Tree Model Library

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Description

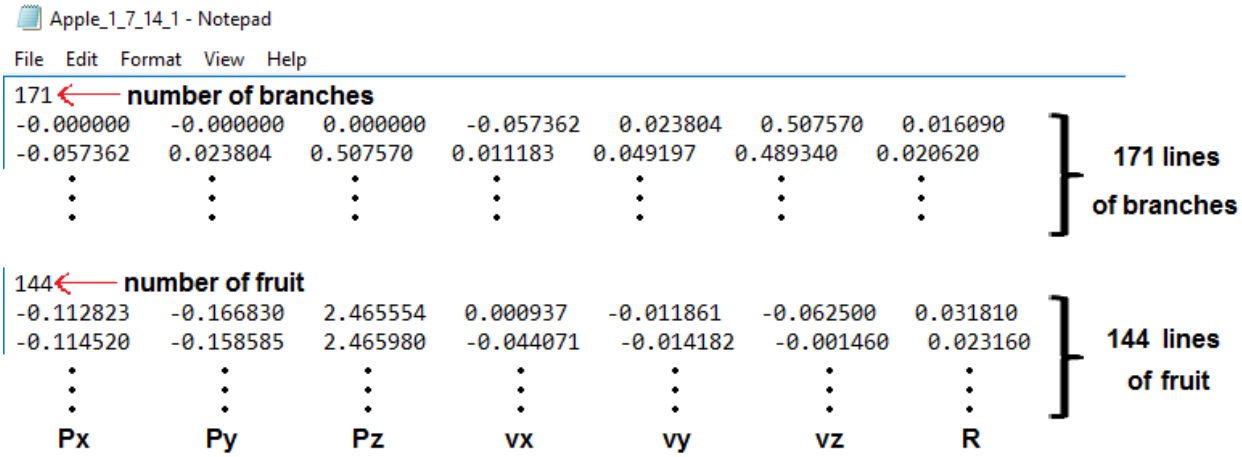
The library of tree models was taken from the Phd Thesis, Victor Bloch, "Methods for Simultaneous Orchard and Harvesting Robot Design".

The library includes description of 20 original plant and their images, method of modeling, and front, side and isometric views of the plant model. The data structure of the models and methods for its reading, presentation and using are described.

The trees are modeled by cylinders and ellipsoids. The branches are divided into straight intervals, which are modeled by circular cylinders with an appropriate base radius. The center of the cylinder base is located at point P with components (Px, Py, Pz). The direction and the length of the straight interval is the vector v with components (vx, vy, vz). The radius of the cylinder is R.

The fruit are modeled by ellipsoids with ratio between the ellipse radii 3:1. The ellipsoid pole connected to its branch is located in the point P with components (Px, Py, Pz). The direction and the length of the long axis of the ellipsoid is the vector v with components (vx, vy, vz). The short axis of the ellipsoid is R.

Text file contains a line with the number of branches, number of lines according to the number of branches containing the coordinate (Px Py Pz vx vy vz R), line with the number of fruit, number of lines according to the number of fruit containing the coordinate (Px Py Pz vx vy vz R).



Matlab Functions

The parameters of a tree model can be read by the function

Tree=TreeRead(FileName,DrawFlag)

where FileName is the name of the text file, DrawFlag is the flag defining if the tree is drawn.

Tree is a structure containing the number of branches and fruit and their parameters.

A tree can be drawn by the function

DrawTree(Tree,BranchColor,FruitColor)

where Tree in the structure containing the tree parameters, BranchColor is a vector containing 3 RGB components of the branch color, FruitColor is a vector containing 3 RGB components of the fruit color.

1. Actual trees and models description

A.1 Tall Spindle apple tree model (Apple_1_TallSpindle, TS)

An apple tree of the type McIntosh was trained by the TS system in Massachusetts in 2010. The tree was reconstructed from the picture by measuring the object's location on the picture plane and assuming the depth.

