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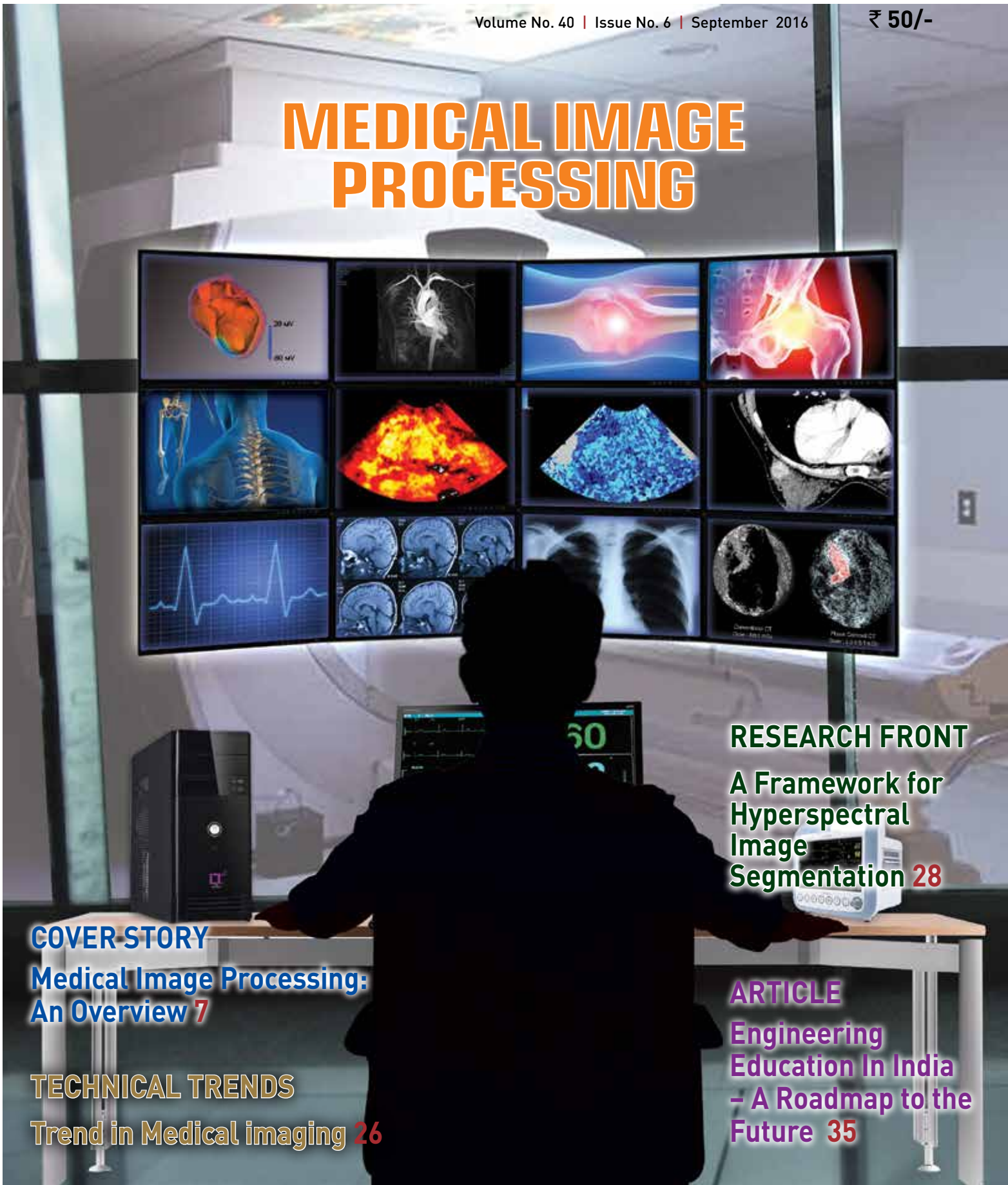
MEDICAL IMAGE PROCESSING



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an individual.

2 are friends.

3 is company.

more than 3 makes a society. The arrangement of these elements makes the letter 'C' connoting 'Computer Society of India'.

the space inside the letter 'C' connotes an arrow - the feeding-in of information or receiving information from a computer.

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Editorial

Dear Fellow CSI Members,

Medical Image Processing deals with the techniques and processes of creating visual representations of the body for medical analysis. It helps in extracting useful information from various body parts for diagnosis and treatment. It helps in identification and analysis of body parts that may not be visible by human eye. It includes the enhancement and analysis of images captured using various techniques like x-ray, ultrasound, MRI, optical imaging. Computer algorithms can provide analysis in 2-dimensions or 3-dimensions to identify patterns and characteristics which are indicative of various ailments.

Medical Image Processing is an interdisciplinary area consisting of Computer science, Information Technology, Medicine, Artificial Intelligence, Mathematics, Physics, Statistics, Psychology etc. The recent advances in medical image processing will help in making significant advances in understanding of life and disease processes, and ability to deliver quality healthcare.

Keeping in mind the importance of Medical Image Processing in today's context, the publication committee of Computer Society of India, selected the theme of CSI Communications (The Knowledge Digest for IT Community) September 2016 issue as "Medical Image Processing".

Cover Story contains first article "Medical Image Processing: An Overview", J. S. Niranjan and N. N. Chiplunkar that explains various steps in medical image processing Next cover story "Medical Imaging and Processing" by D. K. Singh gives an overview of medical imaging with the help of an example of brain tumor detection. Next article in this category "Pathological Brain Detection Systems: A Review" by D. R. Nayak, R. Dash, B. Majhi and P.K. Sa provides an overview of system used to detect abnormalities in the brain correctly with the help of MRI scanning. In next cover story "Overview of Medical Image Segmentation in MR Human Head Scans", R. S. Shankar and K. Somasundara provide an introduction to segmentation technique in medical image processing. Cover story "Medical Ultrasound Imaging " by A. R. Anil and N. K. Ragesh discusses the ultrasound imaging and image quality enhancement. The article "Medical Image Retrieval using DICOM Format" by A. P. Bhagat and M. Atique provides information about a widely used format in medical imaging called DICOM.

Technical Trends contains "Trend in Medical Imaging" by N. Bhatt and A. Agrawal that provides advantages of digital processing in medical applications and discusses imaging market in India and world.

Research Front category contains "A Framework for Hyperspectral Image Segmentation" by B. R. Teja and K. Venkatarao that gives a framework to handle hyperspectral image segmentation. Next article in this category "Model Based Approach for Effective Diagnosis of MS-Lesions" by K. N. Kumar and Y. Srinivas addresses a methodology for identification of MS lesions from the brain MRI images.

We are thankful to Prof. N. J. Rao for sharing his article "Engineering Education In India – A Roadmap to the Future" that reviews the challenges of engineering education and provides a roadmap to tackle these challenges.

This issue also contains Crossword, CSI activity reports from chapters, student branches and Calendar of events.

I am thankful to Prof. A. K. Saini, Chair-Publication Committee and entire ExecCom, in particular to Prof. A. K. Nayak and Prof. M. N. Hoda for their continuous support in bringing this issue successfully.

On behalf of publication committee, I wish to express my sincere gratitude to all authors and reviewers for their contributions and support to this issue.

I hope this issue will be successful in providing various aspects of Medical Image Processing to IT community. The next issue of CSI Communications will be on the theme "Bioinformatics". We invite the contributions from CSI members who are working in the area of Bioinformatics.

Finally, we look forward to receive the feedback, contribution, criticism, suggestions from our esteemed members and readers at csic@csi-india.org.

Wishing a very Happy Teachers day to all Teachers,

Dr. Vipin Tyagi
Editor

Dr. Vipin Tyagi, Jaypee University of Engineering and Technology, Guna - MP, dr.vipin.typagi@gmail.com

President's Message

01 September 2016

Dear CSI members,

From the beginning of this year, we have been trying to increase our reach both in India and abroad. We are trying to attract professionals to CSI from all parts of India and trying to motivate existing members to spread a word to their friends conveying the benefits of CSI Membership.

The different avenues (like IFIP, SEARCC etc.) where our members can participate, have been opened up. The process of selecting our members to the different Technical Committees of IFIP from the large number of applications received is in the final stage. CSI representatives to BIS (Bureau of Indian Standards) have been assigned work on different ISO drafts by BIS officials. We have informed our members about ICANN57 to be held in Hyderabad during November 3-9, 2016. ICANN is a very important conference and the deliberations will be useful for our members involved in network administration. The MOU between IEEE and CSI for CSI-IEEE CS Education Award is in the final stages and will be announced soon.

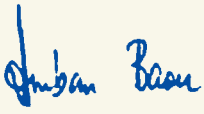
I started the month of August, by meeting Ms. Bernie Scott of British Computer Society (BCS) and explored conducting certification programs of BCS. I was invited to inaugurate an International Conference at Jaipur during August 6-7. I was invited to deliver a keynote address at NITC 2016 at Colombo during August 8-10, 2016. Glimpses of the conference have been given separately in this issue. During my visit to Colombo, I had the privilege of meeting and interacting with Office Bearers of Computer Society of Sri Lanka during the conference and was convinced that there is enormous scope for cooperation between the two countries. On August 18-19, I was closely involved in organizing an International Conference on "Internet of Things" at Bangalore which was attended by leading experts including Prof Raj Buyya (Australia), Prof Sitharama Iyengar (US), Prof Shikharesh Majumdar (Canada), Prof Ernest Cachia (Malta) and leading practitioners from HP Enterprise, TCS, CDAC, Robert Bosch, Happiest Minds etc. A number of research papers were presented and the conference served a useful platform for interaction between Industry and Academics.

The different Committees formed as per CSI Byelaws have started their work and will be meeting again to take things forward. We are trying to enlist members in US and Australia. Awards Committee is working on the different awards of CSI including CSI Fellowship.

Preparations for the Annual Convention of CSI (CSI 2016) to be held in Coimbatore during December 8-10, 2016 is going on in full swing. The organizers have planned an excellent program with international speakers and leading industry practitioners. We are inviting all our members to participate in this event.

I am sure with the support and cooperation of all our Members, CSI will continue to play an important role in building a strong Digital India.

With best wishes.



Dr. Anirban Basu
President, CSI

Dr. Anirban Basu, Bangalore, president@csi-india.org

Vice President's Desk

Welcome to the 71st year of Indian Independence!

I feel proud and take this opportunity to remind you that Computer Society of India (CSI) is serving the nation for more than 50 years in the field of CS&IT out of 70 years of Independence. Information and Technology (IT) has played a vital role in the nation development from last three decades. The significance of IT for development was noticed earlier by CSI and CSI took various initiatives such as IT literacy campaign to rural youth, disabled and elderly. This has been eventually termed as digital movement from the last few years. Now a days the governments are keen in promoting this digital literacy as it fetches or increases the quality of living and other basic necessities of life. CSI step ahead leaves no stone unturned for promoting the digital mission at the grass-root level.

I hope our esteemed Members of society have experienced the quality of the CSI Communications July & August, 2016 edition/s. Active steps have been taken with the support from Esteem Executive Committee of CSI and dedicated staff of CSI to increase the reach and impact of the journal. CSI is very much active in various social networking sites, I request all the members and coordinators from region level to institutional level to promote the activities of CSI through social networking sites and engage more number of students. Persistent improvements are taking place in the CSI web portal.

We are planning to prepare a roadmap and vision statement, SWOT analysis for the same is under process. Inputs from all members will be taken into consideration for analysis purpose. The geographical presence of CSI in 19 states and UT's is less. Assam, Bihar, Chandigarh, Haryana, Puduchery, Punjab are having poor presence of CSI Membership and Andaman & Nicobar, Arunachal Pradesh, Dadra & Nagar Haveli, Daman & Diu, Himachal Pradesh, Jammu & Kashmir, Lakshadweep, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura are very poor with regard to membership of CSI. My sincere appeal to all the members to focus on the CSI membership growth in these states and UT's.

"A teacher takes a hand, opens a mind, and touches a heart"

CSI is playing a very vital role in Academic Institutions and our esteem Faculties of different Institutions are patronizing CSI in different capacities since long. On the "Teachers Day", my regards to esteem Academicians of this country and soliciting necessary guidance for a vibrant Computer Society of India (CSI).

For feedback & suggestions please write to - vp@csi-india.org.

With kind regards

Sanjay Mohapatra
Vice President, CSI

Important Notice

As per the Digital India initiative and directives of the Government of India to Go Green, the Executive Committee of Computer Society of India in its last meeting held on July 9-10, 2016 at Chennai, has decided to stop the printing of Hard Copy of the CSI Communications, from January 2017, for all the individual members. The Green India Initiative, which saves both financial and environmental costs and helps save environment, requires that the CSI Communications be made available to the members through electronic means. This necessarily requires that members should ensure updating their latest email addresses immediately. Limited number of hard copies shall be published, for distribution to Authors, Institutional Members and Students' Branches only, for their Library record. Members, desirous of still receiving the Hard Copies of CSI Communications, are requested to send their special request, for dispatch of Hard Copy of CSI Communications, to swapnil@csi-india.org by October 31, 2016 indicating their CSI membership number.

Such members, who are not receiving the emails of CSI HQ, are also requested to kindly write to sonali@csi-india.org and get their email ID updated, so as to get the CSI publications and other information regularly on their email-id. CSI will not accept any responsibility for non-receipt of CSI publications or any other information, due to their incorrect email IDs.

Thanking you and looking for your cooperation and support.

Prof. A. K. Nayak
Hony. Secretary

Medical Image Processing : An Overview

Jyothi Shetty and Niranjan N Chiplunkar
NMAM Institute to Technology, Nitte, Karnatka

Introduction

Over the years, medical practitioners have made remarkable contributions to a human's ability to view inside the body. Medical imaging techniques allow medical practitioners to take medical images of the parts of human or animal. Doctors can view the interior parts of the body, which makes diagnosis easier. In the last decade, there was a tremendous change in the imaging techniques, which enabled a transition from qualitative to quantitative diagnosis. The significant changes in the imaging techniques have been observed because of advance in Quantum physics theory (e.g. NMR), tremendous increase in speed and capacity of integrated circuits, Revolution in information technology. Established methods for clinical use are X-ray imaging, Computed Tomography (CT), Ultrasound Imaging (US), Magnetic Resonance Imaging (MRI), functional MRI (fMRI), Positron emission tomography (PET), Single-photon emission computed tomography (SPECT) etc.

Advances in imaging have initiated a lot of technological innovations in the field of image processing. Medical image processing includes the analysis, enhancement and display of images captured via different imaging modalities. Modalities used for medical imaging produced a list of modern methods for finding the information about tissue composition, tissue detection, analysis of tumor, etc. With such details, doctors feel diseases can be treated at an early stage and holistically. Today medical image processing has evolved as a field of inter and multidisciplinary activities, which has become very important in recent years. Specificities of medical image processing are,

- Data are rare and expensive. As far as possible approximations must be avoided. Maximum information must be extracted.
- Medical image processing techniques do not decide, they just help to decide.
- Algorithms must be robust and safe. Algorithms are expected to give no answer or a conservative answer, rather than a wrong answer.

Image processing may involve images like 2D X-ray image of bone, Complex CT and MRI images of the head or abdomen etc. The use of 3D, 4D images from advanced imaging modalities have made medical image processing more challenging. Now a day's image processing methods even support multicore processors and GPUs [1].

The study of medical image processing took off with a lot of hype and now the technology is also maturing and good things are emerging from it. Medical image processing is quite helpful in cases where images obtained from PET, MRI, CT etc, .

Many researchers have applied image processing algorithms on brain images to analyse brain tumor. A brain tumor is nothing but the abnormal growth of cells inside the skull. Different image processing techniques can be applied on the brain image to find the tumor size, position, etc. Similar liver studies have been done in liver disease. With liver damage too, the tissue undergoes change. This can be studied well using medical image processing techniques. In fact, Medical image processing has simplified a lot of complex issues in medical images. Apart from these well-characterized diseases, recent studies have increasingly suggested image processing techniques on DNA, skin and hair.

On hair, image processing studies have found that more accurate therapy can be suggested by assessing the properties of hair like density, diameter, length, level of oiliness etc., These algorithms can be used to study hair properties under various levels of illumination [2].

There is also extensive work going on in the field. With image processing one can define the skin's health, by analyzing skin texture image acquired using a UV camera.

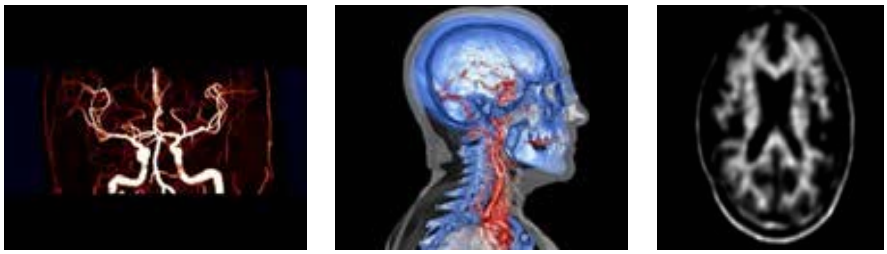
Medical image processing methods are also helping to increase of IVF implantation success rates [3]. The researchers have applied embryo image processing techniques to implant the embryo with the best chance of success by analyzing the embryos using new image segmentation techniques.

