Study on Estimating the Planting Area of Winter Wheat Based on Mixed Field Decomposition of Remote Sensing

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Abstract

Accurate and timely updated information of crop planting area is essential to yield estimation, agricultural management and food security. Along the availability of remote sensing images improved, the mid-resolution image has been the main data used to estimate the crop plant area in large scale by remote sensing.

The per-pixel classification based on statistics is usually used to identify the crop in mid-resolution remote sensing images. But there are two problems including spectra variation inside and spectral mixed on boundary of the farmland, which greatly reduce the reliability of crops per-pixel classification. The method of per-field classification could divide the RS image into many basic parcel cells and force all pixels in a parcel to classify together. Many studies showed that per-field classification of land cover could obtain higher accuracy than per-pixel classification (Jassen et al.(1990), Pedley & Curran(1991), Banair et al.(1995), Lobo et al.(1996), Shandley et al.(1996), Aplin et al.(1999), Smith & Fuller(2001), Tso & Richard(2005), Turker & Arikan(2005)). The boundary of farmland parcel has perennial stability, such as road, ditch and river, which can be obtained by manual digitization from historical high-resolution images. But the interannual crop types in the parcel varies, which must be provided by up-to-date mid-resolution images. If the farmland parcels have single crop, the method of pure per-field classification can be used to identify crop type. If the farmland parcels have more than two crop types, the method of mixed field decomposition can be used to obtain the crop plant area. According to the impartibility of the crop boundary, Lo (2004) suggested that the method of mixed field decomposition may be more suitable. Actually, the condition of several crops mixed in the parcel is very similar to the condition of mixed pixels in per-pixel classification model. Through introducing the idea of mixed pixel

decomposition in the per-pixel classification to resolve the uncertainty and illegibility of per-field classification, it is more reasonable to improve the accuracy of crop plant area.

This paper chooses the urban agriculture region with complex plant structure as experiment area and digitizes the parcel boundary by QuickBird image. By calculating the coefficient of variation of multi-temporal TM image within the parcels, the paper obtains the spatial distribution of mixed parcels. Taken the mixed parcel as end member, the study extracts the eigenvector information of spectrum, vegetation index and texture from multi-temporal TM images. Aimed to the percentage of winter wheat plant area in the mixed parcel, we establish multivariate regression model and mixed field decomposition model based on support vector machine (SVM) to estimate the plant area of winter wheat in the mixed parcels of the study area by different sample size. Taken the visual interpretation result of winter wheat from QuickBird image as true value, the study evaluates the positional accuracy and total accuracy of the plant area estimating of winter wheat based on mixed filed decomposition.

The technique flow of estimating the plant area of winter wheat based on mixed field decomposition is shown as Fig.1, which includes mixed parcel identifying, eigenvector extracting and combining, training sample choosing, multivariate regression model establishing, mixed field decomposition by SVM and accuracy analyzing.
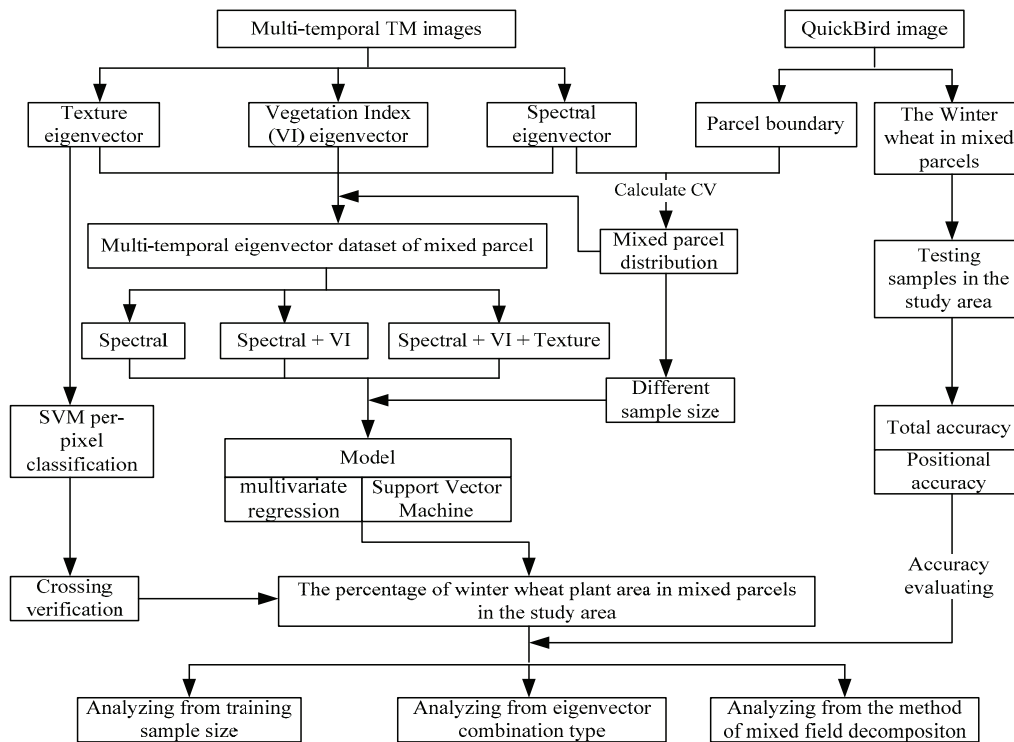
Fig.1 The technique flow of this paper

