# Automated Labeling of Segmented Hyperspectral Image Brian D. Bue<sup>1</sup> (bbue@rice.edu), Erzsébet Merényi<sup>1</sup>, B RICE

# Abstract

We propose a technique for labeling clusters in segmented hyperspectral imagery using a library of spectral signatures. We define a new spectral similarity measure that considers both continuum removed (CR) and continuum intact (CI) reflectance spectra. We show that using both of these characteristics in similarity analysis yields improved results over recently proposed similarity measures. Analysis on an AVIRIS image of an urban scene is presented.

## Methodology

Given a clustered image, we compute the mean signature of each cluster. The spectral library is convolved to the appropriate instrument wavelengths, bands are selected corresponding to those in the cluster signatures, and the resultant library signatures are scaled to the cluster signatures. Labels are assigned by selecting the most similar candidate from the library signatures, according to a given similarity measure.



Figure 1: Spectral Matching Process

# The CICR<sub>d</sub> Spectral Similarity Measure

Many similarity measures do not fully exploit spectral characteristics. Characterizing both the overall shape and the positions/widths of absorption bands is crucial for accurate matching. CICR<sub>d</sub> accounts for both continuum intact and continuum removed (CR) representations in spectral matching.

$\operatorname{CICR}_d(\mathbf{s_i},\mathbf{s_j})$	=	$\frac{d(\mathbf{s_i}, \mathbf{s_j})}{v_{CI}} + \alpha \frac{d(\text{CR}(\mathbf{s_i}), \text{CR}(\mathbf{s_j}))}{v_{CR}}$		( n
$d(\cdot, \cdot)$	=	distance measure (ED or SID)	$ED(\mathbf{x}, \mathbf{y}) =$	$\int \sum (x) dx$
$\mathbf{s_i}, \mathbf{s_j}$	=	CI spectral signatures		i=1
$\operatorname{CR}(\cdot)$	=	continuum removal function	$\mathrm{SID}(\mathbf{p},\mathbf{q})$ =	$D_{KL}(\mathbf{p}$
$v_{CI}, v_{CR}$	=	variance terms		
$ $ $\alpha$	=	CR weight parameter	where $D_{KL}$	$(\mathbf{p}  \mathbf{q}) =$

Figure 1: CICR<sub>d</sub> measure

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## Imaga Data & Commentation





## Spectral Library

1164 field-measured spectra of urban materials [herold 04] (Park/Walk 69 AVIRIS LA image spectra verified as vegetation and soft and sof [merenyi00]



										ľ	Vis	ua	l So	cor	es	fo	r I	nd	ivi	du	al	Cl	ust	ter	S										Mean Vis	sual Score	Mear	n PW <sup>d</sup>
	A	С	D	E	F	G	Ι	J	K	L	M	0	P	Q	R	S	T	U	V	W	X	Y	Z	a	b	c	d	e	f	g	h	i	j	1	All	Selected	All	Selected
CIED	2	1	1	0	1	1	2	1	2	3	1	1	0	1	1	0	1	2	1	2	0	2	2	0	1	0	0	2	2	0	1	1	1	1	1.0571	1.0556	1.0092	1.0068
CR <sub>ED</sub>	0	2	2	0	1	0	2	0	2	3	2	1	0	1	1	0	1	2	2	1	0	1	1	0	1	0	1	2	2	1	0	1	1	1	1.0000	0.9444	1.0033	1.0037
CICR <sub>ED</sub>	2	2	2	0	1	1	2	1	1	3	2	1	0	1	1	0	1	2	1	2	0	2	1	0	1	1	1	2	2	1	0	1	1	2	1.1714	1.2778	1.0033	1.0023
CI <sub>SID</sub>	2	1	2	0	1	2	2	1	2	3	1	1	0	1	1	0	1	2	1	2	0	2	2	0	1	0	0	2	2	0	1	1	1	1	1.1143	1.1667	1.0320	1.0243
CR <sub>SID</sub>	0	2	1	0	1	0	2	0	2	3	2	1	0	1	1	0	1	2	2	1	0	1	1	0	1	0	1	2	2	1	0	1	1	1	0.9714	0.8889	1.0125	1.0144
CICR <sub>SID</sub>	1	2	2	1	1	1	2	1	2	3	2	1	0	1	1	0	1	2	2	1	0	1	1	0	1	1	1	2	2	1	0	1	1	2	1.1714	1.2778	1.0124	1.0102
Average	1	2	2	0	1	1	2	1	2	3	2	1	0	1	1	0	1	2	2	2	0	2	1	0	1	0	1	2	2	1	0	1	1	1				

Table 1: Spectral Match Statistics. Highlighted blue scores are illustrated in figure 4. Green and red text indicate the best and worst scores, respectively. Scores assigned based on the top 3 matches for each cluster.

the top 3 spectral matches for each cluster signature on a scale of zero (worst) to three (best) (Table 1).

Paved Road Seal New

T Rooftop

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Α	Rooftop	Roof Comp Shingle Gray New	
С	Green Tennis Court	Roof Wood Shingle	
D	Rooftop	Roof Comp Shingle Gray New	
Е	Rooftop	Roof Wood Shingle	
G	Road/Park/Walk	Roof Comp Shingle Dark Tan New	of Comp Shingle Gray N
Ι	Road/Park/Walk	Paved Road Asphalt New	of Wood Shingle
J	Road/Park/Walk	Paved Parking Lot Oil Old	of Comp Shingle Gray N
K	Vegetation	Green Dry Mixed Grass	f Wood Shingle
L	Vegetation	Paved Sidewalk Concrete New Shade	of Comp Shingle Dark T
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# Labeling Results with CICR<sub>FD</sub>

	Labe Colo	el/ Expert or Interpretation	Best Spectral Match
New	U	Rooftop	Roof Concrete Tile
	V	Mini Golf Course	Roof Comp Shingle Lt Gray New
New	W	Road/Park/Walk	Paved Parking Lot Oil New
	Ζ	Road/Park/Walk	Paved Parking Lot Asphalt Old
Tan New	a	Rooftop	Roof Comp Shingle Red
	b	Rooftop	Paved Road Asphalt Old
d	f	Rooftop	Roof Comp Shingle Mixed New
	g	Road/Park/Walk	Roof Concrete Tile
e New Shade	h	Road/Park/Walk	Paved Road Asphalt New
	i	Road/Park/Walk	Paved Road Seal New
	j	Water Tower	Coating Paint White Old Thick
	1	Rooftop	Roof Comp Shingle Gray Old

Table 2: Expert interpretation vs. Best spectral matches. Green text indicates strong correspondence to the expert interpretation, while red text indicates poor correspondence. 87.3% of the clustered pixels were assigned semantically meaningful labels.

## Acknowledgements

### References