Different stages of medical image processing

In general, medical image processing involves stages such as image acquisition, image pre-processing, image segmentation, feature extraction and image registration.

Image acquisition

Medical image acquisition can be specified as the method of retrieving an image from the different medical imaging modalities. When the initial CT scanner was invented in 1970's, it took lots of time to acquire one slice of image data and more than 24 hours to get a single image out of the acquired data. Today, this acquisition and reconstruction occur in less than a second. In image processing, image acquisition must be always accomplished as the first step because, without an image, no processing is possible. The image that is acquired is completely unprocessed. Enhanced image can be obtained by using image processing techniques. Figure 1 shows the images obtained from popular modalities like MRI, PET and CT scanner.



(a) (b) (c)

Fig.1 : a) MRI showing blood vessels in the brain [4] b) PET image [5] c) CT scanner image [5]

Image pre-processing

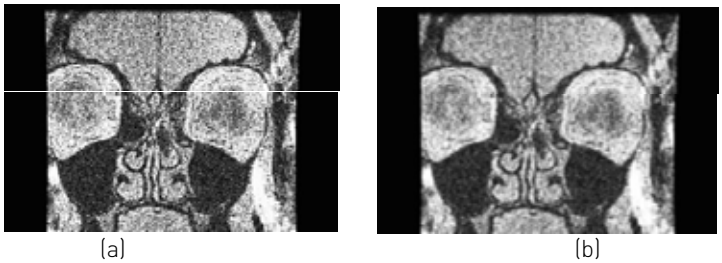
The pre-processing in image processing is required to upgrade the visual appearance of images. Different types of pre-processing include image resampling, grayscale contrast enhancement, noise removal and mathematical operations. Using Image resampling number of pixels of the dataset can be reduced or increased. Grayscale contrast enhancement improves the visualization by brightening the dataset. Noise removal being the popular pre-processing step, makes use of several types of filters to remove noise from the images. Filter used in the literature to preprocess the medical images is depicted in Figure 2. Medical image after applying mean filter is also shown in Figure. The mathematical operations can be used to enhance the particular features. It is possible to apply arithmetic operations like addition, subtraction and morphological operations like dilation, erosion on to the images. Mathematical operations based pre-processing can be used to identify the change in brain size due to aging and dementia.

Image segmentation

Segmentation is defined as a method, where image is partitioned or segmented into several parts based on the values of pixels. The large images generated by the modalities like MRI and CT scans are difficult to study manually, so more effective image segmentation approaches are required. Segmentation can be mainly used in separating different tissues from each other. Various segmentation techniques have been proposed by the researchers to detect lung cancer on CT images and also to segment lung nodule. Other applications of segmentation include simulation of blood and heart flow during surgery, finding disorders in several parts like brain, heart, knee, liver, prostate by segmenting the areas. The results of segmentation applied on the CT image of the lung and MRI image of the knee is as shown in Fig. 3. Thresholding, region growing, classification, clustering are some common method used in segmentation. Research has been directed towards the effective use of data mining, neural network, fuzzy techniques in the segmentation of medical images. Fuzzy techniques are very effective in the segmentation of echocardiographic images as the regions of these images are not well defined.

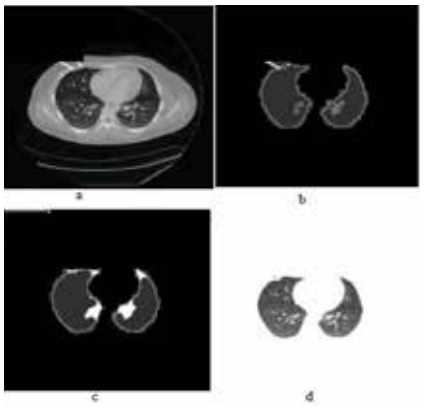
Feature extraction

The main purpose of the feature extraction is to extract the required portions of an image. In medical image sometimes input data to a required algorithm is very large to be processed. It may contain large volume of data, but less information, then the reduced representation can be used by extracting set of features. This transformation is called feature extraction. Features extracted from the input file mainly involve shape, intensity and texture features. Feature extraction methods can be used in applications which help to detect cancerous nodules in the lung. The extraction methods are also applied on brain MRI images to predict the volume of tumor in the brain.



(a) (b)

Fig. 2 : Image pre-processing, using Mean Filter [6] a) Before b) after applying a mean filter



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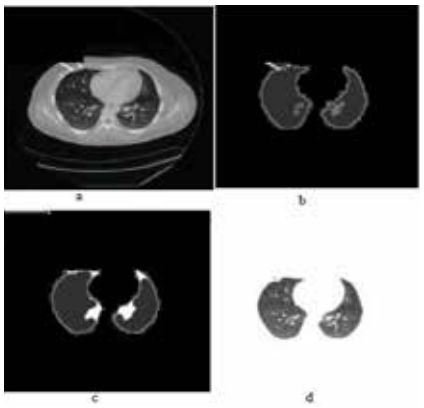

(ii)

Fig. 3: i) Result of watershed segmentation a) original CT image b)Segmented lung borders c)Smoothed lung Borders d) lung regions [7] ii) a) Original MRI of knee bone b), c) &d) are segmented images using clustering method with different parameters. [8]

Image registration

Image registration is the method of superimposing two or more images of the same scene taken at different times, from different positions, and/or by different modalities. Image

registration has been widely used in the medical imaging, but that need to be very accurate. The aim of the image registration in medical image processing is to integrate the information acquired from different sources to accomplish more complex and detailed data.

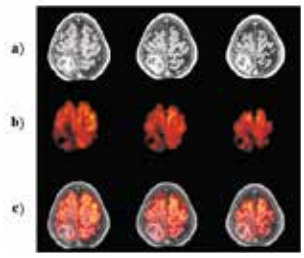

Fig. 4: Row a) MRI with right parietal glioblastoma, Row b) Corresponding PET layers Row c) Fusion of registered layers [9]

The rapid development that has taken place in the image acquisition devices, made image registration more important. Medical image registration can be done on the images taken using a single modality or multi modalities. Single modality based registration compares the image taken from the same modality on the same patient, but may be on different time frames. But multi modality based registration involves images taken from different modalities. The images obtained from computer tomography (CT) and NMR data can be combined using image registration techniques to get more information about the patient or monitor tumor growth, treatment verification, etc., Similarly MRI or CT data can be compared with PET data which has localized picture of the brain area, to get more valuable additional information for diagnosis of the disease. Multi modality based registration on MRI and PET data is as shown in Fig. 4.

Medical image processing often involves elastic registration techniques because it has to deal with deformation of the subject due to respiration and other related issues. Now a days lung CT image registration has become very important for several observations like tracing lung motion over the breathing cycle, observe anatomical changes over time and detecting abnormal mechanical properties of the lungs. Medical image registration can be done using intensity-based or feature-based approaches. Intensity based approaches use differences between intensities between the various images, whereas feature based approaches directly match the features. The feature based registration approaches like current and varifold based image registration are used in the recent literature to perform registrations of MRI and Lung CT images. Image registration can also help to measure how the tumor changes during or after treatment. A long term research goal in the field of image registration is real time registration, which has to perform required processing in real-time. Researchers have already presented a real time registration procedure, which helps in mitral valve repair to be performed while the heart is beating. The recent example also includes use of GPU's for image registration.

Algorithm specific to individual modalities and diseases

The image processing techniques differ widely based on the application, imaging modalities and other aspects. Various modalities are used in imaging, also on various body parts. MRI and CT scanners provide brain, liver, chest, abdominal images. Image processing methods applied to brain tissue has divergent demands from the methods used in the case of liver. The method which gives the correct result with respect to one modality may not work for another.

Conclusion

In the past, the imaging quality was not good and innovations largely focussed on development of new materials. The development of high dimensional techniques and high quality imaging techniques such as high field MRI, CT scanning etc. has made new innovations in image processing more important.

In future, the major goal of the medical practitioner to interpret the images better and derive more information. The days are not far, when a mirror at home may give medical warning regarding the changes in our face or a person gets an alarm on some serious medical conditions such as seizures, depending on her/his walking style, which are captured using imaging devices. This type of perfect decision is possible when advanced image processing algorithms are in place.

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Medical Imaging and Processing

Dushyant Kumar Singh
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The visual presentation of internal body parts is required when those body parts are difficult to be visible from eyes in normal. In such case, images are captured by some means or instruments to perform the clinical analysis and medical intervention. Use of images for clinical analysis and diagnosis is termed as medical imaging. Medical imaging attempts of uncovering the internal structures of body hidden by bones and skin. A number of imaging techniques has now been evolved which phenomenally works well in study of complex medical diagnosis. Some of those are Gamma-Ray Imaging, X-Ray Imaging, Ultrasound etc.

In Gamma-Ray imaging, patient is injected with radioactive isotope emitting gamma-rays. With the decay, images are produced from the emission collected by the gamma-ray detectors. X-rays are electromagnetic radiations and are generally used for bone identification in medical imaging. The Ultrasound imaging uses high frequency sound waves (approx in MegaHz) to create an image. It is safe and painless and it does not ionizing radiation. The ultrasound scan is an event and the sonogram is the image produced when an ultrasound scan is performed. Some other imaging techniques that have their promising role in medical domain are next discussed.

Tactile Imaging: It is a medical imaging technique that uses touch or sense of touch to convert to digital image. It is a function of $P(x, y, z)$, where P is the pressure and x, y, z are point coordinates. It is used to map the pressure or sense of touch on the soft tissues. Breast, prostate, pelvic and muscle are application location of this type of imaging.

Photoacoustic Imaging: is a non-invasive medical imaging technique which allows structural, molecular and functional imaging. It delivers non-ionizing laser pulses into biological tissues. The delivered energy is absorbed by the biological tissues. The heat formed leads to transient wideband ultrasonic emission that generate ultrasonic waves which are then detected by the ultrasonic transducers and analyzed to produce images.

Thermography: It's an example of medical infrared imaging. The most widely used area of thermography is like pain diagnostics, breast imaging in case of breast cancer, and various early stage disease screening.

Tomography: Tomography is a medical imaging procedure that uses special X-Ray equipment to create detailed image or scans of area inside the body. This technique uses a tomographic optical system to obtain tomographic images of a specific cross section of a scanned object allowing the user to see inside the object without making any changes in the actual object.

Electrocardiography (ECG): ECG is used to record the electrical activity of heart by using electrode placed on human skin. The electrodes observe and detect the tiny electrical changes in the human skin that arises from heart muscles. It is a very commonly performed cardiology test. The graph of voltage and time is generated by the non-invasive medical imaging process is referred to electrocardiogram.

Magnetic Resonance Imaging (MRI): MRI machine emits the radio frequency pulses at the resonant frequency of the hydrogen atoms in the water molecules. The radio frequency antenna sends the pulse to the area of the body to be examined. The MRI creates a 2D image of thin slice body which is later examined by the tomographic technique.

Echocardiography : The ultrasound of heart is referred to the echocardiogram. It allows detailed structures of the heart including the chamber size of the heart, function of the heart, shows the number of heart valves and the sac of the heart to be seen. The echocardiography uses 2D, 3D and Doppler imaging to create pictures of the heart and shows the blood flowing through the each valves of the heart. It is widely used in chest pain, shortness of breath, cancer treatment etc.

Positron Emission Tomography (PET): Positron Emission is a nuclear medicine, functional imaging technique which is used to observe metabolic process in the body. The system detects pair of gamma rays emitted indirectly by a positron emitting tracker, which is introduced into the body on biological active molecules. 3D images of tracker concentration within the body are then constructed by the computer analysis.

After a brief note on available imaging techniques, the next part of discussion follows processing of images generated as a result of medical imaging. The study or analysis of behavior present in images can be done manually by the experts and doctors. While with the orientation of technology toward automation, the task of analyzing images for some diagnosis is done with computers. For this, images are processed for particular objective of diagnosis. The processing of medical images is detailed with an example/ case of MRI images.

Image Processing on MRI Images

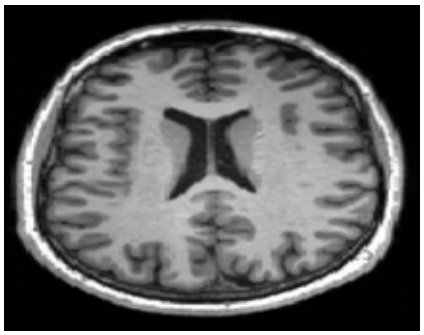

Fig. 1 : T1 weighted scan

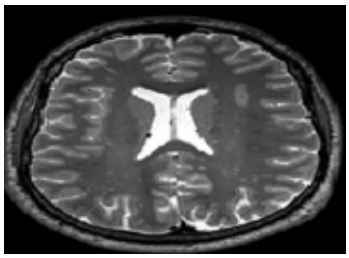

Fig. 2 : T2 weighted scan

Here we will see how image processing can be done to detect tumors in brain. Tumors appear on images obtained from MRI in two ways, either darker in color than brain tissue shown in figure 1 or lighter than brain tissue shown in Fig. 2.

Although radiologists have all these MRI images, but due to lack of any standard process for tumor detection, conclusions based on these images vary from doctor to doctor. There are various techniques that can be used in image processing to detect tumor in brain. The basic flow of process is shown in figure 3.

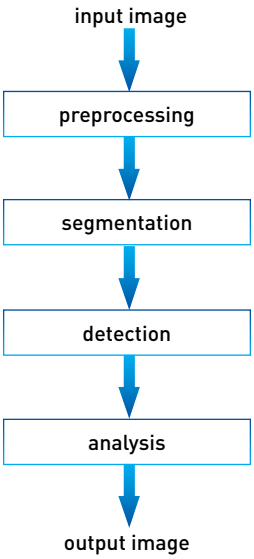

Fig. 3: Basic flow of processing MRI image

The mostly used technique in detecting tumors is the edge detection technique which can detect boundaries and discontinuities present in an image and also for segmentation. Edges of an image are mainly those parts where there is a rapid change in the grey tone of color present. Hence by using edge based segmentation technique we can obtain image of brain without affecting physical qualities of the main image. Histogram equalization is used in this technique for the enhancement of image and edge detection and segmentation for getting patterns of brain tumor. In image segmentation whole image is divided into parts or regions based on similar features. Another technique that can be used for the purpose of segmentation is threshold technique in which all adjacent pixels having grey level, texture, color value etc. lying between certain ranges belong to same class.

Histogram thresholding can also be used for segmentation which is somehow different from one explained above. This technique uses the concept that the backgrounds of images are uniform on which objects are placed irregularly. Thus we can use the histogram of an image for delineation of object and finding an appropriate threshold between object and background for object identification. In this technique to achieve segmentation we can take all pixels having intensity larger than threshold in one group and those having smaller in another group. If we use more than one threshold value then technique is called multi thresholding.

If we use combined method of region growing and edge detection for the segmentation of image, we can reduce the errors in segmentation characteristics arise due to separate use of region growing and edge detection. We can use boundary smoothing for ensuring more realistic region boundaries.

Genetic algorithm can also be used for classification of brain tissues in MRI. It uses a special method called spatial gray level dependence in which optimal texture features are extracted from normal and tumor regions and show the location of tumor in brain. Simple clustering algorithm can also be used to detect the location and shape of tumors in the brain. This technique uses two algorithms for segmentation using computer aided methodology. Clustering algorithm such as Fuzzy C and intelligent optimization tool like genetic algorithm can combine together for this process. This method contains two stages: preprocessing and enhancement of image in first stage and segmentation and classification in second stage.

We can also use machine learning for segmentation of MRI scanned images of brain in various ways. Most commonly used machine learning for these images is a classifier to calculate weights using training data sets. Artificial Neural Networks (ANNs) is then used for segmentation of new data.

Neuro fuzzy segmentation process can also be applied for segmentation of images to detect various tissues in brain like white matter, gray matter, Cerebrospinal fluid (CSF) and tumor. This method classifies images layer by layer and thus high value of tumor pixels can be obtained.

If images are colored then traditional techniques cannot fulfill the segmentation problem completely. Thus for colored images one of the latest technology in computer science known as soft computing is used. Soft computing combinely uses fuzzy logic, neural networks and genetic algorithm for segmentation process. Soft computing mainly deals with approximate models and after processing it gives solution for complex problems.

MATLAB based image processing of MRI images for tumor detection is shown below. Following are the steps performed:

1. Input an MRI Image of brain
2. Change it grayscale
3. Apply high pass and median pass filters respectively
4. Compute threshold segmentation
5. Compute morphological operation
6. Get image of tumor as output

Figures numbered from 4 to 9 are the image results of the operations performed above.

