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Brain Image Representation and Rendering: A Survey

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Abstract: Brain image representation and rendering processes are basically used for evaluation, development and investigation consent experimental examination and formation of brain images of a variety of modalities that includes the major brain types like MEG, EEG, PET, MRI, CT or microscopy. So, there is a need to conduct a study to review the existing work in this area. This paper provides a review of different existing techniques and methods regarding the brain image representation and rendering. Image Rendering is the method of generating an image by means of a model, through computer programs. The basic purpose of brain image representation and rendering processes is to analyze the brain images precisely in order to effectively diagnose and examine the diseases and problems. The basic objective of this study is to evaluate and discuss different techniques and approaches proposed in order to handle different brain imaging types. The paper provides a short overview of different methods, in the form of advantages and limitations, presented in the prospect of brain image representation and rendering along with their sub categories proposed by different authors.

Keywords: Brain, diagnose, disease, image processing, survey, texture

INTRODUCTION

Nowadays judgment of syndromes and diseases identical to cancer or revision of treatment properties typically depends on progressive, non-invasive imaging modalities. Methods corresponding X-Ray, or MRI, Computed Tomography or 3D Ultrasound permit non-invasive learning of composition and have originate their method to every-day usage in hospitals. To focus useful and practical procedures e.g. in blood vessels or tumors, contrast agents or targeting investigations are engaged mutually through practical imaging modalities corresponding Angiography, PET or SPECT. Newest expansions permit conception of molecular developments similar to apoptosis through specifically intended imaging agents and optical tomography methods like FMT. These types of problems are handled and represented through a procedure called image formation and representation.

Similarly, Image-based rendering (IBR) denotes to an assortment of methods and demonstrations that permit 3D sights and substances to be pictured in a representative manner deprived of full 3D model reconstruction. Image-centered Rendering inspects the concept, exercise and applications connected through image-centered rendering and modeling. Image rendering have huge application in regard of MRI, CT, PET, MEG and EEG volume visualization and rendering.

The following sections provide an overview of different existing methods related to image representation and rendering with their advantages and limitations.

IMAGE REPRESENTATION

There are different forms of image formation, main are given in Fig. 1.

The processes described in above figure can be analyzed in Fig. 2.

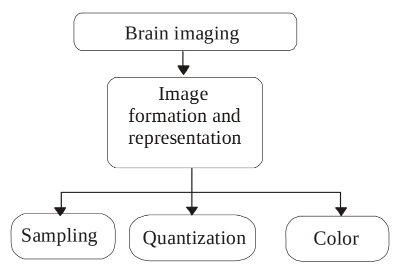

Fig. 1: Image representation branches

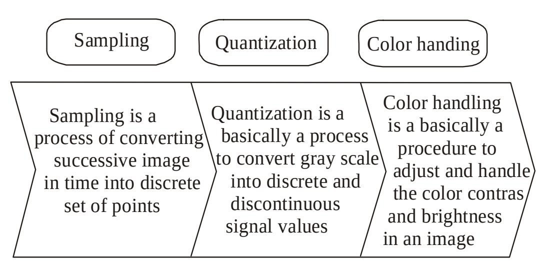

Fig. 2: Image representation branches

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Now we will analyze and discuss different approaches proposed and implemented in this prospect so that we can analyze and discuss differ approaches together with their application, advantages, limitations and results.

MRI: Sparse Representation of Complex MRI Images is proposed in Hari and Jim, (2008). Five diverse methods using CWT or DWT are experienced intended for sparse demonstration of MRI images which are in the appearance of multifarious standards, separate real/imaginary, or detach magnitude/phase. The investigational consequences on real in-vivo MRI images illustrated that suitable CWT, e.g., Dual-Tree CWT (DTCWT), can attain sparsely superior than DWT through analogous Mean Square Error. Similar work is presented in Lijun *et al.*, (2008). The technique is assuming that the preceding MR images are made of numerous estranged areas by means of consistent intensity, consequently, whole disparity can be joined to additionally smooth each area. Similar work can also be analyzed in Saiprasad and Yoram (2011).

4D data representation using MRI is p\proposed in Xavier *et al.* (2007). The method standpoint is that 3D velocity imaging obtained with ECG gated velocity-encoded cine-MRI permits the aortic blood stream lessons. Since the obtained images are not straightly working, so the method presents a 4D-presentation of aortic blood flow in order to optimize the apparition of the particularities of non-laminar flow inside the aorta.

