

# Extracting the height of lettuce by using neural networks of image recognition in deep learning

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## Abstract

The traditional method of measuring the lettuce height is a manual measurement with instruments, which is greatly affected by human error. At present, researchers have proposed to use color cameras to obtain RGB images of lettuce, and to obtain the height of lettuce from the images. However, these tasks usually require camera calibration or a reference object with a known height, which is somewhat restrictive. Considering that deep neural networks have a powerful ability to feature extraction and expression, without camera calibration and reference objects, we try to use four networks of image recognition to explore the effect of deep learning on abstracting the lettuce height from RGB images. On the test set, including 80 images and height from 0.9 cm to 7.5 cm, we achieve a good result with a mean absolute error of 1.22 mm.

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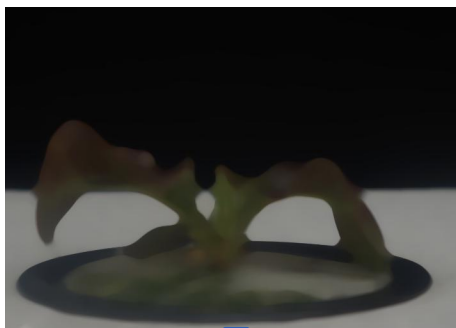
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Lettuce

Plant Height

Neural Networks





Collect data and parameters

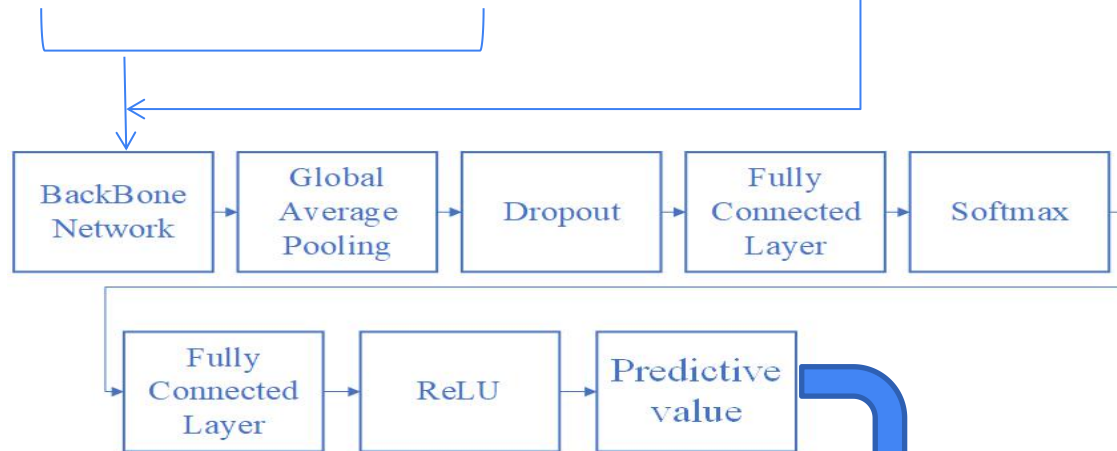
Data Preprocessing

Data Augmentation

MobileNetV1 DenseNet-121

ResNext-50 EfficientNet-B3

model fusion



Model	MAE(mm)	MSE(%)	HAE(mm)	HSE(%)
MobileNetV1	1.45	4.59	7.6	16.83
DenseNet-121	1.36	4.47	9.33	18.49
ResNext-50	1.42	4.55	9.71	15.97
EfficientNet-B3	1.35	4.64	7.28	16.24
Average Fusion	1.22	3.91	7.57	16.07



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# CONTENT

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**2** RESEARCH STATUS

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## nutritional value

protein, vitamin E, vitamin C,  
potassium, calcium,  
copper, carotene

## Edible effect

analgesic hypnotic, expelling  
cold, inhibiting viruses,  
stimulating digestion

## lettuce production in changes in China and the world



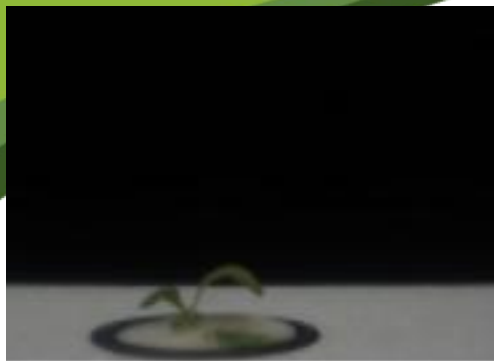
- 1.Traditional plant height measurement methods have low efficiency, high cost and large errors.**
- 2.The plant height measurement method based on special sensors can obtain the highest accuracy, but its sensors are expensive and cannot be used on a large scale**
- 3.The method of using RGB images to obtain plant height information is not only low-cost and convenient to operate, but also its accuracy largely depends on the image processing algorithm used, that is, the software part, which can be improved.**

