Tracking Growth and Decay of Plant Roots in Minirhizotron Images (Supplementary Material)

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1. Varying Hyperparameters

In this section we analyze how the method hyperparameters affect the overall performance of our method. As figure **??** shows our network ist highly susceptible to overfitting. Particularly the stage 1 model which is trained on the same images sees a rapid performance decline, whereas the stage 2 model is slightly more robust thanks to the training on pairs of different images but declines as well after an optimum at around 10 epochs.

Another imporant hyperparameter is the box size b of the extracted descriptors which roughly corresponds to its field of view. It should not be set too low with ca. 32 pixels being the optimum for stage 2.

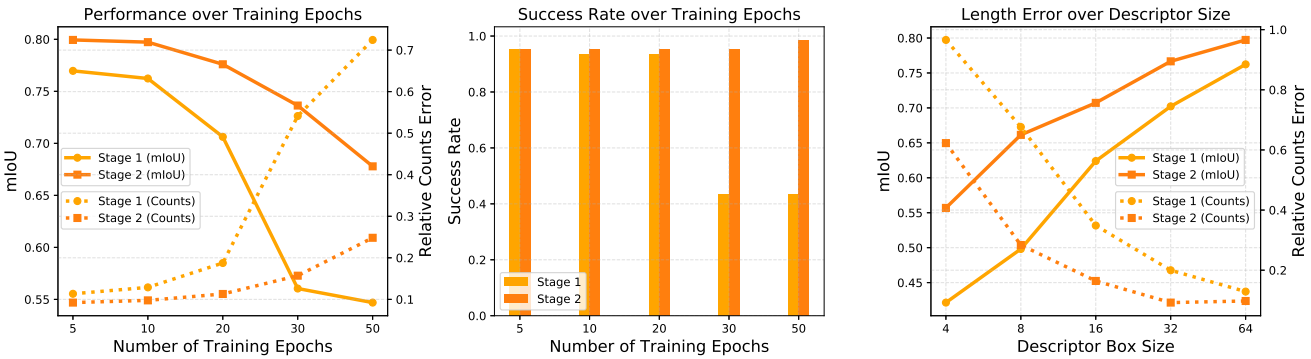

Figure 1: Influence of hyperparameters on the mean IoU, relative pixel counts error and success rate metrics.

2. Regression Analysis

Regression analysis is more common in ecology to describe the predicting power of a model with the coefficient of determination or r^2-value giving the overall fitness. Figure **??** shows regression plots of our stage 2 model. We get excellent r^2-values of over 0.99 for all three turnover map classes.

3. Mesocosms vs Field Experiments

For a more fine-grained analysis we have also evaluated only on images from mesocosms or only field experiments. The rationale here is that field experiments are uncontrolled and conditions may vary greatly over time and thus should be more

