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Crop indentification based on hyperspectral remote sensing

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Abstract: I hyperspectral Remote Sensing provides a new technical means for the identification of crop species<b 12>, which isof significance for thedevelopment of precision agriculture. In this study, spectral characteristics-based identification were conducted on 7 crops at harvest by using different data Forms and commonly used vegetation indices. The reflectivity of Canna is very prominent in 350-500 nm wavelength, and The spectral reflectance of crops varied in 760-915 nm,1 000-1/Nm. The best wavelengths for identification of the 7 crops is 516 nm, 568 nm, 609 nm, 642nm, </b 18>660 nm,nm, 717 nm , 760 nm , 928 nm , 1 001 nm , 1 118 nm , 1 136 nm and 1 327 nm. Among vegetation indices, rv/ showed the strongest identifying potential followed by Msri b129>,NV/, tdv/ , ev/ , ndv/ , sav/ , DV /, tv/ , /pv/.To sum up , The characteristic spectrum and vegetation index are capable of crop discrimination.

Keywords: crop hyperspectral remote sensing; vegetation Classification

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Newsletter Author : Peng Zhilao , (e-nail) pengzhiliang@ 126. Com crop identification is a crop type , Area , Growth and yield information extraction base e|, is the spatial pattern of crops in the region distribution , Agricultural Resource survey , weight of crop yield estimation and disaster monitoring to protect . In recent years , with the wide range of remote sensing technology in agriculture should be with ,Remote Sensing provides new research tools and rich for crop recognition Data support . United States first based on NOAA/ AVHRR Remote sensing Data on a wide variety of food crops like wheat , Soy , Corn , Water Rice etc made a kind of recognition , Acreage and yield estimates °8. then and , Because the data is expensive , multispectral band less , data quality not High , get a long cycle and weather-affected conditions such as , usually cannot meet higher requirements in the agricultural sector . with multispectral remote sensingmore than , hyperspectral imaging technology can be detected on many very narrow bands The subtle differences in crop detection , A reference to the precision of the crop recognition High Possible , Its unique spectral advantages for the development of precision agriculture tools is significant . Wang Yu etc M using measured spectral data towater Rice , wheat , rapeseed , Cotton , Peanut , sweet potato , Eggplant , cabbage, etc. 8 type crop identification Analysis , build BP Neural network model Suppress layer node number highest Overall recognition accuracy . xing dongxing etc based on spectral analysis technology

for maturity of 7 species Irrigationin fruit tree The tree of the is recognized , also established to identify tree

species BP Neural network model . Limited to fruit trees , plus fruit trees blade shaded fruit , cause their original spectral curves to change differently not very obvious . Li Ruijun etc M analyzing the Crown of chili variety Sheng difference between layer reflectance spectral data , at wavelength 753 nm, 698 NM , 494 nm and 767 nm location Easy 8819 line pepper , Qian chun 201, Japanese tri-cherry pepper and Zunyi red pepper etc 4 Chili variety recognition Open , Because the study lacked the spectrum of several capsicum varieties in the year data , canopy spectral reflectance and leaf total nitrogen of different capsicum cultivars amount ,Blade SPAD The correlation between the value and the dry biomass on the ground is not significant .

so , On the basis of previous research results , This study to harvest period southwestern Guizhou Mountain crops Banana Taro , tobacco , Water Rice , pepper , Ginger ,The pea tip and the Coix kernel are the object of study , based on measured canopy spectral reflectance data , through original canopy spectrum , different numberaccording to transform form and Ten species Common vegetation index to 7 crops in Line detailed analysis and hyperspectral identification , Research Harvest 7 seed farming Difference in spectral curves of objects , explore their feature spectrum , for agriculture crop hyperspectral Remote sensing interpretation and precision classification provide references .

