Submission Cover Sheet for 1999 IEEE SoutheastCon

Submission Type (Please Check One):

☐ *Full Length Paper - (Due 11/1/98)* ☑ *Concise Paper - (Due 12/1/98)*

Title of manuscript:
SCENIC BEAUTY ESTIMATION USING INDEPENDENT COMPONENT ANALYSIS AND SUPPORT VECTOR MACHINES

Authors and affiliations (List authors in the order to appear on the manuscript. List affiliations (companies, universities, etc.) and addresses exactly as they should appear. If there are more than 4 authors, please attach a second sheet.

1. Name **Xinping Zhang**
Affiliation **Mississippi State University**
Address **PO Box 9571**
Mississippi State, MS 39762

2. Name **Vijay Ramani**
Affiliation **Mississippi State University**
Address **PO Box 9571**
Mississippi State, MS 39762

3. Name **Zhiling Long**
Affiliation **Mississippi State University**
Address **PO Box 9571**
Mississippi State, MS 39762

4. Name **Yu Zeng**
Affiliation **Mississippi State University**
Address **PO Box 9571**
Mississippi State, MS 39762

Corresponding Author:
Name: **Xinping Zhang**
Address: **PO Box 9571**
Mississippi State University, MS 39762

Telephone: **601-325-8335**
FAX: **601-325-3149**
E-mail: **zhang@isip.msstate.edu**

Key Words: **scenic beauty estimation, ICA, Support Vector Machine**

For Technical Committee Use Only -- Do Not Write Below

Date Received: _____ Manuscript # Assigned _____

Author Notification Date: _____ Date Camera Ready Received: _____

Decision: _____ Session: _____

Notes: _____

Submission Cover Sheet for 1999 IEEE SoutheastCon

Submission Type (Please Check One):

☐ *Full Length Paper - (Due 11/1/98)* ☑ *Concise Paper - (Due 12/1/98)*

Title of manuscript:
SCENIC BEAUTY ESTIMATION USING INDEPENDENT COMPONENT ANALYSIS AND SUPPORT VECTOR MACHINES

Authors and affiliations (List authors in the order to appear on the manuscript. List affiliations (companies, universities, etc.) and addresses exactly as they should appear. If there are more than 4 authors, please attach a second sheet.

5. Name **Aravind Ganapathiraju**
Affiliation **Mississippi State University**
Address **PO Box 9571**
Mississippi State, MS 39762

6. Name **Dr. Joseph Picone**
Affiliation **Mississippi State University**
Address **PO Box 9571**
Mississippi State, MS 39762

Corresponding Author:
Name: **Xinping Zhang**
Address: **PO Box 9571**
Mississippi State University, MS 39762

Telephone: **601-325-8335**
FAX: **601-325-3149**
E-mail: **zhang@isip.msstate.edu**

Key Words: **scenic beauty estimation, ICA, Support Vector Machine**

For Technical Committee Use Only -- Do Not Write Below

Date Received: _____ Manuscript # Assigned _____

Author Notification Date: _____ Date Camera Ready Received: _____

Decision: _____ Session: _____

Notes: _____

SCENIC BEAUTY ESTIMATION USING INDEPENDENT COMPONENT ANALYSIS AND SUPPORT VECTOR MACHINES

X. Zhang, V. Ramani, Z. Long, Y. Zeng, A. Ganapathiraju, J. Picone
Institute for Signal and Information Processing
Mississippi State University
Mississippi State, Mississippi 39762, USA
Ph (601) 325-8335, Fax (601) 325-3149
{zhang, ramani, long, zeng, ganapath, picone}@isip.msstate.edu

ABSTRACT

The main focus of this project is to apply Independent Component Analysis (ICA) and Support Vector Machine (SVM) class modeling techniques to the problem of estimating the scenic beauty of forestry images. This work originated from the United States Forest Service's (USFS's) need to automatically produce forest management decisions which balance the timber needs with the desire of the public to preserve natural beauty. Data modeling techniques such as Principle Component Analysis (PCA) have been applied to this problem with limited success. We believe ICA is a more appropriate technique for the general classification problem since it is able to find a linear coordinate system for the data where the transformation is free to be non-orthogonal. SVMs are also promising because they perform well when the classes are inherently separated by a nonlinear decision surface — clearly human subjective decisions are highly nonlinear. In this work, both ICA and SVMs are tested on a standard subset of 637 images and are used to classify each image as either high scenic, medium scenic, or low scenic beauty. The classification results are compared with the human subjective ratings on a number of disjoint test sets.

SCENIC BEAUTY ESTIMATION USING INDEPENDENT COMPONENT ANALYSIS AND SUPPORT VECTOR MACHINES

SUMMARY

The United States Forest Service has initiated an effort to develop automatic methods for managing forest resources. These methods use forestry images to determine the utility of a plot of forest land both in terms of timber use and scenic quality. Several data modeling algorithms have been used for the scenic beauty estimation of forestry images including Principal Component Analysis (PCA) and Decision Trees. Each has found only limited success on this task. In this paper, we explore the use of two promising new techniques, Independent Component Analysis (ICA) and Support Vector Machines (SVMs).

Independent Component Analysis is the name for a family of techniques which in recent years have produced interesting results on multi-source and single-source audio data, natural images, etc. It is a simple, general purpose method for transforming ensembles of multivariate data into "natural" coordinate systems. When the data is transformed by the ICA transformation, the resulting class variables are said to be as statistically independent as possible. This is a considerable improvement over PCA which considers only orthogonal mappings. Statistical independence is particularly important in the USFS problem where the features are known to have a high degree of overlap.

Support Vector Machine (SVM) is a machine learning technique which has been effective in many pattern matching applications such as face recognition and phone classification. With SVMs, input vectors are mapped into a higher-dimensional feature space through a nonlinear mapping. In this space a linear classification decision region is constructed. This decision region, when mapped back into the original feature space, can take a nonlinear form. The primary advantage of this technique is that it is able to model highly nonlinear data and special properties of the decision surface ensure good generalization. In our work we use the public-domain *SVMlight* package which provides access to many different SVM kernels.

A total of 45 features are extracted from the images including color content, density of long lines, entropy and fractal dimension. We examined many combinations of features to find the one which match the human subjective rating best and thus gave the lowest error rates. The error rates achieved using ICA and SVMs are 34.59% and 32.1%, respectively. These results are superior to all previously reported results on this problem. Encouraged by these results, we believe that we can combine these two techniques to produce a better classification scheme. By using ICA as a front-end to SVMs, we will be able to supply optimally separated distributions to the SVMs, thereby constructing a better nonlinear decision region. We expect that the classification capability of the combined system will be a great improvement over using either technique independently.