Another work can be analyzed in Tian-yi *et al.* (2009). The scheme was completed from nonmagnetic optical fibers and a contact lens, in order to utilize in general clinical MRI circumstances and the cost of developing it is also comparably low and affordable. The brief overview of these techniques can also be seen in Table 1.

CT: Here the first method discussed in this regard is a CT representation method. The method basically deals with representation and demonstration of Anatomic organs or construction/arrangement acquired from X-CT and MilT information that works in a gray scale 3D image. The method makes use of two processes called surface point detector and surface normal estimate. Accurate object representation and fast realistic object rendering is achieved.

Two Parameter representations from 3D information of CT is proposed in Jianmin and Mingquan, (2009). The technique is achieved and made in the course of taking out contours commencing these images and chart these positions into their two parameter room whereas their geometric possessing is simple to be designed and scale assets associations linking their three dimension room are too to be resolute.

Another work on CT representation is proposed in Van Ravesteijn *et al.* (2009). The method is little intricate pattern recognition system centered on a spontaneous characteristic from the abovementioned demonstrations advances recital to fewer than 1.6 false positives per examine at 92% compassion per polyp. Another approach for CT representation can be analyzed in LARSEN *et al.*, (1977). The method is a mixture phantom idea to permit for phantom demonstration through higher-order surfaces in addition to several permutations of essential forms (cubes, quadrics, super-quadrics) and voxel statistics inventing after tomography (segmented CT/MRI volumes). Representation through combination of different procedures for CT is proposed in Van Ravesteijn *et al.* (2009). The method combines volume, mesh and streamline for polyp detection in CT. The method presents

Table 1: MRI brain images representation methods comparison

S. No.	Application	Advantage	Limitation	Result
1	MR images representation (Hari and Jim, 2008)	Method is capable to handle all types of complex MR images.	The major drawback of the technique is the amount of time the system takes to sparse the image.	Results showed that the method can achieve better results than DWT with similar Mean Square Error.
2	MR image representation and enhancement (Lijun *et al.*, 2008)	Method offers excellent combination of noise removal and edge preservation	-	Results demonstrate that the proposed method preserves most of the fine structures in cardiac diffusion weighted images.
3	Blood flow representation from MR images (Xavier *et al.*, 2007)	Able to handle 2D, 3D and 4D data	Not much effective	Obtained results are acceptable
4	MRI analysis (Saiprasad and Yoram, 2011)	Method removes aliasing and noise in one step	Existing similar methods show similar results	Experimental results demonstrate dramatic improvements in reconstruction errorusing the proposed adaptive dictionary as compared to previous CS methods.
5	MRI slicing (Jianmin and Mingquan, 2009)	Preserves image quality	Specific to higher intensity images	The echoing protons are more logical than the other methods
6	MRI diffusion tensor (Peter and Sinisa, 2003)	supports to perceive independent parameters	-	-
7	MRI data representation (Tian-yi *et al.*, 2009)	Preserves image details	A bit complex system	Results showed that the method is reliable and capable to provide basic data to make detailed predictions

a CAD model that, as a result, subsequently reduces false positive while keeping the sensitivity high. Two parameter representations of images in 3D visualization with CT images is proposed in Jianmin and Mingquan, (2009). The method is a three step process.

- Threes pace measurements tress free surfaces might be characterized through two permitted parameters
- Any three space measurement simple surfaces might be two even manifolds in three space measurement implant trouble
- Simple surface concept of significant features of biomedical picturing

Another 3D representation of CT images can be analyzed in Paul *et al*. (1983). The author proposed a method which provides elevated resolution 3-D molded exterior vision of the spine column. The consequential restoration of the vertebral column emerge as if the bones had been removed commencing the body and raised in a mode usually observed on anatomic study skeletons. This pattern sight can build from any viewing angle.

Another application of CT image reconstruction through the process of representation is proposed in Ping *et al*. (2006) that uses Radial Basis Function (RBF) neural network for Computerized Tomography (CT) images commencing a minute quantity of protuberance information. Results demonstrated that the technique being proposed can acquire the enhanced reconstruction as compared to the Filtered Back Projection (FBP) and it is, in addition, further competent than ART technique alone.

The work of representation for alignments of liver from the serial CT examination can be analyzed in Nathan *et al.* (2008). By means of ground facts in the form of corresponding landmarks physically tagged through a radiotherapist, the method takes out a research to conclude whether non rigid registration carries out superior whilst applied to the unique image information or to images built from contained demonstration of the liver. The brief overview of such techniques can also be seen in Table 2.

