muss erneut durchgeführt werden, da sich die Gießpunkte auf das geschnittene ROI_Bild beziehen.

Die letzten Schritte sind die Umrechnung der Bildkorrdinaten in Referenzkorrdinaten und dann die Umrechnung der PIxel-Werte in mm. Dann werden sie als Farmbotsystem-Korrdinaten ausgegeben.


x_img, y_img

x_ref, y_ref

x, y

**InnoBioDev_RandomWatering\src\TrayImageProcessor.py**

```python
# This script is used to generate random watering points for the farmbot tray.

# Import the required libraries
import os # for file operations
import cv2 # for image processing
# from matplotlib import pyplot as plt # for image display if needed
import numpy as np # for numerical operations
from plantcv import plantcv as pcv # for plantcv operations
import time # for calculating the execution time
import random # for generating random numbers
import string # for generating random strings


class TrayImageProcessor:
    # Class variables
    IMAGE_DIR = './InnoBioDev_Randomwatering/data/farmbot_tray/'
    IMAGE_EXT = ('.jpg', '.jpeg', '.png')
    IMAGE_WIDTH = 1280 # in pixels
    IMAGE_HEIGHT = 960 # in pixels
    TRAY_CENTER_X = 0.0 # in mm, this will be updated later
    TRAY_CENTER_Y = 0.0 # in mm, this will be updated later
    TRAY_CENTER_Z = 0.0 # in mm, this will be updated later
    DIA_OF_POT = 60 # in mm
    DIA_OF_ROI = 50 # in mm DIAMETER OF REGION OF INTEREST (ROI), should be less than DIA_OF_POT
    LENGTH_TRAY_A = 150 # in mm
    LENGTH_TRAY_B = 135 # in mm
    ROTATION_ANGLE = -2 # in degrees
    RATIO_MM2PIX = 3.2 # in pixels per mm
    OFF_SET_CAM_X = 0 # in mm
    OFF_SET_CAM_Y = 5 # in mm

    def _rotate_img(self, img, angle):
        angle = - angle
        height, width = img.shape[:2] # image shape has 3 dimensions
        # Calculate the rotation matrix
        rotation_matrix = cv2.getRotationMatrix2D((width / 2, height / 2), angle, 1)
        # Apply the rotation to the image
        rotated_image = cv2.warpAffine(img, rotation_matrix, (width, height))
        return rotated_image

    def ref2img(self, x_ref, y_ref):
        x_img = int(x_ref + self.IMAGE_WIDTH/2 + self.OFF_SET_CAM_X*self.RATIO_MM2PIX)
        y_img = int(self.IMAGE_HEIGHT/2 - y_ref + self.OFF_SET_CAM_Y*self.RATIO_MM2PIX)
        return x_img, y_img

    def img2ref(self, x_img, y_img):
        x_ref = int(x_img - self.IMAGE_WIDTH/2 - self.OFF_SET_CAM_X*self.RATIO_MM2PIX)
        y_ref = int(self.IMAGE_HEIGHT/2 - y_img + self.OFF_SET_CAM_Y*self.RATIO_MM2PIX)
        return x_ref, y_ref

    def get_image(self):
        # Get the list of files in the directory
        file_list = os.listdir(self.IMAGE_DIR)

        # Filter out non-image files
        image_files = [file for file in file_list if file.endswith(self.IMAGE_EXT)]

        # Sort the image files alphabetically
        image_files.sort()

        # Check if there are image files
        if not image_files:
            raise Exception("No image files found in the directory.")

        # Read the first image file
        first_image_path = os.path.join(self.IMAGE_DIR, image_files[0])
        first_image = cv2.imread(first_image_path)
        # Do further processing with the first image

        # Update the tray center coordinates
        filenameparts = image_files[0].split('_')
        self.TRAY_CENTER_X = float(filenameparts[0])
        self.TRAY_CENTER_Y = float(filenameparts[1])
        self.TRAY_CENTER_Z = float(filenameparts[2])
        # check the tray center coordinates, x,y should be positive, z should be 0.0
        if self.TRAY_CENTER_X > 0 and self.TRAY_CENTER_Y > 0 and self.TRAY_CENTER_Z == 0.0:
            print("Tray center coordinates are valid:", "x:", self.TRAY_CENTER_X, "y:", self.TRAY_CENTER_Y)
        else:
            raise Exception("Tray center coordinates are not valid.")
        return first_image, image_files[0]

    def drop_image(self, imagefile):
        # Delete the image file
        imagepath = os.path.join(self.IMAGE_DIR, imagefile)
        os.remove(imagepath)
        print(f"{imagefile} has been deleted.")