The study extracted the training samples with the proportion of 2%, 5%, 10%, 20%, 30%, 40% and 50% and carried out the multivariate regression and mixed field decomposition of SVM to estimate the percentage of winter wheat in the mixed parcels. And the study evaluated the experiment result by positional and total accuracy. In order to avoid the accuracy evaluation depending on one random value, the study carried out six experiments with each sample size and analyzed the mean and standard deviation of six experiments.
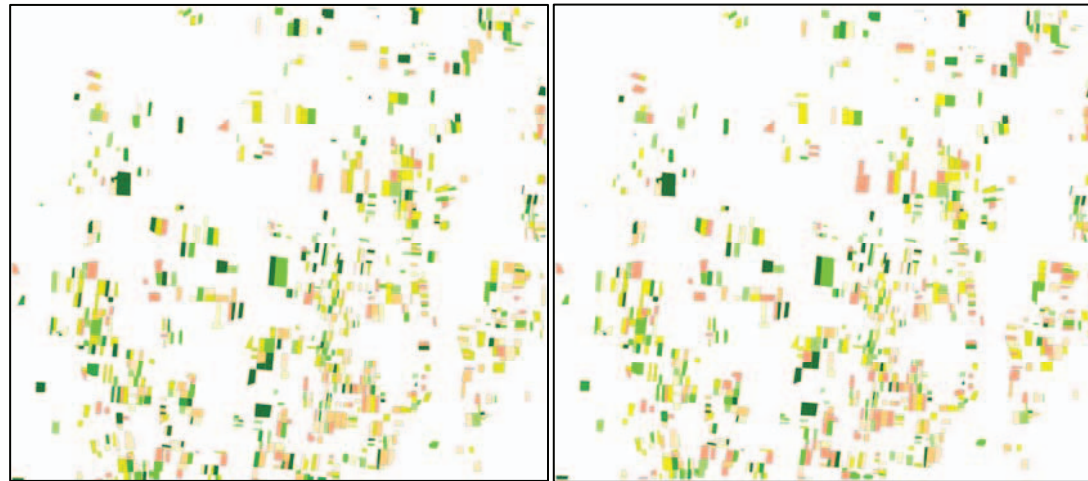
a. Multivariate regression   b. Mixed field decomposition by

| 0–10% | 20–30% | 40–50% | 60–70% | 80–90% |
| 10–20% | 30–40% | 50–60% | 70–80% | 90–100% |

Fig.2 The percentage of winter wheat mapping based on multivariate regression and mixed field decomposition by SVM in the study area
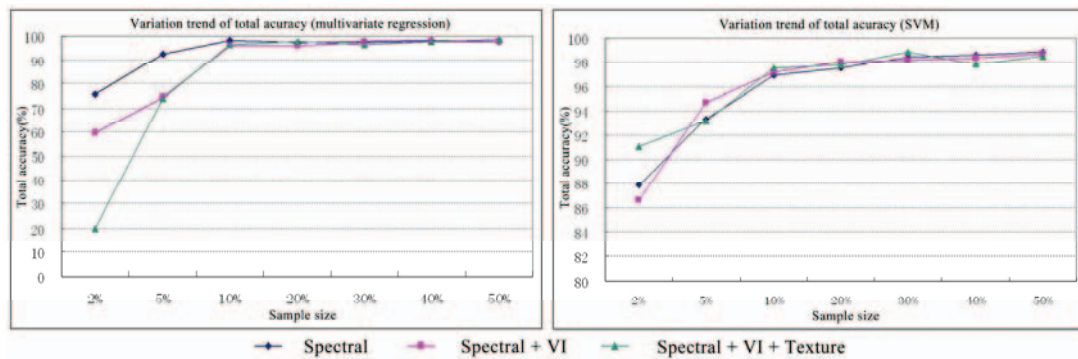

