

Crown Assessment of Urban Street Trees Using Ground-based Digital Imaging

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Introduction

A street tree survey is part of the Urban Forest component of Forest Health Monitoring. Crown variables such as height, diameter, live crown ratio, dieback, transparency, and density are all collected as part of the overall crown assessment. Transparency and density are related to the amount of foliage and thus the photosynthetic potential of the tree. These measurements are both currently based on visual estimates and have been shown to be highly variable between observers (Solberg and Strand 1999). Additionally, the collection methods for these variables are not controlled for repeated measures analysis. Digital image capture using relatively inexpensive digital cameras from monumented (using tree as reference) locations is proposed to enable more sensitive analysis of trends in these variables over time by eliminating observer and viewpoint effects. The additional information of crown profiles and spatial distribution of foliage may also provide useful information for modeling.

Why?

Study of tree crowns and the canopy in general is a growing area of research (Bechtold et al. 2002, Mizoue and Dobbertin 2003, Ferretti 1997)

Indicator for Santiago Declaration

Why use urban trees?

- Urban setting is receiving greater attention -- visible forestry
- Trees located in areas more susceptible to damaging agents (gas emissions, chemical agents, compaction, etc.)
- Canopy characteristics are different from trees grown in forested condition
- Canopy position typically not an issue
- Sick Trees + Urban Area = Damage Risk (lives and \$\$)

Photo Methods for Urban Trees from Monumented Viewpoints



T1



T2



T3

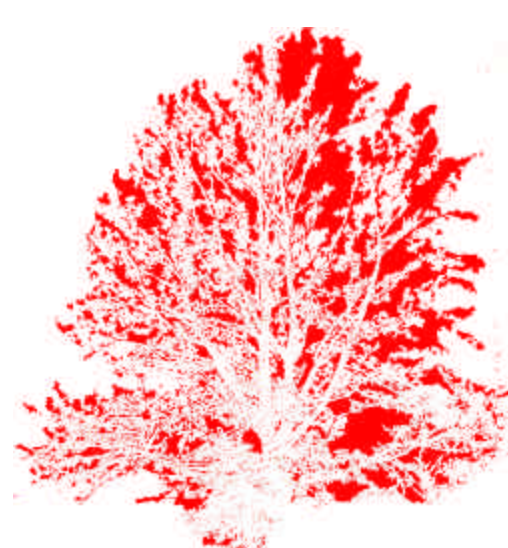
Monumented viewpoints can be used for repeated measures

Creating physical monuments in an urban environment is not often feasible, so the tree itself serves as the monument and an offset distance and direction are defined. Previous photos can also be used for proper alignment using points that typically are visible within the branching structure.

