A Web – Based System for Classification of Remote Sensing Data

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Abstract-The availability of satellite imagery has been expanded over the past few years, and the possibility to perform fast processing of massive databases comprising this kind of imagery data has opened ground-breaking perspectives in various different fields. Remote sensing data have become very widespread in recent years, and the exploitation of this technology has gone from developments mainly conducted by government intelligence agencies to those carried out by general users and companies This paper describes a web-based system which allows an inexperienced user to perform unsupervised classification of satellite/airborne images. The processing chain adopted in this work has been implemented in C language and integrated in our proposed tool, developed with HTML5, JavaScript, Php, AJAX and other web programming languages. Image acquisition with the applications programmer interface (API) is fast and efficient. An important added functionality of the developed tool is its capacity to exploit a remote server to speed up the processing of large satellite/airborne images at different zoom levels. The ability to process images at various zoom levels allows the tool an improved interaction with the user, who is able to supervise the final result. The previous functionalities are necessary to use efficient techniques for the classification of images and the incorporation of content-based image retrieval (CBIR). Several experimental validation types of the classification results with the proposed system are performed by comparing the classification accuracy of the proposed chain by means of techniques available in the well-known Environment for Visualizing Images (ENVI) software package.

Keywords-Remote Sensing data processing, remote server, Satellite/Airbone image classification, web based system.

I.INTRODUCTION

REMOTE sensing image analysis and interpretation have become key approaches that rely on the availability of web mapping services and programs. This paper introduces a web based remote sensing application that can provide advanced image comparison and processing functions for natural habitat conservation and environmental. With a web-based system, users only require a simple web browser to access remotely sensed imagery and perform spatial analyses without the requirements or costs of installing GIS and image processing software packages. This resourceful increase has led to the exponential growth of the user community for satellite/airborne images, not long ago only accessible by government intelligence agencies [1], [2]. In particular, the wealth of satellite/airborne imagery available from Google Maps which now provides high-resolution images from various locations around the Earth1, has opened the appealing perspective of performing classification and retrieval tasks via the Google Maps application programming interface (API). Given this rather general definition, the term *remote sensing* has come to be associated more specifically with the gauging of interactions between earth surface materials and electromagnetic energy. The combination of an easily searchable mapping and satellite/airborne imagery tool such as Google Maps, with advanced image classification and retrieval features [3], can expand the functionalities of the tool and also allow end-users to extract relevant information from a massive and widely available database of satellite/airborne images (this service is also free for non-commercial purposes). It should be noted that the current version of Google Maps does not allow using maps outside a web-based application (except with a link to Google Maps). Here we use Google Maps purely as an example to demonstrate that if we have a data repository we can use the tool we propose, and the logo and Google Maps terms of service2 are always in place. The characteristics of Yahoo Maps are similar to Google Maps (though the spatial resolution of the satellite/ airborne imagery in Yahoo Maps is generally lower than Google Maps . Development of Internet mapping facilities providing analytical tools, and imagery archives when combined with basic Internet access can become an effective management tool for environmental monitoring programs. Such capabilities and analytical resources can be easily shared by multiple users from different locations at the same time. Rest of the paper is organized in the following manner: In Section II we discussed about the related work done on the outlier detection method. In section III we discussed about the System Architecture and in section IV the proposed approached. In section V we discussed about the conclusion and at the last references are given.

II.LITERATURE SURVEY

For illustrative purposes, the Table I show a comparison between the main functionalities of the previous map servers. As shown by Table I, Google Maps offers important competitive advantages, such as the availability of high resolution satellite/airborne imagery, the smoothness in the navigation and interaction with the system, the availability of a hybrid satellite view which can be integrated with other views (e.g., maps view), and adaptability for general-purpose web applications. It should be noted that other open standards for geospatial content such as those included within the open geospatial consortium (OCG) cannot currently provide complete world coverage at high spatial resolution as it is the case of Google Maps. That is why we have decided to use Google Maps service as a baseline for our system. On the other hand, a feature which is currently lacking in Google Maps is the unsupervised or supervised classification of satellite/airborne images at different zoom levels [4], [5], even though image classification is widely recognized as one of the most powerful approaches in order to extract information from satellite/airborne imagery [6]–[8].

