quarterly report for

Applications of High Performance Statistical Modeling to Image Analysis of Forest Structure

submitted to:

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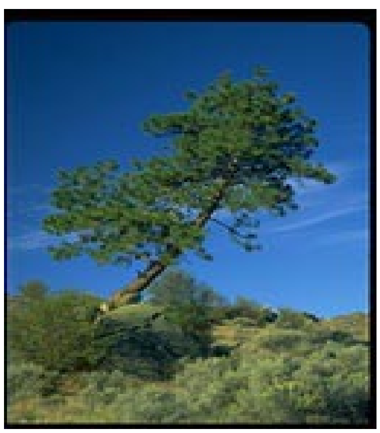

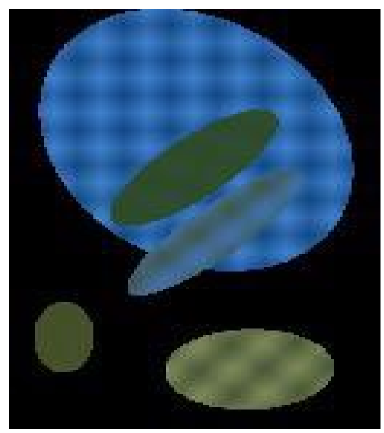

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INTRODUCTION

The need to automatically determine the scenic beauty of a forest scene has been the prime source of motivation for this project. In prior efforts, commonly used features like RGB colors, entropy, number of trees, etc. were used to classify images for scenic beauty [1]. The primary goal of this project is to expand the scope and use various signal processing techniques to extract automatically more diversified information from forestry images. Presently, our efforts are focused on recognizing important objects from a forest scene to assist in the scenic beauty estimation. Hence, in this quarter, we mainly worked on preparing data for future experiments. Since most object recognition algorithms need transcribed training data to build statistical models, we segmented the digital images into different objects such as tree, bush, grass, etc. We developed a software tool to expedite this task. A total of 1784 images, constituting all USFS images processed to date, have been segmented. This large database of segmented images will form the basis for the development of advanced object classification algorithms.

THE SEGMENTATION TOOL

We have developed a segmentation tool named Image Object Labeler (IOL). This tool was rapidly prototyped in Tcl/Tk, and is fairly portable across Unix and PC environments. It was designed to allow a user to select a certain type of object, and to draw a connected polygon around the region defining that object. Each image can be labeled multiple times. A list of images are traversed using a scrolling dialog box. This allows the user to iterate on a set of images until all segmentations are consistent. An example of a labeled image is shown in Figure 1.

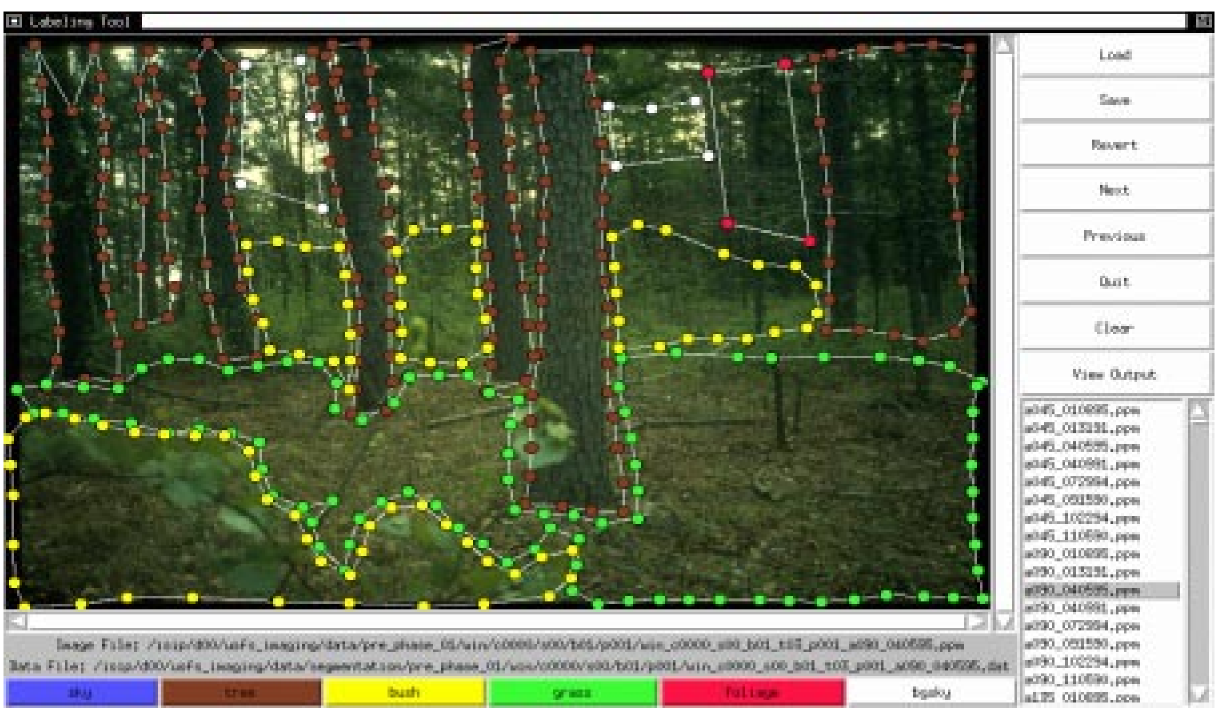

Figure 1. An example of a labeled image using our segmentation tool.

