Interactive Basal Area Estimations from Mobile Phone Images

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The overall objective of the Social Forest Planning project is to develop and demonstrate a novel system for forest management planning and updating of present plans. The system to be developed combines images from cellular phones with remote sensing data to predict forest variables. The variables are input to a Planner Engine that outputs forest resources information for every forest stand and feeds them into a Geographical Information System (GIS). The GPS location tag in the images makes it possible to use them easily as in-situ reference data. The main technical development goal of Social Forest is to develop automatic and interactive methods for the cell phone image analysis. The automatic methods were presented in Remote Sensing Days 2010 [2]. This paper focuses on interactive delineation of tree stems, that enables automatic computation of tree stem basal area $[m^2/ha]$, the key variable in the estimation of the growing stock volume.

The study area is located in the surroundings of Hyytiälä Forest Station (Finland, 61°50'42"N, 24°17'11"E), where tree-wise information and geo-coordinates of about 20 ha of forest are available. Experts from University of Helsinki have selected 54 views over 23 sample plots, covering a wide range of site types, basal area, tree species proportions (mixed and pure plots) and stem dimensions, understory vegetation, as well as ground slopes and illumination conditions. The views were defined by a geo-referenced location within the plot and a direction to acquire the picture from. 316 cell phone images have been acquired on 28-29th of June 2010, simulating operative conditions - "point-and-shoot" without prior knowledge of forest inventory.

A interactive tool relying on the relascope [1] and the central projection principles was developed. Given a relascope factor (typically 0.5 or 1) and knowing the field of view FoV of the camera, a gauge of the corresponding angular size is overlaid on the images in a Graphical User Interface (GUI). It allows to quickly select trees to be included in the interactive basal area estimation. The image represents only a fraction of the full panoramic view that is normally used in forest inventory. The basal area from the angular sector corresponding to the image was extrapolated to the full circle using the multiplication factor $360/FoV$, where $FoV \simeq 52°$.

The interactive basal area estimates from the 54 principal views were compared to reference basal area computed from the forest inventory data. The correlation on total basal area reached 0.71. Scatterplots revealed a slight underestimation of the interactive method. This could be explained in some cases by the occlusions of trees in the background by trees in the foreground.

Future work will include corrections of basal area underestimations. The cell phone-derived data can be used as reference to Unmanned Aerial Vehicle (UAV) images and satellite image analysis to predict the forest variable values wall-to-wall, or combined with stand-wise predictions of forest variables to produce forest management plans.

References

[1] W. Bitterlich, "The Relascope Idea: Relative Measurements in Forestry", 1984, Commonwealth Agricultural Bureaux, Farnham Royal.

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