    def _center_CAM(self):
        # Calculate the middle point of the image
        middle_x = int(self.IMAGE_WIDTH / 2 + self.OFF_SET_CAM_X*self.RATIO_MM2PIX)
        middle_y = int(self.IMAGE_HEIGHT / 2 + self.OFF_SET_CAM_Y*self.RATIO_MM2PIX)
        return middle_x, middle_y

    def locate_pots(self):
        # Calculate the center of the 6 pots
        center_of_pots = []
            # caleculate the center of the 1. pot
        center_x_1_ref = 0 - self.LENGTH_TRAY_B * self.RATIO_MM2PIX
        center_y_1_ref = (self.LENGTH_TRAY_A * self.RATIO_MM2PIX)/2
        center_x_1_img, center_y_1_img = self.ref2img(center_x_1_ref, center_y_1_ref)
        center_of_pots.append((center_x_1_img, center_y_1_img))
            # caleculate the center of the 2. pot
        center_x_2_ref = 0 - self.LENGTH_TRAY_B * self.RATIO_MM2PIX
        center_y_2_ref = -(self.LENGTH_TRAY_A * self.RATIO_MM2PIX)/2
        center_x_2_img, center_y_2_img = self.ref2img(center_x_2_ref, center_y_2_ref)
        center_of_pots.append((center_x_2_img, center_y_2_img))
            # caleculate the center of the 3. pot
        center_x_3_ref = 0
        center_y_3_ref = (self.LENGTH_TRAY_A * self.RATIO_MM2PIX)/2
        center_x_3_img, center_y_3_img = self.ref2img(center_x_3_ref, center_y_3_ref)
        center_of_pots.append((center_x_3_img, center_y_3_img))
            # caleculate the center of the 4. pot
        center_x_4_ref = 0
        center_y_4_ref = -(self.LENGTH_TRAY_A * self.RATIO_MM2PIX)/2
```

```python
        center_x_4_img, center_y_4_img = self.ref2img(center_x_4_ref, center_y_4_ref)
        center_of_pots.append((center_x_4_img, center_y_4_img))
            # caleculate the center of the 5. pot
        center_x_5_ref = 0 + self.LENGTH_TRAY_B * self.RATIO_MM2PIX
        center_y_5_ref = (self.LENGTH_TRAY_A * self.RATIO_MM2PIX)/2
        center_x_5_img, center_y_5_img = self.ref2img(center_x_5_ref, center_y_5_ref)
        center_of_pots.append((center_x_5_img, center_y_5_img))
            # caleculate the center of the 6. pot
        center_x_6_ref = 0 + self.LENGTH_TRAY_B * self.RATIO_MM2PIX
        center_y_6_ref = - (self.LENGTH_TRAY_A * self.RATIO_MM2PIX)/2
        center_x_6_img, center_y_6_img = self.ref2img(center_x_6_ref, center_y_6_ref)
        center_of_pots.append((center_x_6_img, center_y_6_img))
        return center_of_pots

    def show_control_image(self, roh_image, center_of_pots, save_image=False, show_image=True):

        # Copy the first image to a control image
        control_image = self._rotate_img(roh_image, self.ROTATION_ANGLE)
# Draw the horizontal and vertical refference lines on the image
    # Calculate the start and end point of the horizental line based on the angle
        start_x_ref = 0
        start_y_ref = int(self.IMAGE_HEIGHT / 2)
        end_x_ref = self.IMAGE_WIDTH
        end_y_ref = int(self.IMAGE_HEIGHT / 2)
        # Draw the line on the image
        cv2.line(control_image, (start_x_ref, start_y_ref),(end_x_ref, end_y_ref), (0, 255, 0), 2) # green line
        cv2.line(control_image, (start_x_ref, start_y_ref + int(self.OFF_SET_CAM_Y*self.RATIO_MM2PIX)),
                 (end_x_ref, end_y_ref + int(self.OFF_SET_CAM_Y*self.RATIO_MM2PIX)), (0, 255, 255), 2) # yellow line

        # Calculate the start and end point of the vertical line based on the angle
        start_x_ref = int(self.IMAGE_WIDTH / 2)
        start_y_ref = 0
