An End-to-End Deep RNN based Network Structure to Precisely Regress the Height of Lettuce by Single Perspective Sparse Cloud Point

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Abstract

Focusing on non-destructive and automated acquisition of plant phenotypic parameters,this extended abstract proposed an end-to-end deep RNN based network structure for single perspective sparse raw point cloud regression task called DRN. It has been proven to achieve accuracy improvements in PointNet++ and PonitCNN when it comes to regression of lettuce plant height. We believe DRN structure is suitable for feature extraction from plant point cloud data and regression of spatial distance related plant phenotypes like plant height.

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RNN

Point Cloud

Plant Height

Introduction

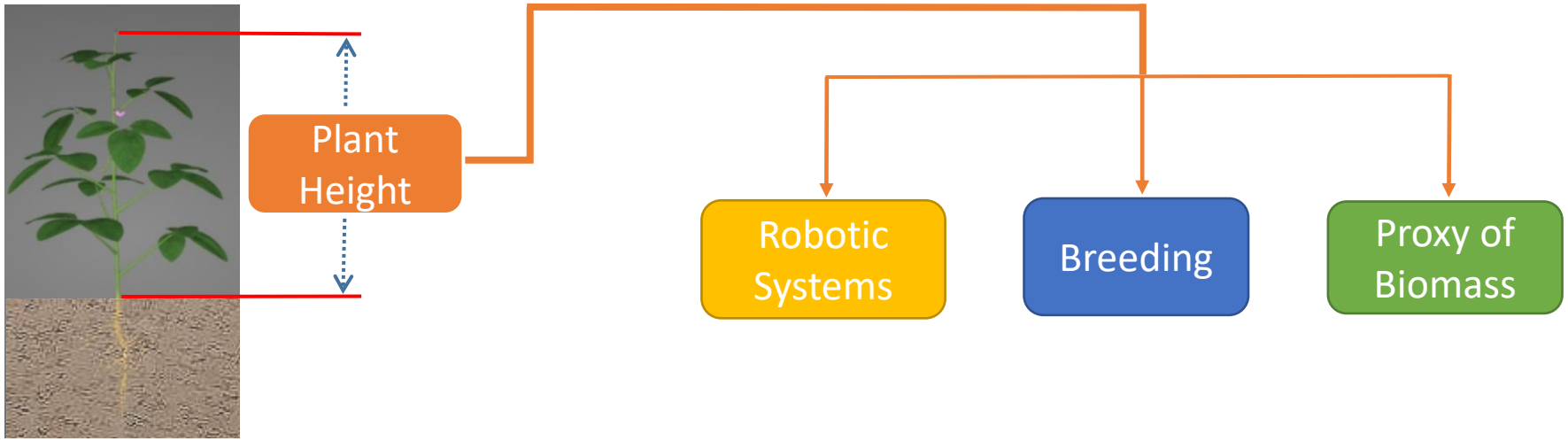


Figure1. Plant Height

Intruduction

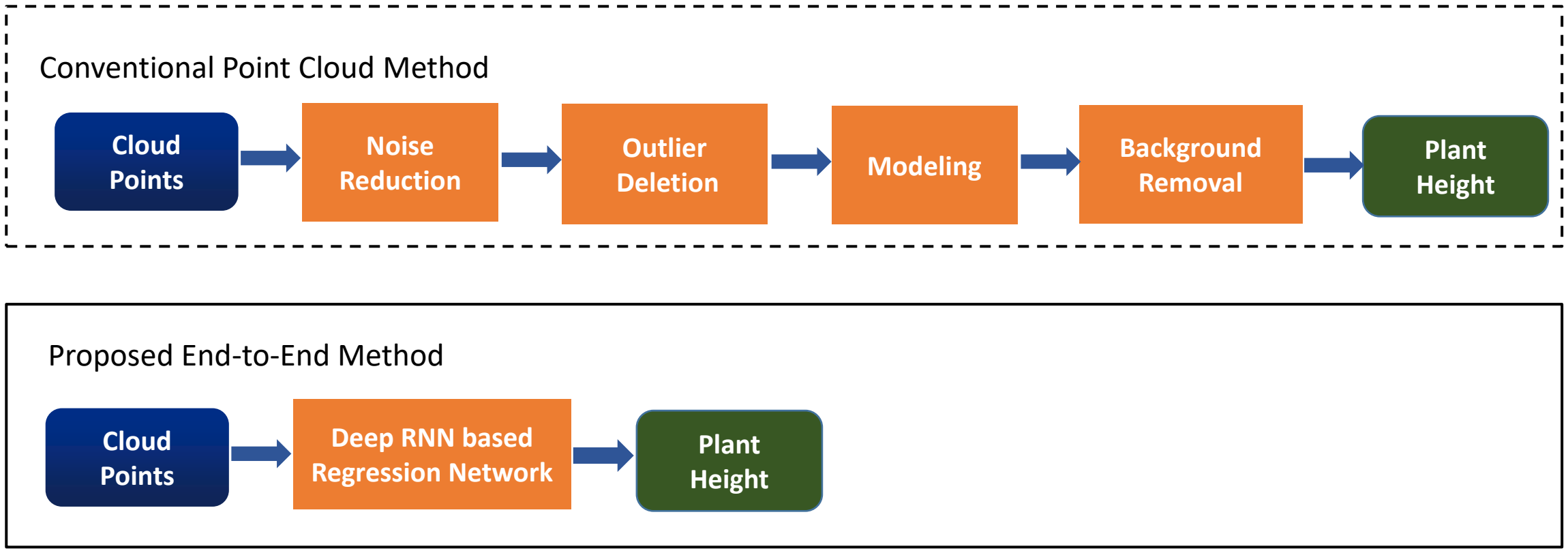


Figure2. Processing flow of plant height estimation

Experimental Data

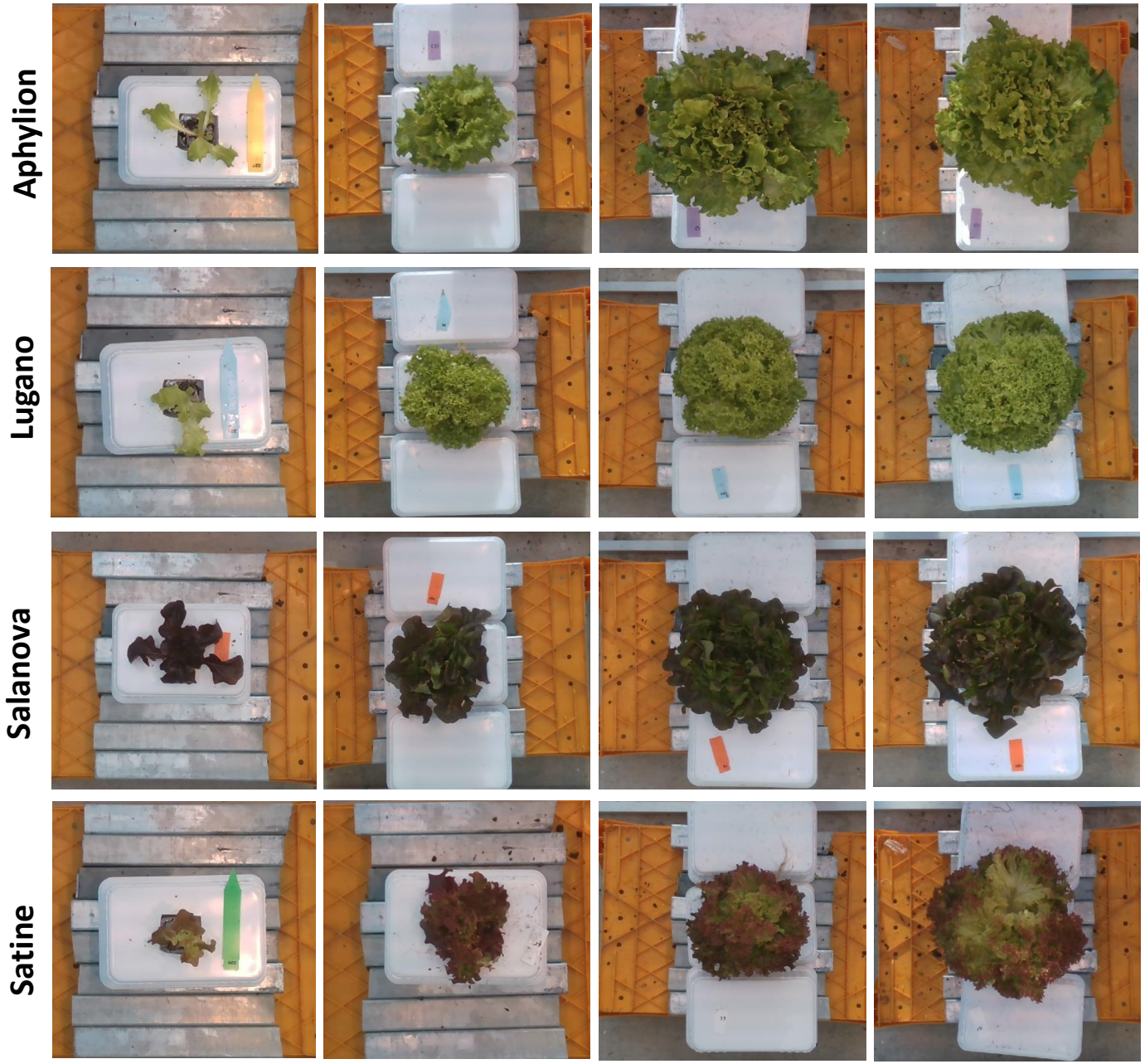


Figure3. Images of 4 varieties of lettuce samples

Preparation Result

