Learning Structural Damage through Real-time Hyperspectral Imaging

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Introduction

Structural surface damage impacts the safety of all civil structures and infrastructures. The current practices to accesses and inspect heavily relies on visual inspection which is costly and time-consuming, and most critically lacks the capability of recognizing both the materials and the damage in a complex environment. Hyperspectral imaging is regarded as a promising utility for the detection of general anomaly and materials in the complex background based on their unique spectral signatures. Instead of traditional imaging, using hyperspectral imaging approach (spatial scanning or push broom technology), we develop a 'snapshot' real-time hyperspectral imaging system that is ready for aerial or ground-based operation. This poster summarizes our development and the preliminary data collection effort.

Goals

1. Demonstrating the capability of hyperspectral imaging in identifying complex structural damage.
2. Introducing real-time hyperspectral image and its promise in civil engineering.
3. Developing a high resolution and hyperspectral imaging system that will be a low cost and highly sensitive tool for noninvasive condition assessment and damage detection of civil engineering structure.

Conclusion

• This Project can be developed into real-time, aerial vehicle based civil engineering structure inspection and detection system.
• Real-time hyperspectral imaging and image-based modeling will open up a new venue for complex damage identification and mapping.
• Discrimination of cracked and non-cracked surface along with vegetation using ROC graph obtained from the hyperspectral image was explored.
• We will build a real-time hyperspectral system intergraded with the unmanned aerial vehicle.

Proposed Methods

The Spectral information contained in each pixel of a hyperspectral image taken through Cubert can thus be utilized to indicate the various types of material and their characteristics. Among many available machine learning algorithms for the propose of classification, the support vector machine (SVM) has attracted a high degree of interest. SVM is highly capable of dealing with high-dimensional feature vectors and delivering high performance in terms of classification accuracy than other commonly used classifiers.

Data Collection and Preliminary Results

SVM has been employed in a wide range of real-world problems such as text categorization, handwritten digit recognition, tone recognition, object detection, and image classification since pursued by Vapnik (Cortes & Vapnik, 1995). Here are the classification results we obtain from the preliminary classification test using SVM. The below plots (sensitivity versus specificity) define the ROC curve and the area under the curve (AUC) is an effective measure of the accuracy of the test. ROC curves are able to provide a richer measure of classification performance.

Accuracy of system is 75.49%
Accuracy of system is 75.31%
Accuracy of system is 81.63%
Accuracy of system is 75.00%

Field Operation

We will do the calibration before every capturing, it divides into two parts: white and black. For black calibration, take a picture when the lens is cover, which will record the internal noise of the camera components. And the white calibration is taking picture of the special reference reflectance board, which can reflect ‘100%’ light. Then the following hyperspectral reflectance image will be the normalized result of black and white reference values.

References