TABLE I

Comparison between the Main Functionalities of Google Maps, Yahoo Maps and Openstreetmap.

	Google Maps	Yahoo Maps	OpenStreetMap
Without restrictions of use	No, up to a certain limit	Yes	Yes
Hybrid satellite view	Yes	Yes, low visibility	No
High resolution imagery	Yes	No	No
Zooming levels	Very high quality	High quality	Medium quality
Error correction	Low	Low	Very high
Smoothness in navigation	Very high	High	High
Adaptivity for desktop and web applications	High	High	High

III. SYSTEM ARCHITECTURE

This section describes the architecture of the system, displayed in Fig. 1. It is a web application which contains several layers or modules. Each module serves a different purpose, and the technology adopted for the development of the system is based on open standards and free software. A combination of these has been used for the development of the system. As shown by the architecture model described in Fig. 1, the proposed system can be described from a high level viewpoint using three different layers, which are completely independent from each other. Due to the adopted modular design, any of the layers can be replaced. Also, the system is fully scalable. The communication between two layers is carried out over the Internet via the hypertext transfer protocol (HTTP) 6. As a result, the performance of the system will depend largely (as expected) on the available bandwidth. Both the map layer (currently provided by Google Maps) and server layer (by us) are available from any location in the world.

A.Map Layer The Map layer contains the source imagery data to be used by the system, i.e., the image repository. Google Maps is used in the current version by means of the Google Maps API V3 as a programming interface intended for accessing the provided maps. The current framework is limited to the types of maps provided by Google Maps. All types of maps provided by the API V3 can be used, including roadmaps (2D mosaics), satellite/airborne images, hybrid view (mixed satellite/airborne images and roadmap, superimposed), or terrain (physical relief). Also, all the potentials and functionalities provided by the Google Maps API V3 are included (this comprises management of zoom levels, image centering, location by geo-spatial coordinates.

B. Server Layer

The server layer is one of the main components in the system. It is created by two sub-modules: web server and compute server. The former is the part of the system hosting the source code of the application (developed using HTML5, Php, JavaScript and CSS) and deal with the incoming traffic and requests from client browsers. We have used the Apache web server due to its wide acceptance, performance, and free-of-charge license. Further, Php is used both in the server layer and also for managing the communications between the clients and the web server (mainly dominated by the transmission of satellite/airborne imagery to be processed), and the web server and the compute server (intended for the processing of satellite/airborne images).

C. Client Layer

The client layer defines the interactions between the user (through an internet browser) and our system. Only one web page is needed as user interface thanks to the adopted AJAX and JavaScript technologies, which allow for the web interface update without the need for interactions with the web server. At this point, it is important to emphasize that AJAX is a programming method (not a piece of software) and that it is built on Javascript (not a standalone programming language).