Fig. 1 *Actual plant.*

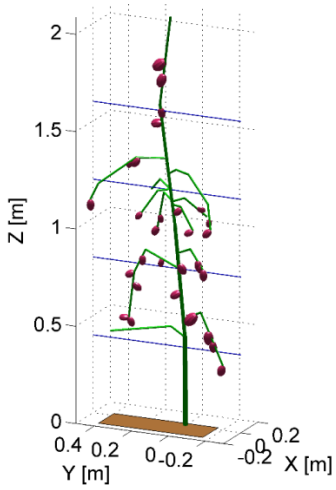


Fig. 2 *Model of Apple_1_TallSpindle.*

A.2 Central Leader apple tree models (Apple_1_7_14, CL1, CL2, CL3, CL4, CL5)

The following five trees were trained by the CL system in a commercial orchard belonging to the Fridman family in Nov, Golan Heights on 1 Jul 2014. The trees were modeled by the measuring device.

Fig. 3 *Actual plants CL1, CL2 and CL3.*

Fig. 4 *Actual plants CL4 and CL5.*

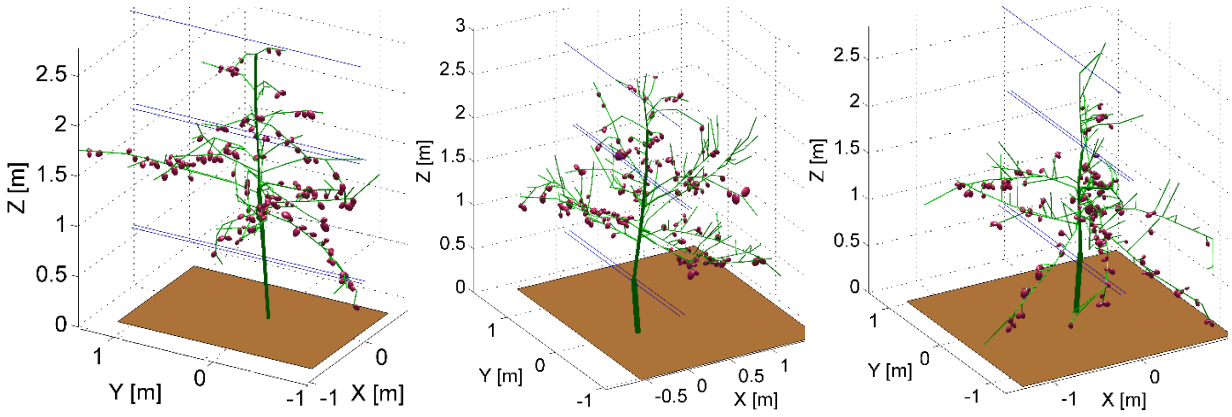


Fig. 5 *Models of LC1, CL2 and CL3.*

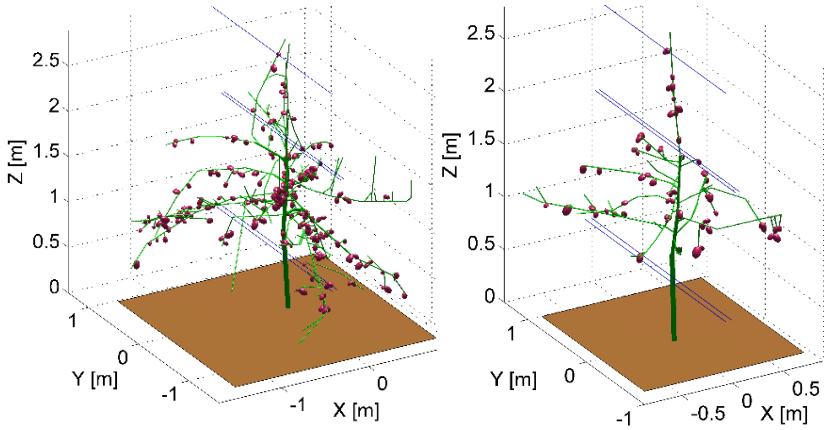


Fig. 6 *Models of LC4 and CL5.*

A row of five trees Apple_1_7_14Row was constructed with the tree models.