Conclusion

Imaging adds up to the effective medical treatments by eliminating extra surgical operations which are required to uncover internal body organs. Imaging being non-invasive makes diagnosis easier and more flexible. It also prevents the many medical risks, especially when very sensitive/caring organs such as brain, back-bone, heart etc are considered. Generated images are

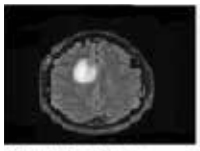

Fig.4 : Input image

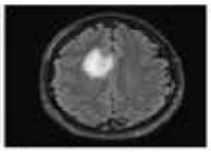

Fig. 5 : Grayscale image

Fig. 6 : HPF image

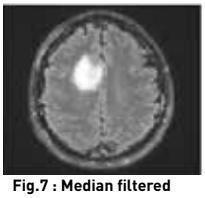

Fig.7 : Median filtered image

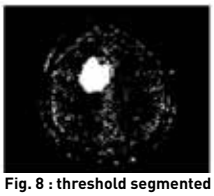

Fig. 8 : threshold segmented

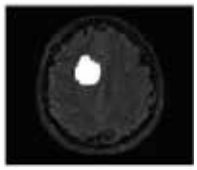

Fig. 9 : Extracted tumor

only useful if some automatic analysis of complex medical images can be done for diagnosis and treatment. Processing these images with different processing techniques for different ailments helps in effectively diagnosing the diseases. A very correct diagnosis can only assert a correct treatment of disease. Example of brain tumor is shown in the article as part of the processing of brain images for tumor detection.

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CSI Student Branch Inauguration at Pydah College of Engineering & Technology, Visakhapatnam

CSI Student Branch at Pydah College of Engineering & Technology, Visakhapatnam aas Inaugurated by Dr. S. Pallam Settyt, Professor, Dept. of CS&SE, Andhra University, Visakhapatnam and Dr. Suresh Chandra Satpathy, Chairperson, Division-V, CSI and graced by Dr. Ramesh Challagundla, Principal, Pydah College of engineering and Technology on 04 August, 2016. Mrs G. M. Padmaja, HOD,CSE welcomed everybody to PYDAH and she stressed on the need for students to associate themselves with organizations like Computer Society of India.

The inaugural function came to an end by presenting Mementos as a token of Gratitude to the Chief Guests by Dr. Ramesh Challagundla, Principal and a vote of thanks by Mr. M. Kamalakar, Associate Professor, SBC- CSI. HOD's of different Departments and faculty members of the CSE Department attended the programme. More than 250 students were present in the programme. The programme was enlightening and inspiring for students. The program was a grand success and paved way for many such endeavors in future.

Pathological Brain Detection Systems: A Review

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1. Introduction

Medical image processing has encountered striking development and has been a vital field of research in the last few decades. Experts from various disciplines like mathematics, computer science, statistics, biology, and medicine find motivation in this area of research. Various medical imaging modalities such as Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), Electrocardiography (ECG), X-ray, Ultrasound etc., have been developed where digital image processing algorithms are applied to improve the image quality. These imaging techniques provide the visual representation of the internal structure of the human body which has potential applications in noise filtering, 3D visualization, registration, segmentation, and classification. Different modalities have their own pros and cons over different organs of the body and no such generalized modality exists to extract relevant information from all the organs. Therefore, it is necessary to know the suitable type of modality before designing an algorithm for a specific disease.

The rate of growth of brain diseases across all corners of the earth has been exponential in the past decade. As per the estimation provided by the National Brain Tumor Foundation (NBTF) in the United States, it is found that brain tumors are the cause of one-fourth of all cancer deaths in children. In 2014, World Health Organization (WHO) reported that around 2, 50,000 people were diagnosed with primary brain tumors in each year across the world. The brain diseases can be classified into four types, namely, cerebrovascular diseases (stroke), neoplastic diseases (brain tumor), infectious diseases, and degenerative diseases as outlined in Figure 1. These diseases cause severe problems and sometimes lead to death. Therefore, it is essential to develop an early diagnosis system to arrive at correct clinical decisions. This process of detecting diseases in the brain is usually dubbed as pathological brain detection (PBD). Magnetic resonance imaging (MRI) being a non-invasive and faster medical imaging technique produces rich information about the soft tissues of the human brain and thus has been used in solving many PBD problems. The MR images are of different types, namely, T1-weighted, T2- weighted and proton density (PD) weighted MR images as shown in Figure 2. T1-weighted MR images are used for visualizing normal anatomy, whereas, T2-weighted is useful for visualizing pathology. PD weighted images give information on the density of protons per unit tissue. In general, T2-weighted images have been utilized for detecting abnormal brain. The most discriminating features of a human brain are the symmetry which is clear in the axial and coronal brain magnetic resonance (MR) images. In contrast, asymmetry in the axial images strongly designates the abnormality/disease. Hence symmetry in axial MR images is an important feature that needs to be considered in deciding whether the MR image at hand is a normal or an abnormal brain.

2. Pathological Brain Detection Systems (PBDS)

The enormous volume of information about MRI makes the manual interpretation process troublesome, costly, and time-consuming. This motivates the researchers to model computer-aided

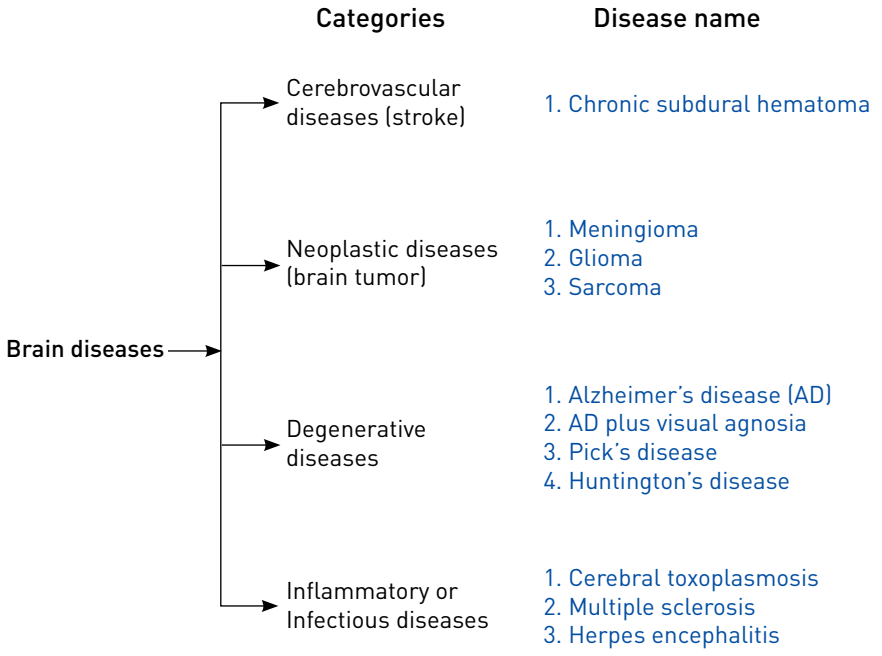


Fig. 1: Types of brain diseases

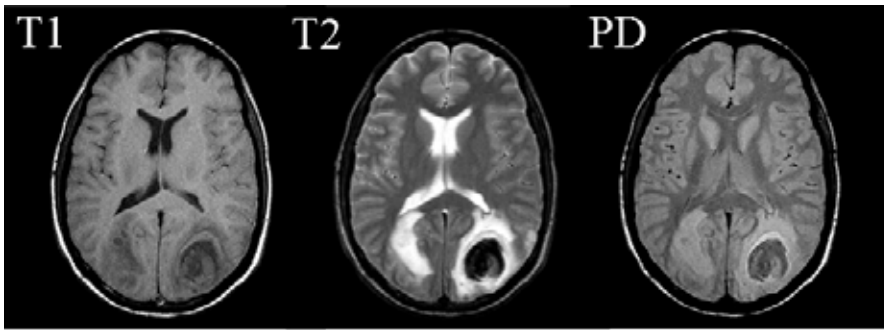


Fig. 2: Types of MRI scans

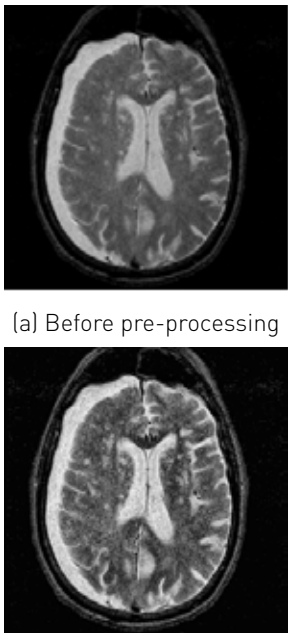
diagnosis (CAD) systems with the goal of assisting radiologists to take correct and faster decisions over unknown MRI data. CAD systems have received much more attention in detecting various diseases with the assistance of different modalities. In fact, CAD has become one of the major research subjects in medical imaging and diagnostic radiology. Although early attempts at computerized analysis of medical images were made in the 1960s, serious and systematic investigation on CAD began in the 1980s with a fundamental change in the concept for utilization of the computer output, from automated computer diagnosis to computer-aided diagnosis [1]. These systems are commonly termed as pathological brain detection system (PBDS) when it is applied to brain imaging. This study presents the motivation and philosophy of automated PBDS with its current status and future potential in clinical diagnosis.

The block diagram indicating one PBDS is shown in Figure 3. The basic steps in a PBDS are

- Image acquisition
- ROI segmentation
- Feature extraction
- Feature reduction , and
- Classification.

2.1 Pre-processing

The quality of acquired MR images in the real datasets may degrade due to improper lightening or the presence of noise. Therefore, it is essential to pre-process the image prior to feature extraction. Figure 4 depicts an original pathological brain and its pre-processing result using contrast limited adaptive histogram equalization (CLAHE) scheme. It can be seen that the diseased regions in the right-hand side image are more distinguishable than left-hand side image. Hence, pre-processing helps in extracting relevant features from the MR images. Many filtering based techniques like median filtering and its variants are also being used to reduce the noise.



(a) Before pre-processing

(b) After pre-processing

Fig. 4: Pre-processing using CLAHE

2.2 ROI segmentation

Segmentation of an image or defining the region of interest (ROI) is very crucial and the most time consuming stage in image analysis. This process divides an image into multiple parts based on certain distinctions. It aids to identify the desired objects and other relevant information in an image. Many methods such as thresholding methods (Otsu's method), color-based segmentation methods (k-means, fuzzy k-means), transform methods (watershed, region growing), texture methods (texture filters), and machine

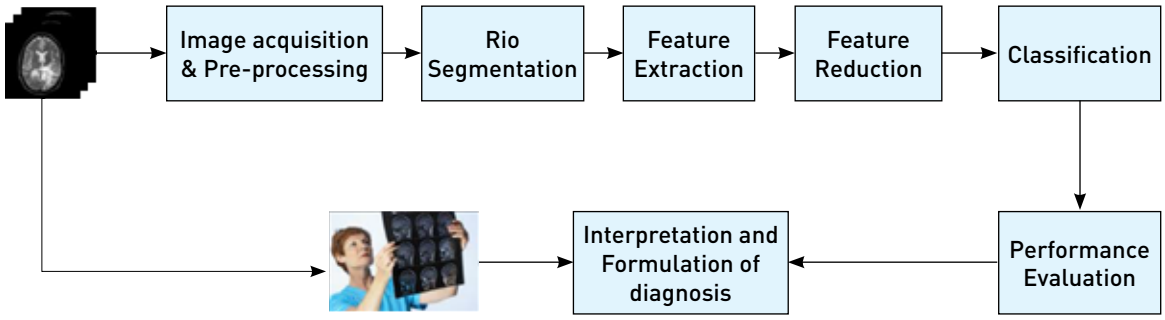


Fig. 3: Overall block diagram indicating a PBDS

learning methods (pulse-coupled neural network (PCNN) and its variations), etc. are often used for object segmentation. Figure 5 shows a result of segmentation of a pathological brain MR image using PCNN. It may be observed that the regions which contains the suspicious abnormality are extracted through segmentation instead of the undesirable regions. Therefore, it is advisable to extract features from these identified regions than other regions.

(a) Before segmentation

(b) After segmentation

Fig. 5 : Segmentation using PCNN

2.3 Feature Extraction

Feature can be defined as the individual measurable property of the process being observed. Feature extraction is a technique which efficiently represents interesting parts of an image as a compact feature vector. Any machine learning algorithms perform classification utilizing the extracted features. There are common feature extraction techniques available in the literature. Some of them are Histogram of Oriented Gradients (HOG), Speeded Up Robust Features (SURF), Local Binary Patterns (LBP), Gabor filters, wavelets, and color histograms. However, the study on pathological brain detection reveals that wavelets and its variants like lifting wavelet, un-decimated wavelet, and dual-tree complex wavelet have been commonly used for feature extraction.

2.4 Feature reduction

Feature reduction stage addresses the issue of removing irrelevant and redundant features from the data. On the other hand, reduction of features saves memory storage, computation time, and increase comprehensibility. It can be categorized into two types, namely, feature selection and feature transformation. In feature selection, a subset of the features of the original features are selected; however, in feature transformation, the data is transformed from the original high dimensional feature space to a new space with reduced dimensionality. Feature selection includes filter based methods, wrapper methods and embedded methods. Feature transformation techniques like Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), and t-Distributed Stochastic Neighbor Embedding (t-SNE) are more commonly used in PBDS.

2.5 Classification

In this stage a classifier is used to map a reduced set of features to a class label. This mapping specifies during the training phase of the classifier. With the advent of complex features, many classifiers have drawn attention among researchers, namely, k-Nearest Neighbors (KNN), Naïve Bayes, Feed forward Neural Network (FNN), Support Vector Machine (SVM), and Random Forests. Each class has their own pros and cons. However, choosing a correct classifier directly is still an active area of research.

2.6 Performance evaluation

In biomedical image processing, pathological brain images are treated as positive classes; while healthy brain images are served as negative classes. The performance of a classifier is determined by a confusion matrix which involves four elements, namely, true positive (), false negative (), false positive (), and true negative (). Several performance measures like sensitivity, specificity, precision, and accuracy have been usually used are defined as follows.

Table 1. Performance measures

Measures	Definition
Sensitivity	*TP/(TP+FN))*
Specificity	*TN/(TN+FP))*
Precision	*TP/(TP+FP))*
Accuracy	*((TP+TN))/(TP+FN+FP+TN))*

Sensitivity calculates the number of pathological samples correctly predicted by the model out of the total number of pathological samples; however, specificity defines the number of healthy samples correctly predicted out of the total number of healthy samples. Accuracy is the total number of samples that are correctly predicted.

3. Materials

Data acquisition is the primary and the most important stage of any image analysis task. Table 2 lists some publicly available datasets and their links which are often used in this field of research. All these datasets include MR images of the human brain; however, some contain other modalities like PET, CT etc.

Table 2 : List of some publicly available datasets

Dataset Name	URL
Harvard Medical School Data	http://www.med.harvard.edu/aanlib/
Open Access Series of Imaging Studies (OASIS)	http://www.oasis-brains.org/
Alzheimer's Disease Neuroimaging Initiative (ADNI)	http://adni.loni.usc.edu/
BRATS	http://www2.imm.dtu.dk/projects/BRATS2012/
Internet Brain Segmentation Repository (IBSR)	https://www.nitrc.org/projects/ibsr

4. Existing PBDS

In the past decade, researchers have developed various PBDSs. Existing PBDSs could be categorized into two types based on the data dimension. First one includes three-dimensional data which require scanning of the whole brain, and the second category selects slices (2D) from the 3D data.

In 2006, Chaplot et al. [3] have first developed a PBDS on 2D MR images where 2D Discrete Wavelet Transform (DWT) has been used for feature extraction. They used Harvard Medical School Data (HMSD) for their experiment and applied SVM for classification of the unknown samples. Later, many methods have been developed based on 2D DWT and different classifiers. Wang et al. [4] in 2015 have proposed a PBDS based on Stationary Wavelet Transform (SWT) which is a translation invariant technique and has potential advantages than conventional DWT. They have validated their scheme on HMSD dataset and achieved better results than DWT using PCA and FNN classifier. In 2015, Zhang et al. [5] utilized 3D DWT to extract features from structural MRI. Their system detected Alzheimer's disease and mild cognitive impairment through the kernel SVM classifier.

5. Observations and inferences

Based on the literature study, it has been observed that numerous PBDS systems have developed in the last decade. All the current systems are validated on a smaller dataset providing significant results which might fail to address the complexity and the majority of real life scenarios. Researchers have been trying to achieve better results by combining different feature extraction techniques with various classifiers. For feature extraction, wavelet has received much more attention than other transforms. However, the major drawbacks in wavelet are: (i) it is translation variant, and (ii) it provides limited directional selectivity. In addition, the dataset used in most of the schemes contain, only images of the brain of patients who are either in the middle or the last stage of the disease. In such cases deformities from the normal is much more and the very purpose of the research for automated minute abnormality detection without human error is lost. This paves the path for in to face the certain challenges in this area of work which needs to be kept in mind for any research advancements.