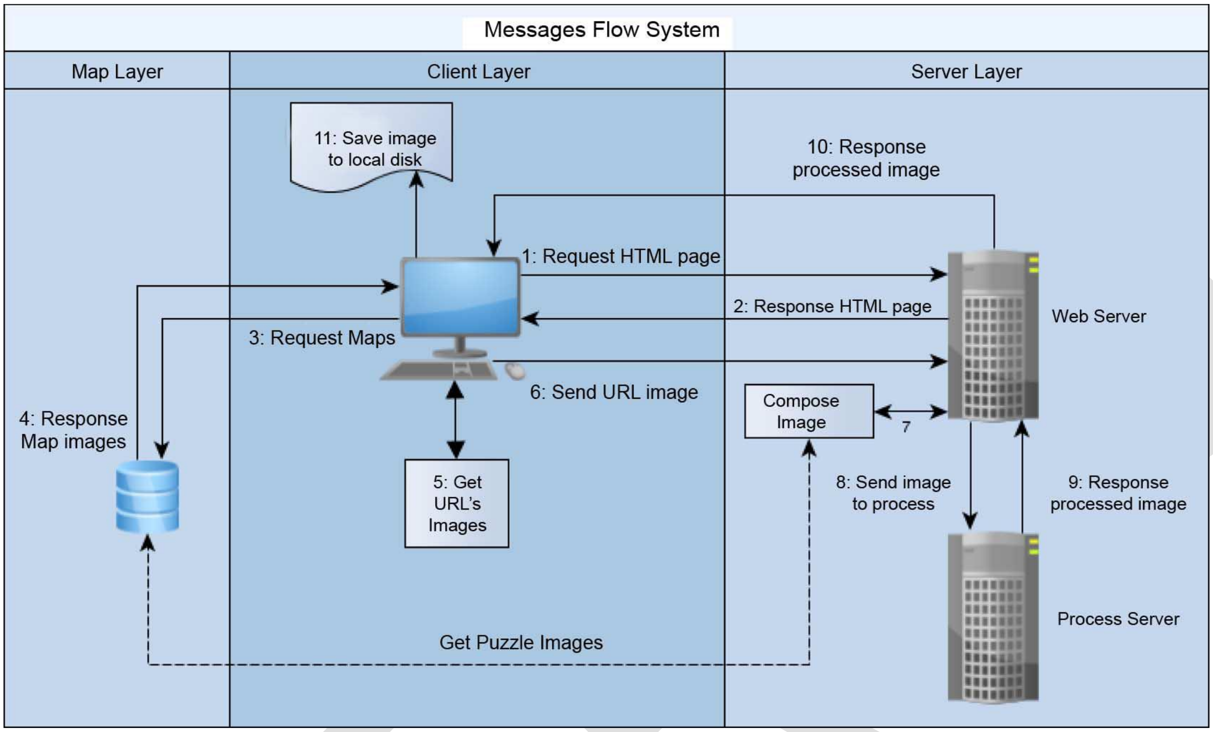

Fig. 2. Interactions between the three main layers (map, client and server) of our system.

In order to understand the interactions between the different layers of our system, an example is provided next about the flow of a processing request started by the client in the system and the different steps needed until a processing result is received by the end-user. The following steps are identified in

1) First, the client starts the use of the system from the local internet browser by requesting a web page. This results in an HTTP request to the web server.

2) The web server receives this request from client and provides the client with an HTML web page and all necessary references (JavaScript libraries, CSS, etc.)

3) At this point, the client requests from the map server the information needed to perform the map modification locally (i.e., zooming). This operation is transparent to the system, and the requests are performed via messages from the client to the map server.

4) The map layer sends the information requested by the client in the form of updated maps that will be locally managed by the end-user.

5) A capture with all the URL addresses associated to each portion that compose the full map is performed to send this information to the web server. This process is locally managed at the client by means of JavaScript functions. We emphasize that the end-user can decide the image view (street, satellite, hybrid etc) and the zoom level and of the map image to be processed.

6) Now, the Universal Resource Locator (URL) addresses associated to each portion of the full image are sent to the web server by means of AJAX functions and asynchronous requests. In this way, the interaction with the application at the client layer can continue when the packet is being transferred to the server.

7) The web server composes the full image by accessing to the Google Maps repository

8) The web server provides the image to be processed to the compute server. Our system thus delegates the processing task to an independent remote server system that takes care of the processing task independently from other layers in the system.

9) Once the image has been processed, the compute server returns the obtained result to the web server. In our current implementation both the web server and the computer server are implemented in the same machine, hence in this case the communications are

minimized. 10) Finally, the processing result is returned to the client so that it can be saved to disk as the final outcome of the adopted processing chain.
11) The client can save processed image to local disk.

IV. CONCLUSION

In this paper we proposed A Web Based System for classification of Remote Sensing Data. This demonstrates that there is a large potential opportunity for web based mapping services and image analytical tools applied to natural habitat preservation and environmental resource management and illustrates possible approaches to implement web based remote sensing applications. Two important lessons were learned from the implementation experiences of this paper. First, web-based mapping facilities are capable to combine remotely sensed imagery, GPS data, and GIS databases together to provide an integrated Framework, Second, data security and system stability will be the major considerations for the Design of web-based remote sensing applications. Many GIS data and remotely sensed images are very sensitive and require protection mechanisms. The combined powers of data collection through remote sensing and on-line, geo-spatial analysis tools through the Internet can significantly reduce the high cost and labor associated with field monitoring.