**Plant height**

**RGB**

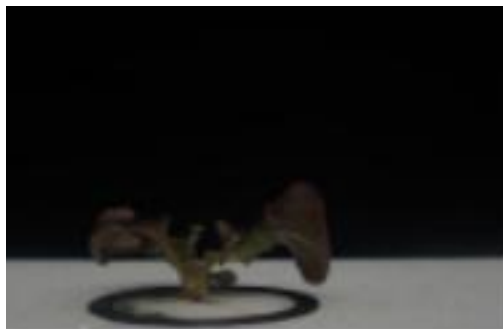
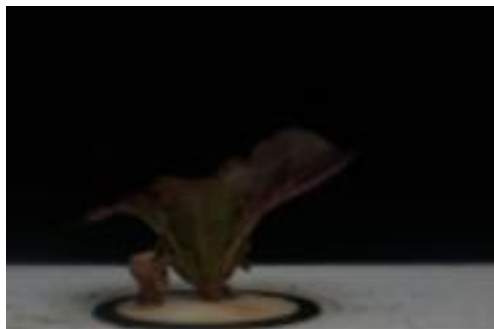


- 1** The image of single lettuce was taken as the research object
- 2** Model fusion technology is used to construct regression model
- 3** Based on the regression model,evaluation the lettuce height based in no-reference object



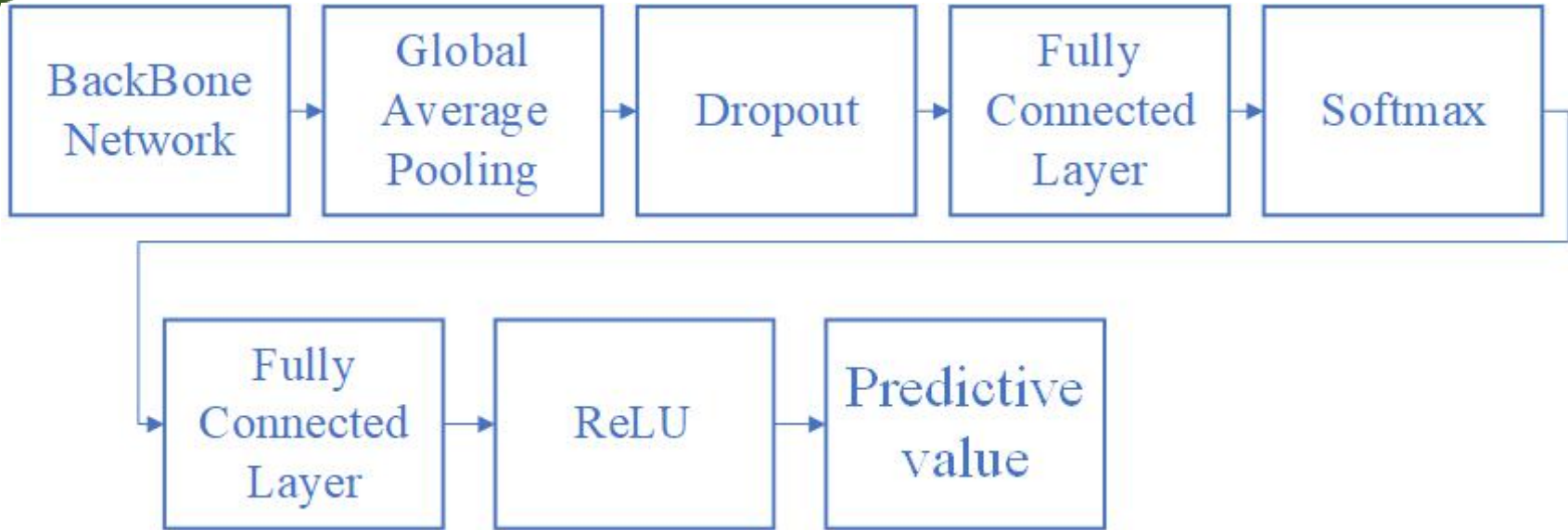
dataset: 402 pictures(train 273,val 49,test 80)

Collection conditions:  
Environmental variables are constant(temperature, humidity, light intensity, and CO<sub>2</sub> concentration)



data preprocessing: Random Lighting,Random,Contrast,Median filtering,Gaussian filter

# Regression Network



# BackBone Network

Model	Parameters (Millions)	MAdds (Millions)	FLOPs (ms)	Accuracy
MobileNetV1	3.23	550	72	0.704
DenseNet-121	7.04	2839	174	0.75
ResNext-50	42.27	4293	297	0.777
EfficientNet-B3	17.67	2806	232	0.817

# The results of all models in predicting the height of lettuce

Model	MAE(mm)	MSE(%)	HAE(mm)	HSE(%)
MobileNetV1	1.45	4.59	7.6	16.83
DenseNet-121	1.36	4.47	9.33	18.49
ResNext-50	1.42	4.55	9.71	15.97
EfficientNet-B3	1.35	4.64	7.28	16.24
Average Fusion	1.22	3.91	7.57	16.07

- 1** It is effective to use image recognition neural networks in deep learning to predict lettuces height from RGB images.
- 2** if a network has higher accuracy on ImageNet, it may perform better in height prediction.

# THE END

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# THANK YOU