Data archive to revisit for *ex post facto* analysis



Change T2-T1

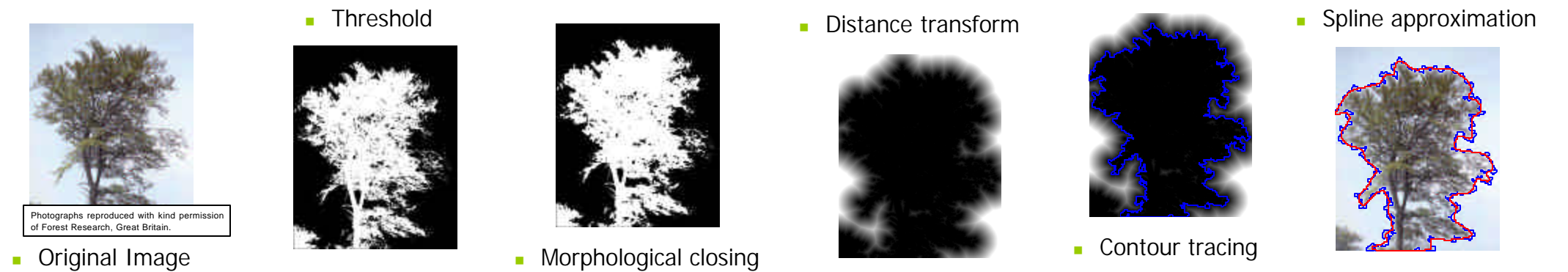


Change T3-T2

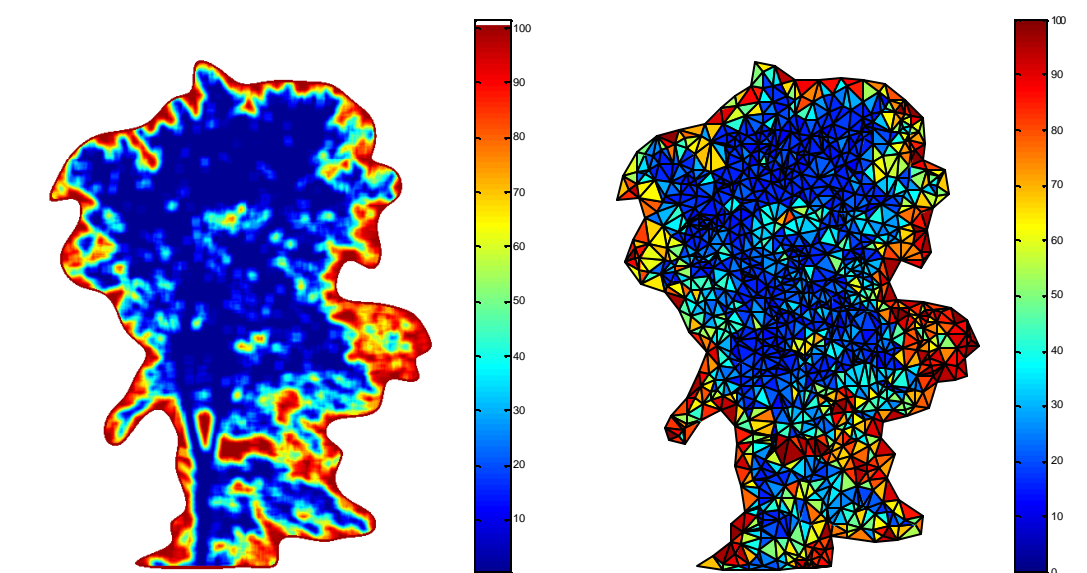
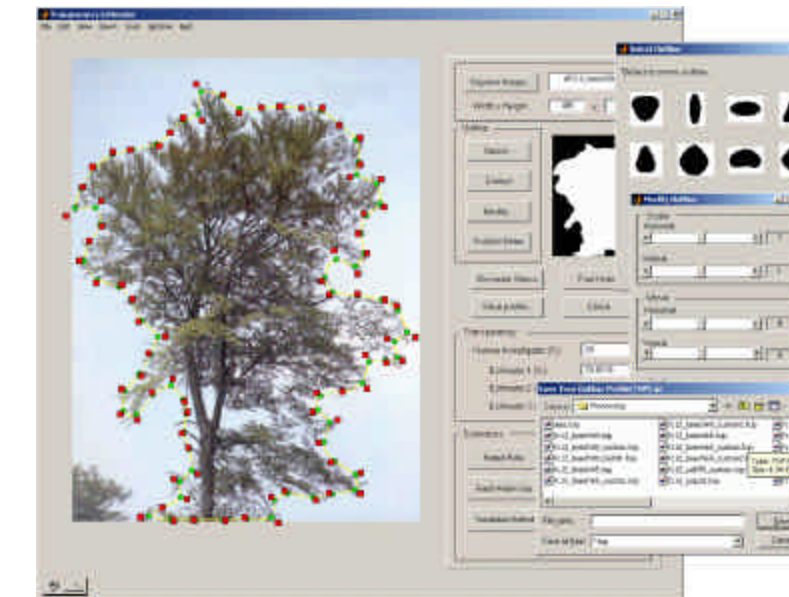


Change T3-T1

Transparency / Density Analysis



A sequence of operations is performed to automatically determine the crown silhouette. The spline can then be manipulated to perform assessments for transparency or density.



Silhouettes (crown profiles) from multiple directions can be used to create a more precise crown model (for volume, surface area, etc.) than the general geometrical ellipsoids commonly assumed.

Point-wise or Region-wise Transparency Distribution Maps can be used to perform more in-depth analysis

Advances

- Results from this study will provide a more precise and reliable method to investigate transparency or density change over time
- An extensive level of primary data can be collected rapidly – this may prove useful for long-term analysis
- Parameters defining the boundary conformity and optical scale will be defined

Things we still need to know:

- What new forms of analysis does this technology enable?
- What practical sampling issues need to be addressed in order to use this method over the long-term?
- What is the sensitivity of this method to varying levels of foliage?

Literature Cited:

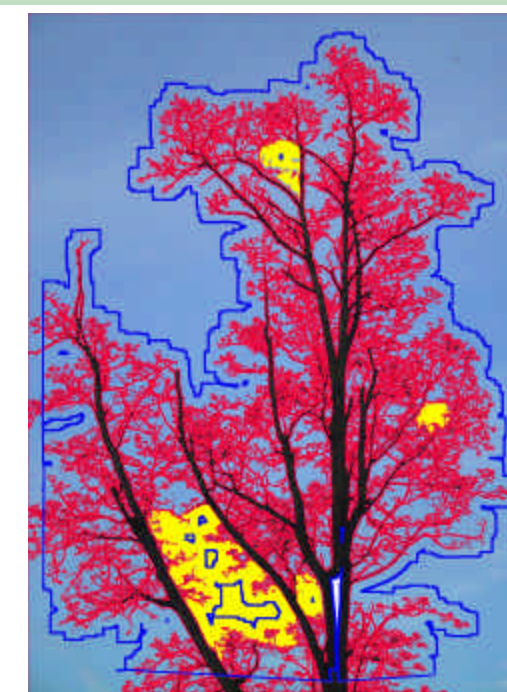
Bechtold, W., M. Mielke, S. Zarnoch. 2002. Comparison of field methods and models to estimate mean crown diameter. *Northern Journal of Applied Forestry*. 19(4):177-182.

Ferretti, M. 1997. Forest health assessment and monitoring – issues for consideration. *Environmental Monitoring and Assessment*. 48(1): 45-72.

Mizoue, N., and M. Dobbertin. 2003. Detecting differences in crown transparency assessments between countries using the image analysis system Croco. *Environmental Monitoring and Assessment*. 89(2):179-195.

Solberg, S., and L. Strand. 1999. Crown density assessments, control surveys and reproducibility. *Environmental Monitoring and Assessment*. 56:75-86

Outline Subjectivity / Image Scale :



With digital image analysis it is possible to quantify the scale of data as well as the level of the “tightness of the shrink wrap” or boundary conformity

The figure above indicates a very tight wrap in **red** (transparency = 0) and a looser wrap in **blue** (transparency > 0). The minimum size of opening within the interior of the silhouette (**yellow**) should also be defined.