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Comparative Study On Land Cover Classification Of Multispectral Remotely Sensed Images Using Basic Color Spaces

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ABSTRACT

Land Cover Classification Of Remotely Sensed Images Plays An Important Role In Many Environmental And Socio Economic Applications. It Classifies The Multispectral Remotely Sensed Images Into Various Land Covers Such As Water Body, Urban, Vegetation, Forest Etc. Feature Extraction Is A Major Step In Multispectral Remote Sensing Image Classification Before Classifying The Image. In This Paper, Color Histogram Features Are Extracted Using HSV, LUV And LAB Color Spaces. The Extracted Features Are Trained And Tested By Random Forest Classifier. The Classification Performance Of The Color Spaces Are Compared Based On The Metrics Accuracy And Kappa Coefficient. An IRS LISS IV Multispectral Orthorectified Dataset Is Taken As The Input Image For This Experiment. It Is Observed That The HSV Color Space Outperformed When Compared To Other Color Spaces.

KEY WORDS
Orthorectified Image, Color Space, Histogram, Confusion Matrix And Random Forest.

1. INTRODUCTION

Remote Sensing Image Classification Is A Dynamic Research Topic In The Field Of Satellite Image Processing To Categorize Images Into A Disjoint Set Of Meaningful Land Cover Classes According To The Content Of The Image. The Classification Accuracy Depends On The Selection Of Features And The Classifier Implemented [1]. Color Is An Important Factor That Humans Perceive When Viewing An Image. As Human Vision System Is More Sensitive To Color, It Is The Most Widely Used Feature Compared With Other Features And It Is Easy To Extract From The Image. Color Is The Most Commonly Used Feature In The Content Based Image Retrieval Since It Is Not Affected By Rotation, Scaling And Other Transformations On The Image. An Appropriate Color Space And A Good Color Descriptor Are Required For The Color Feature Extraction [2, 3]. The Basic RGB Color Space Can Be Transformed Into Other Color Spaces Such As HSV, LAB, LUV, Yc_bc_r Etc [4]. The HSV Color Space Has The Ability To Reduce The Size Of Color And Gray Scale Values Of An Image And It Is More Perceptually Uniform When Compared To Other Color Spaces [5]. Several Experiments Use CIE L*A*B* And L*U*V* Color Spaces By Separating The Lightness Information (L) And Handling The Chromatic Color Similarity As The Euclidean Distance Between The Independent Channels A* B* Or U*V* [6,7,8]. Color Features Are Extracted By Means Of Color Moments, Color Histogram, Invariant Color Histogram And Dominant Color. The Color Histogram Shows Color Distribution Using A Set Of Bins. Color Histograms Have Useful Information About Color Images. The Color Dissimilarity Measure Known As Histogram Intersection And Its Successors Have Been Widely Used For Object Recognition And Image Retrieval [9, 10]. The Classification Methods Are Very Essential For The Success Of The Land Cover Classification Process. Random Forest Is Based On Tree Classifiers And Has Many

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Classification Trees. To Classify A Feature Vector, The Input Vector Is Classified With Each Of The Trees In The Forest. Random Forest Provides Good Classification Accuracy Among Most Of The Algorithms And Efficient Implementation On Large Data Sets. Random Forest (RF) Is Becoming Increasingly Popular In Remote Sensing Image Classification [11, 12].

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2. COLOR MODELS

Color Models Is A System For Quantifying Colors That Can Be Perceived By Human And A Method Of Combining Three Primary Colors Red, Green And Blue Which Can Be Arranged Within A Color Space To Facilitate The Specification Of Colors In A Standardized And Widely Accepted Form. In General, A Color Space Is The Specification Of A Three Dimensional Coordinate System And A Subspace Of This System In Which A Single Pixel Represents Each Color.

2.1 RGB COLOR SPACE

The Name Of The Model Has Been Derived From The Three Additive Primary Colors Red, Green And Blue. In A Light Spectrum, The Primary Colors Can Be Combined Together As One Color And Can Be Mixed Together To Produce New Spectrum Colors. The RGB Color Model Can Be Represented As A Cube By Normalized RGB Color Values In The Range [0,1] With Gray Values On The Main Diagonal Of The Black Values (0,0,0) And White Value (1,1,1) At The Opposite Corner As Shown In Figure-1. It Is Considered As The Base Color Model For Most Image Oriented Applications Since The Acquired Image Does Not Require Any Further Transformation For Displaying On The Screen [13].