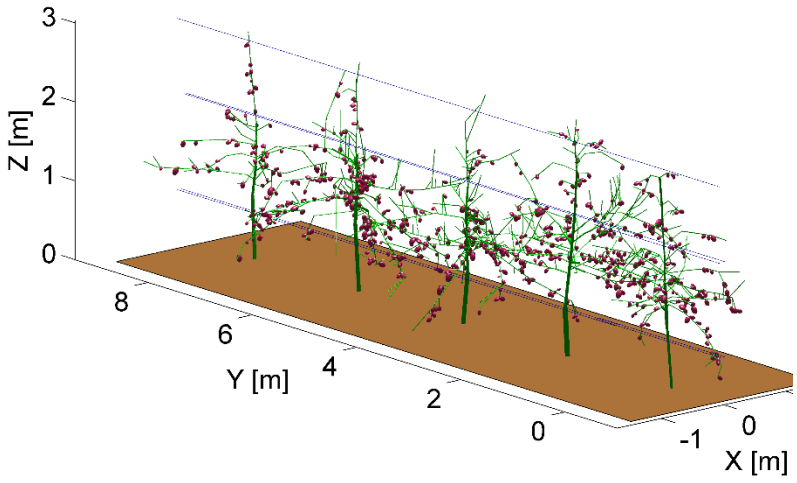


Fig. 7 *Model of Apple_1_7_14Row.*

A.3 Central Leader apple tree models (Apple_11_10_13, Apple_30_10_13)

The following two trees were measured in an experimental orchard in Ramat Matityahu, Upper Galilee. The trees were modeled by the measuring device.

Fig. 8 *Actual plants Apple_11_10_13 and Apple_30_10_13.*

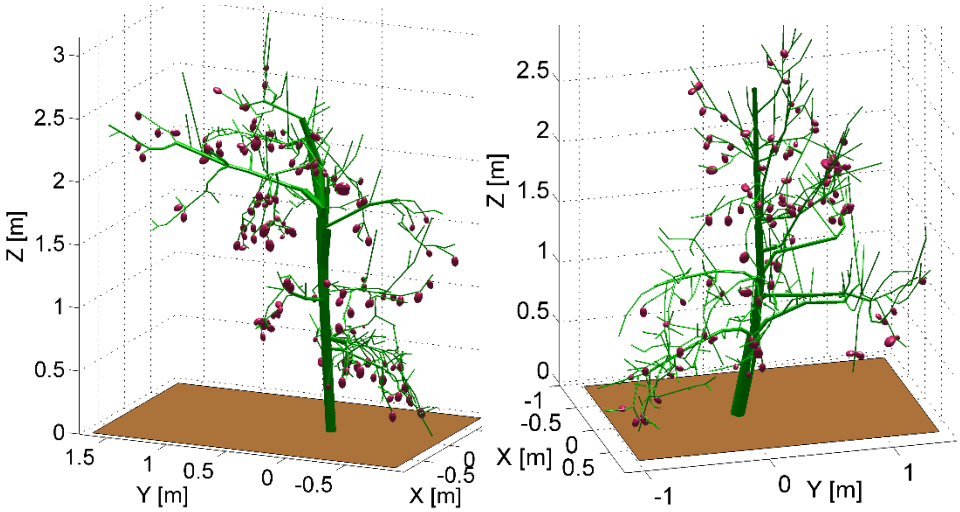


Fig. 9 *Models of Apple_11_10_13 and Apple_30_10_13.*

A.4 Y-trellis apple tree models (Apple_YTrellisL, YT1…5, YTA5…A85)

The tree was reconstructed from the picture. The relatively simple structure of the tree allows formulating the rules of the L-systems. All models were built according to this rule.

