2013

Evaluating Tree Height Using Pictometry® Hyperspatial Imagery

Daniel Unger
Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, unger@sfasu.edu

David Kulhavy
Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, dkulhavy@sfasu.edu

Matthew A. Wade

Evaluating Tree Height Using Pictometry® Hyperspatial Imagery

Daniel R. Unger, David L. Kulhavy, Matthew A. Wade

Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, Nacogdoches, TX 75962

INTRODUCTION

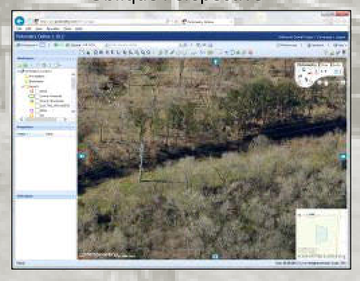
This study evaluated the use of Pictometry® hyperspatial 4-inch (10.2 centimeters) multispectral imagery to estimate height of baldcypress trees on the campus of Stephen F. Austin State University (SFASU), Nacogdoches, Texas. Actual tree heights of 60 baldcypress trees measured with a telescopic height pole were compared to Pictometry® estimated tree height. Linear correlation coefficients (r) and coefficient of determinations (R^2) between actual tree height and Pictometry® estimated tree height for all 60 tress, and the shortest 30 and tallest 30 trees, were calculated. A paired t-test (alpha = 0.05) was calculated for all 60 tress, and the shortest 30 and tallest 30 trees, to test for statistical significance between actual and estimated tree height. The objective was to ascertain if Pictometry® estimated tree height could be used in lieu of field-based tree height estimation for open grown urban trees.

WHAT IS PICTOMETRY®?

- Pictometry® is the name of a patented aerial image capture process.
- Imagery shows the fronts and sides of vertical ground features.
- Images captured by low-flying aircraft.
- Images include nadir and up to a 40 degree angle.
- Images depict up to 12 oblique perspectives.
- Images are stitched together to create composite imagery.
- Can accurately measure surface object size and position.

Ortho Perspective

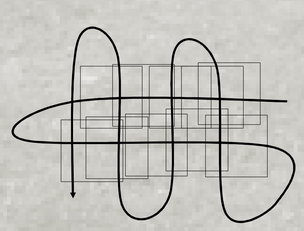
Oblique Perspective



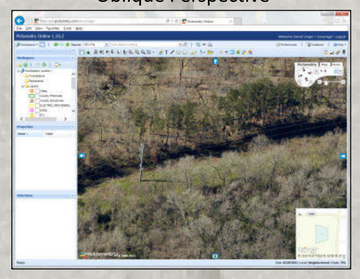
PICTOMETRY® DATA ACQUISITION

- Acquired along a predetermined flight path in all 4 cardinal directions.
- Flight path designed to ensure collection of nadir and up to 12 oblique perspectives at a 40 degree angle.
- Measure height onscreen using composite imagery.

Flight Path

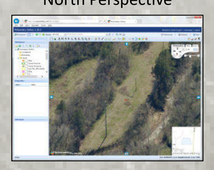


Oblique Perspective



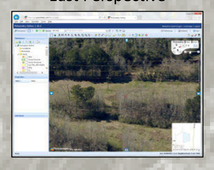
All Four Cardinal Directions

North Perspective



South Perspective

East Perspective



West Perspective

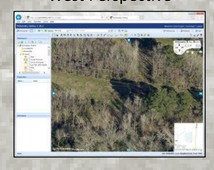


Figure 1. Measuring baldcypress height.

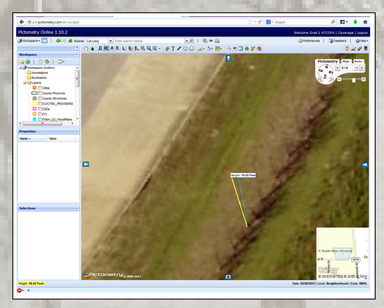


Figure 2. Estimating baldcypress height using Pictometry® web interface.

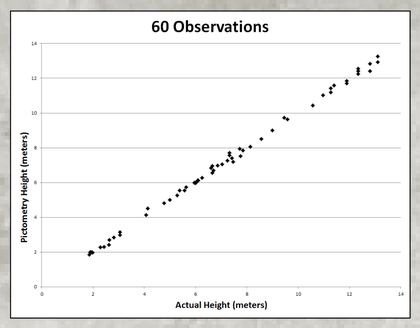
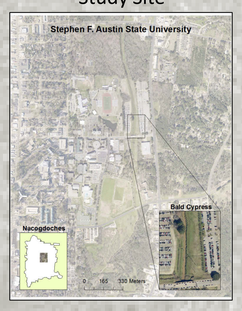


Figure 3. Graph of Pictometry® estimated height versus actual height.

