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A Covariance-based Feature Extraction Method for Temporal PolSAR Imageries

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1 Introduction

■ The Geodesic dissimilarity is implemented to measure the changes of different ground types in different. time.

■ The covariance-based matrix is developed to analyze the feature changes at different time periods, and the main changes can be extracted.

2 Methods

Geodesic dissimilarity:

$$d(A,B) = ||\log\left(Z_A^{-\frac{1}{2}} Z_B Z_A^{\frac{1}{2}}\right)||_F + \ln\left(\frac{2n_A n_B}{n_A + n_B}\right)$$

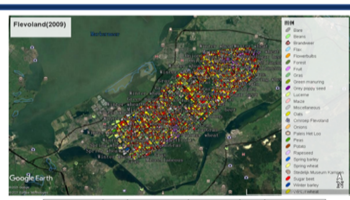
where A and B represent two different PolSAR dataset, Z_i is the polarimetric feature metrix (such as [T]/[C]), and $n_A = n_B = 3$.

Multi-temporal covariance matrix:

$$\hat{C}_{temporal} = \begin{bmatrix} \langle d_{11}\rangle & \langle d_{12}\rangle & \cdots & \langle d_{1N}\rangle \\ \langle d_{21}\rangle & \langle d_{22}\rangle & \cdots & \langle d_{2N}\rangle \\ \vdots & \vdots & \ddots & \vdots \\ \langle d_{N1}\rangle & \langle d_{N2}\rangle & \cdots & \langle d_{NN}\rangle \end{bmatrix}$$

where $\langle d_{ij}\rangle = ||\log(\langle Z_A^{-1} Z_B\rangle)||_F$ is simplified by Geodesic dissimilarity.

3 Dataset



Croptype	Color	# of fields in GIS	Croptype	Color	# of fields in GIS
Bare		17	Miscellaneous		370
Beans		11	Oats		6
Flax		7	Onions		390
Flower bulbs		107	Peas		69
Forest		16	Potato		503
Fruit		147	Rapeseed		8
Gras		1073	Spring barley		105
Green manuring		33	Spring wheat		72
Grey poppy seed		7	Sugar beet		399
Lucerne		34	Winter barley		17
Maize		193	Winter wheat		646

- Flevoland
- 2009/4/14 to 2009/9/29
- C-band
- 5300 x 3100

4 Experiments

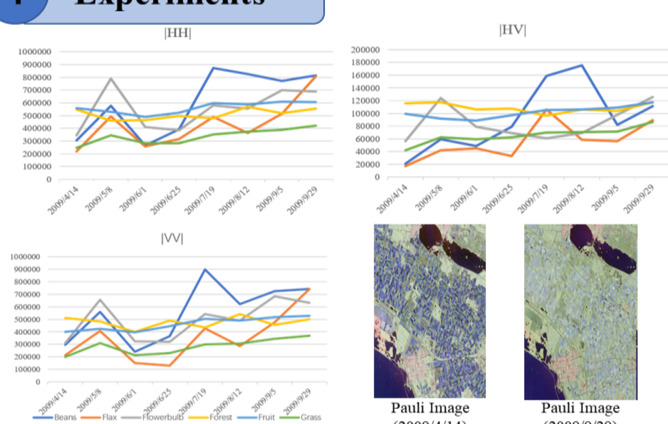


Fig. 1 The temporal PolSAR imagery.

■ The scattering characteristics of difference object types have obvious differences in different time.

■ The temporal changes of ground objects may be reflected in the [T] coherence matrix as the transformation of different scattering mechanisms.

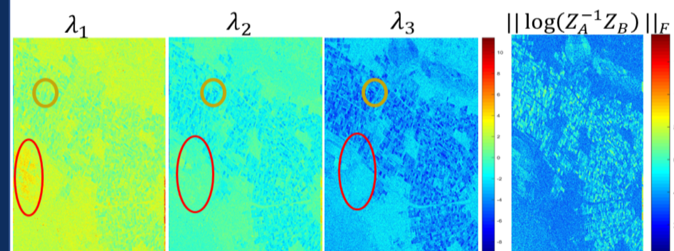


Fig. 2 The eigenvalues of changeable matrix with [T] coherence matrices in 2009/4/14 and 2009/9/29.

The distinguish distance of two PolSAR imageries in Geodesic dissimilarity can be represented by $||\log(Z_A^{-1}Z_B)||_F$. The eigenvalues $\lambda_1 \geq \lambda_2 \geq \lambda_3 \geq 0$ of $Z_A^{-1}Z_B$ represent change degree. $\log(\lambda_i) > 0$ represents positive change, $\log(\lambda_i) = 0$ represents no change, and $\log(\lambda_i) < 0$ represents negative change.

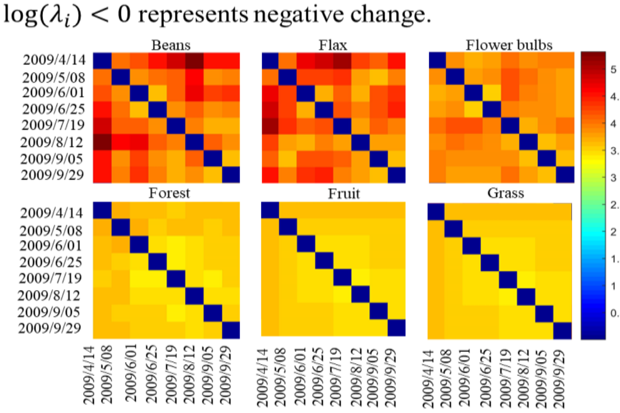


Fig. 3 The multi-temporal covariance matrix of different categories.

In multi-temporal covariance matrix, $d_{i,j}=0$ indicates that the scattering of ground objects do not change. The larger the vaule of $d_{i,j}$ is, the more obvious the change of the ground objects will be.

5 Conclusions

■ The changes of the ground objects in different time can be reflected by the Geodesic dissimilarity and multi-temporal covariance matrix.

■ From the multi-temporal covariance matrix, the degree of feature variation can be reflected, which can lay the foundation for effective feature selection.