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OPEN SOURCE REMOTE SENSING:INTROSPECT AND PROSPECT

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OPEN SOURCE REMOTE SENSING: INTROSPECT AND PROSPECT

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Key words: object-based image analysis, open source, optical image processing, remote sensing software, InSAR processing.

ABSTRACT

It is noteworthy that open source applications have been developed and studied in various fields as well as remote sensing field. Open sources for GIS have long history related to open standards over three decades, but those of remote sensing do relatively short. Moreover, there are still no summary reports for open sources for remote sensing. In this study, we summarized characteristics of open source applications for remotely sensed image processing and discussed their strengths and weaknesses at first. Based on the summary, two open source applications for InSAR Processing and Geographic Object-Based Image Analysis are practically implemented to introspect and prospect open source remote sensing. The developed applications have many advantages compared with existing open source applications because they provide user friendly interface, functions for searching from database and visualizing in mobile devises, concurrent processing of GIS and RS data. The quality of open source software is as good as commercial software. Therefore, OSRS will expand widely and improve continuously due to strengths of open source. We expect this study will be a good guide for users and developers of OSRS.

I. INTRODUCTION

Recently interest in open source software for geo-spatial processing has been increasing. It is closely related to the progress of computing environments such as software as a service, cloud computing, open API accessibility and social networking. In remotely sensed image processing, proprietary software which means commercialized source is widely and intensively used in most of applications. Nevertheless, open source remote sensing is regarded as one of the progressing and advanced fields in remote sensing.

Open source has been mainly developed and integrated in one field till now. Each open source usually works for one module or a target application. Therefore open source mainly provides not several functions but a single function. However several open source modules from various fields will be unified hereafter and we can easily develop software for a specific purpose if open source modules from various field were integrated adequately. Before developing open source software in the integrated user environment for remote sensing, making a list of functions and investigating characteristics should be preceded. Therefore we examined the functions of open source software for remote sensing and compared each other in this study.

In remote sensing area, satellite images including optical images and synthetic aperture radar (SAR) images are widely used. Most of the commercial software offers the functions for processing both optical images and radar images, but it is not easy to find open source software providing processing methods for both types of images. For that reason, we started with the investigation of existing open source programs for optical images and for SAR images separately then compared. At first, OTB, OSSIM and Opticks for optical image processing were compared and then DORIS, ROI_PAC and GMTSAR for SAR image processing were compared. Users can easily choose a suitable open source program via this comparative study. Moreover open source applications can be substituted for the functions in commercial software [1, 7]. In addition, we present practical implementations using open sources and make an attempt to introspect and prospect them for open source applications. One is a case for InSAR processing in the integrated GUI environment, with optical remote sensing image processing modules and another case is for Geographic Object-Based Image Analysis, GEOBIA.

II. OPEN SOURCE REMOTE SENSING (OSRS)

Although there are open source programs for remote sensing, public users, companies and government have some problems to use them as user friendly interface and manuals or documents describing functions are not provided. Moreover

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open source software often has no warranty when a problem happens and it is not easy to find the proper open source among many of them. Even if there are difficulties to use open source, their usage in remote sensing has been increased and the areas using open source have been expanded as there are many efforts to make up for the weak points in OSRS. The difficulties in using open source can be solved as open source code is publicly available. Users are able to customize open source software adding and improving functions.

Other problems which are a few manuals or documents for users and responsibility issues can be solved via the open source user group or community, because most of open source programs support the activities of communities. The developers, public developers and users of open source discuss together and solve the problems through pointing out the bugs and asking the feedback from the community. It provides information as good as manuals or documents. When some problems happen, it can be solved and corrected fast in the community. Developer can download source codes to correct and add a part of codes then upload to the management server again.

The proprietary software is produced for sale so it should be tested in every development environment considering all users before selling it. The test procedure needs a lot of labors and costs. However, in case of open source, users working on different computer environments voluntarily test the programs and report bugs to the community. Consequently, the quality of open source software can be improved saving labors and costs. Another problem, which is a difficulty to find an adequate open source can be solved through comparing various open source applications.

In this study, we selected three open source applications for processing remotely sensed images: OTB, OSSIM and Opticks, and then compared their functions because they are comparable to proprietary software for remotely sensed image processing and continuously updated. This comparison of functions based on the research of Lee and Kang [4] is shown in Table 1. The number of compared functions increased as against the previous study. On the other hand, among open source applications for SAR image processing, DORIS, ROI_PAC and GMTSAR which support the functions like InSAR and DInSAR for monitoring various types of natural disaster such as earthquake, volcano and landslide are selected to compare their functions. The comparison of available functions and the type of supported SAR images based on the researches of Kang and Lee [3] and Simonetto and Follin [6] is presented in Table 2, which release version or patch of each open source is designated with the open source name.

