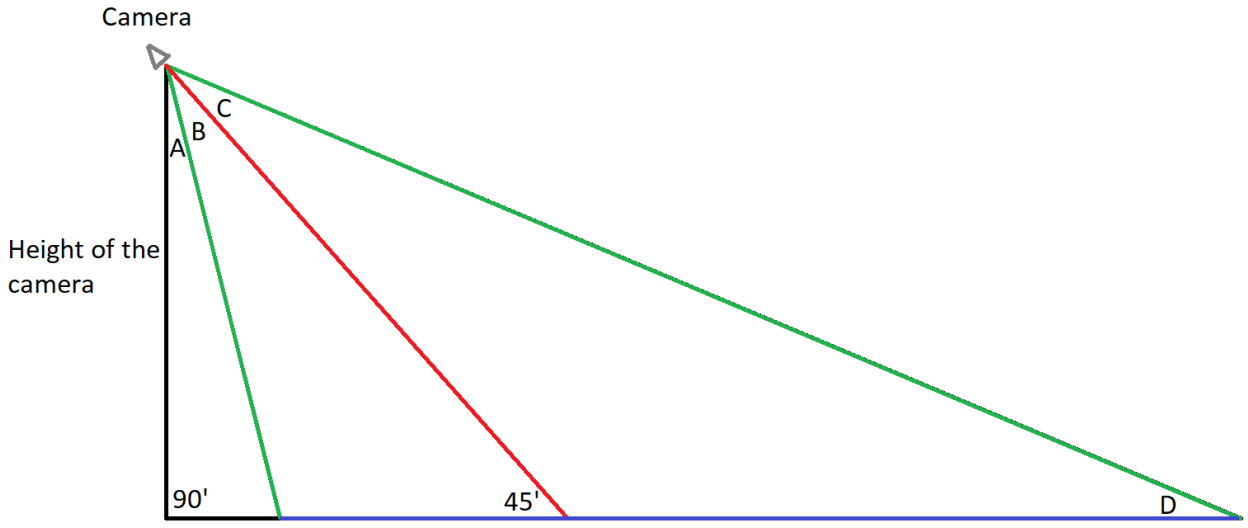
The camera views are not always square and they are all distorted by the lens. Different cameras have different distortion, field of views and resolution. As we are trying to use cameras not only to detect objects but also measure distances of the objects. If the camera is distorted, the distance accuracy will be less. To calibrate the camera I use the python code and chessboard method. Chessboard image is taken from this website for calibration - https://markhedleyjones.com/projects/calibration-checkerboard-collection. When running the code, the camera will detect the corner of the chessboard and will coordinate the corner pixels. From that we got the camera matrix and distortion coefficient matrix. Those data matrixes are used to calibrate the camera which makes the camera undistorted. This method can be used for any camera.

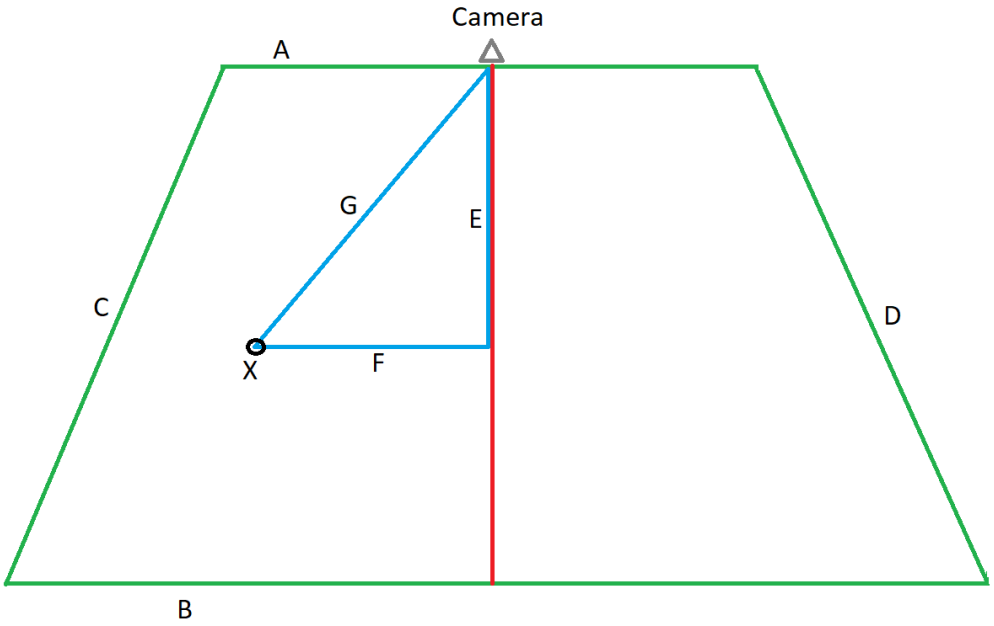
As for calculating the distance between camera and weeds or other objects, I try to measure with camera output pixels per distance.



Side view of the camera

From the “Side view of the camera” image, the green is the area that the camera can see, the red line is the middle point of the camera and it is 45’ degree as it is tilted 45’ degree towards the floor, the blue line is the floor area that camera can see and the black area is the area that camera cannot see. In this case, I used a 640 to 480 pixel camera.

For the side view object distance calculation, I use trigonometry to calculate it. As the camera angle is tilted, I cannot use pixels per distance. The reason is in the image of “Side view of the camera”, the blue line is 480 pixels from camera view but it is not evenly divided. Pixels now depend on the camera view angle so I divided 480 pixels with B+C angle value. Everytime pixels move further, its value of distance will be larger.



Top view of the camera

For the top view calculation, A and B sides have the same pixels (640) but have different lengths. C and D are 480 pixels which is the same as the blue line from “Side view of the camera”. From side view calculation, I got the side E and I got F from the pixel value of the object X. By using trigonometry, I get the value of G which is the distance we want. The further the object moves towards B, the pixel degree value for F distance gets larger.

Measuring the object's distances from the camera is challenging for me as the further the object, the pixels become denser and makes the accuracy incorrect. I didn’t expect to calibrate the camera and camera calibration is the most challenging part for me. If the camera is not calibrated, the distance of the objects we measured will not be accurate. When calibrating, the matrixes of the camera and distortion were never same and it is always slightly different.