Evaluation of Object-based Image Analysis Softwares for segmentation in Remote Sensing Applications

Munmun Baisantry [1]; Dericks Praise Shukla[1]; Geeta Bansal[2]
[1]*Indian Institute of Technology, Mandi,* [2]*Birla Institute of Technology, Pilani*

ABSTRACT

Object-based Image Analysis(OBIA) has dwarfed the impact of conventional pixel-based methods in applications like change detection, fusion, GIS etc. Segmentation plays a pivotal role in the performance of OBIA applications. We have conducted a comparative study of different commercial & open source segmentation softwares. High resolution panchromatic and MSS images were used as test data. Various reference-based metrics were used to compare the performance of softwares in terms of ease, availability, over-/under-segmentation, time, fidelity to reference objects.

INTRODUCTION

Objects are pixel-groups in high resolution imagery having high within-group similarity & low inter-group similarity and features like color, texture, shape, context. Several interactive Object Based Image Analysis (OBIA) softwares are available in the market facilitating different segmentation algorithms. Capability of an Object-based Image Analysis (OBIA) software is primarily judged in its ability to divide an image into spatially continuous, disjoint and homogeneous regions referred to as 'segments'. Topological and shape information extracted from these softwares can be integrated as GIS thematic layers. The open source and commercial softwares surveyed in this article are :

- ❑ **eCognition**
- ❑ **Orfeo Toolbox (OTB)**
- ❑ **Ilastik**
- ❑ **Spring**
- ❑ **MultiSpec**
- ❑ **Ilwis**

EVALUATION PARAMETERS

- **Fragmentation Index(FI)**- should be close to 1

$$FRAG = \frac{1}{1 + p\left|T_N - A_N\right|^q}$$

- **Area Fit Index (AFI)-** should be close to 0

$$AFI = \frac{A_{reference} - A_{largestsegment}}{A_{reference}}$$

- **Average Area Difference(AAD)**-should be close to 0

$$AAD = \frac{\sum (A_{reference} - A_{largestsegment})}{Number\ of\ reference\ objects}$$

- **Average Perimeter Difference(APD)**-should be close to 0

$$APD = \frac{\sum (P_{reference} - P_{largestsegment})}{Number\ of\ reference\ objects}$$

Where $A_{reference}, P_{reference}, A_{largestsegment}, P_{largestsegment}$ are area and perimeter of reference and largest segment of within the area covered by the reference object, Where where T_N is the number of objects in the image and A_N the number of regions in the reference; p and q are scaling parameters

RESULTS & DISCUSSION

FUNDAMENTAL COMPARISON OF SOFTWARES (*TABLE 1*):

Table 1 Comparative study of softwares (fundamental parameters)

	Developer	Algorithm	OS	Inputs	Availability	Formats
eCognition Developer	Definiens Imaging	Multi resolution	Windows	3	Commercial	Raster, Vector
ilastik	Uni.of Heidelberg.	Watershed	Windows Linux Mac OSX	3	Open-Source	Raster
Multispec	Purdue University	Clustering	Windows, Mac,Online	5	Freeware	Raster
SPRING 4.0	INPE, Brazil	Region Growing	Windows	2	Freeware	Raster
Orfeo	CNES	Watershed Mean shift Edison	Windows, Mac OSX, Linux, Android	>5	Open-Source	Raster, Shape
ILWIS	ITC	Clustering	Windows, Linux, Mac OSX	2	Open- Source	Raster

Datasets for study:

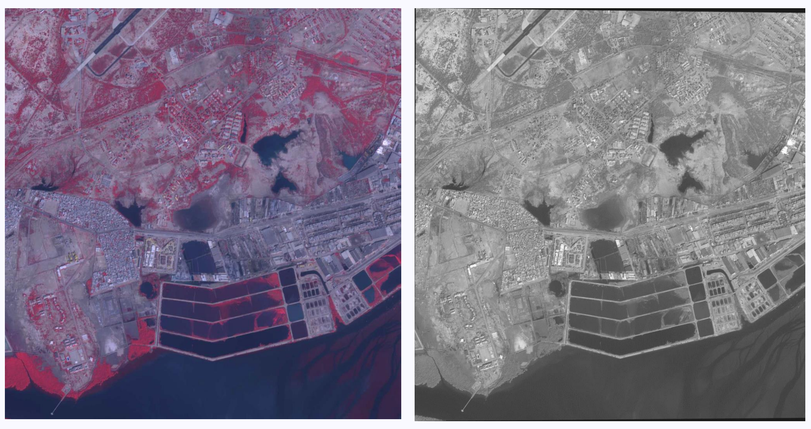
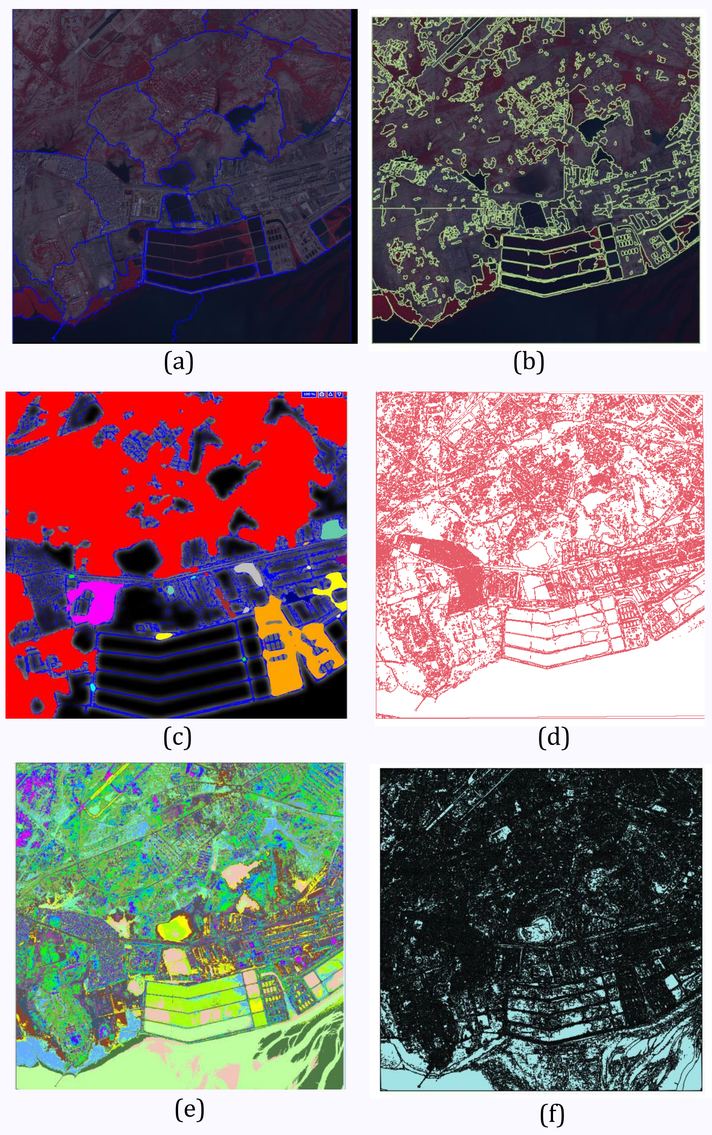


Fig. 1Test datasets

The test site was located in Mumbai, India (18.952° N, 72.8777° E). The extent of the area are (18.961°N, 72.768°E), (18.962°N, 72.864°E), (18.870°N, 72.769°E), (18.871°N, 72.865°E), respectively. For evaluating the segmented results obtained, a reference vector (shape) file was generated which consisted of polygon features digitized using QGIS 2.16 digitization utility. Objects were digitized on the reference image belonging to various classes like buildings, vegetation, roads, bare land etc.