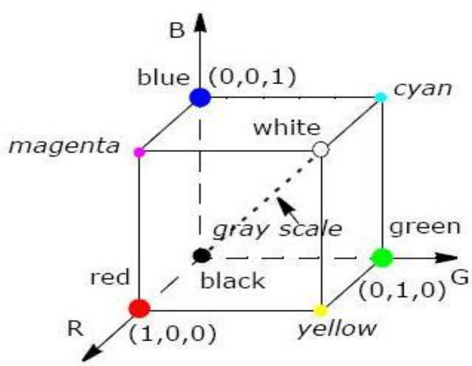

Figure 1 RGB Color Model

2.2 HSV COLOR SPACE

This Color Space Is A Non Linear Transform From RGB Color Space And Can Express The Perceptual Color Relationship More Accurately Than RGB Color Space. HSV Color Space Is Formed By Hue (H), Saturation (S) And Value (V). Hue Denotes The Property Of Colors Such As Red, Green, Blue And So On. Hue Can Represent Millions Of Colors And Express The Actual Wave Length Of The Color Saturation Describes The Intensity Of A Color And Value Denotes The Brightness Of A Particular Color. When A Color Pixel Value In RGB Color Space Is Modified, Intensities Of Red, Green And Blue Channels Of That Pixel Are Also Modified. It Is Difficult To Observe The Color Variation In Complex Color Environment Or Images. HSV Color Space Can Split The Color Into Hue, Saturation And Value Components Which Mean Color Variation Can Be Discriminated. HSV Color Space Can Describe Color In Detail Than RGB Color Space [14].

2.3 CIE L*A*B* COLOR SPACE

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The CIELAB Color Space Is The Second Uniform Color Space Derived From CIE XYZ Space In1976 With White As Reference Point. L*A*B* Color Model Determines The Color Depending On Its Position In A 3D Color Space And Is Device Independent. The L* Component Reflects The Lightness Of The Color. L* =0 Means Black And L* =100 Is Referred To As White. The Chroma A* Indicates Red For Positive Values And Green For Negative Values. The Hue B* Refers To Yellow For Positive Values While Blue For Negative Values As Illustrated In Figure2. The Details Of Conversion From CIE XYZ To CIE L*A*B*And The Inverse From CIE L*A*B* To CIE XYZ Color Models Are Available In Reference [15, 16].

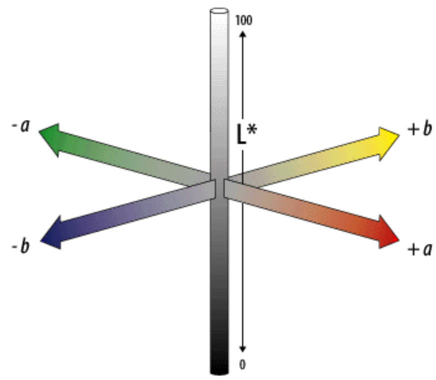

Figure-2 LAB Color Model

2.4 LUV COLOR SPACE

In LUV Color Space, L Means Luminance Whereas U And V Are Chromaticity Values Of Color Image. The Richness Of Red Component In Color Image Implies That The Value Of U Is Positive And The Richness Of Green Component Points That The Value Of V Is Negative. For Converting The RGB Color Space Into LUV Color Space, First, The Conversion Is Made From RGB To XYZ Space, Then From XYZ To LUV. The Detail Of This Conversion Is In Reference [17].

3. STUDY AREA DATASET

This Work Is Tested On IRS Dataset. The Remotely Sensed Image Under Study Is LISS IV Orthorectified Image Supplied By National Remote Sensing Centre, Hyderabad, India. The Image Has Been Captured By Resoucesat2 Satellite In December 2011 With A Spatial Resolution Of 5.8m. Bands 2, 3 And 4 Such As Red, Green And Near IR Of LISS-IV Data Are Combined Together To Form A RGB Image. This Image Of Size 1080 X 715 Covers The Area In And Around Nagercoil Region Of Kanyakumari District, Tamilnadu, India With Latitude 8.18948531 To 8.15692961 And Longitude 77.38930064 To 77.43804056.