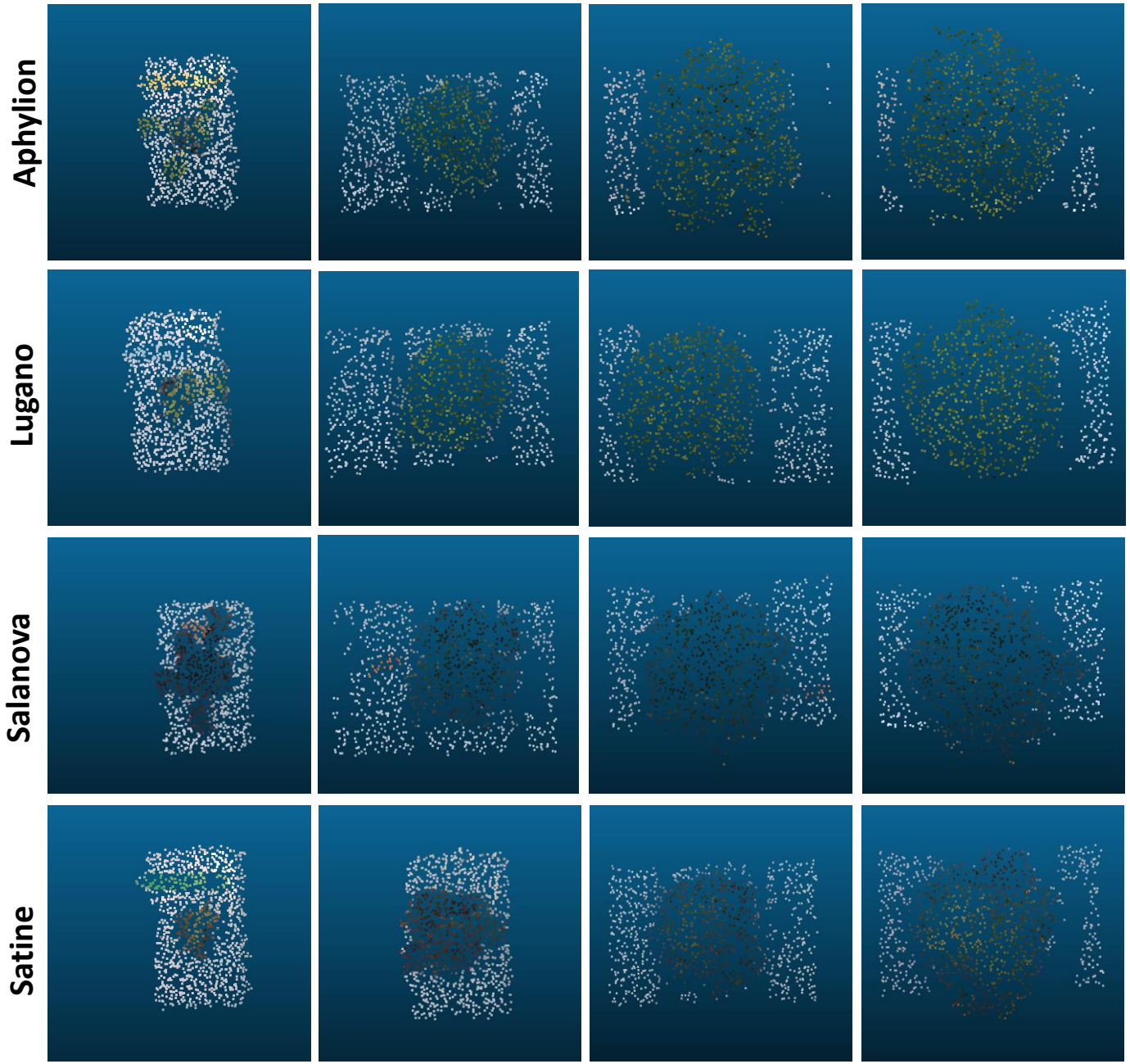


Figure4. Point cloud image of lettuce sample after preparation

Proposed Methods

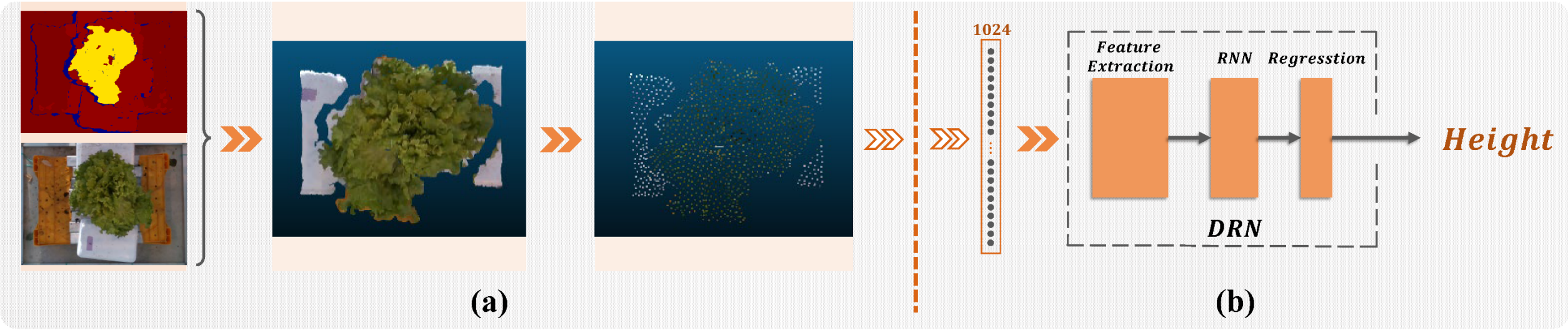


Figure 5. Overview. (a)Data and Data preprocessing, transform the give images into cloud point and downsampling. (b) Regressing lettuce plant height from single perspective sparse cloud point by our proposed DRN structure model