Fig. 10 *Actual plant Apple_YTrellisL.*

L-systems description

The models of the trees trained by the YT method were built with the help of the L-systems method (Prusinkiewicz and Lindenmayer, 1990). The tree geometry was defined by the following L-systems rules (symbols defined in Prusinkiewicz and Lindenmayer, 1990). The parameters of these rules were achieved by analyzing the pictures of trees growing in the orchards.

n = 3

#define α_1 30° /* $\gamma_{trellis}$ */

#define α_2 45° /* branching of the generations 2 and 3 */ Eq. A1.

w: A[&(α_1)FFFFF][\(180°)&(α_1)FFFFF]

p_1: F→A[+(α_2)F][-(α_2)F]

In the designed L-systems, the number of branch generations is three (n = 3). The first branching angle is defined as 30°, and the second as 45°. The axiom (w) builds the following structure: build vertical branch A (the tree trunk), turn around the *X* axis on 30° (&(α_1)), build five branch intervals (FFFFF), return to the previous position (][), turn around the *Z* axis on 180° (\(180°)), turn around the *X* axis on 30° (&(α_1)), build five branch intervals (FFFFF). The rule (p_1) replaces each branch interval F by the following structure: build branch interval A, turn around the up

direction on 45° and build one branch interval (+(α_2)F), return to the previous position (][), turn around the up direction on -45° and build one branch interval (-(α_2)F).

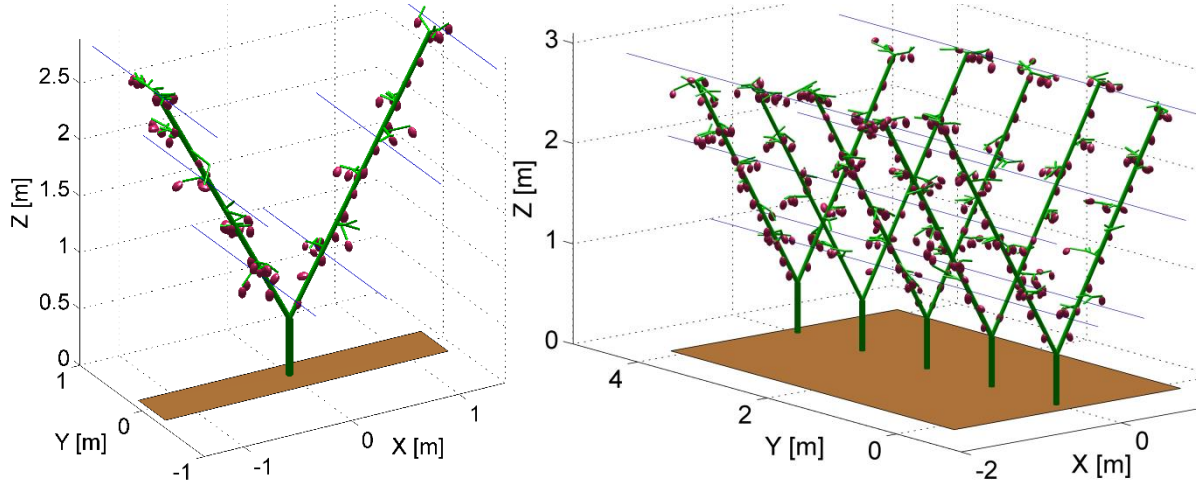


Fig. 11 *Models of Apple_YTrellisL and tree row consisting of five models created by the L-Systems rule.*