1. materials and methods

1.1 Data Source

Choose a wide range of plants in Guizhou , Guizhou and southwestern regions , High added value and crop with regional advantage Banana Taro , tobacco , Rice , Chili ,Live Ginger , pea tip and Yi ren , 7 crop Acreage is in 66.7 HM 2 above , where the plantain artichoke , Chili , Ginger grows in dryland , Rice planting in Paddy fields , tobacco ,Chili , The pea tip and the Coix Paddy dryland are all have planting , and planting area relatively concentrated , plantain taro , Chili , coix line spacing 0. m , spacing 0. , m, Line spacing for rice 0. m , spacing 0. m, , Tobacco line spacing is 0. , m, spacing 0.60 m,, Ginger's line spacing and spacing are 0.40 m and 0.30

m , pea tip for Sower . test area elevation to 1 ~ 1 m . spectral test period 7 crop Harvest / sheng

Fruit , spectral test site for crop canopy .

1.2 measuring Methods

Canopy reflectance spectra using the United States ASD Field Spec® 3 to [] Object Spectrometer (Spectral range ~2 nm , Spectral sampling interval for 1. 377 nm @ (all ~ 1 050 nm) , 2 nm @ (1 ~ 2 / nm) Spectral resolution is 3 nm @ ? nm , Ten nm @ (1 nm, 2 nm) to measure . Determination time 2015 year 11 months early , daily 10:00 -14: , Sky Clear lang no cloud , no wind or breeze , air humidity , instrument probe distance for canopy top 1. 2 ~ 1. 5 m, Vertical down , Select for each crop Measurement Point ,records for each measurement point 5 Spectrum , and then take the average value , every 0. 5 h instrument optimized and corrected .

1.3 Data Processing

uses the ASD Company-supplied instruments with software viewspec Program The handles the measured raw reflectance spectra , with Excel Gets the light Spectral reflection curve . a Strong noise due to the effect of the "water vapor in the air and the plant itself " , data appears to be abnormal , considering to project and related analysis needs , Select only 1 -all nm -Reflection Spectral data processing , to eliminate the abnormal spectral curves of the based on analysis .

2. Results and Analysis

2.1 The ability of the original reflectance spectrum to recognize crops

in Viewspec Programs Program 7 seed farming The original reflectance spectra of the objects are treated with the mean value , on Excel get wavelength on + ~ all nmSpectral reflection curve (diagram 1). from Diagram 1 to see , Overall 7 crop reflectance spectra curve consistent , especially in visible light (380 ~ 780 nm) and near

infrared(780 ~ nm) area ; visible light + nm within the wavelength of plantain artichoke reflectance significantly higher than other 6 crop , reflectivity always in 10% above , ginger reflectance lowest , Other crop reflectance differences not large ; in nm Green Peak (maximum crop reflectance in green area) At the same Rate the reflectance of tobacco and plantain artichoke is close to, mature Coix Renhe Rice in the region Green peak not obvious , This is the same as the previous research conclusion the ; in ~720 nm The highest reflectivity of plantain artichoke in the wavelength , reflection of Ginger rate is also lowest , basically Red Valley (red area crop reflectance minimum appear ; in near-infrared 760 ~915 nm , 1 1 to nm The internal reflectance spectra of the wavelength vary significantly . , almost anti- fire rate all in 28% above , with wavy ups and downs ,Plantain Taro has the highest reflectivity , lowest reflectance of rice , this 2 Spectral segment should focus on crop identification ; In the spectral range of greater than 1 # + nm , Ginger , reflectivity of tobacco and Coix alternating drop or elevation , less significant , other 4 crop reflectance Difference vary large . causes many of these spectral differences. , have crops themselves reason , including crop itself structure , health , Water content , blade The color , The cell construction of the blade . rice in mature stage leaf yellow spike ripe Trend Aging , The leaf area is gradually reduced , and the leaf-intracellular sponge tissue and cell gap binding water missing , Effect of panicle on canopy spectra of rice strong 1344 , causes near-infrared region reflectivity to be lowest . plantain artichoke list cotyledons plant , Its blades are large , The color is green witha dark red , Blade Water High content , The red petals cause the spectral reflection in the near-infrared area . Rate in these crops the highest , reflectivity is in 50% above .