EEG: Detection of Migraine in EEG by Joint Time-Frequency Representation is presented in Zulkamain, (2002). The method is basically a way to represent the migraine detection from the EEG using the frequency component. Spectrogram is calculated from Electroencephalogram (EEG) attained through computing electric capabilities on the scale. Signal answer commencing the occipital capacity was apprehended aimed at examination. Time-frequency investigation of the EEG signal exposed that EEG frequency trace of migraine patients are distributed linked to the normal patients. The results showed that the method of frequency examination is capable to deliver minutiae of frequency

Table 2: CT brain images representation methods comparison

S. No.	Application	Advantage	Limitation	Result
1	Analyzing and detecting anatomic structures from CT (Luo *et al.*, year).	It follows simple computer graphics techniques for fast surface rendering and 3D image manipulation.	Lack realistic and accurate representation.	The results proved that the method is applicable to an atomic structure rendering.
2	3D representation of CT (Paul *et al.*,1983)	Better visual effects	Large storage spaces are necessary.	The results showed that the object can be viewed from any direction without waiting for further processing.
3	CT representation (Jianmin and Mingquan, 2009)	Smooth and simple surface visualization.	Computationally large	Feasible surface representation results are achieved.
4	CT representation	Simple and accurate method	-	Results proved that the method (Van Ravesteijn *et al.*, 2009)-improves performance to less than 1.6 false positives per scan at 92% sensitivity per polyp
5	CT representation (LARSEN *et al.*, 1977)	40% increased computational speed	Direct implementation of the work is not investigated	-
6	CT representation (GuobaoWang and Jinyi, 2009)	Simple and accurate method	-	Results proved that the method improves performance to less than 1.6 false positives per scan at 92% sensitivity per polyp.
7	CT representation (Hongbin *et al.*, 2010)	Smooth and simple surface visualization.	Computationally large	Feasible surface representation results are achieved.
8	3D CT representation (Paul *et al.*, 1983)	Have flexibility to process many different forms of data.	-	The results proved that method provides the ability to view object from any angle without having much processing.
9	CT representation (Joerg *et al.*, 2004)	40% increased computational speed	Direct implementation of the system is not investigated	- Better reconstructed image.
10	Image representation (Ping *et al.*, 2006)	Smoothes the images	Computationally complex	Also better than ART technique.
11	Image representation (Nathan *et al.*, 2008)	Solved the problem of image registration, representation and dissimilarity measures.	Manually marks the landmarks of an image.	Results proved that the method is effective for image registration and representation.

Table 3: EEG brain images representation methods comparison

S. No.	Application	Advantage	Limitation	Result
1	EEG representation	Effective for EEG data representation	Computationally complex	-
2	EEG representation (William *et al.*, 2004)	Shortens the computational time	-	-
3	EEG representation (Joerg *et al.*, 2004)	Sensitivity factor is also handled	-	Improved performance (93 % accuracy)
4	EEG representation (van Ravesteijn *et al.*, 2009)	Obvious advantages in the classification accuracy	-	Accuracy about 94.22% is achieved through the method

Table 4: MEG brain images representation methods comparison

S. No.	Application	Advantage	Limitation	Result
1	MEG data representation (Sung *et al.*, 2003)	The method decreases computation time from 36 to30 ms	Slightly greater computational expense	Results showed that the MEG representation can be effectively presented using described method.
2	Decomposition of MEG (Francois *et al.*, 2005)	Simple and short process	-	Results showed that method is promising for MEG decomposition.
3	MEG representation (Sung *et al.*, 2003)	Computational time is decreased	Computationally expensive	The results showed that accuracy of 0.28 is achieved through the process.
4	MEG/EEG representation (Alexandre Gramfort, 2007)	Powerful approach to consider Multi trial time series.	Method is very general	Results showed that method is effective for EEG and MEG representation.
5	MEG data representation (Sung *et al.*, 2003)	The method decreases computation time from 36 to 30 ms	Slightly greater computational expense	Results showed that the MEG representation can be effectively presented using described method.

spread of migraine actions. Similar work of frequency representation of EEG signals can be analyzed in Francois *et al.*, (2005) which make use of a blind source algorithm. Sparse representation of EEG can also be analyzed in Hongbin *et al.*, (2010). Another EEG representation approach can be analyzed in Ting *et al.* (2003). The procedure looks like the wavelet packet transform through its binary tree exploration aimed at an ideal assortment of orthogonal foundation nonetheless ranges the presentation to the multi-channel scenario. It targets to deliver a thin signal illustration to restrict features in the spatial-spectral-temporal area. Meanwhile the decayed stoms are spatially intelligible apparatuses. Study of synchrony through scalp positions is then conceivable. Spline representation of EEG is proposed in LARSEN *et al.*, (1977). A spline method, that obliges to filter the EEG after Fourier spectral examination. The brief overview of some more techniques can also be seen in Table 3.