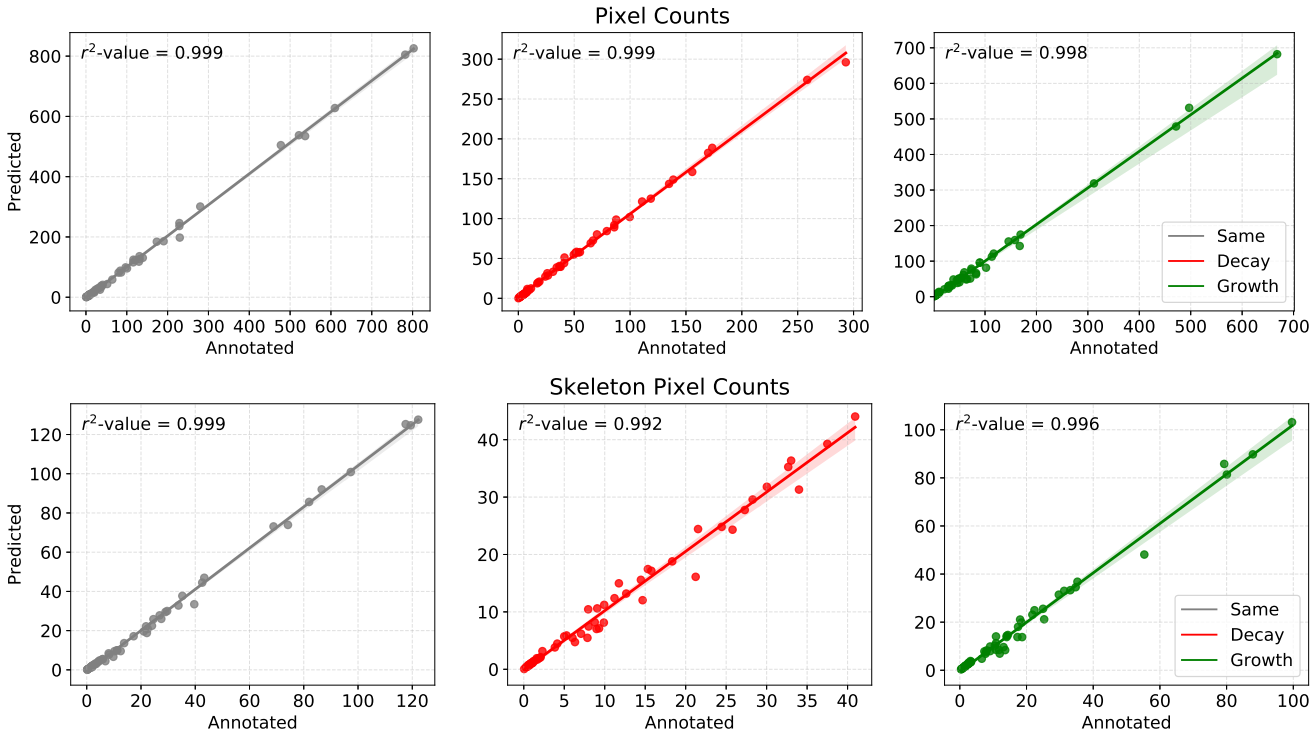

Figure 2: Regression plots with 99% confidence intervals of our stage 2 model. Units are pixels (thousands).

Method	Mesocosms ($n = 40$) IoU↑ s/g	Counts↓ s/d/g	Lengths↓ s/d/g	Success Rate↑
SIFT	.59/.59	.30/.25/.42	.36/.36/.49	75.0%
SIFT(sk)	.66/.63	.22/.28/.29	.28/.38/.34	82.5%
SIFT+VoxelMorph	.76/.61	.13/.75/.18	.11/.53/**.10**	82.5%
f Emb.	.70/.67	.17/.22/.20	.22/.27/.24	87.5%
Ours (Stage 1)	.75/.73	.11/.18/.12	.11/.17/.13	**92.5%**
Ours (Stage 2)	**.84/.78**	**.07/.09/.09**	**.08/.11/.10**	90.0%

Method	Field ($n = 22$) IoU↑ s/g	Counts↓ s/d/g	Lengths↓ s/d/g	Success Rate↑
SIFT	.60/.67	.29/.33/.32	.33/.57/.38	81.8%
SIFT(sk)	.64/.73	.23/.26/.19	.27/.46/.24	**100%**
SIFT+VoxelMorph	.75/.68	.13/.76/.17	**.08**/.50/**.09**	**100%**
f Emb.	.67/.71	.21/.24/.21	.25/.42/.27	90.9%
Ours (Stage 1)	.76/.77	.11/.18/.12	.12/.21/.12	95.4%
Ours (Stage 2)	**.81/.84**	**.10/.13/.08**	.09/**.14/.09**	**100%**

Table 1: The same results as in table 1 of the main paper, differentiating between mesocosm and field experiments.

difficult to process. Table **??** shows the same results as table 1 of the main paper, split into the two experiment types. Contrary to our expectation, the performance differences are not very significant.