2.2 identification of crops in different forms of data transformation

the derivative spectra of the differential treatment can weaken the soil background to the target Effect of spectral effects , and eliminate part of atmospheric effects such as noise , Resolution overlapping spectra , raising signal-to-noise ratio , to better reflect the inside of the crop Biochemical composition and content information M, the Original spectrum is logarithmic and then to reflect the absorption characteristics of objects , A logarithmic transformation can also be combined with a micro divide onestart with M . so , research with First order differential (A-order differential , FD , wavelength interval is 3 nm , 5 nm , 7 nm , 9 nm , One nm , nm , nm), countdown logarithm Ig(1/a)]to and Countdown logarithm first derivative {FD Ig (1/a)], wavelength interval 3 nm, 5 nm, 7 nm, 9 nm, one nm, @ nm, nm} etc A Data transformation form to 7 recognition capabilities for crops .

Viewspec Program calculation and Excel The analysis results indicate , 7 First -order differential light of the first order differential and the reciprocal logarithm of a crop.Spectral curve , Regardless of wavelength interval , Its changes are basically consistent , But in a partial wavelength range 7 First -order differential value difference for crop crops different obvious . A first-order differential transformation of the original Spectrum (wavelength interval 3 nm) For example , Maximum spectral difference between crops is principle , in visible light band 2 Segment Crest Maximum difference , to 485 ~550 nm , ~765 nm , This is also a distinction between 7 farming Best spectral range for crop , Chili , plantain Artichoke , First-order micro-of tobacco divide spectrum significantly more than other 4 crop height . greater than 553 nm Open at the beginning of anegative value , until 670 nm beginning with positive, on 716 nm at peak of , then on 920 nm After Absorption Valley and reflection peak alternate occurrence . Same as , rest - The best light in the form of a data transformation spectral wavelength position See table 1 .

by transforming the data form , The wavelength appears most frequently and is more than The closer wavelength range is the best band to identify crops . from table 1to see , recognizes 7 the optimal wavelength position of the crop is 516

nm , 568 nm , 609 nm , 642 nm , 660 nm , ? nm , 717 nm , 760 nm , 928 nm, 1 001 nm , 1 118 nm, 1 136 nm and 1 327 nm etc .

2.3 The ability of vegetation indices to identify crops

The vegetation index refers to the use of vegetation spectral data in linear and nonlinear combination of spectral indices , near infrared area is crop leaf health the most sensitive flag area , on vegetation differences and plant growth should be sensitive , Indicates whether plant photosynthesis is functioning normally , near infrared and visible light / The Red region of is the most classic band for building vegetation indices . This study selected the most representative page Planting is indexed , Package Include normalized vegetation index (ADV /) , Soil Regulation Vegetation Index (SA - VI), Difference vegetation index (DV/) , ratio vegetation index (BV/) , Enhanced vegetation index(EV /) , Nonlinear vegetation index (NV//) , Improved Simple ratio index (MS ^ I)/ near infrared percent vegetation index (/ PV /) , Go Change vegetation index (TVI)/ Convert difference vegetation index (Tdvi) etc (table 2) to 7 crop recognition . in previous studies ten base on a reference to a common satellite sensor corresponding channel near infrared , Red Middle wavelength: 830 nm , 660 nm, then take 2 -band Farming Object spectral reflectance (P 830 and P660) , through table 2 The calculation formula in is to the vegetation index variance and standard deviation of each crop. (table 3).

consists of the table 3 to see , computed by the Ten Planting is referred to AS number and V/ ,, MS and /,/PV/, 7 T/ value greater than 1, Other 6 planting is The index is 0 ~. through a comprehensive comparative analysis of the, by near infrared vegetation indices for and red-band value calculation Chinese difference and standard deviation most Big and V /, 805 0 and 5.273 1, indicates that the Ten Planting is indexed and VI recognizes this 7 max ability to plant crops ; the minimum variance and standard deviation is the / PV /, is only 0. 001 0 and 0. 028 6, Show this ten Planting is indexed / PV / recognizes this 7 type crop ability minimum , 0 Planting is indexed to identify crops Force size in order and V/ >MSW > NV/ > TDV / > EV/ > NDV/ > SAV/ > DV / > TV/ > /PV// .