MEG: Source localization from MEG with the concept of distributed output representation is presented in Sung *et al.*, (2003). Amulti-layer perceptron (MLP) which receipts these nsor extents by means of inputs, practices one hidden layer and produces outcome as the amplitudes of amenable fields holding a dispersed depiction of the dipole position. MEG representation is proposed in Tolga *et al.*, (2007). The method makes use of a procedure called morphological Component Analysis (MCA). The overview of some additional methods can be seen in Table 4.

PET: Similar work for 3D PET data can be analyzed in William *et al.*, (2004). The technique for the compressed storage of 3D statistical structure, by mean of a division into Tran's axial and axial aid. The decrease in storage necessities possibly will be used to capably and precisely integrate blurring property into the method response matrix formulation. Now talking about the PET representation, in this prospect we can analyze (Hari and Jim, 2008). The technique being presented in this regard is for the compact storage of 3D symmetrical method action matrix coefficients in PET, by means of a departure into axial assistances. The method proves that the method is compact and efficient for better storage with less reliance on rebinding. Sparse representation can also be utilized in reconstruction of PET data. This type of work is proposed in GuobaoWang and Jinyi(2009). The method makes use of linear spectral representation method followed by a Laplacian prior. The results showed that the method is appropriate and effective for estimating parametric images from dynamic PET data. The overview of some additional methods can be seen in Table 5.

In the above section we discussed and evaluated different approaches of brain images representation and formation by means of their main methods, applications, advantages, limitations and results. It can be seen that the work with respect to color handling is done by using various methods, whereas the methods of sampling and quantization in regard to processing brain imaging types are not much applied and developed.

Table 5: PET brain images representation methods comparison

S. No.	Application	Advantage	Limitation	Result
1	Representation of 3D PET data (William *et al.*, 2004)	Compact storage i.e., greatly reduces storage requirements	Computationally complex	Results proved it an efficient method for PET data representation.
2	3D PET data representation (Ting *et al.*, 2003)	More compact storage	-	-
3	PET reconstruction and representation (Tolga *et al.*, 2007)	-	A lengthy procedure	Results have shown that the proposed MAP reconstruction with bias correction achieves better quantification performance than the traditional ML direct reconstruction and the indirect method.

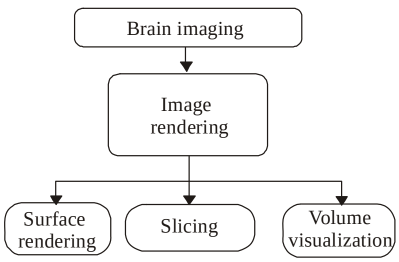

Fig. 3: Image rendering branches

IMAGE RENDERING

There are different forms of image rendering also, main are given in Fig. 3. These processes can be analyzed in Fig. 4.

Now we will discuss and analyze different papers presented and proposed in this prospect. Acceptable work has been done in the prospect of brain imaging rendering and volume visualization. Now we will discuss some of those methods to evaluate them in this prospect.

MRI: Now we will analyze and discuss different approaches proposed and implemented in this prospect so that we can analyze and discuss different approaches together with their application, advantages, limitations and results.

MRI visualization based on volume data processing can be analyzed in Yang *et al.* (2008). The first step being taken here is the utilization of a three-dimensional median filtering process in order to de-noise the data. Another work in this prospect for MRI is presented in Zhen Zheng (2008); the method is segmentation based process which helps out to find and visualize Region of Interest (ROI). The methods being used are y casting, plane segmentation, Cubical segmentation. Similar work can also be analyzed in Zou (2001). MRI field visualization is presented in Tim and Mariappan (2007). MRI visualization based on the contours is proposed in García de Pablo *et al.* (2005). The method presented in Zhang *et al.* (2001) is an approach for volume visualization of DT/MRI. The method is a practical atmosphere which shows geometric demonstration of the volumetric second-order diffusion tensor information and is building communication and apparition methods for two functional areas: analyzing modifications in white-matter models following gamma-knife capsulotomy and pre-operative preparation for brain tumor surgery. Another paper that analyzes different interpolation method for volume rendering in the prospect of MRI can be analyzed in Gordon *et al.* (2000). Another visualization approach of 3D structures volume rendering is presented in Andreas *et al.* (2004). Another MRI base visualization method is proposed in Meghna *et al.* (2006). One MRI visualizing approach can be analyzed in Patrick *et al.* (2010). The overview of some methods can be seen in Table 6.

