

Applicability of force and distance sensors in volume measurement.

Methods to improve tree volume measurements

Measurement accuracy of force and distance sensors in tree volume measurements

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Introduction

Biomass has the highest proportion of total energy production in Finland than in any other industrialized country. Most of the biomass that is used for energy production in Finland is wood (2014). [1] The usage of biomass for energy production has increased and therefore it is important to be able to measure how much biomass is stored in the forests. Another interesting future prospect is carbon storage in forests. In order to estimate the carbon storage capacity of the forest, accurate estimate of the biomass needs to be known. [2]

Accurate measurement system for tree volume is needed, because the volume estimation is currently done by using mathematical models. These mathematical models do not take branches into account, even though their volume is significant. [2] Accurate estimation of the volume is also necessary to determine the density of a tree. Many structural properties of the tree depends on its density. Pine tree's tensile strength varies between 34-192 MPa, when it is being pulled along the grains of the tree. [3] This means that the applicability of a tree is determined by its density.

Volume measurement can be done by using terrestrial laser scanning (TLS). This method allows tree volume measurement without cutting the tree into pieces. With this method, the tree is first digitized by TLS. Then the TLS data is processed by geometric fitting algorithms which can compute the total volume of the measured tree. This method does not take into account branches that are smaller than 7 cm in diameter, which leads to $\pm 30\%$ error in branch volume measurement. This error is significant and the results do not include the density of the tree. [4]

University of Helsinki has a volume measuring device in Hyytiälä forestry field station, which has been developed in collaboration with Aalto university. The device measures volume of desired part by plunging it in water. Force sensor registers the buoyancy and determines the volume by using archimedes principle. [2] Drawback of the machine is that it does not take into account that the buoyancy depends on the temperature of the water [5]. The device has been upgraded with an ultrasonic sensor, for measuring the volume by determining how much the water level rises when the object is plunged into the water. The device can now measure the volume by measuring buoyancy and water level. Our goal is to determine which method is more suitable for this purpose by building a similar device as the original.

Tree volume measurement

- General information about tree volume measurement
- Why measuring the biomass volume is important
- Existing solutions and methods

Sensors in volume measurements

- Comparison of different sensor options for measuring the tree volume

Load cell for buoyancy measurement

Distance sensor for liquid level measurement

Dimensiometer

- Description of the device built
- Measurement results

Conclusion

- Are the results as expected
- Analysis of the results
- Further improvement ideas

References

We found 12 articles, thesis patents and books to begin with [1]–[12].

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