IJCSN - International Journal of Computer Science and Network, Volume 3, Issue 6, December 2014
ISSN (Online): 2277-5420 **www.IJCSN.org**
Impact Factor: 0.274

Innovative Framework for Web Based MR Brain Image Segmentation Services for the Medical Image Analyzer

[1] T. Avudaiappan, [2] R. Balasubramanian, [3] N. Mathavaraj

[1] Research Scholar, Computer Science and Engineering, Manonmaniam Sundaranar University, Tirunelveli, India

[2] Professor, Computer Science and Engineering, Manonmaniam Sundaranar University, Tirunelveli, India

[3] ME Scholar, Computer Science and Engineering, Manonmaniam Sundaranar University, Tirunelveli, India

Abstract - This paper describes the construction of a web service for medical image analysis based on the Service Oriented Architecture (SOA). This proposal can help the medical image analyzer including clinicians and research institutes. The proposed web based framework includes an integrated environment to enable scientists and clinicians to access the previous and current medical image analysis algorithms using a user interface without any access to the algorithm codes and procedures. In this paper, for medical image analysis algorithm, the existing AFCM, BCFCM, GKFCM, SFKFCM, GFC and FLGMM are utilized. These algorithms can be hidden in an application server but allow the users to use the algorithms as a package without any access to see or alter their code. So this framework provides security and privacy to algorithms hidden in the application server. In other words, in the user part, users send their images to the server and choose one of the algorithms, most suitable to serve their purpose, via an interface; in the server part, the algorithm is applied to the uploaded image and results are returned to the user.

Keywords - *Medical Image Analyzer, Image Segmentation, MATLAB NE Builder, Magnetic Resonance Imaging (MRI).*

1. Introduction

Image segmentation is a central task in many research fields including MR Brain image quantitative analyses. It can serve as a tool to help neurosurgeons, physicians and researchers to investigate and diagnose the structure and function of the brain in many clinical and research applications, such as surgery planning, treatment response assessment and uncovering the mechanisms of brain disorder. A major problem for MR Image segmentation is the corruption with noise and a smoothly varying Intensity In Homogeneity (IIH) or bias field, creeping into the sampled images during the acquisition of MR Images [1]. As a result, the intensity of the save tissues vary across voxel locations and may lead to segmentation errors. Therefore, bias field correction and segmentation should be interleaved in an iterative process so that they can benefit from each other and yield better results. Many brain MR image segmentation approaches with bias field correction have been discussed in literature [2]-[6]. Pham and Prince [2] proposed Adaptive FCM (AFCM) algorithm, which is robust to in homogeneities and it computes a smooth gain field based on all pixels in the image. The AFCM algorithm is suitable for multi slices acquisition and volumetric acquisitions. Ahmed et al [3] proposed Bias Correct FCM (BCFCM) by regularization which is useful in segmenting scans corrupted by INU and salt and pepper noise. Yang and Tsai [4] proposed an adaptive Gaussian Kernel Based FCM (GKFCM) algorithm. GKFCM improves the objective function of BCFCM by replacing the Euclidean distance with a Kernel induced distance. GKFCM algorithm becomes a generalized type which presents images with more efficiency and robustness.

Pham and Berger [5] proposed Geostatistical Fuzzy Clustering (GFC) algorithm for automated detection of white matter changes. The proposed segmentation model is derived by extending the objective functions of the fuzzy *c*-means (FCM) with a geostatistical (spatial) model. Zexuan et al [6] proposed a Fuzzy Local Gaussian Mixture Model (FLGMM) algorithm which estimates the segmentation result that maximizes the posterior probability by minimizing an objective energy function, in which a truncated Gaussian kernel function is used to impose the spatial constraint and fuzzy memberships are employed to balance the contribution of each GMM.

FLGMM algorithm gives the better result in both synthetic and clinical images.

2. Motivation and Justification

In medical image analysis, a web environment can be defined as a framework between users and service providers. However, unifying these resources such as existing algorithms, hardware, images etc in a web environment, is an important task which is fraught with a few technical difficulties. Some of the issues are.

- Medical image analysis researchers spend 30% of their research time on implementing and evaluating existing solutions, which represents a significant amount of time. Further, the development environments of the MIA research of each researcher may vary, leading them to look for software solutions, which are compatible development environments.

- The development of user interfaces is another challenge for MIA researchers, since the visualization of a user-friendly user interface takes time and effort which an MIA research prefers to invest in proving concepts and learning new programming languages.

- Another difficulty that MIA researchers face, is obtaining ground truth outlined shapes which are relevant for the validation of image segmentation algorithms. The ground truth images are obtained from either a radiologists or the researcher himself should generate the said image through manual segmentation which is a tedious and time consuming activity.