        end_x_ref = int(self.IMAGE_WIDTH / 2)
        end_y_ref = self.IMAGE_HEIGHT
        # Draw the line on the image
        cv2.line(control_image, (start_x_ref, start_y_ref),(end_x_ref, end_y_ref), (0, 255, 0), 2) # green line
        cv2.line(control_image, (start_x_ref + int(self.OFF_SET_CAM_X*self.RATIO_MM2PIX) , start_y_ref),
                 (end_x_ref + int(self.OFF_SET_CAM_X*self.RATIO_MM2PIX), end_y_ref), (0, 255, 255), 2) # yellow line
        # Draw a circle around the center of the pots
        for i,(x,y) in enumerate(center_of_pots):
            cv2.circle(img=control_image, center=(x, y), radius=int(self.DIA_OF_POT*self.RATIO_MM2PIX), color=(0, 0, 255), thickness=2)
            cv2.circle(img=control_image, center=(x, y), radius=int(self.DIA_OF_ROI*self.RATIO_MM2PIX), color=(255, 0, 0), thickness=2)
            cv2.putText(control_image, str(i+1), (x, y), cv2.FONT_HERSHEY_SIMPLEX, 3, (0, 0, 255), 3, cv2.LINE_AA)
        # Display the control image
        if show_image:
            display_image = cv2.resize(control_image, (int(self.IMAGE_WIDTH/2), int(self.IMAGE_HEIGHT/2))) # Resize the image for better display
            s = 'Press "q" to save and close'
            cv2.putText(img=display_image, text=s, org=[2,22], fontFace=cv2.FONT_HERSHEY_SIMPLEX, fontScale=0.8, color=(0, 0, 0), thickness=2, lineType=cv2.LINE_AA) # create a shadow
            cv2.putText(img=display_image, text=s, org=[0,20], fontFace=cv2.FONT_HERSHEY_SIMPLEX, fontScale=0.8, color=(0, 255, 255), thickness=2, lineType=
cv2.LINE_AA)
            cv2.imshow('Control Image', display_image)
            key = cv2.waitKey(0)
            if key == ord('q'):
                cv2.destroyAllWindows()
        if save_image:
            # Create a directory for saving images if it doesn't exist
            save_dir = 'saved_img'
            if not os.path.exists(save_dir):
                os.makedirs(save_dir)

            # Save the control image as a .jpg file
            save_path = os.path.join(save_dir, 'control_image.jpg')
            cv2.imwrite(save_path, control_image)

    def split_roi(self, center_x, center_y, image):
        # Calculate the coordinates of the top-left and bottom-right corners of the ROI
        roi_x1 = int(center_x - self.DIA_OF_POT * self.RATIO_MM2PIX)
        roi_y1 = int(center_y - self.DIA_OF_POT * self.RATIO_MM2PIX)
        roi_x2 = int(center_x + self.DIA_OF_POT * self.RATIO_MM2PIX)
        roi_y2 = int(center_y + self.DIA_OF_POT * self.RATIO_MM2PIX)

        # Crop the ROI from the image
        roi = image[roi_y1:roi_y2, roi_x1:roi_x2]

        # Set pixels outside of the ROI circle to black
        mask = np.zeros_like(roi)
        radius = int(self.DIA_OF_ROI * self.RATIO_MM2PIX)
        center = (roi.shape[1] // 2, roi.shape[0] // 2)  # Set center as the middle of the ROI
        cv2.circle(mask, center, radius, (255, 255, 255), -1) # fill the circle with white color, -1 means fill the circle
        roi = cv2.bitwise_and(roi, mask)

        # Return the ROI
        return roi

    def split_multi_roi(self, center_of_pots, image):
        # Calculate the area of the ROI for each pot
        roi_areas = []
        for center_x, center_y in center_of_pots:
            print(center_x, center_y)
            roi_area = self.split_roi(center_x, center_y, image)
            roi_areas.append(roi_area)
        return roi_areas

