Evaluating Tree Height Using Pictometry® Hyperspatial Imagery

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Evaluating Tree Height Using Pictometry® Hyperspatial Imagery

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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 (R²) between actual tree height and Pictometry® estimated tree height for all 60 trees, and the shortest 30 and tallest 30 trees, were calculated. A paired t-test (alpha = 0.05) was calculated for all 60 trees, 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.

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.

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.

RESULTS

There was minimal difference between actual tree height and Pictometry® estimated tree height. Mean actual tree height for all 60 trees was 7.07 meters. Mean Pictometry® estimated 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 trees was 0.999. Coefficient of determination between actual tree height and Pictometry® estimated tree height for all 60 trees was 0.999. A paired t-test analysis between actual tree height and Pictometry® estimated 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 trees was 0.19. Calculated p-value between actual tree height and Pictometry® estimated height was 0.10 and 0.66 for the shortest 30 trees and the tallest 30 trees respectively.

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 trees, 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 trees, 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 trees 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.

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

<table>
<thead>
<tr>
<th>Sample</th>
<th>Linear Correlation Coefficient (r)</th>
<th>Coefficient of Determination (R²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All 60</td>
<td>0.999</td>
<td>0.998</td>
</tr>
<tr>
<td>Shortest 30</td>
<td>0.998</td>
<td>0.996</td>
</tr>
<tr>
<td>Tallest 30</td>
<td>0.997</td>
<td>0.994</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Sample</th>
<th>Actual Mean Height (meters, SD)</th>
<th>Pictometry® Mean Height (meters, SD)</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All 60</td>
<td>7.1 (0.15)</td>
<td>7.1 (0.15)</td>
<td>-1.33</td>
<td>0.19</td>
</tr>
<tr>
<td>Shortest 30</td>
<td>4.4 (0.12)</td>
<td>4.4 (0.12)</td>
<td>-1.72</td>
<td>0.30</td>
</tr>
<tr>
<td>Tallest 30</td>
<td>9.8 (0.18)</td>
<td>9.8 (0.18)</td>
<td>-0.44</td>
<td>0.66</td>
</tr>
</tbody>
</table>