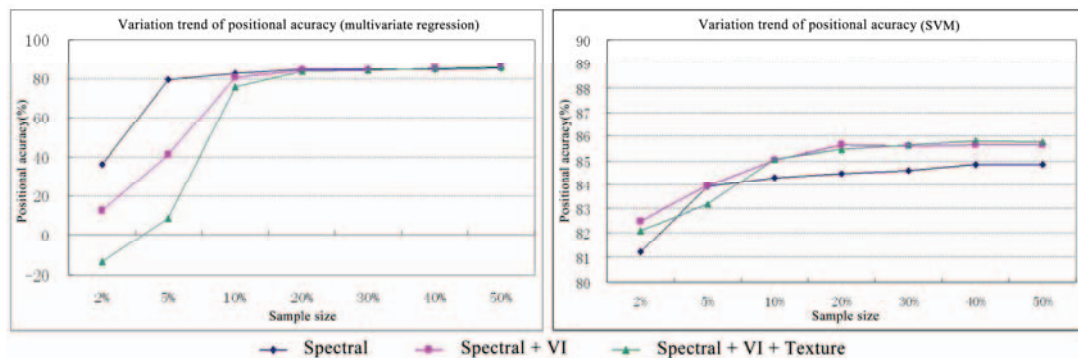Fig.3 Comparing the total accuracy between the multivariate regression and SVM

Fig.4 Comparing the total accuracy between the multivariate regression and SVM

The study shows that the method of estimating plant area of winter wheat based on mixed field decomposition by SVM has higher positional and total accuracy than the multivariate regression model. The method of mixed field decomposition by SVM is suitable for small training sample size. When the training sample size reaches 10%, the positional accuracy and total accuracy of mixed field decomposition by SVM are improved slowly along the sample size increased, which could respectively reaches 84% and 97%. Comparing the per-pixel classification, the method of estimating plant area of winter wheat based on mixed field decomposition has higher total and positional accuracy. The method of per-pixel classification could not resolve the problem of spectra variation inside and spectral mixed on boundary of the farmland parcel in the urban agriculture region with complex plant structure. But the method of mixed field decomposition could establish efficient multivariate regression model and separate hyperplane of SVM among the percentage of winter wheat in the mixed parcels, spectral, vegetation indexes and texture of multi-temporal TM images, which makes the accuracy of plant area of winter wheat reach reliable.

Keywords：Plant area; Winter wheat; mixed field decomposition, Support Vector Machine; Multivariate Regress

[1] Aplin, P., Atkinson, P.M. and Curran, P.J. Fine spatial resolution simulated satellite sensor imagery for land cover mapping in the United Kingdom[J]. *Remote Sensing of Environment*, 1999, 68: 206-216.

[2] Banair A. et al.. A Review of Vegetation Indices. *Remote Sens*. Review, 1995, 13: 95-120.

[3] Brant Tso, Richard C.Olsen. A contextual classification scheme based on MRF model with improved parameter estimation and multiscale fuzzy line process [J]. *Remote Sensing & Environment*, 2005(97):127-136.

[4] Janssen, L.L.F., Jaarsma, M.N. and Van der Linden E.T.M. Integration topographic data with remote sensing for land-cover classification[J]. *Photogrammetric Engineering and Remote Sensing*, 1990, 56: 1503-1506.

[5] Lo, C.P. and JINMU CHOI. A hybrid approach to urban land use/cover mapping using Landsat 7 Enhanced Thematic Mapper Plus (ETM+) images [J]. *International Journal of Remote Sensing*, 2004, 25: 2687-2700.

[6] Lobo, A., Chic, O. and Casterad, A. Classification of Mediterranean crops with multisensor data: per-pixel versus per-object statistics and image segmentation[J]. *International Journal of Remote Sensing*, 1996, 17: 2385-2400.

[7] Pedley, M.I., and Curran, P.J. Per-field classification: an example using SPOT-HRV imagery[J]. *International Journal of Remote Sensing*, 1991, 12: 2181-2192.

[8] Shandley, J., Franklin, J, and White, T. Testing the Woodcock-Harward image segmentation algorithm in an area of southern California chaparral and woodland vegetation[J]. *International Journal of Remote Sensing,* 1996, 17: 983-1004.

[9] Smith, G.M. and Fuller, R.M. An integrated approach to land cover classification: an example in the Island of Jersey[J]. *International Journal of Remote Sensing*, 2001,22: 3123-3142.

[10] Turker M. and Arikan M. Sequential masking classification of multi-temporal Landsat7 ETM+ images for field-based crop mapping in Karacabey, Turkey[J]. *International Journal of Remote Sensing*, 2005, 26: 3813-3830.