    def random_watering_points(self, img, num_watering_points=20, save_image=False, show_image=False, filename="no_name"):
        # Add .jpg extension to the filename if it doesn't have one
        if not filename.endswith(".jpg"):
            filename = filename + ".jpg"
        else:
            filename
        # Define the pot center and radius
        pot_x = int(img.shape[1] / 2)
        pot_y = int(img.shape[0] / 2)
        roi_radius = int(self.DIA_OF_ROI * self.RATIO_MM2PIX)
        # Set a timer for the execution time
        start_time = time.time()
        print('############################# START #############################')
        print('processing image:')
        # mask in H channel
        img_HSV = cv2.cvtColor(img, cv2.COLOR_BGR2HSV)
        img_H = img_HSV[:, :, 0] #all rows, all columns, first channel (Hue)
        img_H_thresh = cv2.inRange(img_H, 20, 40)
        # mask in A channel
        img_LAB = cv2.cvtColor(img, cv2.COLOR_BGR2LAB)
        img_A = img_LAB[:, :, 1] #all rows, all columns, second channel (A)
        img_A_hist_EQU = cv2.equalizeHist(img_A)
        _, img_A_thresh = cv2.threshold(img_A_hist_EQU, 31, 255, cv2.THRESH_BINARY)
        img_A_thresh = cv2.bitwise_not(img_A_thresh)
        # mask in V channel
        img_V = cv2.cvtColor(img, cv2.COLOR_BGR2HSV)[:, :, 2]
        _, img_V_thresh_up = cv2.threshold(img_V, 250, 255, cv2.THRESH_BINARY_INV)
        _, img_V_thresh_down = cv2.threshold(img_V, 50, 255, cv2.THRESH_BINARY)
        img_V_thresh = cv2.bitwise_and(img_V_thresh_up, img_V_thresh_down)
        # combine H A V masks
        img_H_thresh_erode = cv2.erode(img_H_thresh, kernel=np.ones((5, 5), np.uint8), iterations=1)
        img_A_thresh_erode = cv2.erode(img_A_thresh, kernel=np.ones((5, 5), np.uint8), iterations=1)
        img_thresh = cv2.bitwise_or(img_A_thresh_erode, img_H_thresh_erode)
        img_thresh = cv2.bitwise_and(img_thresh, img_V_thresh)
        # closing method to the mask
        mask_dilated = cv2.dilate(img_thresh, kernel=np.ones((5, 5), np.uint8), iterations=2)
        mask_erode = cv2.erode(mask_dilated, kernel=np.ones((5, 5), np.uint8), iterations=3)
        mask_dilated = cv2.dilate(mask_erode, kernel=np.ones((5, 5), np.uint8), iterations=3)
        mask = mask_dilated

        # labeled the regions on the mask image
        _, labeled_mask = cv2.connectedComponents(mask)
        num_mask = np.max(labeled_mask)
        print('{}'.format('\t'),'total', num_mask, 'region(s) found!')

        # just keep the first 10 biggst region on the mask
        count = 0
        region_info={}
        for region_id in range(1,num_mask+1,1):
            mask_region_cnt = cv2.inRange(labeled_mask,region_id,region_id)
            count = cv2.countNonZero(mask_region_cnt)
            region_info[region_id]= (region_id, count)
        list_of_region = list(region_info.values())
        sorted_data = sorted(list_of_region, key=lambda x: x[1], reverse=True)
        sorted_data_cop = sorted_data[:10]

        mask_cop = np.zeros(np.shape(mask),dtype=np.uint8)
        for region_id in sorted_data_cop:
            id = (int)(region_id[0])
            mask_cop+=cv2.inRange(labeled_mask,id,id)

        # calculation the center of mass of the region
        # this will locate the plant
        contours, _ = cv2.findContours(mask_cop, cv2.RETR_EXTERNAL, cv2.CHAIN_APPROX_SIMPLE)
        mask_RGB=cv2.cvtColor(mask_cop,cv2.COLOR_GRAY2BGR)