The Ground Truth Of The Study Area Has Been Taken From ENVI Software. The Dataset Is Classified Into Five Land Cover Classes Such As Water Body, Dense Vegetation Area, Sparse Vegetation Area, Urban Area And Bare Land. The RGB Image And Its Labeled Ground Truth Is Given In Figure

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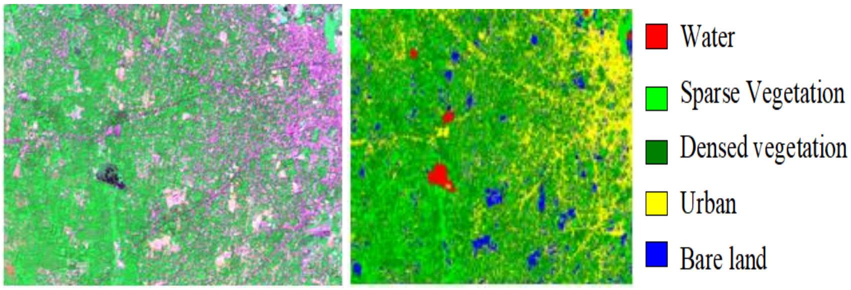

Figure-3 The RGB Image Of Study Area Dataset And Its Labeled Ground Truth

4. Experimental Analysis

The Dataset Is Split Into Regions Based On Their Ground Truth. For Every Color Space, Color Histogram Features Are Extracted As A Feature Vector From Each Region. In RGB Color Space, The Color Histogram Features Are Extracted From Each Color Component R, G And B Separately By Grouping 16 Equally Spaced Bins Each Signifies A Range Of Data Values. In HSV Color Space, The Histograms Are Generated For Each Color Channel H, S And V By Dividing The Hue Scale Into Eighteen Groups, Saturation Scale Into Three Groups And The Intensity Scale Into Three Groups. The Color Histogram Of The LUV Color Space Is Generated By Dividing Each Of The L, U And V Color Components Into 19 Bins. Similar To LUV, The Color Histograms Of The Lab Color Space Is Also Generated By Dividing Each Of The Components L, A* And B* Into 19 Bins. For Each Color Space, The Histogram Of Each Color Channel Is Then Combined Together As A Feature Vector To Classify The Land Cover Dataset. From Each Land Cover Class Fifty Percentage Of The Regions Are Taken Randomly For Training And The Remaining Regions Are Reserved For Testing. For Each Color Space, The Classification Is Done Using The Random Forest Classifier With 160 Trees. A Confusion Matrix Is Used To Measure The Performance Of The Supervised Learning Method. The Confusion Matrix Also Portrays The Misclassification. The Performance Of This Classification Is Analyzed Using The Standard Metrics Such As Accuracy, Specificity, Sensitivity, Precision And F-Score And It Is Exhibited In Table-2. The Overall Accuracy (OA), Average Accuracy (AA) And Kappa Coefficient Are Also Calculated To Measure The Performance Of Classification Accuracy.

RGB					
Category	Water	Sparse veg	Dense veg	Urban	Bare land
Water	0	0	2	0	0
Sparse Veg	0	57	4	1	1
Dense Veg	0	2	57	2	0
urban	0	2	9	65	2
bare land	0	1	0	9	24

HSV					
Category	Water	Sparse veg	Dense veg	Urban	Bare land
Water	0	2	0	0	0
Sparse Veg	0	59	2	2	0
Dense Veg	0	11	49	1	0
urban	0	0	0	77	1
bare land	0	3	0	3	28

LUV					
Category	Water	Sparse veg	Dense veg	Urban	Bare land
Water	0	1	0	1	0
Sparse Veg	0	51	4	6	2
Dense Veg	0	1	47	12	1
urban	0	8	5	64	1
bare land	0	0	3	4	27

LAB					
Category	Water	Sparse veg	Dense veg	Urban	Bare land
Water	0	1	0	1	0
Sparse Veg	0	37	6	18	2
Dense Veg	0	2	45	13	1
urban	0	5	2	71	0
bare land	0	5	3	5	21

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Table-1 Confusion Matrix Of Nagercoil Dataset For Different Color Spaces Using Random Forest Classifier.

Table-1shows The Confusion Matrix For Different Color Spaces Using Random Forest Classifier. The Urban Class Is Classified Well With HSV Color Space. In All Color Spaces, The Water Class Is Misclassified As Vegetation Or Urban Class. Bare Land Is Also Better Identified By The HSV And LUV Color Spaces. The RGB Color Space Distinguished The Sparse Vegetation And Dense Vegetation Regions Almost Correctly. The LAB Color Space Classified The Urban Class Well When Comparing With RGB And LUV Color Spaces. Among All Color Spaces The HSV Color Space Yield Good Classification Result For Most Of The Land Cover Categories.