- The first and foremost challenge we face is, the features extracted from the images of the brain are not translational and rotational invariant. As a solution, focus should be made on those feature extraction techniques which are rotation or translation invariant. In addition, these techniques must provide more directional selectivity.
- As mentioned above, the size of a small dataset may give us satisfactory result, but its robustness is questionable. Finding a standard and large dataset in itself a big challenge. Collection of scanned photocopies from hospitals and private organizations is not easy and prior negotiations and deals need to be taken care of.
- Now even if we have the dataset, we cannot train a classifier efficiently if we are not provided with a sufficient training dataset. The training dataset does contain the information about positive and negative diagnosis, but rarely the situations of early stages of the disease take into consideration. Hence it is a challenging task in itself to get correctly classified data along with a large volume of it even for early detected scans.
- Apart from these, a paramount amount time and resources is applied upon getting the algorithm robust. If current modalities are not being sufficient, newer ones need to be devised.
- Another challenge is how to deal with 3D images in large numbers. To solve this issue, we may use deep learning architectures like convolutional neural network (CNN), auto-encoders, and deep belief network (DBN) for better performance. These techniques take images as the input and are capable to handle features implicitly.

6. Conclusion

Pathological brain detection systems (PBDSs) aim at predicting abnormalities in the brain correctly with the help of MRI scanning. Because of the vital advantages of PBDS, it has gained much more popularity in medical society in past decades. PBDS will help shift the focus on cure rather than diagnosis results. PBDS will provide fast detection of the stage of the disease and suggest the physician with the pre-conditions and present symptoms of the patients from where on, further diagnosis can be made more efficient. PBDS has unraveled the new era of diagnostics of human diseases, giving intricate insight into human and animal brains and may give a solution to our evolution theories which are still under debate. Moreover, these systems can be used to further identify diseases in other organs of the human body.

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Overview of Medical Image Segmentation in MR Human Head Scans

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Image is a collection of pixels with numerical values to represent visual perception of a physical object, from which the knowledge of a particular object is understood or analyzed. Providing a depiction of any object or anatomical structures gives more application possibilities. Medical image processing involves capturing the images, apply filtering in them, enhance them at requirement, segmentation on interested region, compression with very low level of loss or lossless etc. The goal of medical image processing is to enable a physician to make a good understanding of information from the images, quick decision about the nature of disease that afflicts a human organ. Capturing images, processing, storing and sharing them is a huge pipeline process, but by a finest team work, this will give a giant leap for India in Future.

1. Introduction:

1.1 Influence of Images in Medical Field

Images are used in almost all areas in human life cycle. From historical period, images are used to denote the paths and borders. Each and every one in the world is influenced by images. Images of any individual object are used for identification and to know the characterization and properties of the Object. For medical image processing we need information in a format which computations can be understood and done by the experts. Not only that, the diagnosis part is completely with the medical practitioners, surgeons and neurologists. we can't capture the information from all the anatomical parts of Human or living things in the same method or technology. Based on the anatomical properties and the participation of the elements or materials influenced in the anatomical part will decide which modality can be used to capture information from the part or tissues of the Human Body or other living things. Images are used in basic research, in biological studies, and in medical field like monitoring the growth, finding abnormalities and diseases if found. We concentrate here about MRI from imaging modalities and few most used methods in the Segmentation of brain images.

1.2 Existing Imaging Modalities

Image of tissues in human body is obtained by a variety of techniques, depending on the nature of the organ to be imaged. The human body consists of water, fat, bones and other biological items. Each and every parts in the human body reacts to external stimulations like X-rays, radio frequency (RF) radiation, micro waves, ultrasonic waves. Images are captured by using external energy sources or from internal energy. Some imaging energy sources are harmful when exposed to the organs, such as Gamma rays. Based on the biological characteristics or properties such as like fat, calcium, water can be converted into images when imaging modalities are employed to obtain the images of the human organ. Imaging modalities also differ, depending on the nature of information needed and anatomical, physiological or functional [1], [2]. Some of them are X-Ray which can penetrate into the tissues but scattered by bones. Computer Axial Tomography which is obtained by N number of X-rays and suitable formations applying tomography method.

1.2.2. Magnetic Resonance Imaging (MRI)

Magnetic Resonance Imaging uses internal energy generated by the protons found in the human body. Protons in the human body will be excited by an external RF energy in the presence of a strong static external magnetic field in the range of 2 to 4 Tesla. The human body consists mostly of water molecules (H_20) with hydrogen atom. The different tissues found in the human body produce various order of energy release and that energy is captured as values for images by different characteristics. The characteristic of these images depend on the proton density. Fig.1 shows the human head scan images obtained from MRI method. MRI is used to get high contrast and high resolution three dimensional (3D) images of human organ. MRI technique is also used for blood flow measurement. MRI called is captured and processed with specific conditions and situations in the name of functional MRI (fMRI) which is used for studying neural activities. MRI is widely used for imaging brain tissues.

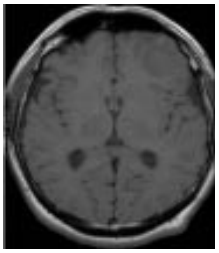

Fig. 1.a

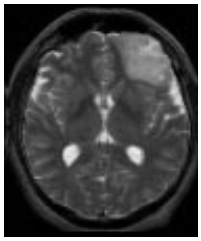

Fig. 1.b

Fig. 1: Fig.1.a and Fig.1.b gives T1 and T2 weighted Axial view of the Human Head Scan images.

2. Need for Segmentation of Brain

Medical segmentation can be done by the physicians. But in not all the cases the physicians can fix a good successful rate. In another case, less number of operations segmentation can be done manually. Each and every part of human body has its own method to segment and not all the time the physician can risk in lives. There meets the requirement between the physicians and Brain segmentation methods. Brain Image segmentation is a unavoidable clinical image processing technique for image analysis and diagnosis with visualization and quantitative assessment of the anatomy or tissues in human body. After an image of a human head scan is obtained, the neurologist try to understand the image features, such as intensity variations, edges, structure etc. From the image features a neurologist is able to identify the location of the tissues which he is interested to analyses and diagnose. For that image analysts are trying to reduce the unwanted parts in the image and give him exactly the region which is intended to look around.

2.1 Existing methods in Segmentation of Brain:

Manual segmentation on brain portion in Human head scans has the possibilities of having errors. They are also slow and are operator biased [3], [4]. There are some semi automated works [5], [6] are based on finding the tumor in the brain portion and brain structures and portions in human head scans. But these methods have a need of human interaction between the processes of segmenting the brain portion. Fully automatic methods like [7], [8] were developed to overcome problems like human interaction and reduced time of the process. These automatic methods give high accuracy and new way of automation too.

There are many other methods used for segmentation of brain portions based on region of interests like region growing, largest connected component, binarization, etc. There are some refined methods like watershed algorithm, snake algorithm are some based on edge based segmentation methods. Mathematical based works are there to support and give some more accuracy in segmentation like using graph theory, exponential functions [9]; Figure 2 shows two set of original images and their segmented images. set properties are basically used directly and indirectly in many image processing methods in current scenario. But each method has its own merits and demerits too.

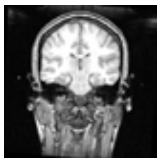

Fig. 2 : Fig 2.a

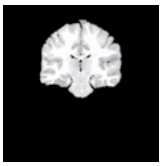

Fig. : 2.b

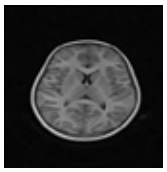

Fig. : 2.c

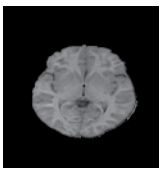

Fig. : 2.d

Fig.2.a and 2.b shows original T1 weighted coronal image and its segmented image. Fig 2.c and 2.d shows Original T2 weighted Axial image and its segmented image.

Every segmentation method is having its own requirements and preprocessing methods like filtering and enhancement. Filters like median filters, binary filters and so are in list of maximum used filters around medical field.

2.2 Clustering and Morphological operations:

2.2.1 Clustering Technique

Clustering concept is used in images for classifying the same type of intensity pixels. We are using clustering because the properties of the brain portion and head scan images are having intensity values within a certain known limit. The numerical values are involved in any form clustering and morphological operations [9]. In Clustering there are many works based in it. Few notable clustering worked so far are K-Means Clustering which could be used for grey scale images. K-Means clustering will add the pixels into a cluster when the pixel property satisfied a condition or it will purely avoid the pixel. Fuzzy C means [10],[11] could be used for clustering the complicated tissues and analysis with more number of clustering options based on the weight or ranking system in Brain portion of Human head scans.

2.2.2 Morphological operations

Morphological operations [2] are used for processing images based on the shape. Basic operations in morphological operations such as Dilation and Erosion are used either to separate or join regions by specified structuring elements as shown in Fig.3 are used in these operations. The other morphological operations are opening, closing, and top-hat and bottom hat which are derived from the basic dilation and erosion operations.

0	1	0
1	1	1
0	1	0

Fig.3 : A Structuring Element of size 3X3

Erosion operations are mostly performed to disconnect weakly connected regions. Erosion removes pixels on the object boundaries and it

will be achieved by using structuring element. The structuring element is placed on all pixel positions in the input image X and it is compared with the corresponding neighbourhood of pixels, and fits the input image. i.e. Y(i,j) = 1 if SE fits X otherwise 0, repeating for all pixel coordinates (i,j).

Dilation is used to add pixels to the object boundaries and it is achieved by using structuring element. The structuring element is placed at all pixel positions in the input image X and it is compared with the corresponding neighbourhood of pixels, i.e. Y(i, j) = 1 if SE hits X otherwise 0, repeating for all pixel coordinates (i, j).

3. Evaluation metrics:

Very basic method used by the physicians are visual perception method, they just see it by bare eyes. For qualitative analysis and also to produce report or exact statistical reports, we need similarity indexes like Jaccard or Dice similarity indexes.

The most used and available for comparing structural similarities of two images are Jaccard coefficient (J) [12] and Dice coefficient (D) [13] are such measurements of asymmetry information on binary regions A and B. where A and B are two data sets. The values will compared with each element in the set and reported with value between o and 1.

4. Conclusions:

In the field of Medical Image Processing, Image Segmentation leads a crucial role and it needs new techniques based on new requirements. It's not about only new method or algorithm; we can try to do more research on hybrid methods too. Very few basic concepts are just reported here, to have basic awareness of the field. There are many things to be achieved. We can find a good pipeline of capturing, pre-processing, segmenting, compressing and storing in future research. Parallel processing may lead a good path towards all the things said above.

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Medical Ultrasound Imaging

A discussion on the ultrasound imaging and image quality enhancement

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1. Introduction

Ultrasonic imaging plays very important role in Medical diagnosis because of its low-cost, non-invasive and real-time imaging properties. An ultrasound machine transmits high frequency sound wave (in 3 to 20 MHz range) through human body. The Ultrasonic transducers convert pulses of electrical signals to ultrasonic waves, which travel through the body tissues and some of them get reflected back from boundaries where tissue type changes – fluid and Soft tissue, Soft tissue and Bone etc. these reflected back signals are received at the transducers and converted back as electrical pulses. The delay between transmission and reception of these pulses are computed to assess the position information. This analysis will be a complex process through which, the tissue changes are computed line by line based on the delay in signal reception. The process of generating the scan lines (from actuating the transducer till the generation of scanline) is called beamforming. These scanlines generated are then passed through different signal conditioning steps to remove the noise as well as to boost the cell information. The processed scan lines are then combined to form the final cross sectional image through a process called scan conversion. The final Image generated is called 'Ultrasonogram' or simply an ultrasound image. The choice of ultrasonic frequency affects the quality and depth of the scan. Higher frequencies provide better image resolution but limits the depth to which the image can be captured, whereas, lower frequencies allow to penetrate to more depth but at a lower image resolution.

There are typically three modes of ultrasound imaging – (1) b-mode, the basic two-dimensional intensity imaging mode, (2) m-mode, suitable for assessing moving objects such as blood flow using Doppler analysis, and (3) Colour mode, with pseudo colouring to the b-mode image based on the cell motion detected through Doppler analysis.

The advantage of ultrasound images being non-invasive, low-cost, harmless and painless, also has to pay a price in the image quality. By nature, ultrasound image contains more noise contents – especially speckle noise – due to the flood of reflected waves from all around the subject body. These noise components have to be removed to generate a legible image suitable for diagnosis. Also the skill of the technician using the transducer probe is also very important in generating a good image. The presence of air between subject and probe as well as within the subject will have very bad impact on the image generated. Fig. 1 shows the process of ultrasound imaging.

2. Understanding and removing noise from ultrasound image

As we discussed, there are different sources of noise in ultrasound imaging. This starts with the loss of contact or air gap between the body and ultrasound transducer probe. The beamforming process may introduce noise due to the excessive scattering of ultrasonic waves. The signal processing stage also introduce data loss while trying to boost some desired information. There could be noise introduced in the scan conversion stage also due to interpolation.

Analysis of noise in ultrasound images as well as the techniques to remove them have been subject of many studies. This study started from the inception of ultrasonic imaging and still continues as there is still long way to go until we get a crisp image as in CT or MRI. Most of these studies focus on a typical noise type called speckle noise, which is a typical noise that affects all coherent imaging systems. This is particularly due to the excessive and inseparable reflection and scattering of the waves from cell locations which are not in focus. The speckle noise degrades the fine image details and limits the contrast, which will make small lesions difficult to detect.

Removal of noise from ultrasonic image can be addressed in two stages – (1) noise removal during image acquisition and (2) noise removal after image is generated. In first case, the imaging system is equipped with extra processing stages to minimize the error induced in the image and in the second case, advanced image processing techniques are applied on the generated image to suppress the noise and boost information content.

Ultrasound Image Acquisition process

To discuss the possibilities of noise reduction during image acquisition, we need to understand how the image is formed in the acquisition process. Fig. 1 shows an overview of this process. Let us discuss this in some more detail.

The first stage in ultrasound image acquisition in beamforming, where, the ultrasound transducers are activated with pulses of ultrasonic wave, and then listens to the reflected waves to generate the scan line. This is repeated for each scan line by adjusting the signal strength of the transducers. Generation of a scan line is happening in different steps, where in each steps, signal pulses are transmitted focussing at each discrete position (let us call it as a pixel in final image context) this focussing is done by adjusting the delay in activating different transducer

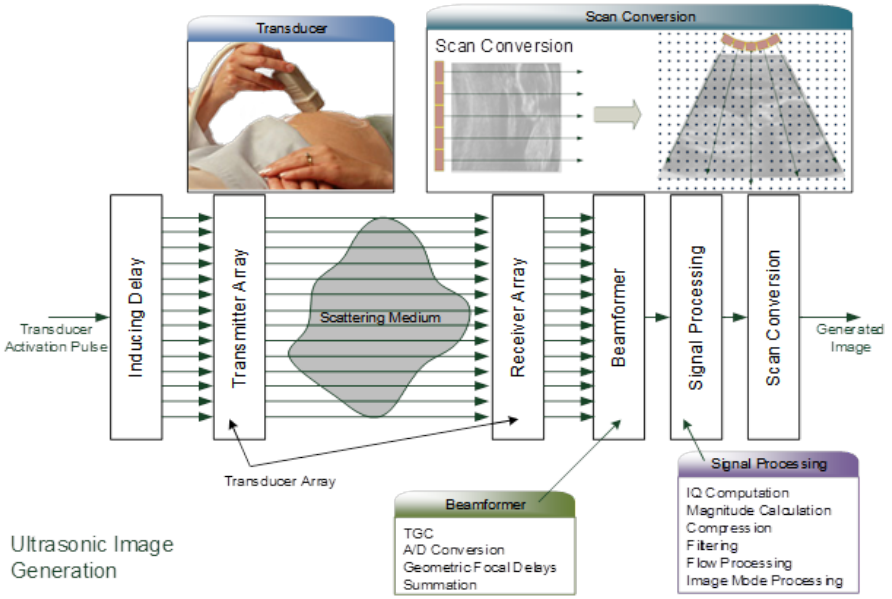

Fig. 1 : Ultrasound Imaging System Overview

elements in the transducer array. The delay is computed based on the distance from transducer array to the focus point and the velocity of sound.

When passing through the human body, a portion of the ultrasound waves get absorbed by the body cells, which will get accumulated and the waves travelling deeper will become weaker and weaker. This signal attenuation is compensated by applying a distance (time) varying gain value to the reflected signal. This process is called Time Gain Compensation (TGC).

