ROS Robot - Weed Spray

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***Abstract*—Using ROS for controlling a Thorvald robot to spray the weeds in row structured crops using a downward looking camera to identify them.**

I. Introduction

WEEDS are bad for the growth of plant so they need to be removed by spraying them. Targeting specific locations with computer vision with robots, we can reduce the ammount of spraying needed. There are numerous benefits for that:

- Reduce the chemicals used
- Early detection and elimination of weeds
- Easier to use through automated procedures

II. Objective

THE objective of this artefact is to find and spray the weeds in a field using a Thorvold robot. We are using a virtual environment that has rows of crops with **onions**, **cabbages** and **basils**. The provided images are on Fig. 1.

Fig. 1. Rows of crops provided.

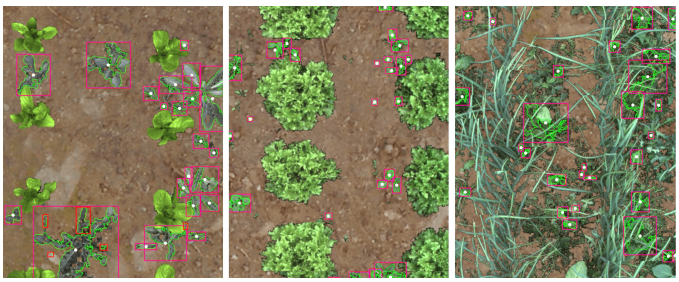

Fig. 2. Rows of crops with their canopy and points.

III. Implementation

ROS can simulate how the robot is moving and all get the input of all our sensors. ROS is very modular and can support multiple nodes so the final code is devided into three nodes.

A. Image Recognition

For the weed extraction I am using OpenCV which finds all the necessary objects through HSV image matching. These are the steps it takes:

- Removes the Background.
- Extracts the canopy of the weed.
- Removes the smallest canopies that are bellow a threshold.
- Finds the middle point.
- Rectify each point with the camera lense.
- Converts all points into real map coordinates.
- Publish as a pointCloud to a specific topic.

The final result from the weed extraction is published as an image and you can see on Fig. 2.

B. GetPoints

At this step a new node is repsonsible for deciding what to do all the points:

- Gets each published pointCloud and filters the duplicates.
- Checks if the sprayer is ontop of one of these points and activates the spraying.
- Publishes the points so that it will be visualized on Rviz.

C. Moving

This node is responsible for moving the robot with the move base. It also publishes on which row it currently is for the image recognition to process.

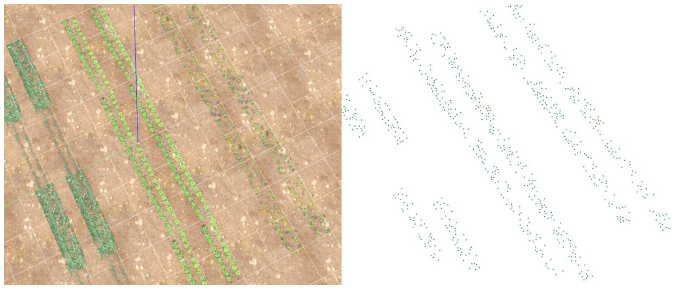

Fig. 3. Original crops (left) and the recognized weeds (right).

IV. Related Work

OBTAINING all the weeds is really difficult because there are many types of weeds and the weather conditions might change from area to area. The color matching approach is working fine on the provided dataset with predefined colors, but in the real world the result will not be as we want it.

There are other approaches that provide results that are working on a more broad data, though they are more difficult to implement. The one I used is the Mask-RCNN which uses Neural Network but it requires to annotate the weeds manually which is a very difficult job to do so this is why I used it only for the weeds on the cabbages.

After the annotation was done, I had to train the dataset which took more than 35 hours to finish and after it was done the evaluation process for each image took more than 3 seconds to be completed.

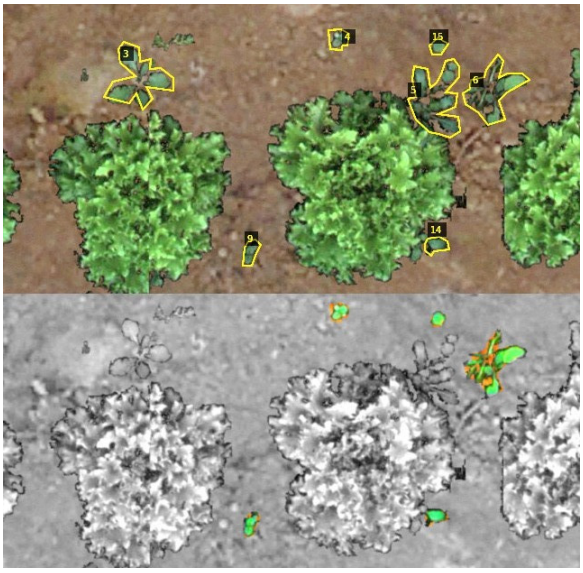

Fig. 4. Annotation of images (top), result of the RCNN evaluation (bottom).

V. Conclusion

BY providing specific images it is very easy and fast to make color matching to get the result it is needed, although by training a model with some datasets of weeds it becomes more dynamic and can be used on more environments.

The RCNN model I created didn't have the expected result, as it didn't find all the plants and it was really slow to get the results. On the other hand the color matching was so fast that it can in real time get all the weeds and do all the transformations so that they could be sprayed.

One problem emerged which had to do with the transformation of points to real world coordinates. All the points are shifted because the robot is constantly moving and the transformation is done at the future position of the robot and not at the moment that the weeds were detected.

References

[1] BPG 11: Weed control https://www.forestresearch.gov.uk/research/best-practice-guidance-for-land-regeneration/
[2] Robotic Weed Control System for Tomatoes https://link.springer.com/article/10.1023/A:1009977903204
[3] Mask RCNN https://github.com/matterport/MaskRCNN