        # let us define the watering point.
        # create watering point
        # the previous mask will be enlarged, so that there will be a safty zone, that we will not water the leaves
```

```python
        mask_with_saftyzone = cv2.dilate(mask_cop, np.ones((15,15), np.uint8), iterations=3)
        watering_points_list = []
        count = 0
        while (count<=num_watering_points):
            angel = random.randint(0,360)
            rel_radius = random.random()
            x_watering_point = (int)(np.cos(np.radians(angel))*(roi_radius)*rel_radius+pot_x)
            y_watering_point = (int)(np.sin(np.radians(angel))*(roi_radius)*rel_radius+pot_y)
            if mask_with_saftyzone[y_watering_point, x_watering_point] != 255:
                watering_points_list.append((x_watering_point, y_watering_point))
                count+=1
        end_time = time.time()
        print('{}'.format('\t'),'Execution time:', round(end_time - start_time, 2), ' seconds')
        print('############################## END ##############################')
        if show_image*save_image:
            img_out = img.copy()
            # lets draw everything on image
            for i in watering_points_list:
                cv2.circle(img_out,i,4,(0,255,0), -1)
            cv2.drawContours(img_out, contours, contourIdx=-1, color=(255,0,0), thickness=3)
        if show_image:
            img_display = img_out.copy()
            s = 'Press "q" to save and close'
            cv2.putText(img=img_display, text=s, org=[2,22], fontFace=cv2.FONT_HERSHEY_SIMPLEX, fontScale=0.8, color=(0, 0, 0), thickness=2, lineType=cv2.LINE_AA) # create a shadow
            cv2.putText(img=img_display, text=s, org=[0,20], fontFace=cv2.FONT_HERSHEY_SIMPLEX, fontScale=0.8, color=(0, 255, 255), thickness=2, lineType=cv2.LINE_AA)
            cv2.imshow('Control Image', img_display)
            key = cv2.waitKey(0)
            if key == ord('q'):
                cv2.destroyAllWindows()

        if save_image:
            # Create a directory for saving images if it doesn't exist
            save_dir = 'saved_img'
            if not os.path.exists(save_dir):
                os.makedirs(save_dir)
            # Save the mask image as a .jpg file
            save_path = os.path.join(save_dir, filename)
            cv2.imwrite(save_path, img_out)
            print(f"image watering points saved to {filename}")
        return watering_points_list

# to do: add a function to save the watering points to a file
    def save_points_to_csv(self, watering_points_list, filename):
        # Add .txt extension to the filename
        filename = filename + ".csv"
        # Open the file in write mode
        with open(filename, 'w') as file:
            # Write the header
            file.write("X,Y\n")
            # Write each watering point as a new line in the file
            for point in watering_points_list:
                file.write(f"{point[0]},{point[1]}\n")
        print(f"Watering points saved to {filename}")
```

```
# to do: calculate the watering points back to the real world coordinates
    def roi2real(self, watering_points_list, center_of_pot):
        # Calculate the real world coordinates of the watering points
        # Calculate the middle point of the image with the whole tray
        middle_x, middle_y = self._center_CAM()
        # Calculate the offset of the middle point of the image with the whole tray
        center_x_img = center_of_pot[0]
        center_y_img = center_of_pot[1]
        # Calculate the real world coordinates of the watering points
        real_world_coordinates = []
        for x_roi, y_roi in watering_points_list:
            x_img = x_roi - self.DIA_OF_ROI + center_x_img
            y_img = y_roi - self.DIA_OF_ROI + center_y_img
            x_ref, y_ref = self.img2ref(x_img, y_img)
            real_x = self.TRAY_CENTER_X + x_ref/self.RATIO_MM2PIX
            real_y = self.TRAY_CENTER_Y + y_ref/self.RATIO_MM2PIX
            real_world_coordinates.append((int(real_x), int(real_y)))
        return real_world_coordinates
```

**InnoBioDev_RandomWatering\src\main.py**

```python
import TrayImageProcessor

def main():
    # create an instance of the TrayImageProcessor
    imgp = TrayImageProcessor.TrayImageProcessor()
    # get the image from the directory
    image, imagename = imgp.get_image()
    # locate the pots in the image
    centrer_of_pots = imgp.locate_pots()
    # show the control image
    imgp.show_control_image(image, centrer_of_pots, save_image=True, show_image=True)
    # split the image into multiple ROIs
    split_images = imgp.split_multi_roi(centrer_of_pots, image)
    # get the watering points for each ROI
    for cnt, img in enumerate(split_images):
        # get the watering points for each ROI
        watering_points_list = imgp.random_watering_points(img, num_watering_points=10 ,
save_image=True, show_image=True, filename=str(cnt+1))
        # convert the ROI points to real world coordinates
        real_world_coordinates = imgp.roi2real(watering_points_list, centrer_of_pots[cnt])
        # save the real world coordinates to a csv file
        imgp.save_points_to_csv(real_world_coordinates, filename=str(cnt+1))
    # delete the image from the directory
    imgp.drop_image(imagename)

if __name__ == "__main__":
    main()
```