Feature Extraction Network: PointCNN

Table 2 Network parameter configuration of PointCNN

Layer	kernel_size	hidden Channels	dilation	Number of Channels
XConv1	8	32	1	48
XConv2	12	64	2	96
XConv3	16	128	2	192
XConv4	16	128	2	384

Feature Extraction Network: PointNet++

Table 1 Network parameter configuration of PintNet++

Layer		Feature Points	Ratio	R	Maximum of Neighbors
SA1	Sampling	512x3	0.5	-	-
	Grouping	512x64x3	-	0.2	64
	PointConv	512x128	-	-	-
SA2	Sampling	128x128	0.25	-	-
	Grouping	128x64x128	-	0.4	64
	PointConv	128x56	-	-	-

RNN Structure

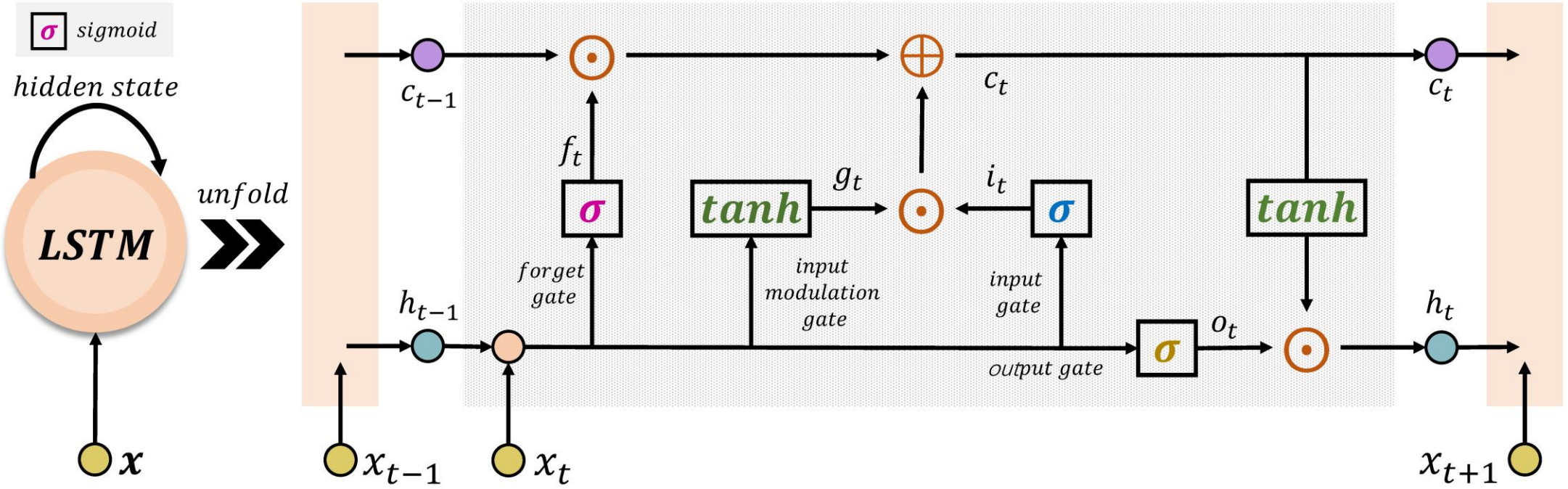


Figure 6. The structure of LSTM. ⊙ represents product, while ⊕ denote addition.