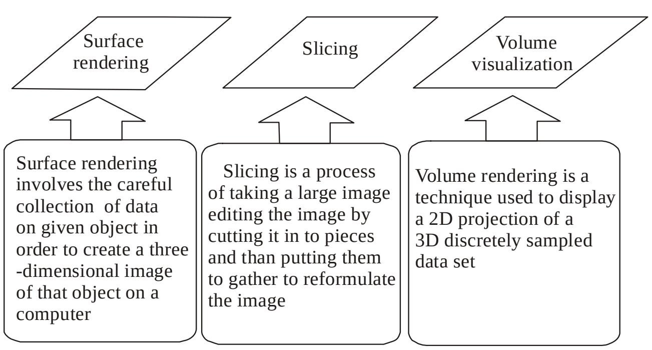

Fig. 4: Image rendering branches description

Table 6: MRI brain images rendering methods comparison

S. No.	Application	Advantage	Limitation	Result
1	MRI visualization (Yang *et al.*, 2008)	Effective visualization	Computationally complex	The results showed that the method is effective for 3D MRI visualization.
2	MRI volume visualization (Zhen Zheng, 2008)	Handles 3D data and preserve details of the image	-	The method effectively highlights the area of interest.
3	MRI visualization (Tim and Mariappan, 2007)	Requires least preprocessing	Does not have the long range visual consistency.	-
4	MRI visualization (Meghna *et al.*, 2006)	Produces high quality images	-	-
5	MRI volume visualization (García de Pablo *et al.*, 2005)	Ventricular volume can be measured quantitatively	-	Better results for ventricular volumes.
6	MRI volume visualization (Zou, 2001)	Handles both 2D and 3D data	-	The results showed that the method gains a powerful ability of structural manipulation and volume visualization.
7	MRI Volume Visualization (Zhang *et al.*, 2001)	Method has strong potential for understanding complicated datasets.	-	Complex geometric models can calculated efficiently.
8	Volume rendering of tensor fields (Gordon *et al.*, 2000)	Suitable for diffusion tensor MRI data	Comparably a large system	Results show three different interpolation methods.
9	MRI representation (Patrick *et al.*, 2010)	Preserves image details and quality	Computationally complex	The results showed that the method obtained sufficient results to visualize the MRI representation.

Table 7: CT brain images rendering methods comparison

S. No.	Application	Advantage	Limitation	Result
1	Volume rendering of CT (Zhenwei and Zhang, 2010)	A smooth and fast process	Needs careful repeated trials	The results proved that the shading and classification transfer functions being designed can highlight the tissues/organs in which we are interested.
2	Volume rendering of PET and CT (Jinman *et al.*, 2008)	Suppresses less-relevant information from the PET.	Computationally complex	The results showed that the method can easily and efficiently navigate and interpret dual-modal PET-CT images.
3	CT visualization (Nicolas *et al.*, 2006)	Handles 4D data	Practically not implemented	Enhanced MGH's capabilities to monitor the patient.
4	CT visualization (Runzhen *et al.*, 2003)	Effectively handles the noise factor as well.	Real time rendering and operations limited to only a portion of the volume.	The results show that the method eliminates any errors that occur in the process of CT visualization.
5	CT volume handling (Hao and Xuanqin, 2010)	Noise is removed effectively	Comparably a bit slow processing system	The results showed that the proposed de-nosing methods are promising in low-dose multi-slice CT or CBCT and the normal-dose CBCT, as a post-processing followed with the procedure of scatter correction.

CT: Starting from CT images, the method is proposed for volume rendering of CT images (Zhenwei and Zhang, 2010). The method is based on ray casting concept. They proposed a general shading and classification transfer function to emphasize diverse parts of CT volume. The results indicate that the proposed method effectively highlights the area of interest and rendering efficiency is greatly increased using graphic cards. The method proposed in Jinman *et al.* (2008) is similar work effective for both CT and PET volume rendering. In this method interactive assortment of a Point-of-Interest (POI) by means of fused-MIP of PET-CT is utilized in order to mechanize and automate the image enrichment, for instance transfer function production, intended for subsequent DVR apparition used in additional image judgment.