REFERENCES

[1] R. A. Schowengerdt, *Remote Sensing: Models and Methods for Image Processing*, 2nd Ed. New York: Academic Press, 1997.

[2] D. A. Landgrebe, *Signal Theory Methods in Multispectral Remote Sensing*. New York: Wiley, 2003.

[3] J. A. Richards and X. Jia, *Remote Sensing Digital Image Analysis: An Introduction*. New York: Springer, 2006.

[4] M. Fauvel, J. A. Benediktsson, J. Chanussot, and J. Sveinsson, "Recent advances in techniques for hyperspectral image processing," *Remote Sens. Environ.*, vol. 113, pp. 110–122, 2009.

[5] A. Plaza, J. A. Benediktsson, J. Boardman, J. Brazile, L. Bruzzone, G. Camps-Valls, J. Chanussot, M. Fauvel, P. Gamba, J. Gualtieri, M.Marconcini, J. Tilton, and G. Trianni, "Spectral and spatial classification of hyperspectral data using svms and morphological profiles," *IEEE Trans. Geosci. Remote Sens.*, vol. 46, no. 11, pp. 3804–3814, 2008.

[6] E. Quirós, A. M. Felicísimo, and A. Cuartero, "Testing multivariate adaptive regression splines (MARS) as a method of land cover classification of Terra-Aster satellite images," *Sensors*, vol. 9, no. 11, pp. 9011–9028, 2009.

[7] A. Cuartero, A. M. Felicísimo, M. E. Polo, A. Caro, and P. G. Rodriguez, "Positional accuracy analysis of satellite imagery by circular statistics," *Photogramm. Eng. Remote Sens.*, vol. 76, no. 11, pp. 1275–1286, 2010.

[8] D. Tuia, F.Ratle, F. Pacifici, M. F. Kanevski, and W. J. Emery, "Active learning methods for remote sensing image classification," *IEEE Trans. Geosci. Remote Sens.*, vol. 47, no. 7, pp. 2218–2232, 2009.

[9] A. Plaza, J. Plaza, and A. Paz, "Parallel heterogeneous CBIR system for efficient hyperspectral image retrieval using spectral mixture analysis," *Concurrency and Computation: Practice and Experience*, vol. 22, no. 9, pp. 1138–1159, 2010.

[10] S. Bernabé, A. Plaza, P. R. Marpu, and J. A. Benediktsson, "A new parallel tool for classification of remotely sensed imagery," *Comput. Geosci*, vol. 46, pp. 208–218, 2012.

[11] G. Ball and D. Hall, ISODATA: A Novel Method of Data Analysis and Classification, Stanford University, 1965, Technical Report AD-699616.

[12] J. A. Hartigan and M. A. Wong, "Algorithm as 136: A k-means clustering algorithm," *J. of the Royal Statistical Soc., Series C (Appl. Statist.)*, vol. 28, pp. 100–108, 1979.

[13] P. Gamba, F. Dell'Acqua, F. Ferrari, J. A. Palmason, and J. A. Benediktsson, "Exploiting spectral and spatial information in hyperspectral urban data with high resolution," *IEEE Geosci. Remote Sensing Lett.*, vol. 1, pp. 322–326, 2005.

[14] A. Plaza and C.-I. Chang, *High Performance Computing in Remote Sensing*. Boca Raton, FL: Taylor & France

[15] A. Plaza, D. Valencia, J. Plaza, and P. Martinez, "Commodity cluster based parallel processing of hyperspectral imagery," *J. Parallel and Distributed Computing*, vol. 66, no. 3, pp. 345–358, 2006.

[16] A. Plaza, J. Plaza, A. Paz, and S. Sanchez, "Parallel hyperspectral image and signal processing," *IEEE Signal Process. Mag.*, vol. 28, no. 3, pp. 119–126, 2011.

[17] S. Kalluri, Z. Zhang, J. JaJa, S. Liang, and J. Townshend, "Characterizing land surface anisotropy from AVHRR data at a global scale using high performance computing," *Int. J. Remote Sens.*, vol. 22, pp. 2171–2191, 2001