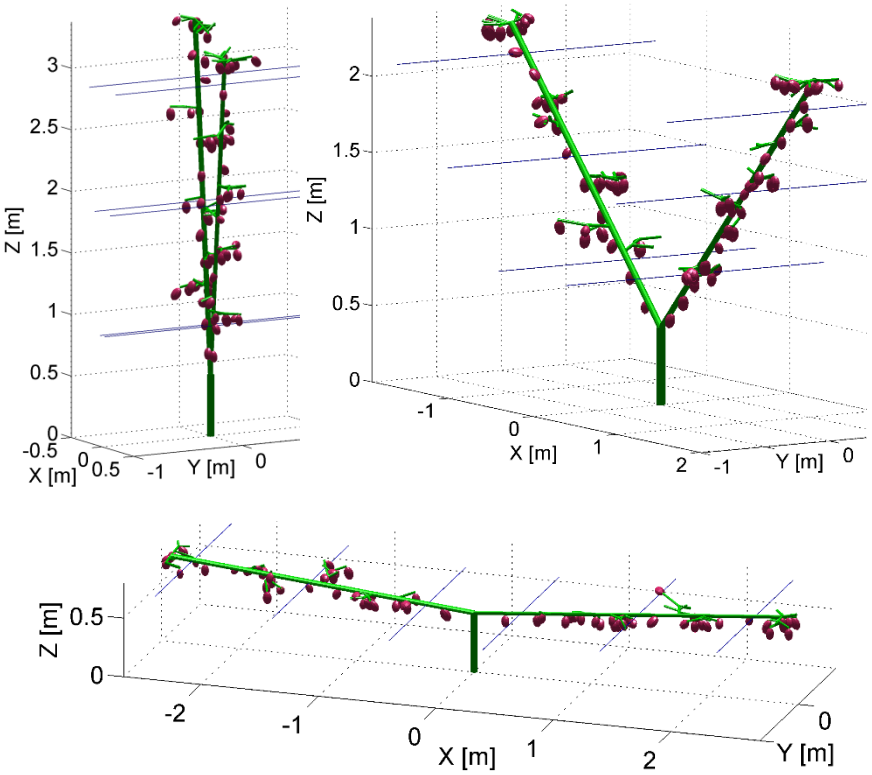


Fig. 12 *Models of Apple_YTrellisL with trellis tilt angles 5°, 30° and 85° created by the L-Systems rule.*

A.5 Nectarine tree models (Nectarine_30_6_14, N1, N2, N3, N4, N5)

The following five trees were measured in the Fridman family commercial orchard in Nov, Golan Heights, on 30 Jun 2014. The trees were modeled by the measuring device.

Fig. 13 *Actual plant Nectarine_30_6_14.*

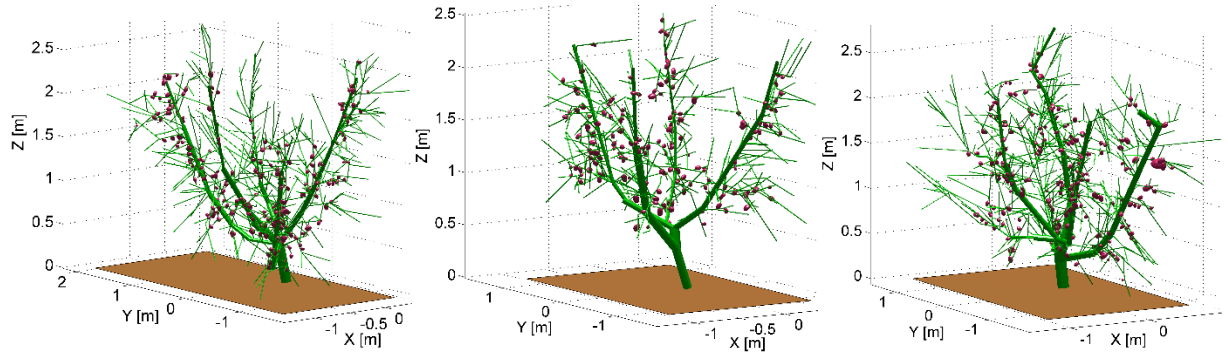


Fig. 14 *Models of N1, N2 and N3.*

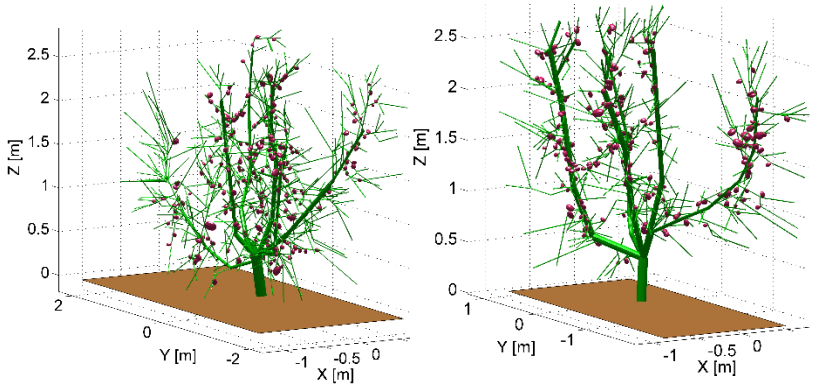


Fig. 15 *Models of N4 and N5.*

A row of five trees Nectarine_30_6_14Row was constructed with the tree models.