III. INTROSPECT AND PROSPECT

In this section, we attempt to introspect and prospect open source applications for remote sensing via practical cases which are developed using open sources. The first case is the study of Kang and Lee [2] and it is a GUI version of DORIS

Table 1. Comparative list for function types of OTB, OSSIM and Opticks, as of the half of 2011.

Main Category	Sub Category	OTB 3.10	OSSIM 1.8.4	Opticks 4.7.1
Reading and Writing Data	Data	●	●	●
Basic Filtering	Threshold	●	●	▲
	Gradients	●	▲	▲
	Edge Detection	▲	▲	▲
	Neighborhood Filter	●	●	▲
	Smoothing Filter	●	▲	○
	Distance Map	●	○	○
	Convolution Filter	●	●	●
	Convert	▲	●	▲
	Rasterization	●	○	○
Feature Extraction	Textures	●	○	○
	Interest Points	●	▲	○
	Alignments	●	○	○
	Lines	●	○	○
	Density Features	●	○	○
	Geometric Moments	●	○	○
	Principal Component Analysis	●	○	●
	Road Extraction	●	○	○
	Cloud Detection	●	○	○
	Urban Area Extract ion	●	○	○
Image Segmentation	Region growing	●	▲	○
	Level Set	●	○	○
Classification	K-Means	●	○	○
	SVM	●	○	○
	SOM	●	○	○
Change Detection	Simple Detectors	●	○	○
	Statistical Detectors	●	○	○
	Multi-Scale Detectors	●	○	○
Radiometry	NDVI	●	▲	▲
	ARVI	●	○	○
	AVI	●	○	○
Orthorectification and Map Projection	Sensor Models	●	●	●
	Map Projections	●	●	●
	Orthorectification	●	●	●
Image Fusion	Fusion Algorithms	▲	▲	▲
Combine	Mosaic	▲	●	▲
Image Registration		●	▲	▲
Correction	Radiometry	●	●	○
Spectral Processing	Target Detection	○	○	●
	Anomaly Detection	○	○	●
	Material ID	○	○	●
	Preprocessing	○	○	●
	Transforms	○	○	●
	Data Merge	○	○	●
	Tool	○	○	●
SAR Processing	Speckle Remove	●	○	●
	Edge Detect	●	○	●
	Segmentation	○	○	▲
	Compute Intensity	●	○	▲
	Calibration	●	○	●
Object Based Image Analysis		●	○	○

[Note] ●: Supported feature, ▲: Partly supported feature, ○: Weakly supported feature.

Table 2. Comparative list for function types of DORIS, ROI_PAC and GMTSAR, as of June, 2011.

		ROI_PAC 3.0.1	DORIS 4.04	GMTSAR GMT 4.5.5
Command Line		●	●	●
GUI		×	×	×
InSAR		●	●	●
DInSAR		●	●	●
Geocoding		●	●	●
Supported Operating System		Linux/ Unix	Linux/ MacOSX/ Unix	MacOSX, Linux
Supported SAR Data	ERS-1&2	●	●	●
	ENVISAT	●	●	●
	RADARSAT	●	●	○
	JERS-1	●	●	○
	ALOS PALSAR	●	●	●
	TERRASAR-X	●	●	●
	COSMO-SkyMed	●	●	○

[Note] ●: Supported feature, ○: Weakly supported feature, ×: Not supported feature.

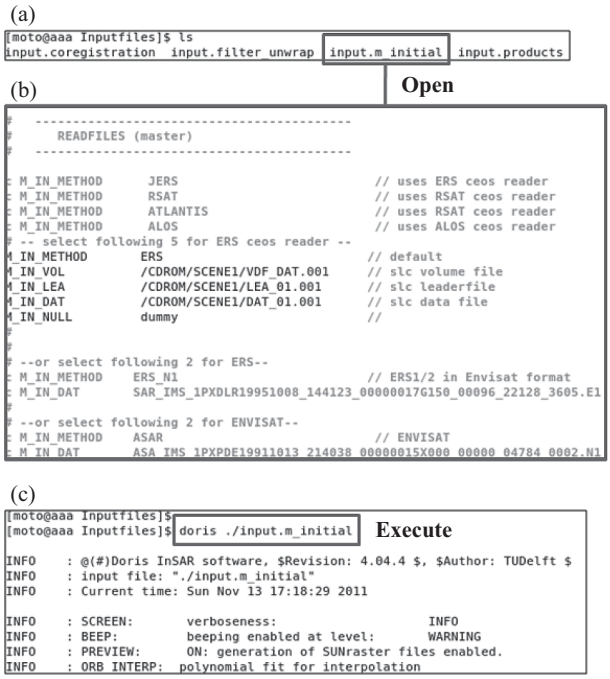

Fig. 1. (a) The part of DORIS execution file, (b) Some of contents of input.m_initial file and (c) the example of input.m_initial execution.