Study Site



METHODS

We had three specific objectives: (1) measure the actual height of baldcypress trees in the field; (2) use Pictometry® hyperspatial imagery to measure the height of baldcypress trees onscreen via a web based interface; and, (3) compare the accuracy of field-based measurements to remotely sensed Pictometry® measurements. The study site was located on the bank of LaNa Creek on the campus of SFASU. The heights of 60 baldcypress trees along the banks of LaNa Creek were measured during April and May, 2013. Tree height was measured *in situ* with a telescopic height pole in 2.54 centimeter increments (1 inch increments) by an undergraduate forestry student within ATCOFA (Figure 1).

The heights of all 60 baldcypress trees were measured onscreen using Pictometry® oblique hyperspatial 4-inch (10.2 centimeters) multispectral imagery via a web based interface during summer 2013 by a ATCOFA graduate research assistant (Figure 2). Onscreen height measurements were recorded to 0.03 meters (0.1 feet). The Pictometry® oblique hyperspatial 4-inch (10.2 centimeters) multispectral imagery was acquired in February and March, 2013. Onscreen and field measured tree heights, recorded by two separate individuals to eliminate tree height bias estimation, represent *in situ* conditions before the start of the spring 2013 growing season.

Linear correlation coefficients and coefficient of determinations between actual tree height and Pictometry® estimated height for all 60 tress, and the shortest 30 and tallest 30 trees were calculated. A paired t-test was calculated for all 60 tress, and the shortest 30 and tallest 30 trees, to test for statistical significance between actual and estimated tree height (alpha = 0.05).

RESULTS

There was minimal difference between actual tree height and Pictometry® estimated tree height. Mean actual tree height for all 60 tress was 7.07 meters. Mean Pictometry® estimate tree height for all 60 trees was 7.10 meters. Pictometry® measured tree height was within on average 1.78% of actual height for all 60 trees. Pictometry® measured tree height was within on average 2.16% and 1.40% of actual height for the shortest 30 trees and the tallest 30 trees respectively. A scatter graph of Pictometry® estimated tree height and actual tree height indicated a strong relationship between *in situ* and remotely sensed height (Table 1, Figure 3). A linear correlation coefficient between actual tree height and Pictometry® estimated height for all 60 tress was 0.999. Coefficient of determination between actual tree height and Pictometry® estimated tree height for all 60 tress was 0.998. A paired t-test analysis between actual tree height and Pictometry® estimated tree height with a 95 percent confidence level (alpha = 0.05) indicated no statistical difference between *in situ* and remotely sensed height (Table 2). Calculated p-value between actual tree height and Pictometry® estimated height for all 60 tress was 0.19. Calculated p-value between actual tree height and Pictometry® estimated tree height was 0.10 and 0.66 for the shortest 30 trees and the tallest 30 trees respectively.

Table 1. Linear correlation coefficient and coefficient of determination results.

Sample	Linear Correlation Coefficient (r)	Coefficient of Determination (R^2)
All 60	0.999	0.998
Shortest 30	0.998	0.996
Tallest 30	0.997	0.994

Table 2. Actual and Pictometry® estimated mean height, t-value and p-value results.

Sample	Actual Mean Height (meters, SD)	Pictometry® Mean Height (meters, SD)	t-value	p-value
All 60	7.1 (0.15)	7.1 (0.15)	-1.33	0.19
Shortest 30	4.4 (0.12)	4.4 (0.12)	-1.72	0.10
Tallest 30	9.8 (0.18)	9.8 (0.18)	-0.44	0.66

SUMMARY AND CONCLUSIONS

Actual heights of open grown 60 baldcypress trees measured *in situ* were compared to Pictometry® estimated tree height using hyperspatial 4-inch (10.2 centimeters) multispectral oblique imagery onscreen via a web based interface. Linear correlation coefficients and coefficient of determinations between actual tree height and Pictometry® estimated height for all 60 tress, and the shortest 30 and tallest 30 trees, were all greater than 0.994. Pictometry® measured tree height was within on average 1.78%, 2.16% and 1.40% of actual tree height for all 60 trees, the shortest 30 trees, and the tallest 30 trees respectively. Results from a paired t-test for all 60 tress, and the shortest 30 and tallest 30 trees, indicated no statistical difference between *in situ* and remotely sensed height. Remote sensing with its ability to collect data systematically over large geographic areas has the potential to aid field-based tree height estimation within an urban setting. Estimating height of open grown urban tress using Pictometry® hyperspatial 4-inch (10.2 centimeters) multispectral oblique imagery onscreen via a web based interface could be used to supplement or replace time consuming field-based tree height estimation.