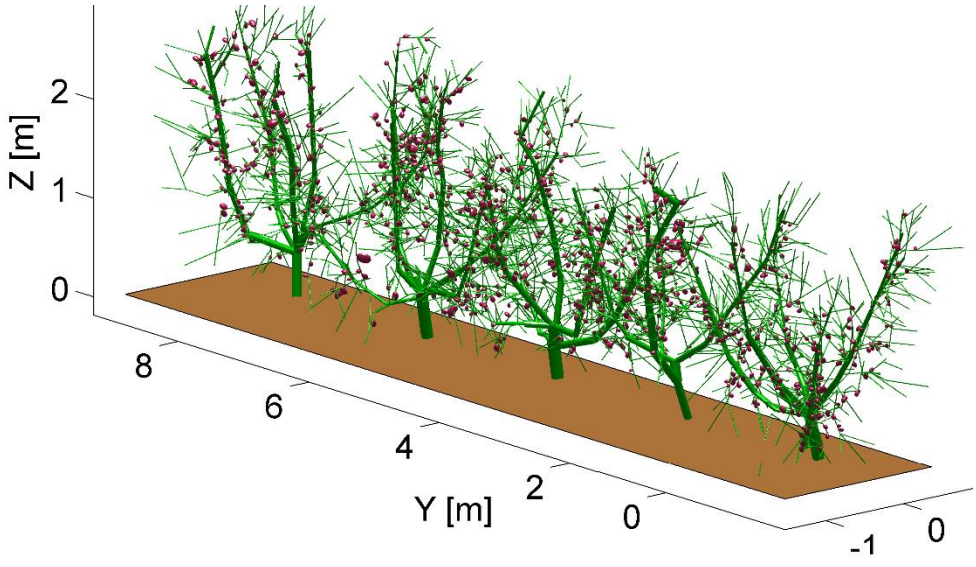


Fig. 16 *Model of Nectarine_30_6_14Row.*

A.6 Nectarine tree models (Nectarine_6_4_14, Nectarine_30_3_14)

The following four trees were measured in an experimental orchard at the Volcani Center in Bet Dagan. The trees were modeled by the measuring device.

Fig. 17 *Actual plant Nectarine_6_4_14 and Nectarine_30_3_14.*

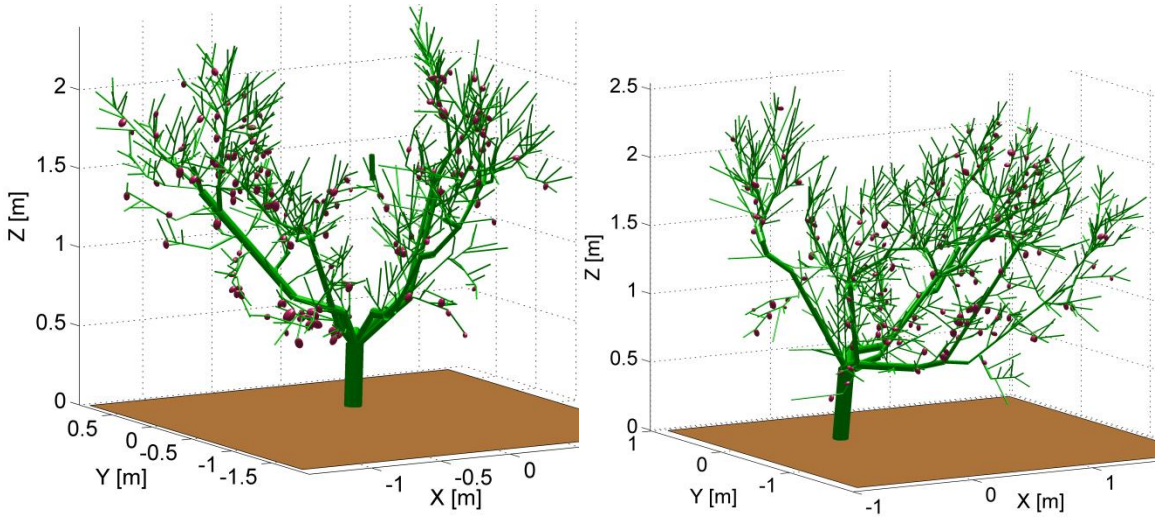


Fig. 18 *Models of Nectarine_6_4_14 and Nectarine_30_3_14.*

A.7 Peach tree models (Peach_23_03_14, Peach_24_03_14)

The following trees were measured in an experimental orchard at the Volcani Center, Bet Dagan. The trees were modeled by the measuring device.

