International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 1564-1568 www.ijaem.net ISSN: 2395-5252

Image segmentation of sky/cloud images

Sumit Kumar, Ravindra Rawat, Narender Kumar

Submitted: 15-05-2021 Revised: 26-05-2021 Accepted: 28-05-2021

ABSTRACT:-Image asegmentation ais aconsidered aas aone aof athe amain asteps ain aimage aprocessing. aImage aprocessing ais aa amethod ato aperform asome aoperations aon aan aimage, ain aorder ato aget aan aenhanced aimage aor ato aextract asome auseful ainformation afrom ait. aIt ais aa atype aof asignal aprocessing ain awhich ainput ais aan aimage aand aoutput amay abe aimage aor acharacteristics/features aassociated awith athat aimage. aThe atechnology aof aimage asegmentation ais awidely aused ain amedical aimage aprocessing, aface arecognition apedestrian adetection, aetc.Sky/cloud aimaging ausing aground-based aWhole aSky aImagers a(WSI) ais aa acost-effective ameans ato aunderstanding acloud acover aand aweather apatterns. aThe aaccurate asegmentation aof aclouds ain athese aimages ais aa achallenging atask, aas aclouds ado anot apossess aany aclear astructure.

Keywords:- Remote asensing, Image asegmentation, Colour spaces, Principal Component Analysis, Clustering.

I. INTRODUCTION:-

Cloud aanalysis aplays aan aimportant arole ain aweather aprediction, aclimate amodeling, asolar airradiation ameasurement afor arenewable aenergy ageneration, aand aanalysis aof asignal aattenuation ain asatellite aand aother aspace-to-ground acommunications. aGround-based aWhole aSky aImagers a(WSIs) acan aprovide ahigher aspatial aand atemporal aresolution afor ahighly-localized acloud aanalysis, aand aseveral atypes ahave abeen adeveloped. aThe adetection aof aclouds afrom asky aimages ais achallenging aas aclouds ado anot apossess aany adefinite astructure, acontour, ashape, aor asize. aAs aa aresult, acolour ahas abeen aused aas athe apredominant afeature afor asky/cloud asegmentation. aNumerous atechniques abased aon adifferent acolour amodels aand aspectral awavelengths ahave abeen aproposed ain athe aliterature ato asolve athis aproblem. a aSky-imaging asystems aare aapplied ain aautomatic acloud aobservation ausing anew ahardware atechnologies, afor aexample, acharge-coupled adevices a(CCDs) aand adigital aimage aprocessing atechniques. aCurrently, athere aare atwo atypes aof afrequently areferred aimager asystems: aone ais athe awhole-sky aimager a(WSI) aseries adeveloped aby athe aScripps aInstitute aof aOceanography, aUniversity aof aCalifornia, aSan aDiego. aWSIs ameasure aradiances aat adistinct awavelength abands aacross athe ahemisphere aand aretrieve acloud acharacteristics a(Voss aand aFibroid a1989; aShields aet aal. a1998; aLi aet aal. a2004; aKasyanov aet aal. a2005). aThe aother aimager asystem ais athe atotal-sky aimager a(TSI) aseries, awhich aare amanufactured aby aYankee aEnvironmental aSystems, aInc. a(YES). aTSIs aprovide acolour aimages afor athe adaytime ahemispheric asky aconditions aand aderive afractional asky acover aand aother auseful ameteorological ainformation a(Long aet aal. a2006; aCalbo aand aSabburg a2008; aSylvia aet aal. a2010).All aof athese asky aimagers acapture asky aconditions awith ared–blue a acolour aimages. aTherefore, acloud adetection, awhich ameans athe aclassification aof aeach apixel ain aa acloud aimage ainto aeither a‘‘cloud’’ aor a‘‘sky’’ aelements, abecomes aa afundamental atask afor afurther aapplication aof asky aimagers, abecause ait ais athe aprecondition afor aderiving aother ainformation, asuch aas acloud acover, acloud atype, aand acloud abrokenness a(Long aet aal. a2006).