ColorSpace	Category	Accuracy	Sensitivity	specificity	precision	Fscore	Kappa	OA
RGB	Water	0.9916	0.0000	1.0000	0.0000	0.0000	0.7989	0.8529
	Sparse Veg	0.9538	0.9048	0.9714	0.9194	0.9120		
	Dense Veg	0.9202	0.9344	0.9153	0.7917	0.8571		
	urban	0.8950	0.8333	0.9250	0.8442	0.8387		
	bare land	0.9454	0.7059	0.9853	0.8889	0.7869		
	Average	**0.9412**	**0.6757**	**0.9594**	**0.6888**	**0.6789**		
HSV	Water	0.9916	0.0000	1.0000	0.0000	0.0000	**0.8561**	**0.8950**
	Sparse Veg	0.9160	0.9365	0.9086	0.7867	0.8551		
	Dense Veg	0.9412	0.8033	0.9887	0.9608	0.8750		
	urban	0.9706	0.9872	0.9625	0.9277	0.9565		
	bare land	0.9706	0.8235	0.9951	0.9655	0.8889		
	Average	**0.9580**	**0.7101**	**0.9710**	**0.7281**	**0.7151**		
LAB	Water	0.9916	0.0000	1.0000	0.0000	0.0000	0.627	0.7311
	Sparse Veg	0.8361	0.5873	0.9257	0.7400	0.6549		
	Dense Veg	0.8866	0.7377	0.9379	0.8036	0.7692		
	urban	0.8151	0.9103	0.7688	0.6574	0.7634		
	bare land	0.9328	0.6176	0.9853	0.8750	0.7241		
	Average	**0.8924**	**0.5706**	**0.9235**	**0.6152**	**0.5823**		
LUV	Water	0.9916	0.0000	1.0000	0.0000	0.0000	0.7181	0.7941
	Sparse Veg	0.9076	0.8095	0.9429	0.8361	0.8226		
	Dense Veg	0.8908	0.7705	0.9322	0.7966	0.7833		
	urban	0.8445	0.8205	0.8563	0.7356	0.7758		
	bare land	0.9538	0.7941	0.9804	0.8710	0.8308		
	Average	**0.9176**	**0.6389**	**0.9423**	**0.6479**	**0.6425**		

Table-2 Performance Of RGB, HSV, LUV And LAB Color Spaces With Random Forest Classifier

The Overall Classification Accuracy Of RF Classification For All The Color Spaces Is Above 70%. The Random Forest Classifier Yields Higher Classification Accuracy For HSV Color Space Where It's Overall Accuracy Is 89.5% And Its Kappa Coefficient Is 0.8561. The Classification Accuracy And Kappa Coefficient Is Lower When Comparing To Other Color Models. The Overall Classification Accuracies Of The Color Spaces Take The Order HSV, RGB, LUV And LAB With Values 89.5%, 85.2%, 79.4% And 73.1% Respectively.

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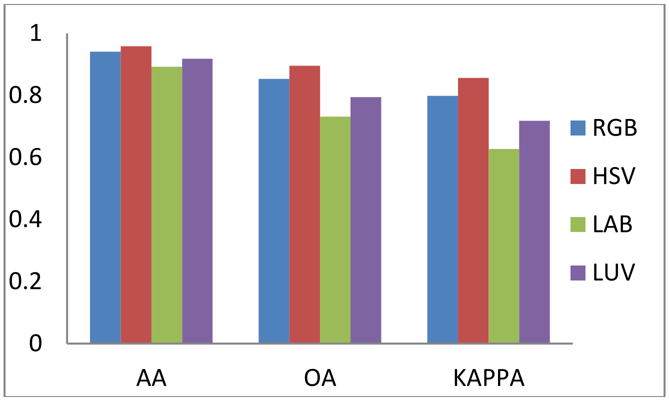

Figure - 4 Classification Performance Comparison Of Random Forest Classifier For Different Color Spaces.

Figure 4 Shows The Comparison Of The Average Accuracy, Overall Accuracy And Kappa Coefficient Of Random Forest Classifier With Different Color Spaces. It Portrays That By Comparing The Performance Of All Color Spaces, The HSV Produces Good Result For All Metrics.

5. CONCLUSION

In This Paper A Comparative Result Analysis Is Implemented With RGB, HSV, LUV And LAB Color Models For Classification Of Multispectral IRS LISS IV Image. Each Color Model Has Its Own Representation And Components With The Ability Of Transforming From One Color Space To Another Through Standard Formulae. The Study Area Dataset Is Classified Using Random Forest Classifier. The Classification Performance Is Analyzed Based On The Metrics Average Accuracy, Overall Accuracy And Kappa Coefficient. Among The Color Spaces, The HSV Color Space Produced Good Result For All Metrics.

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