Peach_23_03_14 Peach_24_03_14

Fig. 19 *Actual plants Peach_23_03_14 and Peach_24_03_14.*

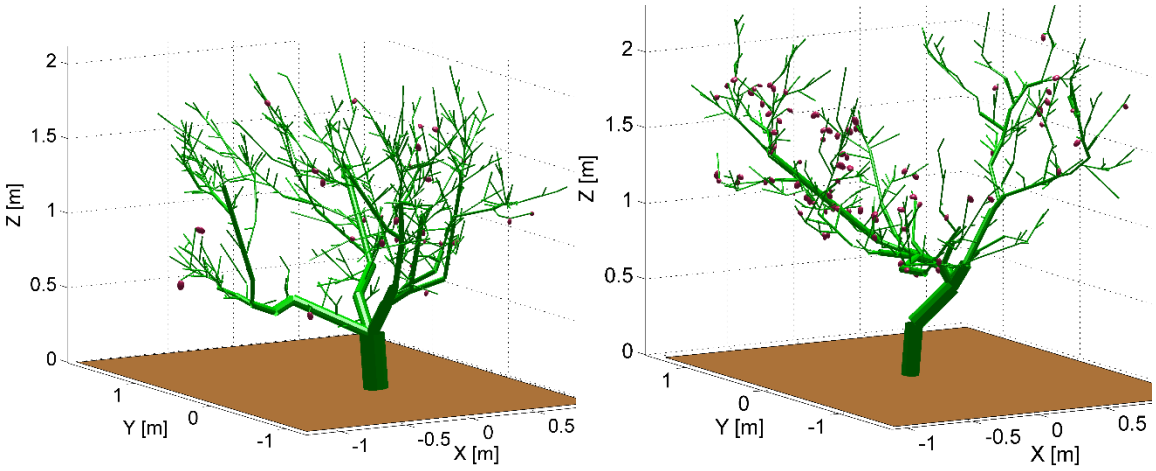


Fig. 20 *Models of Peach_23_03_14 and Peach_24_03_14.*

A.8 Tangerine tree models (Tangerine_20_3_14)

The tree was measured in a commercial orchard. The tree was modeled by the measuring device.

Fig. 21 *Actual plant Tangerine_20_3_14.*

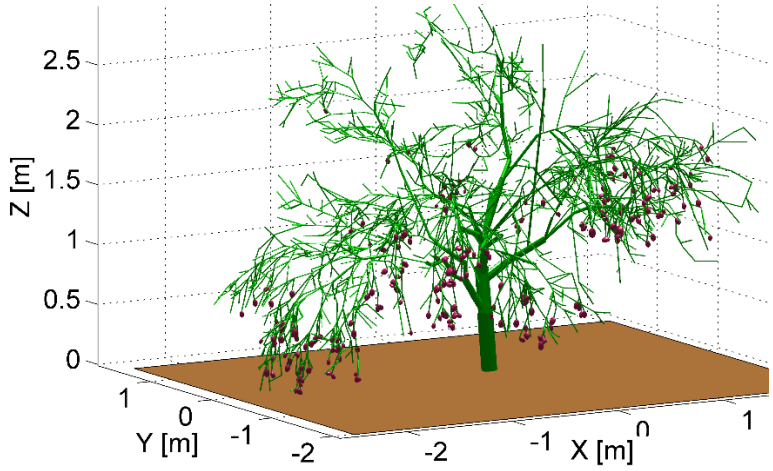


Fig. 22 *Models of Tangerine_20_3_14.*