- Information sharing is often a sensitive issue, because most researchers are apprehensive about sharing their research or algorithms. They feel threatened if someone else uses their approach or research and hence it is a challenge to obtain cutting edge research methods and compare it with one's own research to develop better framework or algorithms.

But, web environment can be a boon to medical image analysis research, since it helps researchers, by unifying all image analysis resources in one environment. Hence, MIA researchers can test their new algorithms, visualize the results and compare with other algorithms by applying on standard ground truth images without spending much time or energy. In order to achieve this goal, the segmentation algorithms are implemented in MATLAB and which are connected with ASP.Net using MATLAB NE Builder [7].

This paper is divided into various sections, In System Design section the overview of the proposed architecture is described, the Experimental Results section describes the experimental and comparative results and Conclusion section discusses the conclusion and future enhancements.

3. Architectural Design

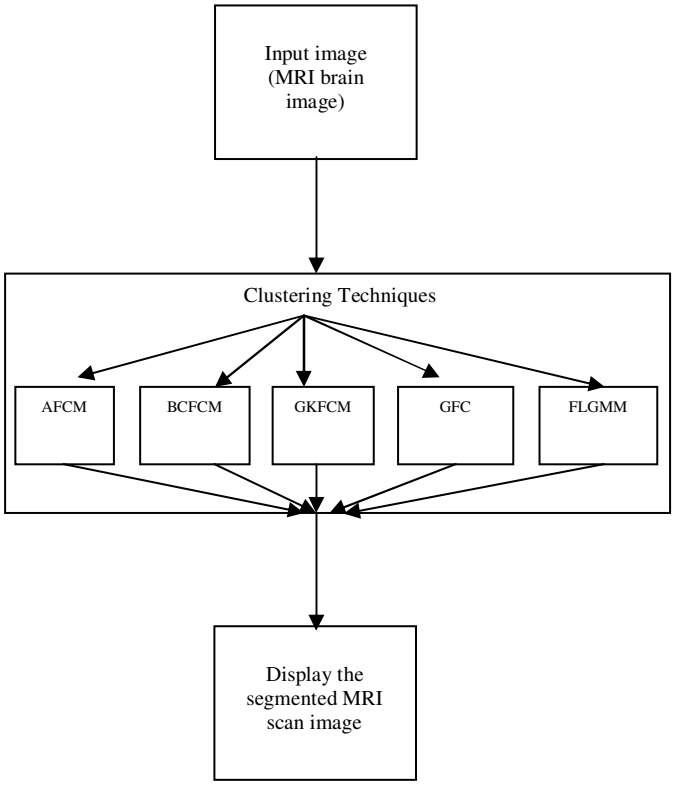

Fig 1: Conventional Architecture Design

Fig.1 describes the detailed architecture of conventional mode design of six standard methods of segmentation. There is a great difference between traditional and web service based imaging processing methods. The traditional methods are always implemented by the centralized computing model. However, the web service method is based on distributed computing model.

Fig. 2 allows a platform to have an independent access to remote computing services, its web services allow end users to fully interact with data, information requests as well as applications with a low level of user interaction.

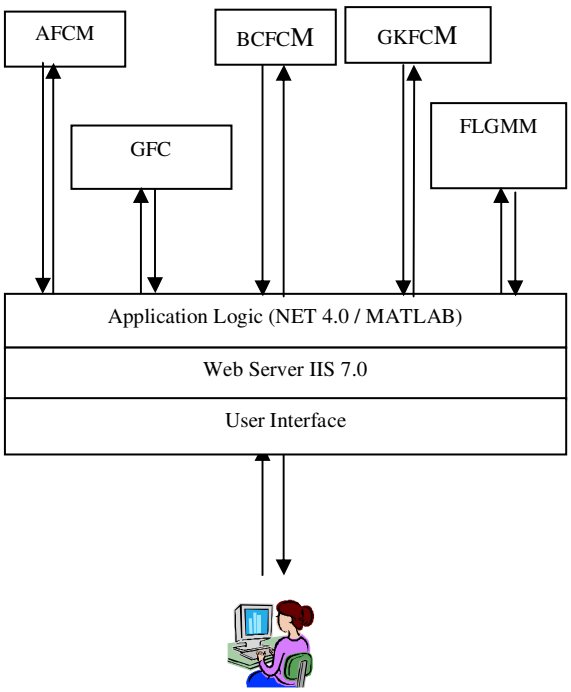

Fig 2: Web Based Proposed Architecture

4. Web Service Implementation

Web Service Technology provides an implementation of the Remote Procedure Call (RPC) concept over HTTP, thus allowing the interaction of components that are developed with different technologies. A web service is exposed as a remote object hosted on a web server, and method invocations are transformed in HTTP requests, opportunely packaged using specific protocols such as Simple Object Access Protocol (SOAP).