II. APPROACH & TOOLS:-

Colour aModels:-Several atechniques abased aon adifferent acolour amodels ahave abeen aproposed afor asky/cloud asegmentation. aLong aet aal. ause athe aratio aof ared aand ablue achannels a(R/B) ato adetect aclouds ausing aappropriate athreshold avalues. aCalbó aand aSabburg ause athe asame a(R/B) aratio ato aderive astatistical afeatures a(mean, astandard adeviation, aentropy aetc.) aof athe aclouds aand assubsequently aclassify athe asky/cloud aimages ainto adifferent acloud atypes. aHeinle aet aal. autilize aa ak-nearest-neighbor aclassifier ausing athe adifference aof ared aand ablue achannels a(R−B) ato aclassify acloud atypes. aSouza-Escher aet aal. achoose asaturation afor athe aestimation aof acloud acoverage. aMantelli-Neto aet aal.classify aclouds aby

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 1564-1568 www.ijaem.net ISSN: 2395-5252

aexploiting athe alocus aof apixels ain athe aRGB acolour amodel. aMost arecently, aLi aet aal. ause aa anormalized adifference aof ablue aand ared achannels a(aB−R aB+R a) afor acloud adetection.

aThe achoices aof acolour amodels aare abased aon aempirical aobservations aabout athe acolour adistributions aof acloud aand asky apixels.

C1	R	C4	H	C7	Y	C10	L∗	c13	R/B	c16	C
C2	G	C5	S	C8	I	C11	a a∗	c14	R a− aB		
C3	B	C6	V	C9	Q	C12	b a∗	c15	B−R aB+R		

Table 1: Colour aspaces aand acomponents aused afor aanalysis

We aconsider athe afollowing acolour aspaces aand acomponents afor aanalysis a(see aTable a1): aRGB, aHSV, aYIQ, aCIE aL∗ aa a∗b a∗ a, athree aforms aof ared-blue acombinations a(R/B, aR a− aB, aB−R aB+R a), aand achrome aC a= amax(R, aG, aB) a− amin(R, aG, aB). aIn aaddition ato athe acolour achannels ac1−9 aand ac13−16 aused ain athe aexisting aliterature, awe aalso ainclude ac10−12 aand ac16, aas aseparating achromatic aand aachromatic ainformation amay aprove abeneficial afor asky/cloud aimage asegmentation.

Colour aDistribution

Since awe aare aessentially atrying ato adistinguish abetween atwo aclasses aof apixels a(sky aand aclouds), aa acolour amodel awith aa abimodal adistribution acan afacilitate athis atask. aPearson's aBimodality aIndex a(PBI) ais aa apopular astatistic ato aevaluate athe abimodal abehavior aquantitatively a[10]. aIt ais adefined aas:

PBI a= ab2 a− ab1, a a a a a a a a a a a a a a a a a(1)

where ab2 ais athe akurtosis aand ab1 ais athe asquare aof askewness. aA aPBI avalue aclose ato a1 aindicates ahighly abimodal adistributions.

Principal aComponent aAnalysis

We ause athe aPrincipal aComponent aAnalysis a(PCA) ato a(a) acheck athe acorrelation aand asimilarity abetween adifferent acolour acomponents, aand a(b) adetermine athose acolour acomponents athat acapture athe agreatest avariance.

The aPCA ais acomputed aas afollows. aLet aus aassume aa asample aimage aXi aof adimension am a× an apixels afrom aa aset aof aN aimages a(i a= a1, a..., aN). aEach acolour achannel aof athe asample aimage ais areshaped ainto aa astraight avector acj aof adimensions amn a× a1. aThese acolumn avectors aare astacked aalongside aeach aother ato aform aa amatrix aXˆ ai aof adimensions amn a× a16:

Xˆ ai a= a[c1, ac2, a..,cj a.., ac16]; aj a= a1, a..., a16 a a a a a a a a a a a a a a a a a a a a a(2)

The aranges aof athese a16 acolour achannels aare adifferent aand aneed ato abe anormalized aso athat ano acolour achannel ais aunder- aor aover-represented ain athe aPCA aanalysis a.. aEach aof athe a16 acolour achannels ais anormalized ausing aits amean aand astandard adeviation aacross aall athe aimages ain athe adataset, athereby agenerating athe anew aimage arepresentation aX¨ ai awith azero amean aand aunit avariance:

X¨ ai a= a[ac1 a− ac¯1/ a aσc1 a, ac2 a− ac¯2/ a a aσc2 a, a.., acj a− ac¯j/ a aσcj a, a.., ac16 a− ac¯16/ aσc16 a] a a a a a a a a a a a(3)

Subsequently athe acovariance amatrix aMi ais acomputed afor aeach aof athe aX¨ ai a. aLet athe aeigenvector aeij aand aeigenvalue aλij a(j a= a1, a..., a16) abe aobtained afrom athe aeigenvalue adecomposition aof athe amatrix aMi a.

Clustering

For aclustering athe asky/cloud aimages, awe aemploy athe afuzzy acmeans aalgorithm a ato aassign aprobabilities aof acloud adetection ato athe aset aof apixels aof athe ainput aimage. aThe aalgorithm afor athe aeffective asegmentation aof aclouds afrom athe asky/cloud aimages aemploys athe aminimization aof athe afollowing aobjective afunction:

J a= aX a2 ar=1 aXmn as=1 apr(xs) aτ ad(xs, avr), a(4)

where aτ ais acalled athe afuzziness aindex, awhich acontrols athe adegree aof afuzziness aduring athe aclustering aprocess; awe aset aτ a= a2. ad(xs, avr) adenotes athe a2D aEuclidean anorm abetween athe ainput avector axs aand athe acluster acenters avr. aBoth av1 aand av2 aare avectors aof adimension ak, awhere ak acan atake aany apositive ainteger anumber.

III. EVALUATION :-

Sky/Cloud Image Database

To aour aknowledge, athe aonly acurrently aavailable adatabase afor asky/cloud aimages awith asegmentation aground atruth ais athe aHYTA

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 1564-1568 www.ijaem.net ISSN: 2395-5252

adatabase.. aIt aconsists aof a32 adistinct aimages aof avarious asky/cloud aconditions.

Distribution aBimodality

The asegmentation aof ainput aimage ainto atwo aclasses a(sky aand aclouds) abecomes aeasier afor athose acolour achannels awhich aexhibit ahigher abimodality. aThe abimodal abehavior aof aa acolour achannel afor athe aconcatenated adistribution ais ameasured ausing aPearson's aBimodality aIndex a(PBI).

Fig. 1: Sample images (top row) along with corresponding sky/cloud asegmentation a aground truth (bottom row) from the HYTA database

IV. COMPARISON:-

S ano	Authors	Year	Object	Platform
1	aJ. aX. aYeo, aY. aH. aLee, aand aJ. aT. aOng	2011	Performance aof asite adiversity ainvestigated athrough a aRADAR aderived aresults	RADAR aderived
2	J. aE. aShields, aM. aE. aKarr, aR. aW. aJohnson, aand aA. aR. aBurden	2013	Day/night awhole asky aimagers a afor a24-h acloud aand asky aassessment	Sky a aImages
3	C. aV. aJawahar, aP. aK. aBiswas, aand aA. aK. aRay	1997	Investigations aon afuzzy athresholding abased aon afuzzy aclustering,"	fuzzy aclustering,

4	J. aC. aBezdek, aR. aEhrlich, aand aW. aFull	1984	The afuzzy ac-means aclustering aalgorithm," aComputers a& aGeosciences,	clustering aalgorithm
5	C. aN. aLong, aJ. aM. aSabburg, aJ. aCalbó,	2006	Retrieving acloud acharacteristics afrom aground-based adaytime acolour aall-sky aimages	ground-based adaytime acolour aall-sky aimages
6	] aS. aDev, aF. aM. aSavoy, aY. aH. aLee, aand aS. aWinkler	2014	WAHRSIS: aA alow-cost, ahigh-resolution awhole asky aimager awith anear-infrared acapabilities	WAHRSIS
7	aT. aR. aKnapp,	2007	Bimodality arevisited	Bimodality
8	A. aHeinle, aA. aMacke, aand aA. aSrivastav	2010	Automatic acloud aclassification aof awhole asky aimages,	Sky aImage

V. CONCLUSION :-

Experimental aevaluation awith aa acloud asegmentation adatabase ayields aconsistent aresults aacross aanalysis amethods. aOur aproposed amethod ais abased aon asuperpixel asegmentation aof athe aimage aand ais aentirely athreshold-free. aWe apresented aa asystematic aanalysis aof acolour achannels afor athe adetection aof aclouds afrom asky/cloud aimages ausing adistribution abimodality, aPCA, aand aclustering.