Another CT volume rendering approach is presented in Nicolas *et al.* (2006). The method being presented there produced a revelation browser and sustaining toolkit which permits for volume rendering of 4-D CT images. Method proposed in Runzhen *et al.* (2003) is another CT visualization approach. The method makes use of region growing methods and a 2D histogram interface to make possible volumetric feature extraction of CT images. The overview of some methods can be seen in Table 7.

PET: Similar approach is presented in Jinman *et al.* (2007). The technique segments the images interactively

Table 8: PET brain images rendering methods comparison

S. No.	Application	Advantage	Limitation	Result
1	PET and CT volume rendering (Jinman *et al.*, 2007)	High-memory bandwidth	Specific to low-cost graphic hardware	-
2	Volume rendering of Medical data (Thean *et al.*, 2008)	Illustration of different features of objects is possible	-	-
3	Volume rendering of PET and CT (Jinman *et al.*, 2005)	Handles visualization, segmentation as well as volume manipulation methods	Comparably a slow processing approach	-

Table 9: EEG/MEG brain images rendering methods comparison

S. No.	Application	Advantage	Limitation	Result
1	MEG representation (Christopher *et al.*, 1989)	-	Has limited specifications	The results showed that Linear estimation is a valuable means for MEG localization.
2	EEG visualization (OuBai, *et al.*, 2004)	More accurate analysis of task related neural activity.	Signal quality is affected	Results showed that tool is useful for examining patterns of EEG rhythms.

and in real time. Similar approach is proposed in Jinman *et al.* (2005), the method is a way of three-dimensional (3D) visualization of dual-modality PET and CT information to balance the 2D visualization. Volume rendering can be studied at Thean *et al.*, (2008). The overview of these methods can also be seen in Table 8.

EEG and MEG: Visualization of EEG is proposed in OuBai *et al.* (2004) for examining and having vision of spatiotemporal samples of EEG oscillations. The overview of some such methods can be seen in Table 9. So far we have discussed and evaluated different approaches developed and proposed in the prospect of image rendering. From the above evaluation we can conclude that not much work is done in this prospect of brain images rendering. The work is only done in the field of volume visualization and rendering of brain imaging. Surface rendering and slicing approaches do not contain sufficient techniques in this regard.

CONCLUSION

The study is a short description and analysis of the techniques and methods proposed and implemented for processing brain imaging types in the prospect of representation and rendering processes. There are six main types of brain imaging, each type is analyzed and discussed by means of different methods that are applicable to them. The brain images are discussed from the prospect of representation and rendering processes and the different ways that are proposed and implemented in this regard. There are basically two main types of brain image compression, each type with its all reconstruction methods are discussed and presented. A comparison of different approaches with respect to their applications, advantages, limitations and results is also discussed and presented. It is observed from the analysis that huge work has been done in this regard, but still there exists space for further work.

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REFERENCES

Alexandre Gramfort, M.C., 2007. Low Dimensional Representations of Meg/Eeg Data Using Laplacian Eigen Maps. Joint Meeting of the 6th International Symposium on Noninvasive Functional Source Imaging of the Brain and Heart and the International Conference on Functional Biomedical Imaging, NFSI-ICFBI, pp: 169-172.

Andreas, W., F.K. Daniel, Z. Song and H.L. David, 2004. Interactive volume rendering of thin thread tructures within multivalued scientific data sets. IEEE T. Vis. Comput. Gr., 10(6).

Christopher, W.C., E.G. Richard and K. Ismail, 1989. New Approaches to Source Localization in Meg. Proceedings of the Annual International Conference of the IEEE Engineering in Engineering in Medicine and Biology Society, Images of the Twenty-First Century., 4: 1256-1258.

Francois, V., C. Andrzej, D. Gerard, M. Toshimitsu, M.R. Tomasz and G. Remi, 2005. Blind source separation and sparse bump modeling of time frequency representation of EEG signals: New tools for early detection of Alzheimer’s disease. Machine Learning for Signal Processing, 2005 IEEE Workshop on, pp: 27-32.

García de Pablo, M.M., N. Malpica, M.J. Ledesma-Carbayo, L.J. Jiménez-Borreguero and A. Santos 2005. Emi automatic estimation and visualization of left ventricle volumes in Cardiac MRI. Comput. Cardiol. IEEE, pp: 399-402.

Gordon, K., W. David and H. David, 2000. Strategies for direct volume rendering of diffusion tensor fields. IEEE T. Vis. Comput. Gr., 6(2).