Finally, the intensity at a particular pixel is the delayed sum of the reflected sound waved produced by all the active transducers. The summed signal is then passed to the Signal processing block, where the signal envelope is extracted, decimated and then log compressed to fit the dynamic range to that required by the system to generate the image. Different axial and lateral filters are applied on the signals at different stage to improve the image quality.

The processed signal will then be given to the Scan conversion module as scan lines, which will actually generate the image from the scan lines by doing a geometric mapping as shown in Fig. 1. The final image is generated by interpolating the image pixels from the mapped scan lines.

Once a complete scanline is processed, the same is repeated for next scan line and then the complete image.

Image Quality Enhancement During Acquisition

The quality of generated image can be improved during the acquisition by using (1) high quality transducers, (2) ensuring the proper contact without any air bubble using gel medium between the transducer and the body, (3) appropriate axial and lateral filters while doing the signal processing and (4) adaptive interpolation techniques while doing the scan conversion. A detailed discussion of these techniques are out of scope of this article.

Image Quality Improvement After Acquisition

Once the image is generated by the scanning system, the quality can be further enhanced by computer processing using advanced digital image processing techniques. This is addressed in the next section.

3. Digital Image Processing for Quality Enhancement of Ultrasound images

Digital Image processing is the study and application of various 2- dimensional signal processing techniques to modify the properties of the digital image. A digital Image is nothing but a 2-dimensional signal, which can be visualized as spatial distribution of luminous intensity and colour information. Different image processing techniques are used depending on what type of alteration or transformation is required on the image. For example, changing the image brightness or contrast or altering the shape through geometric transformations. There could be a variety of basic operations as well as their combinations to generate different effects like quality enhancement, object detection etc. Here in our case, we need to improve the quality of the image by removing the speckle noise present in it.

The speckle noise is typically a type of multiplicative noise, which are generally addressed by 2-dimensional image filters like Median filter, Lee filter etc. However, the process is not as simple as applying a single filter. When the noise is removed, a considerable amount of the information content is also will be lost. To avoid this, we need to find an efficient combination of different linear and non-linear image processing operations, so as to supress the noise while retaining the image information content.

Active research is happening in this area considering the advantages of the ultrasound imaging techniques over other medical imaging modalities. Different solutions are proposed, producing variable results mostly context sensitive – or in other words, suitable for a particular imaging scenario or requirement. A generic quality enhancement solution, to produce ultrasound images of quality similar to CT or MRI, is far from reality. This keeps ultrasound image de-noising an open and attractive area for new research scholars. We are not discussing these techniques in detail here as that is outside the scope of this article.

4. Performance evaluation of different Ultrasound image de-noising techniques.

The performance of different image quality enhancement techniques is compared using different image quality metrics. There are subjective image quality metrics as well as objective methods. The objective metrics provides statistical information which are good indicators of signal quality, however, these metrics treat images as signals and does not include the human factor into it. Human perception of image is not just its statistical property. Methods considering how human brain is interpreting the image are more suitable in cases like this.

Objective methods are easy to implement and have lesser computational complexity. However, subjective image quality metrics without human involvement is difficult to implement and requires implementation of Artificial intelligence techniques, which is computationally complex and still evolving.

Conclusion

Ultrasound imaging and enhancing the quality of the generated image are in focus of different research scholars for a long time and still there are open challenges where more efficient algorithms and techniques are yet to be developed. Our intention is to bring this interesting area to the focus of budding researchers as attract them to share their contributions to this demanding area.

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Medical Image Retrieval using DICOM Format

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Medical Image Retrieval using DICOM Format

In 1970's, variety of digital diagnostic imaging modalities has been invented with the emergence of computed tomography (CT). With the emergence of medical image modalities increased uses of the computers in clinical applications are observed. The requirement of standard method for transmission of images and allied information among the devices manufactured by numerous vendors has been identified by American College of Radiology (ACR) and the National Electrical Manufacturers Association (NEMA). Different types of digital medical images in variety of formats are produced by these devices.

ACR and the NEMA formed the joint committee. This committee specified standards in 1983:

1. Independent of device manufacturer encourages transmission of digital image information.
2. Enable the implementation and extension of picture archiving and communication systems (PACS) which can also interconnected with other components of hospital information systems.
3. Permit the construction of diagnostic information databases that can be accessed by extensive types of devices distributed geographically.

Different standards are suggested by ACR-NEMA. These standards are maintained by years. These standards identified a minimum collection of software commands, a stable set of data formats, and a hardware interface. The numerous key improvements to earlier versions of the ACR-NEMA standard are suggested by the DICOM (Digital Imaging and Communications in Medicine) standard.

1. DICOM standard is applicable to perform operations in a networked environment using TCP/IP industry standard networking protocol. While the ACR-NEMA Standard was applicable only to a P2P environment. For network based operations it requires a Network Interface Unit (NIU).
2. Choice of logical file system of physical media or a file format to be used for storage and representation were not specified by the ACR-NEMA Standard. PC file system such as NTFS, FAT32, FAT16, logical file systems ISO 9960, industry standard media CD-R can be utilized to support offline operations in DICOM standard.
3. The transmission of data is the only objective of the ACR-NEMA Standard. While DICOM standard generates the semantics of commands and linked data using the terminologies of service classes.
4. A least level of conformance is provided by the ACR-NEMA Standard. The provision is given to the implementer for structuring the conformance statement for selecting required options in DICOM standard.
5. DICOM standards are provided in a multi-part document. This enables advancement of the Standard in a quickly changing environment by easing the inclusion of novel features. ISO instructions for structuring multi-part documents have been utilized in the creation of the DICOM Standard document.
6. Explicit Information Objects are introduced in DICOM standards for graphics and images as well as for printing, reports, waveforms, etc.
7. Any Information Object can be uniquely discovered using specified established technique. The association among the Information Objects transferred over network can be unambiguously obtained.

The interoperability of medical imaging devices can be enabled by specifying the DICOM Standards:

1. A collection of protocols must be followed by devices requesting conformance to the standards for communications in network.
2. The commands and related information's semantic and syntax which can be transferred using these protocols must be specified.
3. A collection of media storage services to be utilized by devices requesting conformance to the standard, file format, a medical directory structure utilized to simplify access to the images and related information stored on exchange media must be specified.

The following are not specified by the DICOM Standard:

1. The details of implementing any features of the Standard on a device requesting conformance.
2. A system implemented by incorporating a collection of devices every requesting DICOM conformance with overall collection of features and functions to be expected from.
3. For assessing the implementation's conformance to the standard with a testing/validation.

DICOM Communication Model and File Description

The DICOM Standard belongs to the domain of Medical Informatics. In this domain the transmission of digital information among medical imaging devices and other systems is addressed in DICOM standards. Most of the medical equipment is interoperable with other medical devices; the DICOM standards should cover all the areas of medical informatics. The devices requesting conformance must be interoperable as per DICOM. Specifically, it:

1. Specifies the semantics of

commands and associated data for devices to communicate. As per standards it specifies how devices react to commands and associated data, not only the information which is to be exchanged among devices.

2. Specifies the semantics required for offline communications using the information directories, file formats and file services.
3. Defines the conformance requirements of implementations explicitly for the standard. Sufficient information must be specified by conformance statement for determining the functionalities for which interoperability can be estimated with another device requesting conformance.
4. Enables task in a networked environment and it is organized to accommodate the novel services, thus enabling support for emerging medical applications.

The PACS solutions can be implemented using the DICOM standard but it may not guarantee all the objectives will be achieved by utilizing DICOM standards only. The generic communication model for the standard which extents both media storage offline communication and networks on-line communication is shown in Fig.1. The following boundaries may cover all the applications:

1. The independence from protocols such as TCP/IP and networking communication physical support is provided by the *Upper Layer Service*.
2. Independent access to storage media for accessing files structures and storage formats using the *Basic DICOM File Service*.

A header and image data are contained in a single DICOM file. A header comprises information such as image dimensions, type of image scan, patient's information, patient ID, scan date, etc. The image data may contain information in three dimensions. In the traditional Analyze format, image data is maintained in one file (*.img) and the header data in another file (*.hdr) unlike DICOM format. Compression or encapsulation can be applied to DICOM image data for reducing the size of DICOM image but it is not possible with Analyze image format. An example of imaginary DICOM image file is shown

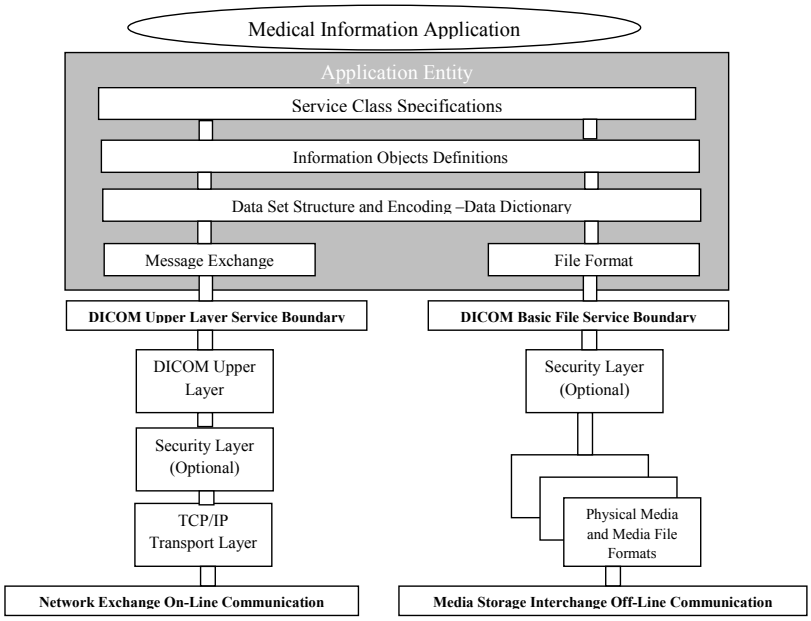

Fig. 1 : Generic communication model.

in Fig. 2. As it can be observed from the Fig. 3 for the DICOM format header the first 794 bytes are used. These bytes describe image dimensions and maintain text information about the DICOM scan.

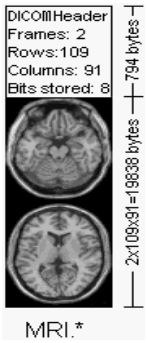

Fig. 2 : DICOM image file.

Depending on the total information to be stored the size of header varies. In this case, an image with 109x91x2 voxels dimensions is defined in the header, using 1 byte per voxel data resolution resulting in the total 19838 as image size. After the header image data is present. The single file is utilized for storing the image data and the header information. A 128 byte preamble, in which all bits are generally set to zero, is required by DICOM, the letters 'D', 'I', 'C', 'M' are available after preamble as shown in Fig. 3. Header information organized in groups is followed after this. For example, the file meta information group contains the group 0002hex (on the left in the example) containing three components: the length of group is defined by first, file version is denoted by second, and the transfer syntax is stored by third.

The type of image decides the required DICOM elements as specified in DICOM standard Part 3. For example, the group:element 0008:0060, the modality shown is 'MR'. The MRI echo time must be described by its element. The DICOM standards will be violated if this information is not present. The presence of many of these elements is not checked in reality by various DICOM viewers such as ezDICOM, MRIcro, only the header information is extracted by them for knowing the required parameters. The 128 byte header information and the letters 'DICM' are not present in the NEMA format. Multi-frame images such as 3D images cannot be defined by NEMA.

The **"Transfer Syntax Unique Identification"** is defined by the important element "group: element 0002:0010" as presented in table 1. The structure of the image data such as whether it is compressed is reported by this value. Only uncompressed raw data is handled by most of the DICOM viewers. Both schemes lossy JPEG and lossless JPEG can be used to compress DICOM images. In lossy JPEG compression some high frequency information is lost.

Lossless JPEG scheme is mostly used in medical imaging which is basically Huffman lossless JPEG not efficient and recent JPEG-LS approach.

```
First 128 bytes: unused by DICOM format
Followed by the characters 'D','I','C','M'
This preamble is followed by extra information e.g.:

0002,0000,File Meta Elements Group Len: 132
0002,0001,File Meta Info Version: 256
0002,0010,Transfer Syntax UID: 1.2.840.10008.1.2.1.
0008,0000,Identifying Group Length: 152
0008,0060,Modality: MR
0008,0070,Manufacturer: MRIcro
0018,0000,Acquisition Group Length: 28
0018,0050,Slice Thickness: 2.00
0018,1020,Software Version: 46\64\37
0028,0000,Image Presentation Group Length: 148
0028,0002,Samples Per Pixel: 1
0028,0004,Photometric Interpretation: MONOCHROME2.
0028,0008,Number of Frames: 2
0028,0010,Rows: 109
0028,0011,Columns: 91
0028,0030,Pixel Spacing: 2.00\2.00
0028,0100,Bits Allocated: 8
0028,0101,Bits Stored: 8
0028,0102,High Bit: 7
0028,0103,Pixel Representation: 0
0028,1052,Rescale Intercept: 0.00
0028,1053,Rescale Slope: 0.00392157
7FE0,0000,Pixel Data Group Length: 19850
7FE0,0010,Pixel Data: 19838
```

Fig. 3 : DICOM header.

The codes presented in table 1 are described in the DICOM standards part 5. Transfer Syntax UID reports compression technique and the raw data byte order. "Big endian" and "little endian" techniques are used by different computers for storing integer values in two different ways. For example, the value 257 as a 16-bit integer: the value 01 is stored by the most significant byte, while the value 02 is stored by the least significant byte. Depending on the memory assignment schemes some computers save this value as 02:01, while others will store it as 01:02. For matching the ordering used by the computer, a DICOM viewer may need to exchange the byte order of the data if data more than 8-bits per sample is present.

Table 1: Description of Transfer Syntax Unique Identifier.

Transfer Syntax UID	Definition
1.2.840.10008.1.2	Raw data, Implicit VR, Little Endian
1.2.840.10008.1.2.x	Raw data, Explicit VR **x** = 1: Little Endian **x** = 2: Big Endian
1.2.840.10008.1.2.4.xx	JPEG compression **xx** = 50-64: Lossy JPEG **xx** = 65-70: Lossless JPEG
1.2.840.10008.1.2.5	Lossless Run Length Encoding

The image can be also described by Photometric Interpretation (0028:0004), the Bits Allocated (0028:0100), the Samples per Pixel (0028:0002) in addition to the Transfer Syntax UID. The photometric interpretation is a continuous monochrome, basically represented with pixels in grayscale, for many of the CT and MRI images. 'MONOCHROME1' with low values representing bright, and high values representing dim or 'MONOCHROME2' with low values representing dark, and high values representing bright are called as a photometric interpretation for describing monochrome DICOM images. Various photometric interpretations such as RGB, YBR, CMYK, Palette, etc. are used to represent color ultrasound images or color medical photographs. Three samples per pixel are stored by color images such as in RGB one each for red, green and blue, while only one sample per image is stored in monochrome or palette images. Most of the images are stored in 8-bits (256 levels) or 16-bits per sample (65,535 levels), or even in 12-bit or 32-bit resolution. 16 million colors are described by a RGB image that stores 3 samples per pixel at 8-bits.

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Trend in Medical imaging

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Rising aspirations, growing stress, changing lifestyle and fast food culture have led to unhealthy society across the globe requiring medical intervention from very early stage. On other side; in last few decades, inventions in medical science have grown phenomenally. One such invention is in form of medical imaging technology that helps medical professionals to see inside the body and also allows them to do keyhole surgeries without opening much of the body. Newer techniques like CT Scan, Ultrasound and MRI have overtook the initial technology of X-Ray imaging by allowing doctors to visualize the interior of the body in three dimensions. Under this backdrop, this paper provides an overview of various medical image processing systems and their benefits. Subsequently, it covers global and Indian market of medical image processing systems.

1. Medical Image Processing Systems

Various image processing systems used today are:

a) Endoscopy
b) Radiography
c) Contrast Agents
d) Nuclear Medicine
e) Ultrasound
f) Computed Tomography
g) MRI
h) PACS & DICOM.

2. Advantages of Digital Processing for Medical Applications

- Digital data remain same after multiple copying.
- It enables displaying images immediately after acquiring.
- Image quality can be enhanced and compared quickly, making interpretation easier.
- It provides a set of images for educating the medical professionals.

3. Global Scenario of Medical Imaging Market

At present, the global diagnostic imaging market is dominated by North America as a result of growing incidences of chronic diseases and large chunk of aged population. According to a study by Yole Development, the global market for medical imaging sensors is projected to grow to 6.7 million units in 2019 from 2.1 million units in 2013, exhibiting a CAGR of 11 percent reaching US$ 142 million by 2019. Asia-Pacific region is projected to grow at a rate of 6% through 2022, with China and India witnessing fastest growth because of increasing awareness and healthcare expenditure, high patient ratio, and government's focus on health. Key players in this market are GE Healthcare, Siemens Healthcare, Philips, Samsung Electronics, Hitachi, Toshiba Corporation, Carestream Health.

