Modeling Light Propagation in Leaves With Discrete Exterior Calculus (DEC)

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Key Words: light propagation, forestry, physical modeling, discrete exterior calculus

ABSTRACT

As light interacts with matter, its properties change and the changes can be recorded using hyperspectral imaging technology. Mathematical models can be used to explain what is detected in recorded images. Hyperspectral imaging has shown great promise in vegetation health monitoring in many recent studies, e.g. [1, 2]. Automatic monitoring of health vegetation makes it easier to detect nutrient deficits and pest insect infestation in time to counter the destructive consequences.

In vegetation analysis, leaf light propagation model can be used to generate hyperspectral images with known biophysical and biochemical properties. It’s inversion explains what kind of vegetation parameters would have caused the detected images. Analysis of hyperspectral images is often based on neural networks but providing measured training data (hyperspectral images and corresponding ground measurements of vegetation parameters) for them is not practical due to large amount of manual work. Instead, we can use the inverted model to generate the necessary training data. Optical leaf models have been built based on Kubelka-Munk theory, e.g. [3], and Monte Carlo processes, among others [4]. Our goal is to construct a physical model that can be solved using existing discrete exterior calculus (DEC) software presented in [5]. We will first establish a working optical leaf model in two dimensions, which will later be expanded into three dimensions.

REFERENCES