4. Additional Images

Figure **??** shows additional images of minirhizotron experiments for better understanding of the application background. Figures **??**, **??** and **??** show additional full-sized images and results.

(a) Minirhizotron tube installation

(b) A minirhizotron inserted into soil with high water content which is particularly prone to movement

(c) Mesocosm Experiments

(d) Field Experiments

Figure 3: Setup of minirhizotron experiments

Figure 4: Additional full-sized result illustrating the amount of root turnover that can occur over 10 months (from May to March). Our method is still able to capture the few remaining roots and differentiate them from new ones.

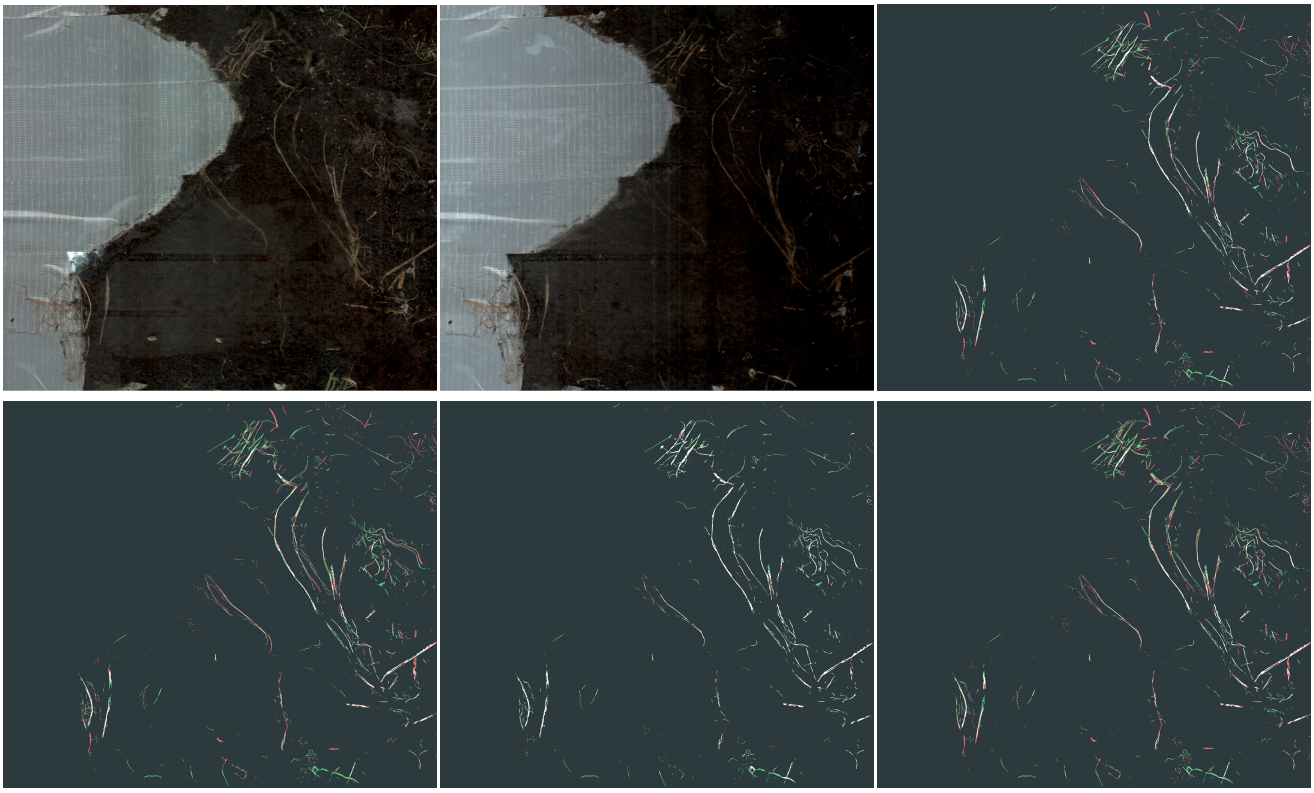

Figure 5: Additional full-sized results. Top row: input images and annotation turnover map. Bottom row: Outputs of the methods SIFT(sk), VoxelMorph and our stage 2 method.