The BRIC (Brazil, Russia, India and China) medical imaging device sector is expected to grow by CAGR of 10.5 percent reaching US$7.6 billion in 2018. This growth rate is attributed to the launch of cost-effective imaging solutions, increasing prevalence chronic disorders, and enhanced private and public funding in healthcare infrastructure. A 2013 report of Markets and Markets says that analytical software for diagnostic imaging devices market is forecast to reach approximately US$ 2.4 billion by 2017 from US$ 1.7 billion in the year 2012.

Strategic corporate developments in recent past have further strengthened the corporate outlook and expectation towards this promising market. Some of the noticeable ones being TowerJazz and Panasonic JV in April 2014, equity funding to CMOSIS by TA Associates and China-based Hua Capital's US$ 1.7 billion bid to buy OmniVision Technologies. Investments are not the only indications towards the prospects and potential this segment offers but on innovation side too, companies are showing their forte.

4. Imaging Market in India

Diagnostic imaging device sector in India is estimated to register robust growth rate through 2022, due to low market penetration and rising medical procedures along with government's support. Major suppliers of high-end systems in India are GE Healthcare, Toshiba Medical Systems, Siemens Healthcare and Philips Healthcare. IRIA (Indian Radiological and Imaging Association) is also promoting the research on various imaging modalities using various platforms. A recent study by Decision Resources Group's (DRG) on imaging diagnostic market in India suggests three key ingredients for the growth of this segment. These are high growth of medical tourism due to a low cost; upward trend in acquiring high-end and advanced imaging systems; and increasing demand for refurbished devices in order to check on prices.

As per a trend analysis, large MNCs are now looking to modify their products to match the requirements of Indian healthcare facilities. For example, GE Healthcare launched Discovery IQ, a PET (Positron emission tomography)/CT molecular imaging system designed in India is claimed to be 40% more affordable. Toshiba Medical Systems has introduced Vantage Elan MRI system with optional power-saving mode and compact design. Entry of Dabur into imaging segment in Delhi/NCR region is also an interesting development in this niche marketplace.

Conclusion

Growth of diagnostic imaging in India will serve the interest of all stakeholders as introduction of new and cost-effective imaging solutions would be on priority to translate the benefits to the patients. Diagnostic imaging sector in India is largely concentrated in the urban market In future, a major

percentage of healthcare facilities in small cities and rural areas along with government hospitals will drive the demand for imaging devices in the country.

With this growth, it is necessary that doctors follow proper ethics and such interventions are used only when required. There are enough evidences in India and abroad that show Doctors ordering for medical imaging even when it is not needed. Therefore, Medical Council of India (MCI) need to issue strong code of conduct in this regard so that patients not only save their precious money incurred on costly tests but also get reduced exposure from unnecessary radiation. Further, India companies should also foray into this growing market. They can leverage Government of India's 'Make in India', 'Digital India' and 'Startup India' programmes for the same.

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A Framework for Hyperspectral Image Segmentation

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Introduction :

Remote Sensing technology refers to gather and interpret information about an object on the earth without any physical contact. This technology uses sensors to construct an image by capturing the energy emitted and reflected from the surface of the earth. There are two kinds of remote sensing systems, passive systems and active systems. This differentiation is based on the source of the energy used in remote sensing image acquisition. In passive systems, Sun's radiation is used as a source of energy. The sensors capture the energy which is reflected by the earth's surface due to the sun's radiation. This energy measured by the sensor is usually collected in several spectral bands, with each band having the spectral resolution. Sensors that collect data of many narrow spectral bands are called hyperspectral data. In active sensors, the sensor itself emits energy which is directed towards the surface of the earth, reflected by the object and captures the energy by sensor. This article mainly focuses on passive systems, that to hyperspectral imaging.

Hyperspectral Imaging

In hyperspectral imaging systems, the sensors are operated from visible wavelength to infrared wavelength capturing simultaneously hundreds of spectral bands (channels) from the same Earth's surface area [1]. The data collected by sensor is represented in the form of vector, where each vector corresponds to specific wavelength. The hyperspectral images are used in various applications such as Ecological science (to study land cover changes), Geological science (to recover physico-chemical mineral properties), Mineralogy (to identify minerals), Hydrological science (to determine changes in wetland characteristics), Agriculture (to classify agricultural classes) and Military applications (target detection) [2]. An important task in hyperspectral data processing is to segment the spectral image without losing any valuable details. Hyperspectral data set consists of stack of images from the same scene on the surface of earth. In earlier studies, to segment hyperspectral data set, the algorithm was operated on the few selected spectral channels less than five. The efficiency of the algorithm depends on the selection of spectral channels. Some channels may contain much information about the scene and some may contain less information. The performance of any segmentation algorithm in terms of accuracy will decreases as the number of data channels increases. This high dimensional data will provide data information content significantly, but provides a challenge to develop algorithms that analyze data more accurately – A BIG DATA CHALLENGE. In this article, we present a framework to segment the hyperspectral data set by taking the features of all spectral channels. The framework was shown in Fig. 1.

The framework for segmentation of hyperspectral dataset is done in three stages, first- band selection (Dimensionality Reduction), second- Image fusion of selected bands and third segmentation using supervised/ un-supervised algorithms. The basic algorithms that are used at each stage are presented in this article.

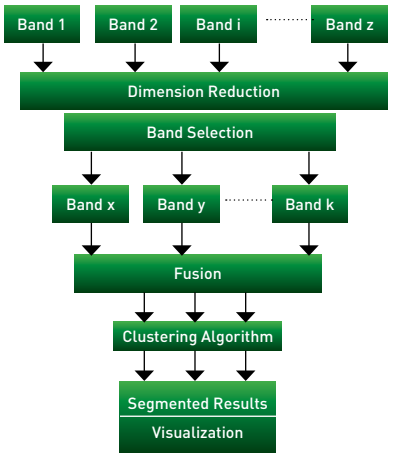

Fig. 1: Framework for hyperspectral segmentation

Dimensionality Reduction

The hyperspectral dataset contains hundreds of bands with fine spectral resolution and spatial information. The analysis of this large volume of data causes difficulties in data storage, processing and transmission. The dimensionality of hyperspectral data strongly affects the performance of any segmentation algorithm. Some of the bands in the data set contain redundant information and some bands may contain less discriminatory information. So it is desirable to reduce the size of data set without losing valuable details i.e., remove the bands that convey less information. The band selection methods are classified into two types, supervised and unsupervised. Supervised methods require priori information about the object under the scene, where as unsupervised methods

need not require any information. Some of the band selection metrics are described below:

Euclidean Distance [3] is a distance measure between any two vectors X and Y defined as

$$ED(X,Y)=\sqrt{\sum_{k=1}^{N}(X_k-Y_k)^2}$$

Spectral Angle Mapper [4] is a angle measure between any two vectors X and Y, defined as

$$SAM(X,Y)=\arccos\left(\frac{X^T.Y}{\|X\|.\|Y\|}\right)$$

Spectral Correlation Mapper [5] is a correlation measure that measures the strength of the linear relationship between two vectors X and Y, defined as

$$\text{SAM}(X,Y)=\frac{\sum_{k=1}^{N_b}(X_k-\mu_x).(Y_k-\mu_y)}{(N_b-1).\sigma_x-\sigma_y}$$

Band Correlation [5] is statically a correlation measurement that indicates the information redundancy of each spectral band, defined as

$$\text{BC}(i,j)=\frac{\sum_{p=1}^{N_b}(x_{ip}-\mu_i).(x_{jp}-\mu_j)}{\sqrt{\sum_{p=1}^{N_b}(x_{ip}-\mu_i)^2}.\sqrt{\sum_{p=1}^{N_b}(x_{jp}-\mu_j)^2}.}$$

Image Fusion of Selected Bands

After using band selection methods, we selected some bands from the original data set which contain valuable details. These bands are fused into a single image in-order to produce a single high contrast image for visualization and analysis purpose. The goal of image fusion is to merge all the features from the selected bands into a single image. Some of image fusion methods such as averaging method, 1-bit transform method, Principal Component Analysis, Hierarchical image fusion, Spectral weighted fusion etc are used for hyperspectral data fusion. The averaging method of image fusion is described below [6]:

The fused image F(x,y) can be represented as a linear combination of M selected bands $I_k(x,y)$, with weights W for the pixel at location (x,y). The weights are directly proportional to the finer details in the hyperspectral band. The averaging method of image fusion is given as:

$$F(x,y)=\sum_{k=1}^{M}w_k(x,y)I_k(x,y)$$

and

$$\sum_{k=1}^{M}w_i(x,y)=1,\forall(x,y)$$

Segmentation

One of the most important research topics in hyperspectral data sets is segmentation. Segmentation refers to partitioning the pixels of the image into multiple regions, with each region has specific characteristics. Methods used for segmentation are broadly classified into the following categories: Histogram methods, Edge detection methods, Region based methods and Clustering algorithms. In this article, we mainly focus on Fuzzy c-means clustering algorithm for segmentation of hyperspectral image. The FCM algorithm is described as follows [7]:

1. Take randomly K initial clusters $\{C_1, C_2,.....,C_k\}$ from the pixels $\{I_1, I_2, I_3,.....,I_{m*n}\}$.
2. Initialize membership matrix u_{ij} with value in range 0 to 1 and value of m=2.

Assign each pixel to the cluster $_{Cj}$ {j=1,2,.....K} if it satisfies the following condition [D(. , .) is the Euclidean distance measure between two values].

$$u_{ij}^m D(I_i,C_j)<u_{iq}^m D(I_i,C_q),q=1,2,...,K$$

$$j\neq q$$

The new membership and cluster centroid values as calculated as

$$u_{ik}=\frac{1}{\sum_{j=1}^{K}\left(\frac{D(C_i,I_k)}{D(C_j,I_k)}\right)^{\frac{1}{m-1}}},for 1\le i\le$$

$$C_j^{\wedge}=\frac{\sum_{j=1}^{n}u_{ij}^m I_j}{\sum_{j=1}^{n}u_{ij}^m}$$

1. Continue 2-3 until each pixel is assigned to the maximum membership cluster.

This basic work is performed on Indian Pines data set collected from [8]. This data set contains 200 spectral bands, with 16 classes. Out of which 43 bands are selected using ED band selection method. These 43 selected bands are fused into a single image using averaging method of fusion. The fused image is segmented using Fuzzy C-means clustering algorithm. The result is shown in figure 2.

Conclusions

This article presents a framework for hyperspectral image segmentation. This work is carried out in three stages- Dimensionality reduction, Image Fusion and Segmentation. At each and every stage there is a lot of scope to develop new algorithms for efficient analysis of hyperspectral data sets. As the hyperspectral data set is very large, the problem is considered as a big data analysis.

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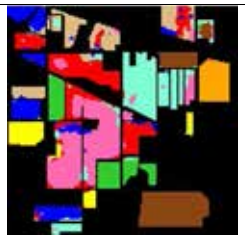
Indiana pines Data set – Image band 100	Fused Image after Band selection	Segmented using FCM
		

Fig. 2 : Hyperspectral image segmentation

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Model Based Approach for Effective Diagnosis of MS-Lesions

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This article addresses the novel methodology for identification of MS lesions from the brain MRI images. MS Lesion is a brain deformity which is foreseen during the brain injury or disease. Understanding these images and identifying the disease is the challenging task. In this article, we address the issue by proposing a model based Multivariate Generalized Gaussian Mixture Model (MGGMM). The results derived are analysed with respect to benchmark images and the performance is evaluated by using quality metrics.

1. Introduction:

The brain consists of three major tissues namely white matter, Grey matter and Celebro Spinal Fluid (CSH). Among these tissues, whenever a deformity is outseen, it is either observed in the white matter or grey matter. As a result of these occlusions, the damages in the brain tissues cannot be outratedly witnessed and thereby causes brain deformities to the brain. The various diseases that generally focussed among the brain diseases are Sclerosis, Lesion, Tumour and In-Homogenities. Identification of each of these diseases is a challenging task. Most of the cases that are related to brain diseases consist of similar common symptoms which results in to misguidance and hence in most of the cases, it results in to improper diagnosis. The impact of these diseases results in to either Parkinson's diseases or Alzimers, Brain dead and in most of the cases, it leads to vitality. Therefore proper identification of the diseases related to the brain is a challenging task. In this article, we try to address the issue of a particular symptom and disease – MS Lesion. In order to identify the disease, it is customary to segment the medical image and identify the deformities. For this purpose, we have developed and designed a medical image segmentation algorithm based on multivariate generalised Gaussian mixture model. The results are extracted by considering the images from Brain web imaging site and results derived are tested against performance evaluation using quality metrics such GCE, PRI and VOI. The segmentation process is carried by using k-Means algorithm. The rest of the article is presented as follows. In section 2, a brief review of the related work is presented and section 3 highlights the model. In section 4 of the article, we deal with the experimentation and the results derived are subjected to evaluation and presented in section 5 of the article. The conclusions together with the scope for further improvement are highlighted in the last section of the article.

2. Review of Literature on Brain Image Segmentation :

As highlighted in the introduction, it is a complicated task to identify the deformities of the brain, therefore many reviewers have presented their ideas by considering different types of images such as T1- weighted image, T2-weighted image, Flair and Photon density based images [1,2,3,4]. Among these images, the results derived by considering the Flair images are mostly producing effective results. Lot of research work has been presented off late on Flair images. Many models based on generative, degenerative and Pseudo generative models were highlighted in the literature. Among the non-degenerative models, lot of work is highlighted based on Artificial Neural Networks, Support Vector Machines, Kernel based approaches and Curvelet based approaches [5,6,7,8]. Models based on generative approaches were also highlighted and these models are proven to be more effective than the generative approaches [S.K. Pal and N.R. Pal (1993)]. Therefore, many of the probabilistic models based on Hidden Markov approaches, GMM with Gibb's sampling, MRF imaging with GMM, Gamma distributions are mostly focussed in the literature [10,11,12]. However, some literature is also available on Pseudo supervised models such as clustering algorithms. However, as it is obligatory to identify the damaged pixels more precisely, it is therefore necessary to understand the pattern of the pixels so that effective modelling can be subjected and thereby effective segmentation can be planned such that the deformities can be more precisely rooted out. With this basic assumption, literature is driven towards the usage of generative approaches [K. Srinivasa Rao et.al., (2007), V. Nagesh et. al.,(2011), GVS Raj kumar et.al.,(2011), K. Naveen Kumar et.al.,(2015)]. Among the generative models available in the literature, to have better approach, it is customary to identify the pattern of the pixels and for which multivariate approaches have better approximation compared to univariate approaches [K. Naveen Kumar et.al., (2015)]. Also the anatomy of the brain images is mostly

varying in nature and therefore for the proper identification of the diseases, more features are to be taken in to consideration before segmentation.

3. Brain Image Segmentation Model:

MS Lesion is a disease that can be witnessed whenever an injury takes place within the brain regions. There may be several symptoms that are witnessed during the initial stages which include headache, neck pain, vomiting, vision changes, memory loss, behavioural changes and moving difficulties. These symptoms are to be significantly noted and need to be approximated before concluding the disease. Also different types of lesions are highlighted which damage the brain and results into different disease such as cerebral infraction, multiple sclerosis and tumour. Therefore, identification of the proper disease is a critical task. Most of the univariate cases fail to generate effective results because of considering a single symptom and may result in to improper diagnosis. Therefore, to have a more specific identification approach, in this article, we have considered a multivariate approach wherein we have considered multiple factors such as memory loss, vision and moving difficulty. These features are considered as inputs to the model considered.

3.1 Multivariate Gaussian Generalised Gaussian Mixture Model:

The features considered in the above section are taken in to the proposed model. The cumulative probability density function of each of the medical image regions under consideration will be of the form

$$p(\vec{x}_r/\theta)=\sum_{i=1}^{M} w_i g_i\left(\vec{x}_r,\theta\right) \quad (1)$$

where, $\vec{x}_r=(x_{rij})$, is a D dimensional arbitrary vector for j=1,2,3...D values, representing the feature vector; i = 1,2,..M represents the regions in the medical image and the pixels are represented with i=1,2,3..T values. The parametric set is $\theta=(\mu,\sigma,\beta)$, w_i is the mixing weight such that $\sum_{i=1}^{M} w_i=1$ and the probability of i^{th} pixel belonging to the medical texture feature vector of the medical image is $g_i\left(\vec{x}_r,\theta\right)$ and the generalized Gaussian distribution of D-dimension is given by

$$g(\vec{x}_r/\theta)=\prod_{j=1}^{D}\frac{\beta_j K(\beta_j)}{2\sigma_j}\exp\left\{(-A(\beta_j)\left|\frac{x_j-\mu_j}{\sigma_j}\right|^{\beta_j}\right\} \quad (2)$$

where, μ_j,σ_j,β_j are location, scale and shape parameters.

