# SYNCHRONOUS RETRIEVAL OF FOREST CANOPY COVER BY AIRBORN LIDAR AND OPTICAL REMOTE SENSING

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## 1. INTRODUCTION

Retrieval of forest structural attributes using remote sensing data is a hotspot in the field of forest remote sensing. Canopy cover is key forest canopy attributes which can contribute to the monitoring of forest health. Various remote sensing data such as optical image, LiDAR, SAR have been used in the retrieval of forest canopy cover. No matter which remote sensing data were used, the common approaches of forest canopy attributes can be divided into two types: method based on empirical regression and method based on model. Both of these methods have the problem of mixed pixel. The mixed pixels have serious effects on the retrieval precision of forest canopy attributes. It must be induce many errors if we retrieve the forest canopy attributes directly from the mixed spectrum (Hu et al.. 2004). Therefore, the decomposition of the mixed spectrum is a very important step to improve the precision of retrieval parameters of mixed pixels. As the development of the mixed pixel decomposition theory, many decomposition models of mixed pixels such as linear model, probabilistic model, Geometric-Optical models, stochastic geometry models and fuzzy analysis were exploited. The Geometric-Optical models have been proved to effectively retrieve the canopy cover (Chopping et al., 2006, 2008; Franklin and Strahler, 1988; Franklin and Turner, 1992). All these retrieval models were built based on the prior knowledge of end-members. This paper purposed to retrieve the forest structure parameters using the LiDAR data, and used a linear spectrum decomposition model to fetch the reflectances of the spectral scene components, which were regarded as the prior knowledge in the retrieval of forest canopy cover using Li-Strahler Geometric-Optical model based on SPOT HRG data.

## 2. STUDY AREA AND DATA

The study area of Dayekou is situated in the Qilian Mountain area, with its geographic coordinate ranging from N38°29′ to 38°35′ in latitude and from E100°12′ to 100°20′ in longitude within Gansu province, western China. An airborne laser scan flight was carried out over the test area in June 2008. The process of the airborne LiDAR data in the study area is mainly divided into two parts. One is the rethorectification and topographic correction to the optical image. We have processed the SPOT-5 image using the DEM derived from the LiDAR data (the green area in figure 1). The other one is that we have processed the high density LiDAR data (the blue area in figure 1) for it is benefit for the exact description of the ground. Therefore, the high density LiDAR data is used to extract the individual tree parameters and create the forest canopy cover.

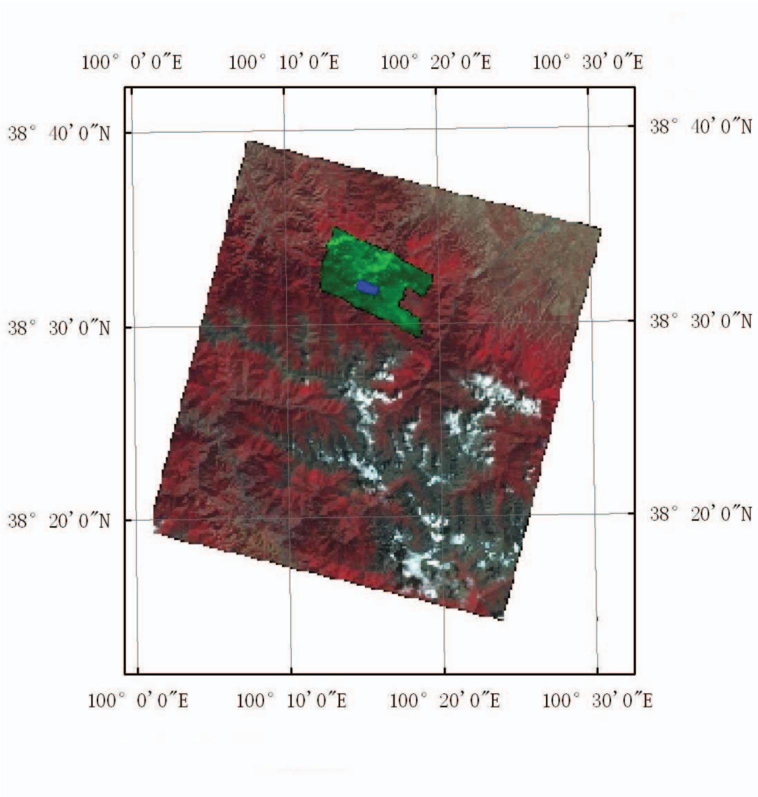



Figure 1. The site of the LiDAR data.

