EARTHSHOT LABS

An automatic mobile approach for Tree DBH Estimation Using a Depth Map and a Regression Convolutional Neural Network

Presentation at ICLR 2023 Workshop: Tackling Climate Change with Machine Learning

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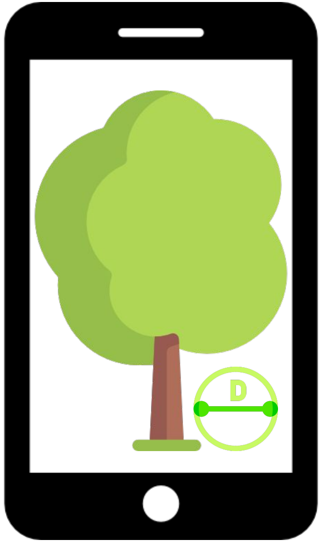
Introduction

We propose an automatic mobile computer vision method to estimate the DBH of a tree using a single depth map on a smartphone, along with our created dataset **DepthMapDBH2023**.



Dataset

- Train set: 1008 trees' RGB pictures along with their corresponding 192x192x1 depth maps and tape-measured DBH values
- Test set (164 samples) with different physical trees of diameters ranging from 0 cm to 109 cm

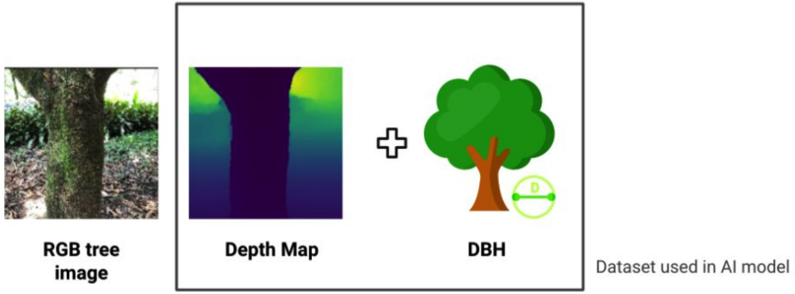


Figure 1: Dataset structure

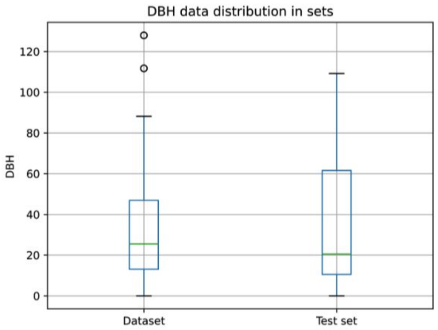
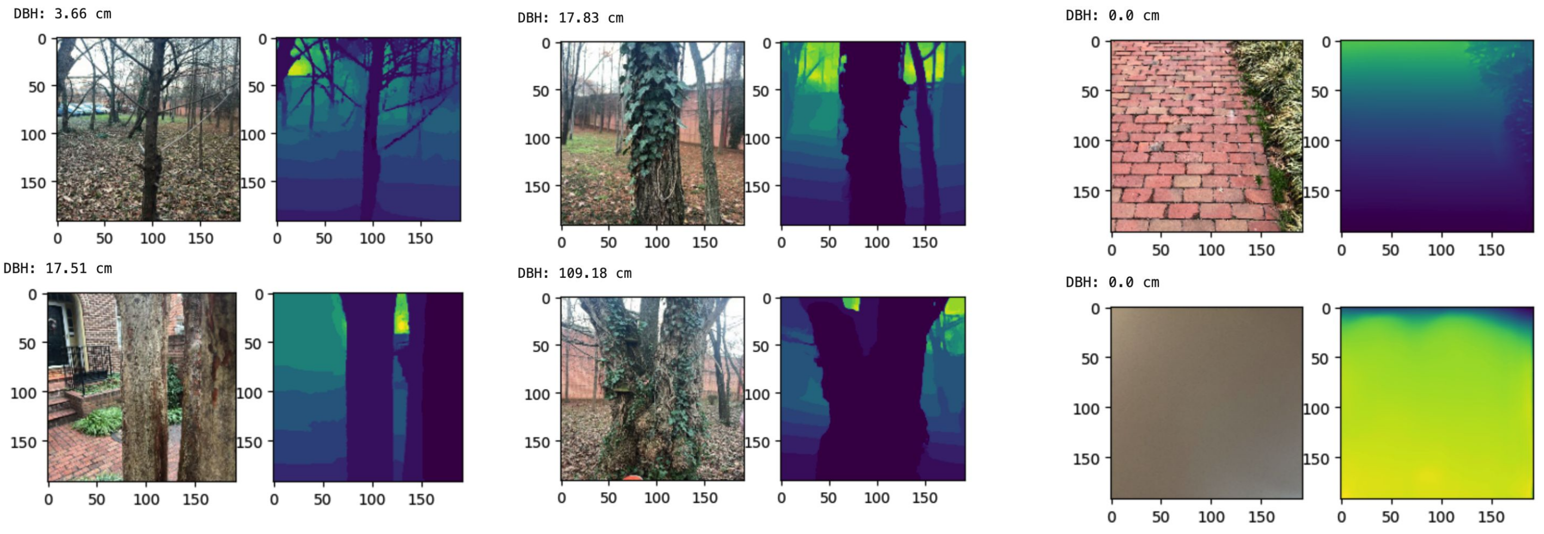