We have currently labeled the images using a simple system involving a six-way classification. This classification scheme is shown below in Table 1.

Label	Description
tree	a woody perennial plant having a single usually elongated main stem generally with few or no branches on its lower part
bush	a low densely branched shrub or a close thicket of shrubs suggesting a single plant
grass	grass or land covered with growing grass, or other green-colored ground cover
foliage	a cluster of leaves, flowers, and branches
sky	a region typically containing sky and few obstructions such as trees; strictly limited to the top of the image
background sky	sky in the background and other objects in the foreground (but still clearly identified as sky)

Table 1. The six categories used to label images.

The segmentation process begins by creating a list of images to be segmented. The button named “load” is used to load both image file list to be labeled and data file list which will keep the results of the labeling. When an image is chosen and displayed, we can label objects as listed at the bottom of the window. As an example, to label a tree in the image, just click the button named “tree” first, then proceed to draw a polygon around the tree. After finishing labeling of all objects in the image, use the “save” button to write the data into the corresponding data file. Then click “next” to get the next image file in the file list, or “previous” to the previous image file. In labeling, we use “clear” to clear all the labels and use “revert” to go back to the most recently saved file. The “view output” button provides a corresponding look at the output data. As we can see, the user interface is simple and intuitive.

The time needed to segment an image varies from image to image. For some simple images which just contain one or two objects such as a foliage plus background sky, only 2 minutes are required, some of which is simply the time required to load the image (between 10 and 30 secs). On the other hand, for some really complicated images, it takes as much as 8 minutes to label all the objects in one image. The average time used to segment an image is 4 minutes or so. This implies it will take about 120 hours to segment the entire database, or approximately 6 weeks at 20 hours per week.

An example of the data file format is shown in Figure 2. The data file begins with the name of the image file, followed by the object name, followed by the coordinates of all the label points used to mark this object. There can be multiple instances of any object in the file, and the order of the objects is arbitrary (each object is written in the order it was created). The description of an image

```
/isip/d00/usfs_imaging/data/phase_01/cd_0012/img0002.ppm
Class tree
954  32
954  386
...
1106  30
Class foliage
186  32
...
```

Figure 2. An example of the output file format used by the segmentation tool to store image segmentation information. A simple ASCII file format is used for portability.

is terminated by either a new image filename or the end of the file.

SEGMENTATION OF THE DATABASE

With the tool introduced above, we manually segmented all USFS image data that we have been provided. The images are located on ISIP computers in the same place as the image data: /isip/d00/usfs_imaging/data/pre_phase_01/ and /isip/d00/usfs_imaging/data/phase_01/ respectively. The first set consists of 637 images taken from Winona Ranger District. The latter set consists of 1147 images taken from Ouachita and Ozark National Forest. There are a total of 1784 images.

SUMMARY

We have developed an image segmentation tool that allows rapid and accurate segmentation of images. The entire USFS image database has been segmented using a six-way classification scheme. Software has been designed that will make use of this information to train image classifiers using some of the techniques described previously [2].

We also plan to implement new color computation and classification schemes. The colors brown and yellow [3] have been shown to play an important role in human perception of the scenic beauty of images. Therefore, we are going to incorporate brown and yellow into our color measurement scheme, and evaluate its effectiveness on the scenic beauty estimation problem.

REFERENCES

[1] N. Kalidindi, A. Le, H. Yaqin, L. Zheng, J. Picone and V. A. Rudis, "Scenic Beauty Estimation of Forestry Images," *Proceedings of IEEE Southeastcon*, pp. 337-339, Blacksburg, VA, USA, April 1997.

[2] X. Zhang, V. Ramani, Z. Long, Y. Zeng, A. Ganapathiraju and J. Picone, "Scenic Beauty Estimation Using Independent Component Analysis and Support Vector Machines," submitted to the *IEEE Southeastcon*, Lexington, Kentucky, USA, March 1999.

[3] W. Yhang, J. H. Gramann and V. A. Rudis, *Color Visibility by Season and Silvicultural Treatment: Effects on the Scenic Beauty of Southern U.S. Pine-Oak Forests*, Texas A&M University, College Station, TX and USDA-FS Southern Research Station, Forest Inventory and Analysis Unit, Starkville, MS, USA, October 1998 (manuscript draft).