GuobaoWang and Q. Jinyi, 2009. Direct reconstruction of dynamic pet parametric images using sparse spectral representation, IEEE International Symposium on Biomedical Imaging: From Nano to Macro, ISBI '09. pp: 867-870.

Hao, Y. and M. Xuanqin, 2010. Projection Correlation Based Noise Reduction in Volume CT. Nuclear Science Symposium Conference Record (NSS/MIC), IEEE, pp: 2948-2953.

Hari, P.N. and J. Jim, 2008. Sparse Representation of Complex MRI Images. Engineering in Medicine and Biology Society, EMBS 30th Annual International Conference of the IEEE, pp: 398-401.

Hongbin, Y., L. Hongtao, O. Tian, L. Hongjun and L. Bao-Liang, 2010. Vigilance Detection Based on Sparse Representation of EEG Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), pp: 2439-2442.

Jianmin, D. and Z. Mingquan, 2009. Two Parameter Image Representation in 3D Biomedical Visualization with CT Images. International Association of Computer Science and Information Technology-Spring Conference, pp: 506-509.

Jinman, K., C. Weidong and F. Dagan, 2005. Dual-Modality PET-CT Visualization using Real-Time Volume Rendering and Image Fusion with Interactive 3D Segmentation of Anatomical Structures. Proceedings of the IEEE Engineering in Medicine and Biology 27th Annual Conference Shanghai, China, September 1-4, pp: 642-645.

Jinman, K., C. Weidong, E. Stefan and F. Dagan, 2007. Real-time volume rendering visualization of dual-modality pet/ct images with interactive fuzzy thresholding Segmentation. IEEE T. Inf. Technol. B., 11(2).

Jinman, K., K. Ashnil, E. Stefan, F. Michael and F. Dagan, 2008. Interactive Point-of-Interest Volume Rendering Visualization of PET-CT Data", IEEE Nuclear Science Symposium Conference Record, pp: 4384-4387.

Joerg, P., N. Oliver and B.S. Ralf, 2004. Hybrid Phantom Representation for Simulation of CT Systems Using Intrinsic Shapes, Tomo-graphic Volumes and Higher-Order Surfaces. Nuclear Science Symposium Conference Record IEEE, 4: 2453-2455.

Larsen, R.D., E.F. Crawford and P.W. Smith, 1977. Reduced Spline Representations for EEG Signals. Proceedings of the IEEE, 65(5): 804-807.

Lijun, B., L. Wanyu, Z. Yuemin, P. Zhaobang and E.M. Isabelle, 2008. Sparse Representation Based MRI Denoising with Total Variation Signal Processing, 2008. ICSP, 9th International Conference on pp: 2154-2157.

Meghna, S., T. Richard, B. Anup, R. Jana and M. Mrinal, 2006. Image Based Temporal Registration of Mri Data for Medical Visualization. IEEE International Conference on Image Processing, pp: 1169-1172.

Nathan, D.C., V. Grace, G. Lena, B. Joanne, J. Alison Noble1 and J. Michael Brady, 2008. Investigating Implicit Shape Representations for Alignment of Liversfrom Serial Ct Examinations. Biomedical Imaging: From Nano to Macro, 2008. ISBI 5th IEEE International Symposium on, pp: 776-779.

Nicolas, D., J. Buffy and C. George, 2006. Visualization of 4D Computed Tomography Datasets. Image Analysis and Interpretation. IEEE Southwest Symposium, pp: 120-123.

OuBai, G.N., Z. Mari, V. Sherry and H. Mark, 2004. Visualization of Spatiotemporal Patterns of EEG Rhythms during Voluntary Movements. Proceedings of the 17th IEEE Symposium on Computer-Based Medical Systems (CBMS’04), 1063-7125/04.

Patrick, C.T., S. Guillermo and A.W. Brian, 2010. Creating Connected Representations of Cortical Gray Matter for Functional MRI Visualization. IEEE T. Med. Imaging, 16(6).

Paul, C.L., L. Robert, D.R. Robert, F. Gleason, B.W. James and M.P. Chan, 1983. MOLDED 3-d representations reconstructed from sequential ct scans. Computer Applications in Medical Care, Proceedings the Seventh Annual Symposium on pp: 775-778.

Peter, J.B. and P. Sinisa, 2003. A normal distribution for tensor-valued random variables applications to diffusion tensor MRI. IEEE T. Med. Imaging, 22(7).