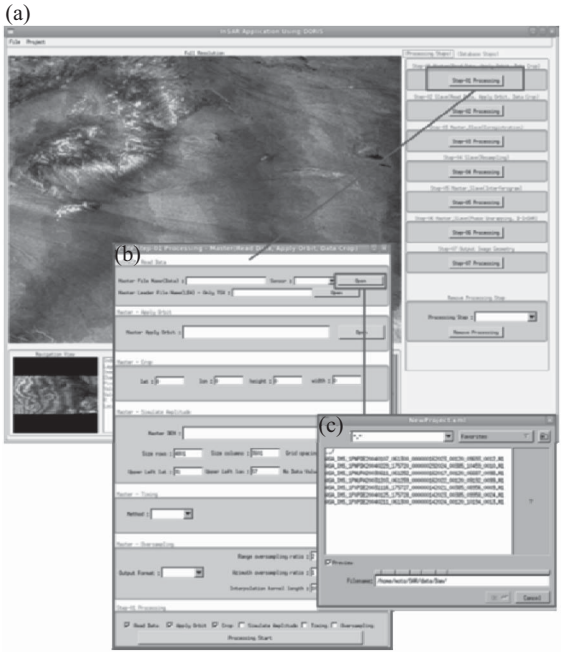

Fig. 2. (a) The main frame of software for InSAR processing based on DORIS, (b) The window for master imaging and (c) the dialogue to open SAR image.

which is open source software for InSAR processing having command line interface.

Furthermore, new modules for database and metadata are added. Consequently, we can search and display the results of InSAR processing in mobile app in Kang and Lee [3]. Kang and Lee's study [2] started to improve the existing programs for remote sensing. As mentioned in the second section, most of open source software doesn't provide user friendly interface and it causes the limits of public user access. DORIS is good to deal with InSAR process but inconvenient because users should manually correct files using edit programs and execute them using command. Even if software offers many functions, users won't choose the software if it were not intuitive and convenient. However, users can improve open source software through customizing as open source code is publicly available. Kang and Lee [2] integrated various open source applications to offer the functions in DORIS using GUI. DORIS was used as core program to handle InSAR process and FLTK for developing GUI, OTB to display SAR images, PostgreSQL and Post GIS for database are used. Android 2.2, which is open operating system, is used for mobile app. For browsing app, gvSIG was used. Fig. 1 shows the process to modify files and to execute program in Linux terminal. In Fig. 2, the GUI of software developed by Kang and Lee is presented.

The second case is approach for GEOBIA with database (Lee and Kang [5]). This is different from other software for OBIA based on file system because it used database, open source software and library. This pilot program was implemented to deal with GIS data and remotely sensed images simultaneously integrating various open source applications. FLTK is supporting GUI part. PostgreSQL and PostGIS which are open source DBMS are used to save shapefiles and results of the software. The program is developed through combining various open sources for different functions. Although an open source has been developed and used for one or

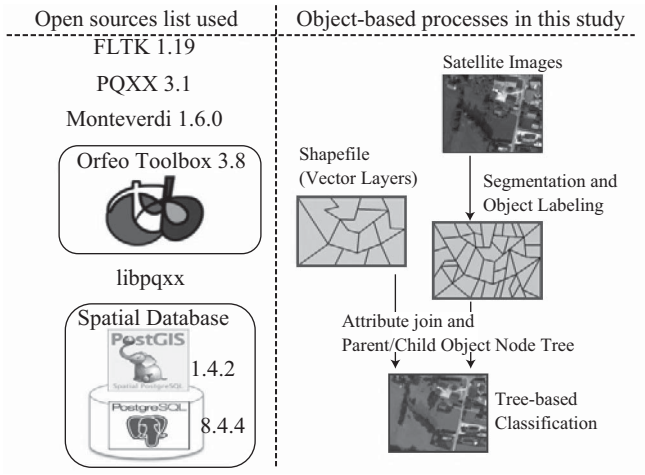

Fig. 3. Work flow for object-based processing and open sources used in this study. More detailed description in [5].

multi-purpose, advantages might be highlighted through combining various open sources. Currently, most of open source software for remote sensing consist of several open sources and this type will be maintained and used more frequently. The basic ideas about GEOBIA and the list of used open sources which are suggested by Lee and Kang [5] is shown in Fig. 3.

