Visibility Improvement Through Hyperspectral Band Integration

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Recommended Citation

Sidike, Paheding; Diskin, Yakov; and Arigela, Saibabu, "Visibility Improvement Through Hyperspectral Band Integration" (2014). *Stander Symposium Posters*. Book 534.  
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Visibility Improvement Through Hyperspectral Band Integration
Paheding Sidike, Yakov Diskin, Saibabu Arigela, and Vijayan K. Asari

**Objective**
- To exploit band information of the hyperspectral imagery
- To develop adaptive contrast enhancement technique
- To assist in object detection/classification

**Spectral Angle Mapper**
The Spectral Angle Mapper classification (SAM) is an automated method which is insensitive to illumination change since it uses only the vector direction and not the vector length. This technique may be mathematically modeled as

\[
SAM(s_i, s_j) = \cos^{-1}\left(\frac{\sum_{l=1}^{L} s_{il} s_{jl}}{\sqrt{\sum_{l=1}^{L} s_{il}^2} \sqrt{\sum_{l=1}^{L} s_{jl}^2}}\right)
\]

where \(s_i, s_j\) are the spectral signatures of two pixel vectors, and \(L\) is total band number in a classification.

**Methodology**
The hyperspectral image enhancement procedure is broken into nine steps resulting in an improvement of visibility.

1. Raw Hyperspectral Image
2. Image Normalization
3. Mean Spectral Signature
4. Spectral Matching (i.e. SAM)
5. SAM Scaling
6. SAM Boosting
7. Super Resolution
8. Image Restoration
9. Enhanced Image

**Super Resolution**
The single image resolution enhancement is applied to the SAM image. This technique uses adaptive kernel regression technique based on multi-level local covariance to estimate the high resolution image from a low resolution input.

**Sample Results**
Super Resolution Results

**Spectral Angle Mapper**

**Super Resolution Results**

**Sample Results**

**Indoor System**

**Outdoor System**

**Hyperspectral Sensor**

- **Spectral Range**: 400 - 900 nm
- **Spectral Resolution**: 2.1 nm
- **Spectral Channels**: 240
- **Spatial Channels**: 640
- **Max Frame Rate**: 145 fps

**SAM**: Spectral Angle Mapper

**Input LR patch**

**Original Image**

**Enhanced Image**