

University of Naples “Parthenope”



Department of Sciences and Technologies

PhD on **Geomatics, Navigation and Geodesy**

Cycle XXVIII

Applications of GEOBIA (Geographic Object-Based Image Analysis) algorithms on medium and very high resolution satellite images

Tutors:

Prof. Claudio Parente

Prof. Manuel Ángel Aguilar Torres

Author:

Andrea Vallario

Coordinator:

Prof. Salvatore Troisi

2015

CONTENTS

INTRODUCTION	1
REFERENCES	3
CHAPTER 1	4
SATELLITE IMAGES CORRECTIONS	4
1.1 GEOMETRIC CORRECTIONS	4
1.1.1 SOURCES OF GEOMETRIC DISTORTIONS	5
1.1.2 GEOMETRIC MODELLING OF DISTORTIONS	6
1.2 RADIOMETRIC CORRECTIONS	10
1.2.1 EXTERNAL ERROR	11
1.2.2 INTERNAL ERROR	14
1.3 REFERENCES	16
CHAPTER 2	18
IMAGE SEGMENTATION	18
2.1 POINT, LINE AND EDGE DETECTION	19
2.1.1 DETECTION OF ISOLATED POINTS	20
2.1.2 LINE DETECTION	22
2.1.3 EDGE DETECTION	22
2.2 REGION-BASED SEGMENTATION	25
2.2.1 REGION GROWING	26
2.2.2 REGION SPLITTING AND MERGING	27
2.3 CLUSTERING SEGMENTATION	28
2.3.1 HIERARCHICAL CLUSTERING	28
2.3.2 PARTITIONAL CLUSTERING	31
2.3.3 MEAN SHIFT	33
2.4 REFERENCES	37
CHAPTER 3	40
SATELLITE IMAGE CLASSIFICATION	40
3.1 PIXEL-BASED APPROACH	42
3.1.1 SUPERVISED CLASSIFICATION	43
3.1.2 UNSUPERVISED CLASSIFICATION	49
3.2 OBJECT-BASED APPROACH	50

3.2.1	MULTIRESOLUTION SEGMENTATION.....	51
3.3	CLASSIFICATION ACCURACY ASSESSMENT	56
3.4	REFERENCES	59
CHAPTER 4	62
OBIA APPROACH FOR COASTLINE EXTRACTION USING VERY HIGH RESOLUTION WORLDVIEW-2 SATELLITE IMAGERY		62
4.1	STUDY AREA	63
4.2	DATA AND METHODS	64
4.2.1	WORLDVIEW-2 IMAGERY	64
4.2.2	PRE-ELABORATION (GEOMETRIC CORRECTION - PAN-SHARPENING APPLICATION).....	67
4.2.3	IMAGE SEGMENTATION	70
4.2.4	COASTLINE EXTRACTION.....	76
4.3	RESULTS AND DISCUSSION.....	80
4.4	COMPARISON WITH OPEN SOURCE SOFTWARE	82
4.5	REFERENCES	87
CHAPTER 5	90
OBJECT-BASED APPROACH FOR GREENHOUSE HORTICULTURAL CROP IDENTIFICATION USING MULTI-TEMPORAL SATELLITE IMAGERY		90
5.1	STUDY AREA.....	92
5.2	DATASETS	93
5.2.1	WORLDVIEW-2 DATA AND PRE-ELABORATION.....	93
5.2.2	LANDSAT 8 DATA AND PRE-ELABORATION	97
5.2.3	REFERENCE GREENHOUSES.....	100
5.3	METHODS.....	101
5.3.1	SEGMENTATION AND REFERENCE OBJECTS.....	101
5.3.2	DEFINITION AND EXTRACTION OF FEATURES.....	104
5.3.3	DECISION TREE MODELING AND EVALUATION	107
5.4	RESULT AND DISCUSSION.....	109
5.4.1	CLASSIFICATION ACCURACY WITH REGARD TO DATA SOURCES AND FEATURES	109
5.4.2	OPTIMAL TIME PERIOD FOR COLLECTING SATELLITE IMAGES	116
5.5	CONCLUSION.....	119
5.6	REFERENCES	121
CONCLUSIONS		126

INTRODUCTION

In the last decades, with the advent of high resolution satellite imagery, remote sensing moved from pixel-spectra based model to a dynamic multiscale object-based contextual model that attempts to emulate the way humans interpret images (Hay and Castilla, 2008). This typology of approach establishes a new methodology to classify the satellite images named GEOBIA (Geographic Object-Based Image Analysis) (Blaschke, 2009; Blaschke et al., 2014; Estoque et al., 2015). Obviously, it derives from the term OBIA (Object-Based Image Analysis) but this acceptance may be too broad because it is used in many different disciplines such as Biomedical Imaging, Astronomy, Microscopy, Computer Vision and others.

According with Hay and Castilla (2008), it can be considered as a sub-discipline of GIScience devoted to partitioning remote sensing imagery into meaningful image-objects, and assessing their characteristics through spatial, spectral and temporal scale; at its most fundamental level, it requires image segmentation, attribution, classification and the ability to query and link individual objects in space and time.

Blaschke and Strobl (2001) claim a different handling of entities between pixel and object units, introducing the concepts of neighbourhood, distance and location, since using the pixel as the basic scale of analysis may have certain drawbacks. Aplin and Smith (2011) declare that object-based approaches, which operate at the scale of real-world objects rather than pixels, offer a means to analyse Earth observation data in a realistic context and integrate associated ancillary information to support real-world applications.

GEOBIA represents a critical bridge between raster domain of remote sensing data and the vector domain of GIS (Geographic Information Systems). Aryal (2013) remarks the urgent need of research in testing the robustness of extracted objects and making a recommendation to measure it.

This thesis is aimed to investigate methodological aspects concerning the application of GEOBIA to Medium and Very High Resolution satellite images.

Applications of GEOBIA (Geographic Object-Based Image Analysis) algorithms on medium and very high resolution satellite images

Particularly two fundamental purposes are considered: coastline automatic extraction and horticultural crops identification.

About the first aspect, two indices are used on WorldView-2 satellite images to perform the segmentation for coastline extraction: Normalized Difference Vegetation Index (NDVI) and Normalized Difference Water Index (NDWI). To enhance geometric resolution of the results pan-sharpening is applied so to obtain maps with the same pixel dimensions of the panchromatic data (Maglione et al., 2014). Image segmentation is carried out using and comparing both free and open source software (QGIS) as well as commercial software (eCognition).

About the second aspect, object-based image analysis and a decision tree classifier (DT) are applied to a set consisting of eight Landsat 8 OLI images and a single WorldView-2 satellite image. In this approach, basic spectral information, textural features and several vegetation indices (VIs) derived from Landsat 8 and WorldView-2 multi-temporal satellite data are computed on previously segmented image objects in order to identify four of the most popular autumn crops cultivated under greenhouse in Almería, Spain (Aguilar et al., 2015).

This work was supported by FEDER funds and the Spanish Ministry of Economy and Competitiveness (the Spanish Government) under the research project called GreenhouseSat with the Grant Reference AGL2014-56017-R.