Ping, G., H. Ming and J. Yunde, 2006. RBF Network image Representation with Application to CT Image Reconstruction. Computational Intelligence and Security, 2006 International Conference on pp: 1865-1868.

Runzhen, H., M. Kwan-Liu, P. McCormick and W. William, 2003. Visualizing industrial CT volume data for nondestructive testing applications. IEEE Visualization, pp: 547-554, 10.1109 /VISUAL. 2003. 1250418

Saiprasad, R. and B. Yoram, 2011. Highly undersampled MRI using adaptive sparse representains. Biomedical Imaging: From Nano to Macro, 2011 IEEE International Symposium on pp: 1585-1588.

Sung, C.J., B.A. Pearlmutter and N. Guido, 2003. MEG source localization using an MLP with a distributed output representation. IEEE T. Biomed. Eng., 50(6).

Thean, W.O., I. Haidi and K.V.T. Kenny, 2008. implementation of Several Rendering and Volume Rotation Methods for Volume Rendering of 3D Medical Dataset. IEEE Conference on Innovative Technologies in Intelligent Systems and Industrial Applications, CITISIA, pp: 49-54.

Tian-Yi, Y., J. Feng-Zhe and W. Jing-long, 2009. Visual field representation and location of visual area V1 in human visual cortex by functional MRI. Complex Medical Engineering. CME, ICME International Conference on, pp: 1-5.

Tim, M. and N. Mariappan, 2007. Fast Texture- Based Tensor Field Visualization for DT-MRI. 4th IEEE International Symposium on Biomedical Imaging: From Nano to Macro, pp: 760-763.

Ting, K.H., M. Shen, P.C.W. Fung and F.H.Y. Chan, 2003. Multi-channel Fourier Packet Transform of EEG: Optimal Representation and Time-Varying Coherence. Biomedical Engineering, IEEE EMBS Asian-Pacific Conference on, pp: 120-121.

Tolga, E.Ö., S. Mingui and J.S. Robert, 2007. Decomposition of MEG Signals with Sparse Representations . Bioengineering Conference, 2007. NEBC '07, IEEE 33rd Annual Northeast, pp: 112-113.

Van Ravesteijn, V.F., L. Zhao, C.P. Botha, F.H. Post, F.M. Vos and L.J. Van Vliet, 2009. Combining mesh volume and stream line representations for polyp detection in CT colonography. Biomedical Imaging: From Nano to Macro, 2009. ISBI '09 IEEE International Symposium on, pp: 907-910.

William, A.W., S.S. Adler, H.A. Kudrolli, J.D. Nevin, Leonid V. Romanov, 2004. Compact representation of pet 3d system response matrices. Biomedical Imaging: Nano to Macro, IEEE International Symposium on 1: 756-759.

Xavier, M., A. Lalande1, P.M. Walker, C. Boichot, A. Cochet, O. Bouchot, E. Steinmetz, L. Legrand and F. Brunotte, 2007. Dynamic 4D blood flow representation in the aorta and analysis from cine-MRI in patients. Comput. Cardiol., 34: 375-378, ISSN: 0276-6574.

Yang, F., W.M. Zuo, K.Q. Wang and H. Zhang, 2008. 3D cardiac MRI data visualization based on volume data preprocessing and transfer function design. Comput. Cardiol., 35: 717-720.

Zhang, C.D., D.F. Keefe, P.J. Basser and E.A. Chiocca, 2001. An Immersive Virtual Environment for DT-MRI Volume Visualization Applications: A Case Study. Visualization, 2001. VIS '01. Proceedings IEEE, pp: 437-584.

Zhenwei, L. and J. Zhang, 2010. Study on Volume Rendering of CT Slices based on Ray Casting. 3rd IEEE International Conference on Computer Science and Information Technology (ICCSIT), pp: 157-160.

Zhen Zheng, X.M., 2008. MRI Head space-based segmentation for Object Based Volume Visualization. International Conference on Computer Science and Information Technology, ICCSIT '08, pp: 691-694.

Zou, Q., K.C. Keong, N.W. Sing and O.C. Yinta, 2001. MRI Head Segmentation for Object Based Volume Visualization. Seventh Australian and New Zealand Intelligent Inf6rmation Systems Conference, pp: 361-366.

Zulkamain, M.A., 2002. Detection of Migraine in EEG by Joint Time-Frequency Representation. 2002 Student Conference on Rcscarch and Development Proceedings, Shah Alam, Malaysia, 0-7803-7565-3 IEEE.