Also we have $K(\beta_j)=\frac{\Gamma(3/\beta_j)^{1/2}}{\Gamma(1/\beta_j)^{3/2}}$

and $A(\beta_j)=\left[\frac{\Gamma(3/\beta_j)}{\Gamma(1/\beta_j)}\right]^{\beta_j/2}$

with $\Gamma(\cdot)$ being the gamma function.

$\beta_j\geq 0$ is the parameter that controls the shape of GGD.

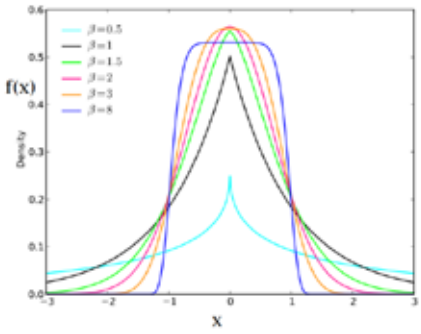


Fig. 1 : Plot of GGM PDF with shape parameters, β

3.2 Estimation of Model Parameters Using EM Algorithm:

In this section, the model parameters are estimated by considering EM algorithm that maximizes the likelihood function of the model. To obtain the refined estimates of parameters w_i,μ_{ij} and σ_{ij} for i=1,2,3,...M; j=1,2,.....,D; the expected value likelihood or log likelihood function is to be maximized. The EM algorithm is used for obtaining the refined estimates. By making use of the steps in EM algorithm, one can obtain the updated equations for the parameters w_i,μ_{ij} and σ_{ij} as depicted below.

$$w_i^{(l+1)}=\frac{1}{T}\sum_{r=1}^{T}\left[\frac{w_i^{(l)}.g_i(\vec{x}_r,\theta^{(l)})}{\sum_{i=1}^{M}w_i^{(l)}.g_i(\vec{x}_r,\theta^{(l)})}\right] \quad (3)$$

where $\theta^{(l)}=\left(\mu_{ij}^{(l)},\sigma_{ij}^{(l)}\right)$ are the estimates at i^{th} iteration.

$$\mu_{ij}^{(l+1)}=\frac{\sum_{r=1}^{T}t_i(\vec{x}_r,\theta^{(l)})^{A(N,\beta_{ij})}(x_{tij})}{\sum_{r=1}^{T}t_i(\vec{x}_r,\theta^{(l)})^{A(N,\beta_{ij})}} \quad (4)$$

Such that $A(N,\beta_{ij})$ is some function equal to 1 for $\beta_{ij}=2$ and must be equal to $\frac{1}{\beta_{ij}-1}$ for $\beta_{ij}\neq 1$, in the case of N=2, it is observed precisely that $A(N,\beta_{ij})$ be an increasing function in terms of β_{ij}.

$$\sigma_{ij}^{(l+1)}=\left[\frac{\sum_{r=1}^{T}t_i(\vec{x}_r,\theta^{(l)})\left(\frac{\Gamma\left(\frac{3}{\beta_{ij}}\right)}{\beta_{ij}\Gamma\left(\frac{1}{\beta_{ij}}\right)}\right).\left|x_{rij}-\mu_{ij}\right|^{\frac{1}{\beta_{ij}}}}{\sum_{r=1}^{T}t_i(\vec{x}_r,\theta^{(l)})}\right]^{\frac{1}{\beta_{ij}}} \quad (5)$$

3.3 Initialisation of Model Parameters:

The estimation of initial parameters is very much needed for obtaining the revised estimates of the model parameters. To obtain the initial estimates, the clustering algorithm is utilized since it gives better estimates. The most generally used method in initialization is to draw a random sample within the medical image from the entire data set. Using these initial estimates, the refined estimates are obtained by simultaneously solving the equations (3), (4) and (5) in MATLAB environment.

4. Experimentation and Results:

In order to depict the proposed model, we have considered the brain web images and experimentation is conducted by considering brain web images. Each of the images is pre-processed to eliminate the noise and each of the images are enhanced by using edge enhancement techniques. Then the processed images are considered for the experimentation. Each image is extracted from the MRI scan images and each of the images is normalized to 468X468 pixels. The step by step process of the experimentation is presented in the segmentation algorithm in 4.1.

4.1 Segmentation Algorithm:

The various steps involved in

segmenting the Brain MRI images for analysis of data to extract meaningful information for medical diagnosis is shown below.

Step 1: Consider the brain images normalized to sizes of 468X468.

Step 2: Pre-process the images to eliminate noise.

Step 3: Enhance the images using edge enhancement technique.

Step 4: Consider the k-Means algorithm and segment the images.

Step 5: In order to have effective segmentation, consider the features presented in section 3.

Step 6: The segmentation process is based on likelihood estimate.

Step 7: Evaluate each segment against the quality metrics GCE, PRI and VOI.

4.2 Results:

The segmentation procedure is carried out where each pixel from the image is segmented basing on the maximum likelihood criteria. The resultant images are as shown in Fig. 2.

5. Performance Evaluation:

A random sample of five images is considered from the Brain web images database and experimentation is conducted to evaluate the performance measures namely GCE, PRI and VOI and compared with that of Gaussian mixture model. The image performance measures viz., GCE, PRI and VOI are computed for the proposed model. The GCE metric formulated by Martin. D et al. (2001), PRI formulated and given by Unnikrishnan. R et al. (2007) and VOI given by Meila. M (2007) are computed and depicted in the table 1.

6. Conclusion and Scope for Further Improvement:

The present article presents a innovative methodology for proper identification of the deformities in the brain and in particular about lesions. The developed work has a potential usage in the field of medical domain which helps for better treatment of the disease. The results derived from this method showcases that it has achieved good segmentation accuracy with respect to segmentation quality metrics. The method is considered basing on multivariate features and is addressed for a particular disease of brain. However, the methodology can

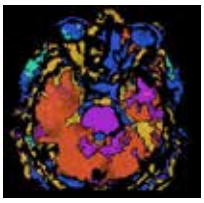
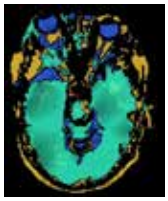
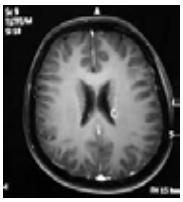
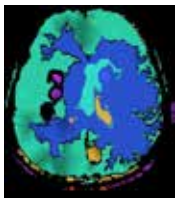
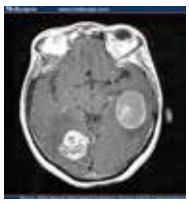
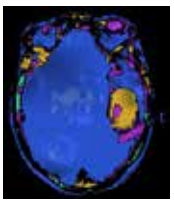
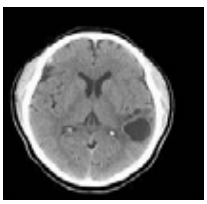
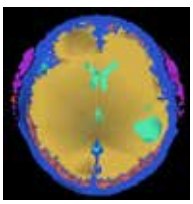
Description	Original Images	Segmented Images
Image 1		
Image 2		
Image 3		
Image 4		
Image 5		

Fig. 2 : Segmentation Results of Brain Image segmentation

Description	Model	PRI	GCE	VOI
Optimal Values		1	0	Infinity
Image 1	GMM	0.739	0.187	1.196
	MGGMM	0.884	0.132	0.981
Image 2	GMM	0.815	0.15	1.72
	MGGMM	0.825	0.138	1.648
Image 3	GMM	0.834	0.231	1.02
	MGGMM	0.984	0.182	0.974
Image 4	GMM	0.812	0.468	1.92
	MGGMM	0.781	0.444	1.768
Image 5	GMM	0.636	0.364	1.192
	MGGMM	0.788	0.331	1.161

Table 1: Segmentation performance Measures of the Brain MRI Images

be further extended to identify the in-homogenities within the brain so that better prognosis can be gained.

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Engineering Education In India – A Roadmap to the Future

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1. Introduction

The Indian higher education scene has gone through a dramatic change in last 1-2 decades with a phenomenal increase in engineering institutions, particularly with private initiatives. It has resulted in several issues and challenges as can be seen from the recent report on engineering education. Briefly these are –

- Ph.D and PG faculty is very small in Indian engineering institutions,
- Engineering students going for PG courses are small. It is dismal when it comes to Ph.D programmes.
- Indian engineering institutions are small in terms of size, student enrollment, and faculty.
- Curricula is obsolete and employability of almost 25% graduate is not up to the mark.
- Diversity of governance systems and too much controls are mindboggling.
- Quality of faculty and shortage is resulting in poor teaching , high failure rates and poor employability.

Quality and quantity of technical education in a country is proportional to GDP which in turn depends on Human Capital, Population, Natural capital / resources, and Investment capital or on per capita income.

With a staggering 900 million expected to be in working age group by 2050 in India, we look at this potential to get a competitive edge in the community of nations through proper competence and skill building. The reality today is India fares badly in UN Innovation Index, which depends on Human Capital Index and Technical capability index.

The engineering courses are failing to attract large number of students due to several reasons. These include better job opportunities in other sectors, relative neglect of manufacturing sector in creating jobs, difficult and rather poor engineering curriculum not meeting the industry needs. Globalization and off shore outsourcing, demand for engineering graduates to be updated, flexible and communicative. These are some of the issues. This is compounded by rather slow and poor response of government and academic institutions. The key challenges in India are poor proficiency in language, acute shortage of quality faculty, lack of absorbing capacity of students, lesser exposure to reality, rapid growth in engineering institutions and number of students.

2. The Challenges

This is a period of fast development globally with great change. The exponential growth of knowledge, increasingly connected global society through information and communication technology is bringing changes fast. Several issues are questioning the old values and society is in a great flux in the name of modernism.

This is coupled with increasing global population, particularly in developing nations like India. Sustainability is at stake. In a knowledge driven well connected society, the search for skill and resources is global. The buzz words are "Outsourcing", and "off shoring". The thrust is on market driven economy and this is guiding public policies. The need is open sources and transparent processes. Free market driven philosophies decide investments. Result is increasing regional imbalances and tension, social divide and disparity in society.

The environment promotes competitiveness and this drives technology growth. All these need to aim at "Human wellbeing". The need is to create academic systems and organizations which capture these thought processes and translate them into practice through good curriculum and teaching – learning process, We are heading for a technology driven society to address to societal issues to bring sustainability , security and equity with wellbeing as core trait.

The need is for an engineering student to be adaptable to varying cultures, knowledge levels and markets. While delivering the products and services, engineer is required to be a 'Global Citizen' meeting the specific local needs with global knowledge. How to train the engineer is the biggest challenge .

The convergence of Info-Bio-Nano technologies needed for complex mega systems forces engineers to be trained in multi-disciplinary traits, a path completely different from current discipline specific engineering curricula. The need will be to look for innovative solutions to approach economic, social, security and human wellbeing issues. This calls for an input in engineering which is "Holistic" and an approach away from traditional. Can we bring such changes?

Has engineering moved away from closeness to people and society compared to other professions like law and medicine? The approach of traditional economics based decision making has lead to lower priorities to societal, environmental and human wellbeing issues. Engineers have become commodities which can be disposed off when they become obsolete and do not respond to changing needs. Indeed the fast pace of knowledge growth makes engineering professional obsolete fast. The need is to wake up and address to these issues in engineering education to make it relevant and responsive to current societal demands.

The world is passing through a transition. High expectations

and resource crunch are realities. Increasing global tension and societal divide forces us to revisit engineering profession of today to make it relevant to 21st century needs. We need engineering professionals who are competent, dynamic and updated to provide innovative solutions to global issues. The single minded purpose has to be "Human wellbeing" as an end result with assured sustainability. The curriculum has to develop a new mindset in building engineers who are capable of sustaining nature, conserving natural resources and creating contentment and wellbeing among people. We have to move away from the concept of 'Control nature' to 'Adopt and live with nature'. Technology should drive the concept of 'With nature' rather than controlling it. This paradigm shift is the essence of finding new path ways to engineering education.

New ways will be found with this approach and it will usher in a new world where sustainability will be the core motto with contended society and economic viability as end results. Indeed a great challenge for engineering profession. Engineering profession must move on the 'Triple bottom line' (namely 3P's – Planet, People and Profit). Capture the societal and environmental issues along with economic viability in engineering decision making. Appropriate technology will provide the right leverages. This will be the corner stone of engineering education to address to the challenges. We need to take well calculated, planned risks in altering nature to ensure human welfare with sustainability.

The new paradigm of engineering education will be based on holistic approach which will ensure three fundamentals, namely (i) Participate with nature and not against it, (ii) ensure sustainability and account for 'Natural capital', (iii) Ensure societal welfare and equity.

The new education recipe for engineering must capture the principles of sustainable development through appropriate technology and resource conservation and management. The education for engineers must focus on real world issues of tomorrow namely increasing population, limited resources in a finite world, increasing aspirations of people demanding equity.

There are certain harsh realities of the developmental process like global warming, climate change, loss of bio-diversity, loss of cultural diversity, changes in moral and ethical values, increasing life expectancy. The need is to ensure that engineers of tomorrow must have the skill and knowledge to supplement their technical, analytical strengths with several soft skills related to social, environmental, cultural, ethical, moral, communicative and economic domains. We need engineers who are 'Honest Brokers' and true "Global Citizen Engineers". The engineers of tomorrow need to have more innovative skills with technical knowledge, social bent of mind and sustainability approach embedded in them with the only target of "Human wellbeing" as end result. Innovation is a continuous process of search for alternate paths. Research provides us the new knowledge to help look at new products, services , processes, path ways which ensure capturing the triple bottom line of 3P's.

Our institutions, most of them ill equipped, with outdated syllabus, below par faculty resource, marginalized in terms of industry interaction and policy support of governments, have an uphill task to take up the challenges in engineering education. They are to be restructured, supported and syllabus updated. Practice and theory must be well integrated in a flexible multi disciplinary mode with student centric focus. The engineer of tomorrow, to be a global citizen engineer, has to be technically competent, globally exposed, culturally adaptable, has skills to take calculated risks and innovate, has entrepreneurial ability. The name of the game is "Flexibility" in teaching engineering.

The engineering education process must fulfill the following:

- Capture inter disciplinary holistic approach of social, economic environmental, legal and local issues in global perspectives
- Develop and practice relevant and new technologies with human well being target
- Combine tera-conventional-nano scale with info-bio-nano systems.
- Capture the mega trends of digitization, sustainability and changing world order
- Ensure diversity, quality and details are embedded.

We need to transform engineering education to capture needs of tomorrow. The changes taking place in such spheres like demographics, globalization, society have to be adequately captured. It should help move from natural capital to human capital to wellbeing.

The employability of engineering graduates is of prime concern today which dictates its popularity. With relatively low growth in new job creation and increasing productivity, the situation has becomes gloomy. The engineering education has to focus on this aspect by bringing greater industry interaction, introduction of relevant industry specific subjects, creation of greater skills and flexibility besides looking at improved communication skills among graduates.

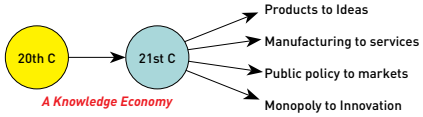
The global challenges dictate the way society conducts itself. The challenges include globalization of economy, demographics, technological changes, plug and play generation with innovation.

3. The Drivers

The drivers moving the society are

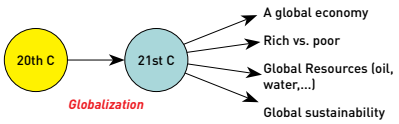
- Knowledge Economy
- Globalization
- Demographics
- Technological Change
- Technological Innovation

a) The Knowledge Economy



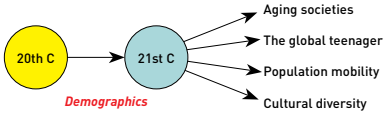
We are in an era of abrupt changes, discontinuities in the moral, ethical fabric and seeing rapid social transformation. This is an era where technology dominates. Knowledge based society is emerging and moving away from agrarian and industrial era. The time of material and labour intensive days are over and the knowledge intensity will drive the products and services. The advent of internet, social media along with standardization dictate the way products are managed, developed, the way production and distribution process manifest. The approach is global and solution is local friendly.

b) Globalization



The impact of globalization on economy expresses in terms of smart and capable people advancing technology. Any issue is a global issue and internet creates transparency and democracy. There has to be investment in knowledge resources to ensure economic prosperity and social well being. The need is for highly capable, knowledgeable and skilled workforce that can innovate, apply knowledge. The need is creation of human capital with skills, competence and entrepreneurial strengths. Can engineering education respond to this need?