Results analysis

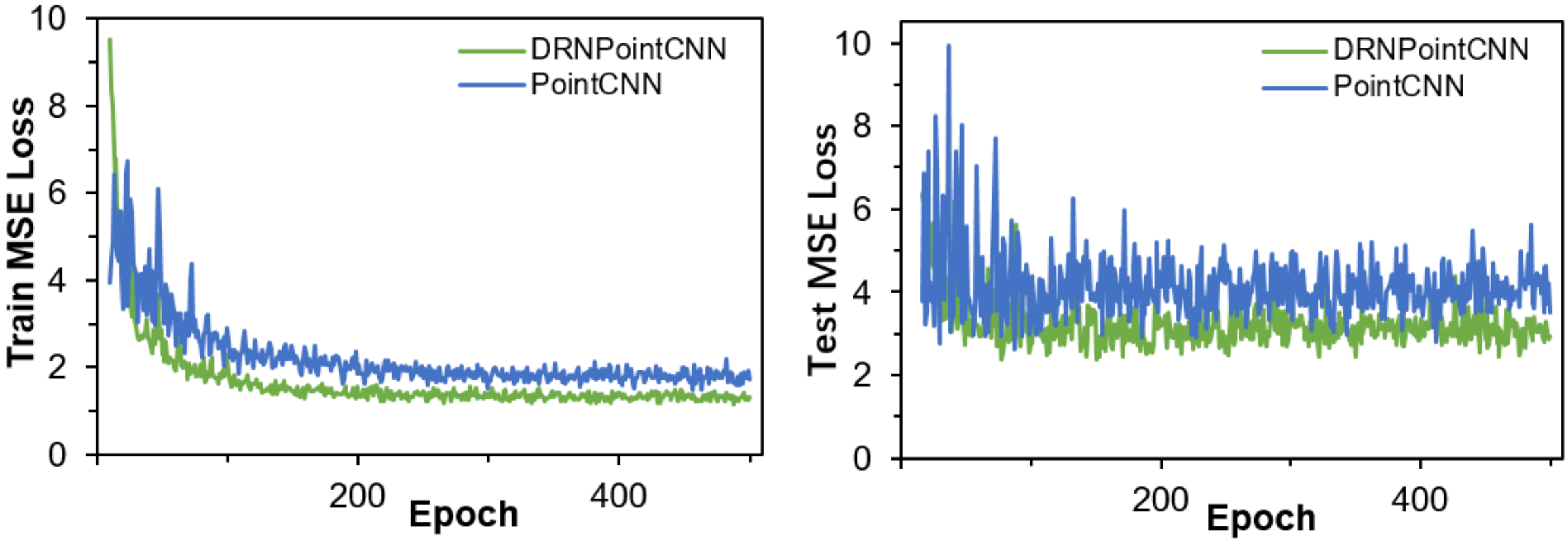


Figure 7. Predict MSE from DRNPointCNN and PointCNN based model on training data and testing data.