REFERENCES

[1]. aJ. aX. aYeo, aY. aH. aLee, aand aJ. aT. aOng, a"Performance aof asite adiversity ainvestigated athrough aRADAR aderived aresults," aIEEE aTransactions aon aAntennas aand aPropagation, avol. a59, ano. a10, app. a3890–3898, aOctober a2011. a

[2]. aJ. aE. aShields, aM. aE. aKarr, aR. aW. aJohnson, aand aA. aR. aBurden, a"Day/night awhole asky aimagers afor a24-h acloud aand asky aassessment: ahistory aand aoverview," aApplied aOptics, a2013.

[3]. aM. aP. aSouza-Echer, aE. aB. aPereira, aL. aS. aBins, aand aM. aA. aR. aAndrade, a"A asimple amethod afor athe aassessment aof athe acloud acover astate ain ahigh-latitude aregions aby aa aground-based adigital acamera," aJournal aof aAtmospheric aand aOceanic aTechnology, avol. a23, ano. a3, app. a437–447, aMarch a2006.

[4]. aC. aN. aLong, aJ. aM. aSabburg, aJ. aCalbó, aand aD. aPages, a"Retrieving acloud acharacteristics afrom aground-based adaytime acolour aall-sky aimages," aJournal aof aAtmospheric aand aOceanic aTechnology, avol. a23, ano. a5, app. a633–652, a2006.

[5]. aS. aDev, aF. aM. aSavoy, aY. aH. aLee, aand aS. aWinkler, a"WAHRSIS: aA alow-cost, ahigh-resolution awhole asky aimager awith anear-infrared acapabilities," ain aProc. aIS&T/SPIE aInfrared aImaging aSystems, a2014. a

[6]. aQ. aLi, aW. aLu, aand aJ. aYang, a"A ahybrid athresholding aalgorithm afor acloud adetection aon aground-based acolour aimages," aJournal aof aAtmospheric aand aOceanic aTechnology, avol. a28, ano. a10, app. a1286–1296, aOct. a2011.

[7]. aJ. aCalbó aand aJ. aSabburg, a"Feature aextraction afrom awhole-sky aground-based aimages afor acloud-type arecognition," aJournal aof aAtmospheric aand aOceanic aTechnology, avol. a25, ano. a1, app. a3–14, aJan. a2008. a
[8]. aA. aHeinle, aA. aMacke, aand aA. aSrivastav, a"Automatic acloud aclassification aof awhole asky aimages," aAtmospheric aMeasurement aTechniques, avol. a3, ano. a3, app. a557–567, a2010.
[9]. aS. aL. aMantelli-Neto, aA. avon aWangenheim, aE. aB. aPereira, aand aE. aComunello, a"The ause aof aEuclidean ageometric adistance aon aRGB acolour aspace afor athe aclassification aof asky aand acloud apatterns," aJournal aof aAtmospheric aand aOceanic aTechnology, avol. a27, ano. a9, app. a1504–1517, a2010. a
[10]. aT. aR. aKnapp, a"Bimodality arevisited," aJournal aof aModern aApplied aStatistical aMethods, avol. a6, ano. a1, app. a3, a2007.
[11]. aJ. aC. aBezdek, aR. aEhrlich, aand aW. aFull, a"FCM: aThe afuzzy ac-means aclustering aalgorithm," aComputers a& aGeosciences, avol. a10, ano. a2-3, app. a191–203, a1984.
[12]. aC. aV. aJawahar, aP. aK. aBiswas, aand aA. aK. aRay, a"Investigations aon afuzzy athresholding abased aon afuzzy aclustering," avol. a30, ano. a10, app. a1605–1613, aOct. a1997.