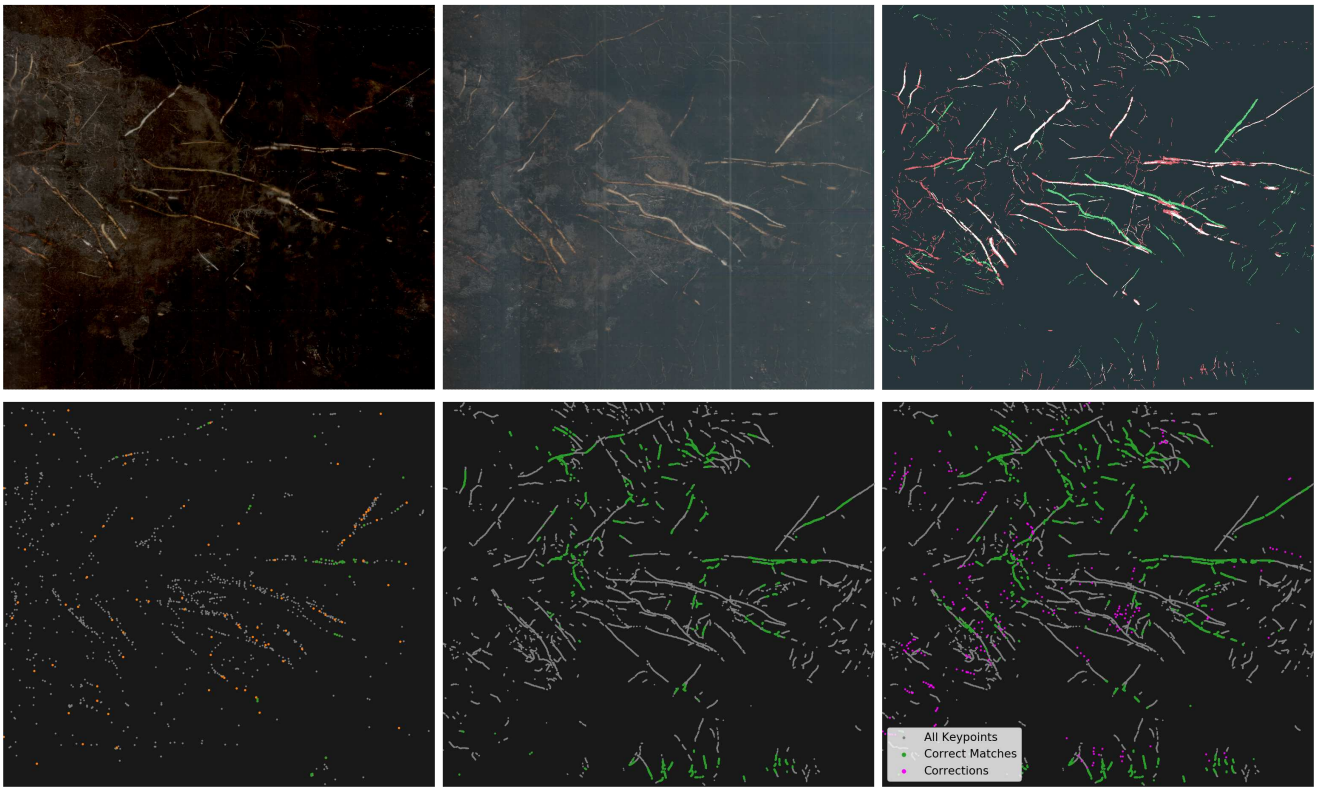

Figure 6: Top row: Full sized input images and stage 2 output turnover map
Bottom row: Keypoints of SIFT, stage1 and stage 2. Keypoints in gray were rejected by the ratio test, cross checking or outlier rejection. Magenta keypoints are the manual corrections added by annotators.