Results analysis

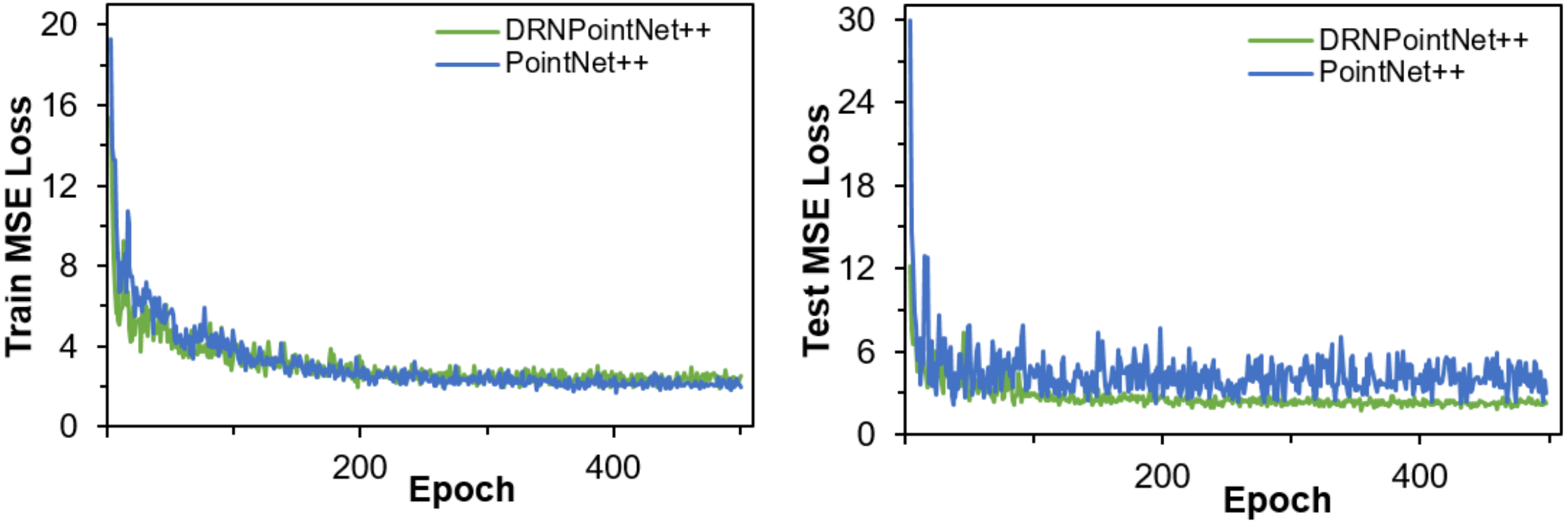
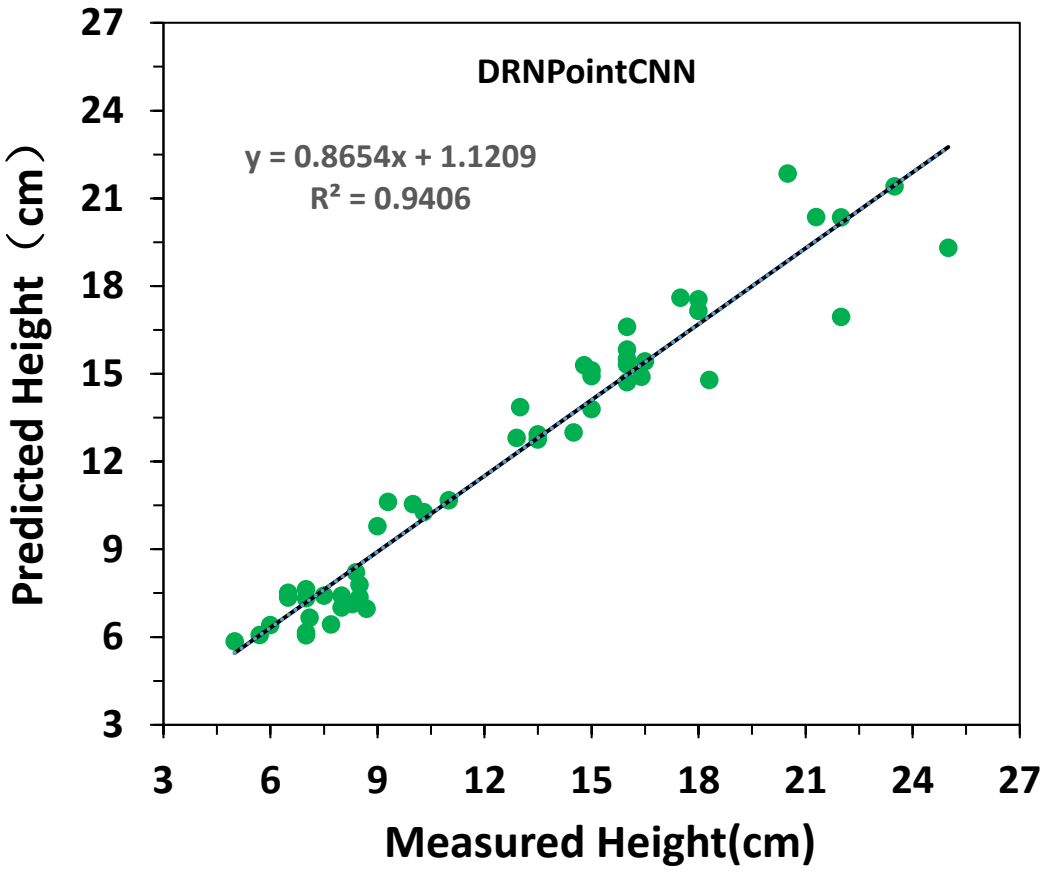


Figure 8. Predict MSE from DRNPointNet++ and PointNet++ based model on training data and testing data.