Figure 2: Plots of the distribution of the dataset (a) Dataset (b) Separate Test set

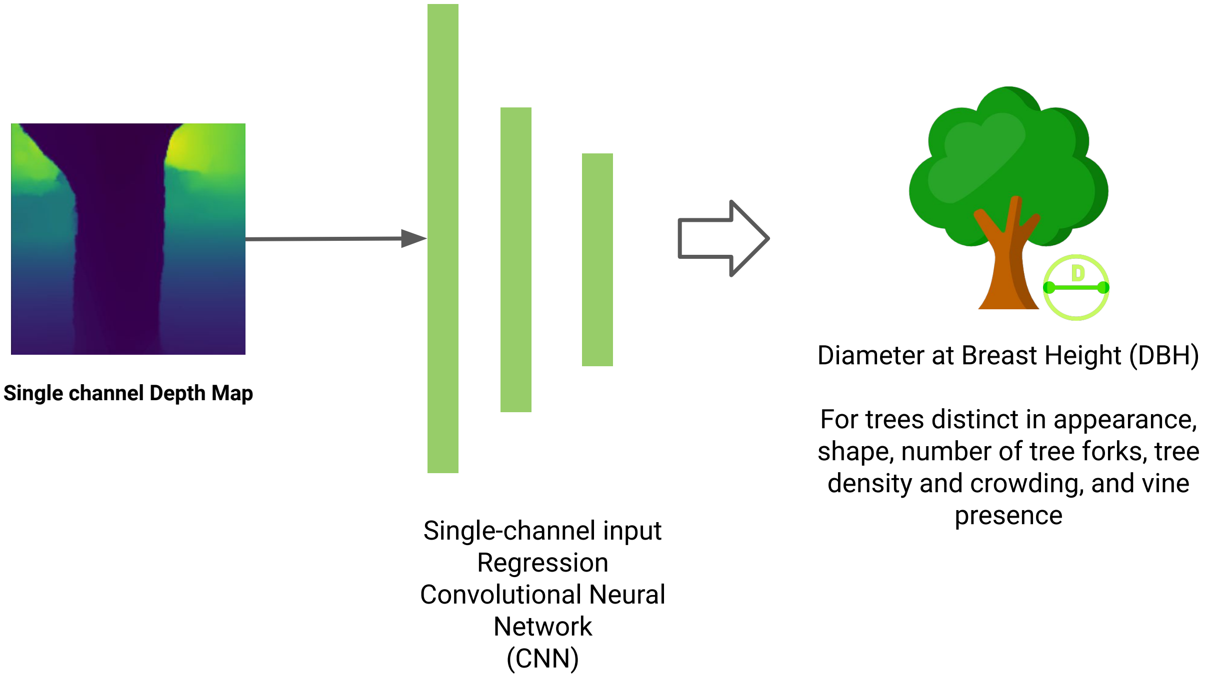
The dataset is publicly available on Kaggle: https://www.kaggle.com/datasets/earthshot/depthmapdbh2023