Web service Technology is a logic unit that allows programs written in different programming languages and on different platform to communicate through standard internet protocols Microsoft has stated: XML web services platform will enable developers to create programs that transcend device boundaries and fully harness the connectivity of the internet. Web services allow applications, which may be written in different programming languages or on different platforms, to communicate and share data through standard internet protocols. Fig .3 describes the overview of the proposed methodology which includes basic web technologies XML, WSDL, SOAP, and UDDI.

- WSDL provides a description of service behaviour and the interface contract.
- The HTTP protocol, while not the only protocol available is the most widely used regardless of the technology platform. It's identifies a network service in a unique way using the URLs.
- SOAP provides a platform independent protocol for sending messages across the wire.
- UDDI provides the means to discover the service both at design time and at run time.
- XML is the technology that underpins it all. Since XML is text based, it can be read by virtually any machine on any platform giving a high degree of interoperability.

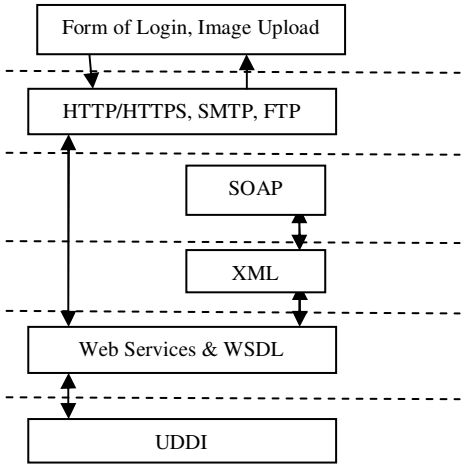

Fig 3: Web Technology

4.1 Service Oriented Architecture

Service Oriented Computing organizes a distributed system in terms of services, which represent the major abstraction for building system. Service orientation express applications and software systems as aggregation of services those are coordinated within Service Oriented Architecture (SOA). Even though there is no designed technology for the development of service oriented software system, web services are the de facto approach for developing SOA.

There are three major roles within SOA: the service provider, service registry and service consumer. The service provider is the maintainer of the service and the organization that makes available one or more services for the other to use. The service registry center is a database that can store service description information in the registry centre, services provider publish services and service requestor can discover and access binding information. The service consumer can locate the service metadata in the registry and develop the required client components to bind and use the service.

Web services currently represent the best technology for implementing SOA. The technology stack used in web service maps onto the principles of SOA formerly explained.

The overview the SOA method consists of two main modules, namely 1) User interface 2) The processing unit. The MRI process can be transmitted and stored in a remote server, which performs the segmentation and returns the results.

5. Results and Discussion

We will present in this section some experimental results of the performance increase in the implemented service by web based image segmentation tasks for several input images. Five test images have been selected from the brain web, which are described in Table 1. They have different sizes, noise level and INU level. The server on which the tests have been performed has the following characteristics: Intel XeonE5 (Quad Core) processor, 8 GB RAM, windows server 2008 and IIS7. The client have installed in desktop computer with Intel Quad Core processor with 4 GB of RAM and 64 bits windows 8 operating system. Each test image is inserted into our image analysis system which performs the segmentation and returns the results.

Table 1: Clinical Dataset for INU Level and Noise Level.

Set	*Dimension*	*Noise Level*	*INU level*	*Ground truth*
D1	128*128	0-1%	20%	Available
D2	256*256	0-3%	60%	Available
D3	256*256	0-5%	20%	Available
D4	128*128	0-7%	40%	Available
D5	256*256	0-9%	20%	Available

The Table 1 shows the five datasets, that are divided by different INU level and Noise level and each dataset contains the 25 images. The experimental results are compared by using the following performance metrics:

5.1 Accuracy

Accuracy is the starting point for analyzing the quality of the predictive model, as well as obvious criteria for prediction. Accuracy measures the ratio of correct prediction to the total number of cases evaluated.

Accuracy = (TP+TN) / (TN+FP+FN+TP) ----------(1)

Where

TP – True Positive: White matter is correctly identified as White matter

FP – False Positive: Gray matter is incorrectly identified as White matter

TN – True Negative: Gray matter is correctly identified as Gray matter

FN – False Negative: White matter is incorrectly identified as Gray matter

5.2 Sensitivity

Sensitivity (also called the true positive rate) relates to the test's ability to identify a condition correctly.

Sensitivity = TP / (TN+FN) ---------- (2)

The performance of five algorithms is measured using performances metrics Accuracy and sensitivity. The computational results showed that the FLGMM provides better result compare to the other four segmentation algorithms. Results described in Table 2 and Table 3.