Results analysis



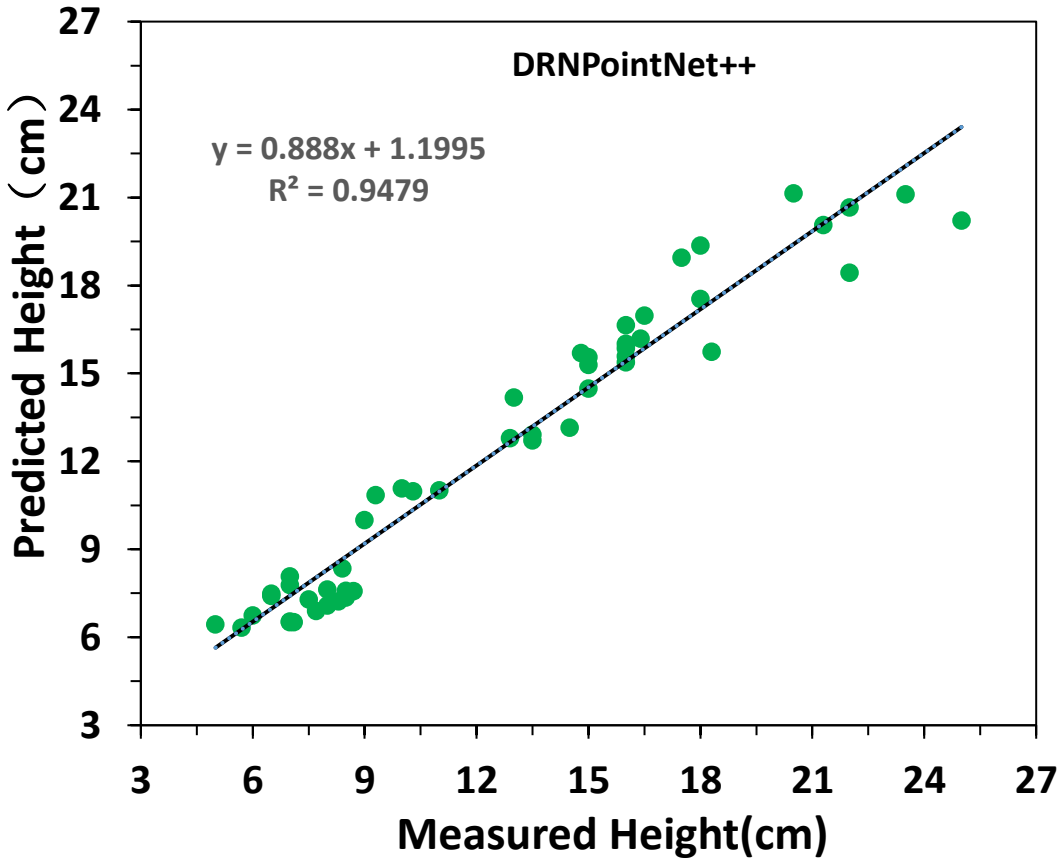


Figure 9. Scatter plot of cross-validation between predicted and measured plant height of DRNPointCNN and DRNointNet++ .

Conclusion

Table 3. Performance Analysis of DRN Structure in PointCNN and PointNet++

Methods	PointCNN	DRNPointCNN	PointNet++	DRNPointNet++
Train MSE (cm)	1.72	**1.27**	**2.06**	2.11
Test MSE (cm)	3.74	**2.86**	3.45	**2.16**

Thank You

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