Challenges

- ❖ We created a special iOS application for LiDAR iPhones to generate the depth maps required for our research
- ❖ Diversity in the dataset to build a robust real-world model: trees distinct in appearance, shape, number of tree forks, tree density and crowding, and vine presence + we generated depth maps from different angles and distances for each tree



Method


Single channel Depth Map
Single-channel input
Regression
Convolutional Neural
Network
(CNN)
D
Diameter at Breast Height (DBH)
For trees distinct in appearance,
shape, number of tree forks, tree
density and crowding, and vine
presence

Experiments

- We tested four efficient modified convolutional neural network models (under 35MB each), all pre-trained on ImageNet: MobileNet, MobileNetV2, DenseNet121, and EfficientNetB0

- We experimented with adding RGB data to the inputs, but the results during the preliminary tests for single-channel depth maps proved to be superior to 4 channels (RGB + Depth map)

- Different hyperparameters: batch sizes of 8, 16 and 32, a plateau-reduced learning rate starting at 0.001, the Adam optimizer and MSE loss

Results on test set

Model	MAE	MSE	RMSE	R2	batch size	seed	Model size (MB)
Modified DenseNet121	3.21	24.40	4.94	0.97	32	8809	33
Modified MobileNetV2	3.63	38.21	6.18	0.96	8	7150	14
Modified MobileNet	3.94	42.46	6.52	0.96	8	8439	16
Modified EfficientNetB0	8.17	121.63	11.03	0.88	32	3191	29

Table 1: Best performance on the test set for each modified regression CNN

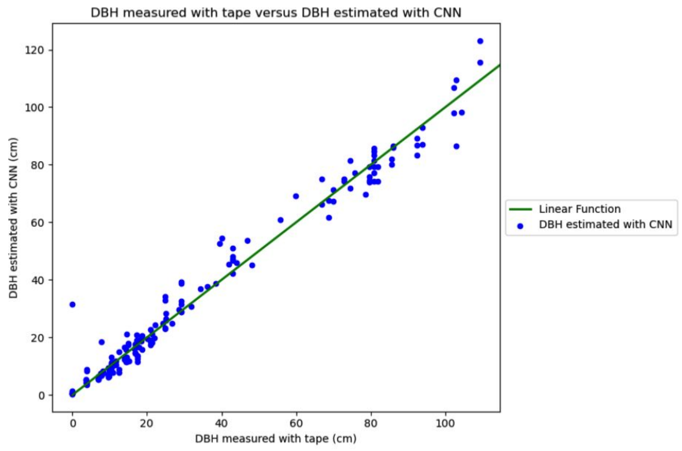
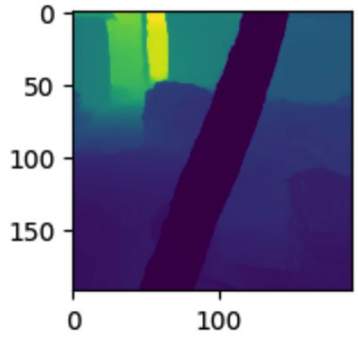


Figure 4: Scatter plot of the measured DBH (test set) values versus the estimated DBH by the best modified DenseNet121 model

Real DBH: [9.549296], predicted DBH: [9.101099]



Conclusion

- We introduce a new dataset called **DepthMapDBH2023** consisting of 1008 training samples and 164 test samples.
- We have successfully demonstrated that this single channel depth map dataset contains the necessary information to estimate DBH when paired with a CNN
- The modified DenseNet121 was selected as the optimal DBH estimation model
- The modified MobileNetV2 model is a notable runner-up if the size of the model is to be taken into consideration
- The goal of this project is to ultimately help crews in the field who are creating forest inventories to measure trees in a faster and more cost-efficient way

Thank you! 🌳