## 3. METHODOLOGY

The synchronous retrieval approach can divide into three parts: (1) Calculate the proportion of area covered by crown and shadow that is in illuminated crown $K_g$ using the forest parameters in the sample plot extracted from airborne LiDAR data; (2) Calculate the reflectance of illuminated background $G$ and the average reflectance of the other scene components $X_0$ using linear spectrum decomposition models according to the value of $K_g$ and surface reflectance extracted from SPOT-5 HRG image; (3) Put the reflectance of the two end members gained from step (2) into Li-Strahler Geometric-Optical model and calculate the proportion of pixel not covered by crown or shadow $K_g$ of each pixel in the image. Then fetch the canopy coverage of each pixel according to $K_g$.

In our research, we simply regard the remote sensing signal of the mixed pixel as a dimidiate component model:

$$S = K_g G + (1 - K_g) X_0 \qquad (1)$$

$X_0$ is the total of the other scene components except the illuminated background.

The reflectance of the dimidiate end members is calculated using the method of factor analysis. We first explored the proportion of the area of the end member using the high precision tree parameters retrieved by the airborne LiDAR data, and then used the method of linear spectrum decomposition model to fetch the reflectance of the end members.

With the value of the end members in the pixel and the pixel reflectance of the SPOT-5 image, the proportion of pixel not covered by crown or shadow $K_g$ can be calculated using the simply Li-Strahler Geometric-Optical model equation (1). Then the variance of m is gained by equation:

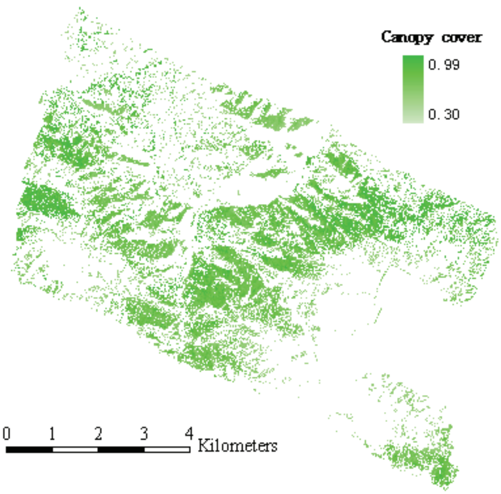
$$m = \frac{-\ln(K_g)}{(\sec\theta_i + \sec\theta_v)(\pi - t + \cos t \sin t)} \qquad (2)$$

And finally the canopy cover is calculated by the equation (3):

$$CC = 1 - e^{-\pi m} \qquad (3)$$

## 3. RESULT AND VALIDATION

Through the above synergy inversion algorithm, we input the forest parameters which were extracted from the LiDAR data into Li-Strahler geometric-optical model, and synchronous using the SPOT-5 HRG data to calculate the proportion of pixel not covered by crown or shadow $K_g$. With the extracted variance of $K_g$, we can easily retrieve the forest canopy cover. As shown in figure 2, the light green areas indicate a low forest canopy cover while the deep green areas indicate a high forest canopy cover.



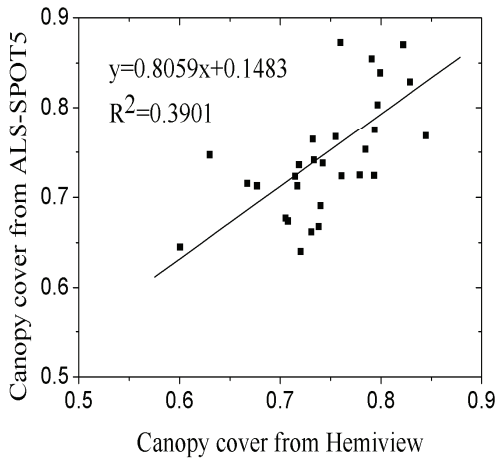




Figure 2. Retrieval results of forest canopy cover. Figure 3. Comparison of canopy cover from retrieval and Hemiview

For we don't have the simultaneous ground measurements, the forest canopy cover measured by Hemiview in June 2008 which is two months earlier than the SPOT-5 data was used to validate the result. The sample of Hemiview measured data is 25 m ×15 m in size, while the retrieved image has a spatial resolution of 10 m. So we must resample the retrieved image into a spatial resolution of 25 m and then compare it to the measured data. As shown in figure 4, the $R^2$ between retrieved data and measured data is 0.3901. That's because the acquired time of SPOT-5 image and measured data has a discrepancy of about two months which caused many errors. Therefore, the retrieved result needs a further validation.

## 4. REFERENCES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