Fig. 4 shows the display windows of the implemented software.

IV. CONCLUDING REMARKS

In this study, we described fundamentals of open source for remote sensing and compared functions in more detail than previous studies. We believe that outcomes of this study will be of help to select adequate open source software and to replace commercial software with open source software. Meanwhile, developers can refer to this study in order to save time for developing programs, to secure the reliability and to add or modify functions. Moreover, two cases of open source software for remote sensing were implemented. The implemented open source applications have many advantages compared with existing applications. They provide user friendly interface so users who don't know programming languages can access these applications easily. GIS and RS data which should be processed separately can be handled and displayed simultaneously in a single application. Moreover, functions for searching from database and visualization in mobile devises are implemented.

Consequently, the quality of open source software is as good as commercial software, but actual applications of open source software are relatively few due to some problems. However application areas have been expanded, and functions and reliability have been improved due to strengths of open source applications. Therefore open source will be more important and more useful. We expect that open sources in

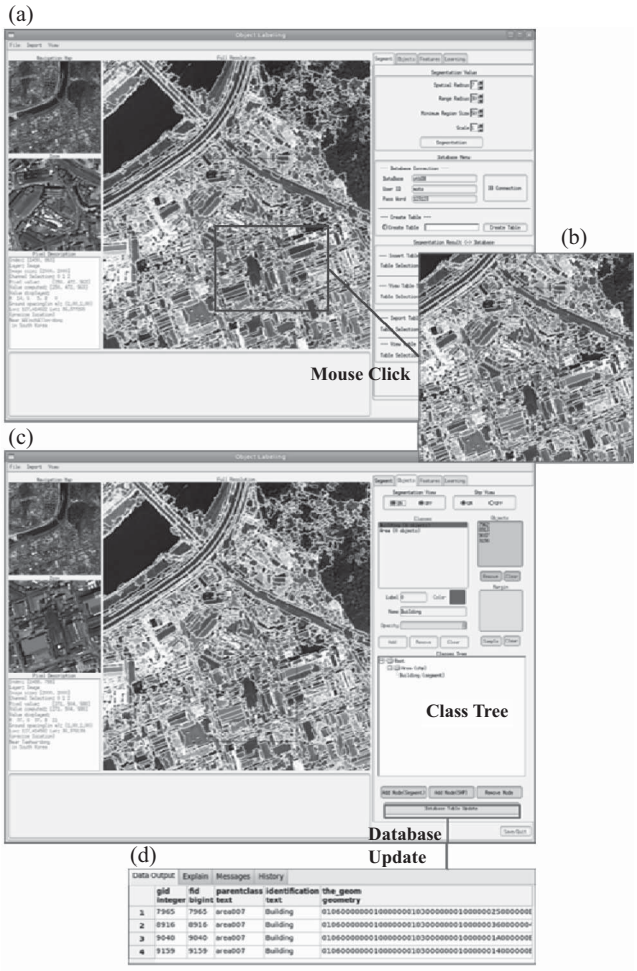

Fig. 4. The execution display of GEOBIA software: (a) Display window for the result of satellite image segmentation, (b) Display window for clicked image, and (c) Overlay polygon shape and segmentation/the sub-window for class tree and (d) Result of updated database.

remote sensing field will be widely used through this study to introspect and prospect open sources using actual applications. Also, this research will be a good guide for users and developers of OSRS. Concerning the further work, these implementations are now prototype versions, so that more strategic consideration and practical modification are necessary. As well, open source application will be tested in a target purpose dealing with multiple formats or types in remote sensing area, not limited to generic or general uses.

ACKNOWLEDGMENTS

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APPENDIX

The URL list of open sources cited or used in this study.

- OTB: http://www.orfeo-toolbox.org/otb/
- OSSIM: http://www.ossim.org/OSSIM/OSSIM_Home.html
- Opticks: http://opticks.org/confluence/display/opticks/Welcome+To+Opticks
- PostGIS: http://postgis.refractions.net/
- PostgreSQL: http://www.postgresql.org/
- ROI_PAC: http://pages.uoregon.edu/das/WikiRoiPac/doku.php
- DORIS: http://doris.tudelft.nl/
- GMTSAR: http://topex.ucsd.edu/gmtsar/

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