(a) (b) (c) (d) (e) (f)

Fig.3 Segmentation as seen in (a)eCognition (b) Orfeo Toolbox (c)iLastik (d)SPRING 4.0 (e)ILWIS (f)MultiSpec

OBSERVATIONS (*TABLE 2 & FIGURE 2*):

Orfeo
- Many parameters (with default values)
- Oversegmentation difficult to control.

iLastik
- Supervised segmentation , batch processing
- Under-segmentation & time consuming

Spring
- seeded region growing
- over-segmentation ; patchy & sporadic

Ilwis
- Clustering-based
- oversegmentation to large extent.

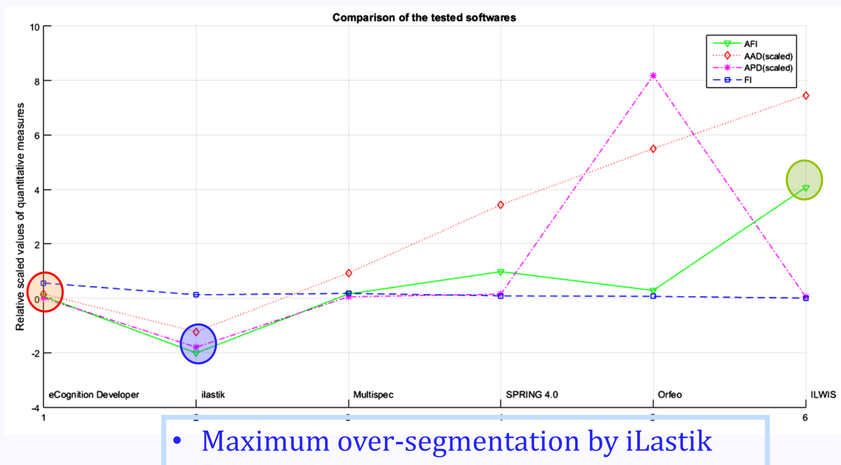
Multispec
- Few parameters & simple to follow
- optimal number of clusters.

eCognition
- Multi-resolution, optimal segments.
- parameters :scale, color and shape.

Table 2 comparison of softwares (*quantitative*)

	eCognition Developer	Ilastik	Multispec	SPRING 4.0	Orfeo	ILWIS
AFI	0.96	2.01	0.78	0.07	0.29	0.07
AAD	1.52	12.29	9.32	34.35	55.00	74.63
APD	0.25	179.61	5.52	15.35	818.63	5.44
FI	0.56	0.13	0.18	0.09	0.07	0.01
Time (mins)	3.87	2	1.5	1	0.6	
Object count	241	1,020	586	12,844	57,569	4,68,110

Fig. 2 Graphical representation of scaled quantitative measures



- Maximum over-segmentation by iLastik
- Best performance by eCognition
- Maximum under-segmentation by ILWIIS

CONCLUSION

- Different OBIA softwares evaluated.
- Test of conformity over area, shape, perimeter & number of fragments.
- Over-segmentation -Spring, Orfeo and Ilwis
- iLastik -Under-segmentation.
- Realistic parameters like scale , color/ shape lead to appreciable results in eCognition.
- Commercial software less popular among students and amateur researchers.

REFERENCES

- Baatz, M., and A. Schape. (2000). Multiresolution segmentation: an optimizing approach for high quality multi-scale segmentation. J. Strobl *Angewandte eographich Informationsverarbeitung, XII*. Heidelberg, Germany: Wichmann, pp. 12-23.
- Hay G.J., Marceau D., Dube P., Bouchard A. A multiscale framework for landscape analysis: Object-specific analysis and upscaling . Landscape Ecology. 2001;16(6):471–490.
- James C. Tilton, Selim Aksoy, and Yuliya Meinel, G. & Neubert, M. (2003). Evaluation of segmentation programs for high resolution remote sensing applications. In: *Proceedings of the joint ISPRS/ EARSel Workshop " High Resolution Mapping from Space 2003"*, Germany, October 6-8, 2003.

For further queries, contact:
Munmun Baisantry, Research Scholar(munmunbaisantry@students.iitmandi.ac.in)
Dr..Dericks Shukla, (dericks@iitmandi.ac.in)