3. Discussion

Banana Taro in southwestern Guizhou province , Tobacco , Rice , hot Pepper , Ginger ,

Bean tips and Lois 7 Crop as research object , through the original canopy reflectance spectroscopy Discovery , this 7 main crop reflectance spectrum curve big difference , in~500 nm The Banana taro in the wavelength highest reflectivity , on 760 ~915 nm , L ~ up to nm Wavelength inside 7 main crop reflectance spectra curves are significantly different ; based on no Best knowledge of the wavelength with the most frequency after the data transformation no wavelength , Best identification 7 The wavelength position of crops is 516 nm, 568 nm, 609 nm, 642 nm, 660 nm, m- nm, 717 nm, 760 nm, 928 nm, 1 001 nm, 1 118 nm , 1 136 nm and 1 327 nm , and so on . Use original spectral calculation ten Planting referred to number of crops ability from strong to weak in turn, and VI > MS«/ > NVI > tdvi > EVI > NDVI > SAVI > DVI > TVI > ipvi.

Harvest 7 The original canopy reflectance spectra curve of crops in 760 ~915 nm and 1 ~ 1 nm wavelength segment is significantly different , is the appropriate band to distinguish them . in visible light region banana Taro Crest layer highest reflectivity , lowest ginger reflectivity ; Neba in near-infrared area plantain canopy highest reflectivity, lowest reflectivity of rice . As a result of collection when the original spectrum was planted density of crops , Height , blade characteristics and soil Soil Spectrum interference , may cause spectral curves to be somewhat beat or poor xor , such as pea tips and ginger cling to the ground to grow , unavoidably partially Surface Soil spectral interference . so , under the influence of many factors , causes The original spectra of crops collected by the to be significantly worse in some bands to,, That's why hyperspectral can identify different crops. M.

Data Transformation of the original spectra to identify differences between crops is also more obvious . research results show , due to visible area general Vegetation Original spectral reflectance value , after derivative transform can be limited

Low Frequency background spectrum (is usually soil , litter and terrain Spectra) to target spectra effects , enhanced visible area with logarithmic transform field spectral differences , It also reduces the multiplier

caused by illumination conditions factor effect 11647 . one order differential (FD logarithm of), countdown Ig(1/ a)][,] reciprocal logarithm of first derivative {FD [[(1/a)]} Data Transformation expands on the original Spectrum , to make different crop The difference between, is very clear , Relatively strong ability to recognize, thus recognized as The object's accuracy is relatively high , One-order differential (FD) than countdown log [ ) G(1/a)], First Order differential of the countdown logarithm {FD [g(1/a)]} knowledge crop Precision is high . like 1/a The data form transformation narrows the difference between a object , relatively weak recognition , recognizes crop precision to below original Spectrum ten , therefore no research for 1/ a transformations .

for southwestern Guizhou 7 The original spectra of special crops Feature Analysis , identification of different data transformations and different vegetation indicesresearch , better at different wavelength intervals and specific wavelength locations no 7 crop crops , shows the advantage of hyperspectral remote sensing for crop recognition . based on the results of this study , for more intuitive , more representative of each Advantages of a special crop planting area , ensure acreage extraction fromPrecision , The also needs to be combined with hyperspectral remote sensing image data interpretation and field pumping Sample Survey , to Achieve real crop remote sensing precision recognition .

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