Table 2: Results of Web Based Image Segmentation - Accuracy.

Data Set	*Accuracy*				
	AFCM	*BCFCM*	*GKFCM*	*GFC*	*FLGMM*
D1	84.51	85.64	85.73	89.14	**93.34**
D2	83.54	85.26	85.82	88.95	**92.21**
D3	84.22	86.02	86.5	90.06	**93.46**
D4	82.31	83.02	85.32	89.27	**92.15**
D5	83.4	85.64	86.16	89.73	**93.02**

Table 3: Results of Web Based Image Segmentation - Sensitivity.

Data Set	*Sensitivity*				
	AFCM	*BCFCM*	*GKFCM*	*GFC*	*FLGMM*
D1	85.61	86.14	86.41	91.04	**92.14**
D2	85.2	86.51	87.52	89.57	**93.51**
D3	86.24	86.14	86.56	90.72	**93.64**
D4	84.14	85.54	87.52	88.68	**94.02**
D5	85.16	85.51	88.01	89.96	**93.14**

6. Conclusion and Future work

In this paper we have has presented a web service for image segmentation that focuses on the challenges and problems posed by very large datasets. It has been implemented using MATLAB NE Builder for very large datasets in web environment. In terms of performances, the web Environment was faster than the standalone

Environment. A web service reduces the time and the computing power for image segmentation algorithm. The computational results showed that the FLGMM provides better result compare to the other four segmentation algorithms. Our system is implemented based on SOA technology for consideration of the consistency, security and interoperability of web services. Furthermore, this study also defines the ways for cloud service implementation through the SOA approach and evaluation steps.

References

[1] Uros Vovk, Franjo Pernus and Bostjan Likar. "A review of methods for correction of intensity in MRI", IEEE Trans. Med. Imag., vol. 26, no. 3, Mar. 2007.

[2] Dzung L. Pham, student member, IEEE, and Jerry L. Prince, Member, IEEE. "Adaptive fuzzy segmentation of magnetic resonance images", IEEE Trans. Med. Imag., vol. 18, no.93, Sep. 1999.

[3] M.N. Ahmed, S.M. Yamany, A. A. Farag and T. Moriarty, "Bias Field and Adaptive Segmentation of MRI data using a modified fuzzy c means algorithm", IEEE 1999.

[4] Miin-Shen Yang, Hsu-Shen Tsai. "A Gaussian kernel based fuzzy c means algorithm with a spatial correction", Elsevier 2008.

[5] Tuan D. Pham, Senior Member, IEEE, and Klaus Berger," Automated Detection of White Matter Changes in Elderly People Using Fuzzy, Geostatistical, and Information Combining Models", IEEE Transactions on Information Technology In Biomedicine, Vol. 15, No. 2, March 2011.

[6] Zexuan Ji,Yong Xia, Quansen Sun, Member IEEE., "Fuzzy Local Gaussian Local Gaussian Mixture Model for Brain MR Image Segmentation", IEEE 2012.

[7] Avudaippan Tharmiah, Murugan Velsamy, Balasubramanian Ramasamy. " Design and implementation of automated detection of brain quantitative using INU corrected fuzzy c means clustering on web environment", ANESI journals, ISSN 1991-8178,2014.

T. Avudaiappan completed his B.E Degree from the Department of Computer Science and Engineering, Jayaraj Annapackiam CSI college of Engineering from Anna University; Chennai in the year 2010.He has completed his M.E Degree from the Department of computer science and Engineering in Karpagam University, Coimbatore in the year 2012. He is a Research Scholar in the Department of Computer Science and Engineering, Manonmaniam Sundaranar University, Tirunelveli. His research interests include, Cloud Computing, Parallel Computing, Image Processing and Web Development.

Dr. R. Balasubramanian received his B.E [Hons] degree in Computer Science and Engineering, from Bharathidhasan University in the year 1989. He completed his M.E degree in Computer Science and Engineering, from Regional Engineering College, Trichy/Bharathidhasan University in the year 1992. He is working as a Professor in the department of Computer Science and Engineering, Manonmaniam Sundaranar University, Tirunelveli. He received his Doctorate in Computer Science and Engineering, Manonmaniam Sundaranar University, Tirunelveli in the field of Digital Image Processing, in the year 2011.He has published papers in many National and International Level Journals and Conferences. His research interests in the field of Digital Image Processing, Data mining, and Wireless Network & Cloud Computing.

N. Mathavaraj received the B.E. degree in Electrical and Electronics Engineering from Manonmaniam Sundaranar University, Tirunelveli, India, in 1994.He is currently an M.E. Scholar in Department of Computer Science and Engineering, Manonmaniam Sundaranar University, Tirunelveli, India.