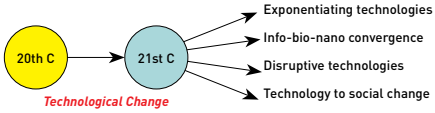
c) Demographics



The global demographic trends are fascinating. While developed nations are aging rapidly, the developing nations, including India has a significant proportion of population below 20 years of age. Thus the future of knowledge driven economy is clearly in the hands of the developing nations. This means technical education in developing nations like India needs immediate attention. The focus should be on paradigm shift in engineering education to address to social disparities and regional conflicts on one hand, creating human well being through sustainable development on the other.

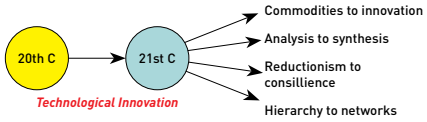
We must address to this diversity in demographic, namely diversity of race, culture, region, economic level, to create quality education base.

d) Technological Change



IT, Bio, Nano technologies are seeing exponential growth. Similarly developments opportunities are in Tera scale issues (related to ecology, energy, infrastructure, healthcare, logistics, transportation, communication) conventional scale issue (with emphasis on close cycle economic models using the concepts of green, clean and closed cycle operations), nano scale issues (to ensure surface area based properties of materials and bio systems are exploited). Similarly adoption of digital technology is the clarion call of the day. e-commerce, e-governance, e-learning, e-everything will be common activities in society. We need interfacing, interlinking or cyber infrastructure for the knowledge society to survive. They will be the new disruptive technologies which will try to provide solutions to global issues and ensure sustainable growth.

e) Technological innovation



Innovation, doing things differently, will be the parameter for success in the current century. Innovation or Immovation (Imitation + Innovation) will thrive in education and the result will be productivity improvement, improvement in standards of living, greater transparency and trust or in short Human well being. Technological changes will drive not only new technology creation, but innovation, decentralization and democratization. The potential is immense. It has to find a proper place in engineering education.

The result will be Human welfare with sustainable growth.

4. The Future Engineers

The future engineers have to be "Global Citizen Engineer" and "Honest Broker" at heart. This will come from their training and learning. This process has to be multidisciplinary flexible learning process. While fundamentals are important, skills in communication, team work, adaptation, social and environmental consciousness are essential for success. Adaptability should be the passion, and ability to drive change should be the motto. Lifelong learning should be the dream, and excellent communications skill a pre-requisite.

While technical skill is a must, interdisciplinary approach to systematic problem solving is essential. The engineer should understand "Multi Stake Holder" "Multi objective" decision making and should be an agent to create optimal solutions to societal issues. Global perspective, ability to innovate and integration of knowledge across disciplines is the target for tomorrow's engineers.

The decision making process will be built on the principles of 3 SPERM (or life) :

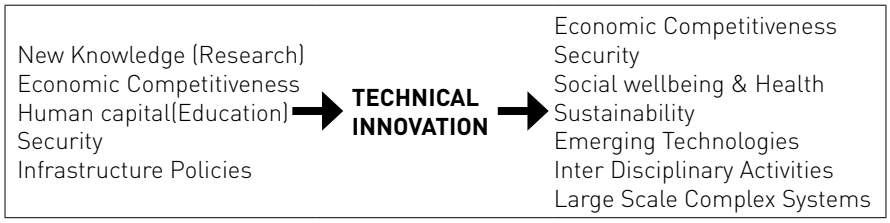
Society	**S**ecurity	**S**ustainability
Profit	**P**roduction	**P**roductivity
Energy	**E**nvironment	**E**fficiency
Resource	**R**ecovery	**R**ecycle
Material	**M**oney	**M**anpower

These form the cornerstones of modern engineering education.

5. The Plug and Play Generation

We have moved from oral to written words to images (films) to TV to Computer to Smart Mobiles. The social aspect probably did not go hand in hand. From write to read to listen to view is a transition culminating in multimedia.

Traditional class rooms are being challenged. Probably gone are the days of blackboard, chalk and duster. Students are born with a phone in the ears or a mobile picture in front. They are born in a digital world. They are immersed in videogames, home computers. smart phones, instant messaging and photographing. The demand of young generation is "Interaction". They do not like one sided lectures. They approach learning as "Plug and Play" experience. Sequential learning is not in their blood. Reading manuals is a waste of time to this generation. Instead they like to get immersed and learn by being a part of it. This approach needs to be introduced. Our teachers need to be reoriented



for the new generation of students. The current generation of students believe in "Multitasking" rather than conventional sequential modes. The young generation has developed the skill of rapid context changing. This is a new challenge for teaching faculty.

6. Student-Faculty Learning Teams

Interaction, collaboration and teamwork will be the new mantras for today's students who are active learners. The sequential learning of yester years is giving way to non-linear interactive mode. Multitasking and context switching will be the new order. This needs flexible, problem solving systematic approach with hands on exposure to problem solving. The active learning student is a member of teaching-learning process, along with the teacher. The need is to experience learning and analyse the outcomes, before next step. Technological Innovation, engineering design will be integral to skill development. That will be real challenge to engineering institutions. Creativity has to be encouraged.

The new paradigm of engineering education will include the following :

a) Interdisciplinary teaching with stress on socio, economic, environmental issues for wholesome sustainable development.
b) Adopt multi-stake holder – multi-objective system based problem solving approach with hands on exposure
c) Inculcate in students the spirit of adventure, calculated risk and innovations through technology
d) Create the desired knowledge and skills keeping in mind the pace of change and societal needs
e) Imbibe in students lifelong learning habit with focus on transparency, responsibility and sincerity
f) Research and practical exposure should become integral to engineering learning process

7. Roadmap

The challenges to engineering teaching learning process are the result of human evolution and development process. The discipline specific teaching adopted so far is considered narrow and inflexible. The multidisciplinary and sustainability activities are not focused. The impact on society has missed attention. The new roadmap has to look at

1. Introduction of flexible teaching learning process.
2. Adoption of interdisciplinary approach with stress on knowledge creation in holistic manner.
3. Development of interactive mode of teaching learning with problem solving approach.
4. Sustainability, environmental, societal and economic issues must form parts of multi stakeholders - multi criteria decision making process.
5. Stress on communication skills, morals and ethics and transparency must improve.
6. Focus must change to globalized knowledge for localized solutions.
7. We need to redefine role of industry, government and professional societies in teaching – learning process.
8. Assessment process must capture innovation, doing differently from rote memorising.
9. Syllabus must be relevant and updated.
10. Teacher development must be integral to teaching learning process.

The roadmap must lead to creation of engineering pool who are skilled, competent, capable of providing holistic systematic solutions to societal problems and are truly "Honest Brokers" and "Global Citizen Engineers"

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About the Author

Prof. N. J. Rao is currently Vice-Chancellor of Jaypee University of Engineering and Technology, Raghogarh, Guna (MP). A graduate/PG from IITKGP, he served over 34 years at IIT Roorkee / University of Roorkee at Chemical Engineering Department and Department of Paper Technology. He worked for several years as Director of Institute of Paper Technology. He was the Director of Central Pulp and Paper Research Institute, a national laboratory for one year. He has several awards for best papers and best teacher and is associated with several National and International bodies like UNEP(NIEM), CPCB, NPC, MOEF, DST, CSE, HNL, CSE, WBCSD, IL & FS and has visited many countries like China, France, UK, Norway, Sweden, Finland, Germany, Canada, Thailand, Vietnam, Indonesia. He had been a visiting professor at NTH Trondheim (Norway). An active researcher, a forceful speaker and an excellent teacher Prof. Rao had several publications to his credit. He can be reached at jrnandagiri@yahoo.co.in.

Computer Society of India

Academic Awards 2016

Call for Applications

Computer Society of India has been honouring academic excellence through Academic Awards every year. The awards will be presented during the CSI Annual Convention which is scheduled to be held from 8th to 10th December 2016 at Coimbatore. Applications are invited for the following awards for the period from **July 2015 to June 2016** from the accredited student branches who meet the criteria and are currently in good standing.

S. No.	Name of the Award	Criteria	To be submitted by
1	Best Accredited Student Branch Award	Good standing – during the award year and currently, large student strength & large number of activities as defined in the specified form	Student Branch Counsellor (SBC) with necessary recommendation from Regional Student's Coordinator (RSC) and approval from Regional Vice President (RVP)
2	Largest Student Branch Award	Continuous good standing for the past 3 years with highest 3 years averaged strength	Decided by Awards Committee
3	Best CSI International Students Event Host Award	Institutional member hosted maximum students competition participated by minimum 10 foreign students	SBC with necessary recommendation from RSC and approval from RVP
4	Highest Sponsorship of CSI Events Award	Institutional member extending maximum support for CSI events during the award year	SBC with necessary recommendation from RSC and approval from RVP
5	Longest Continuous SBC Award	Longest continuous tenure as SBC over the last 3 years	SBC with necessary recommendation from RSC and approval from RVP
6	Faculty with maximum publishing in CSI Publications	Publishing maximum articles in CSI publications digital library during the award year	Self with necessary recommendation from RSC and approval from RVP
7	Paper Presenter at International Conference for Faculty	Presentation of paper at prestigious International Conferences during the award year	Self with necessary recommendation from RSC and approval from RVP
8	Students with maximum publishing – CSI publications	Publishing maximum articles in CSI publications digital library during the award year	SBC with necessary recommendation from RSC and approval from RVP
9	Highest Committed Accredited Student Branch Activist Award	Most active CSI Volunteer from the Student Branch during the award year	SBC with necessary recommendation from RSC and approval from RVP
10	Best Ph D Thesis Award	CSI member, who submitted a high-quality thesis (Thesis quality to be evaluated by a panel of eminent research scientists) leading to acceptance for Ph D degree by a recognized University	Research Scholar (who got the Ph D during the award year) / the Research Supervisor / Current Employer

The applications for the awards are invited only from the CSI members or from CSI Accredited CSI Student Branches in good standing during the current year as well as during the Award year. Application Forms are available at http://www.csi-india.org/CSI_Academic_Awards.aspx

The applications should reach via email – edawards@csi-india.org in specified form latest by 7th October 2016.

Prof. Bipin V Mehta	Mr. Raju L Kanchibhotla	Prof. M. N. Hoda	Mr. Ravikiran Mankikar	Dr. S. C. Satapathy
Chairman, Awards Committee	Member	Member	Member	Member

Computer Society of India™

Regional Student Coordinators for the year 2016-17

Region	Name & Affiliations
I	 **Mr. Saurabh Agrawal** Head, Marketing and TTH Delivery (MEA), TCS, Ghaziabad-201010 Mob : +91-92668 39339 saurabh1.agrawal@tcs.com

Region	Name & Affiliations
V	 **Prof. C. Srinivas** Associate Professor in CSE Kakatiya Institute of Technology & Science, Warangal, Telangana Mob : +91-90300 70247 csrinivas067@gmail.com

State Student Coordinators for the year 2016-17

Region	Name & Affiliations
I Uttar Pradesh	 **Prof. M. U. Bokhari** Professor & Chairman in CS Aligarh Muslim University (AMU) Aligarh Mob : +919412640294 mubokhari@gmail.com
Himachal Pradesh	 **Prof. Amarjeet Singh** Professor in CS Himachal Pradesh (HP) University, Shimla Mob : +91-94184 84855 aj_singh_69@yahoo.co.uk
Punjab	 **Dr. Maninder Singh** Associate Professor in CS & IT Thapar University, Patiala Mob : +91-98156 08309 msingh@thapar.edu
Delhi	 **Dr. Anupam Baliyan** Associate Professor Bharati Vidyapeeth's Institute of Computer Applications and Mgmt. (BVICAM), New Delhi Mob : +91-98183 27524 anupam_hod1976@yahoo.co.in
Uttarakhand	 **Dr. Ashutosh Kumar Bhatt** Dept. of Computer Science Birla Inst. of Applied Sc. Bhimtal, Nainital Mob : +91-94123 27953 ashutoshbhatt123@gmail.com
Haryana	 **Dr Brijesh Kumar** Dean Academics and Dean SOET K R Mangalam Univ., Sohna Road, Gurgaon Mob : +91-9811326840 muskanbrijesh@gmail.com
Srinagar (J&K)	 **Dr. Muheet Ahmed Butt** PG Dept. of Computer Science University of Kashmir, Srinagar (J&K) Mob :+91- 94194 26555 ermuheet@gmail.com
Jammu (J&K)	 **Dr Jasbir Singh** Sr. Assistant Professor in CS & IT University of Jammu, Jammu -180006 Mob : +91-9419115626 jasbir_mca@yahoo.co.in

Region	Name & Affiliations
V Telangana	 **Dr. A. Kanaka Durga** Professor in CSE and HOD - IT Stanley College of Engineering and Technology for Women, Hyderabad Mob : +91- 98493 84247 drakanakadurga@stanley.edu.in
	 **Prof. Srikanth Chintakindi** Professor in CSE and HOD - IT Stanley College of Engineering and Technology for Women, Hyderabad Mob : +91-98493 84247 drakanakadurga@stanley.edu.in
Andhra Pradesh	 **Prof. P E S N Krishna Prasad** Dept. of Computer Science & Engg Prasad V Potluri Siddhartha Institute of Technology, Kanuru, Vijayawada Mob : 91- 94949 55850 surya125@gmail.com
	 **Prof. Pritee Parwekar** CSE Department Anil Neerukonda Inst. of Tech. & Sciences. Sangivalasa, Vishakapatnam Mob : +91-90002 49712 pritee2000@gmail.com
Karnataka	 **Prof. Suman Jayakumar** Asst. Professor, Dept. of ISE, VVIET, Mysore Mob : +91- 99721 37917 jayakumarsuman@gmail.com
VI Goa	 **Prof. Ramrao Surya Wagh** Associate Professor in CST Goa University, Goa Mob : +91-94238 82964 ramrao@unigoa.ac.in
VII Kerala	 **Prof. A. R. Anil** Head & Professor Sree Budha college of Engineering, Patoor Mob : +91-94474 77577 anilar123@gmail.com

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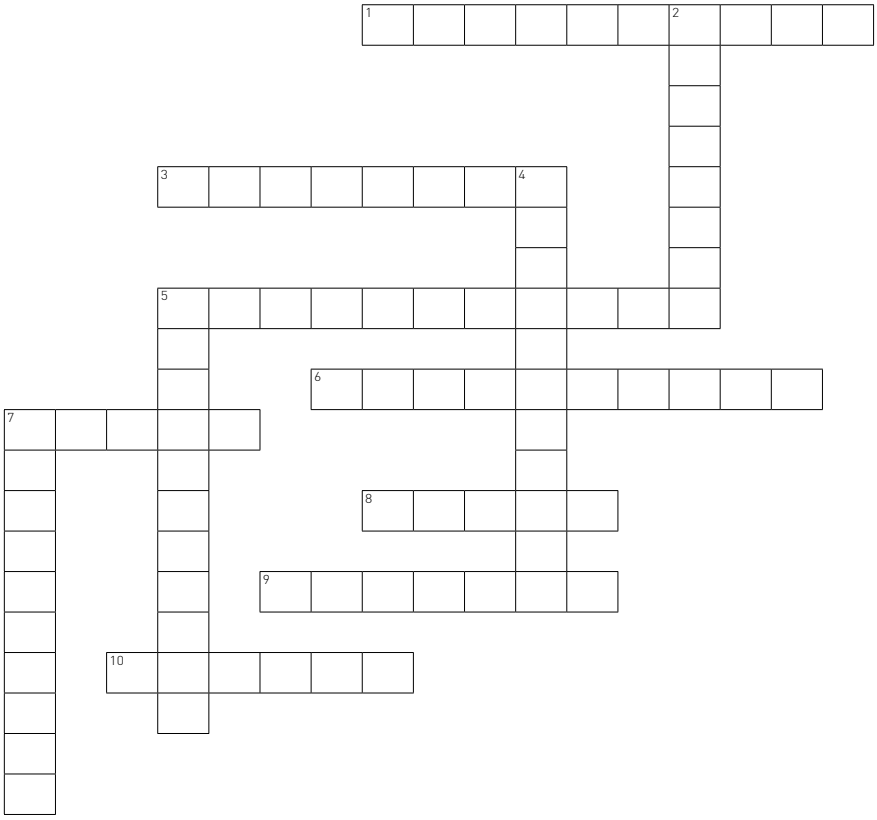
CrossWord »

Durgesh Kumar Mishra
Chairman, CSI Division IV Communications
Professor (CSE) and Director Microsoft Innovation Center, Sri Aurobindo Institute of Technology, Indore.

Test your knowledge on Medical Image Processing

Solution to the crossword with name of first all correct solution provider(s) will appear in the next issue. Send your answer to CSI Communications at email address csic@csi-india.org and cc to drdurgeshmishra@gmail.com with subject: Crossword Solution – CSIC September 2016 Issue.



CLUES

ACROSS

1. Having ultrasonic frequencies
3. A biomaterial that is made up of polymer chains
5. An X-Ray imaging technique to detect breast disease
6. Two photon absorption
7. A measure of strength of magnetic field
8. An standard related to images
9. Mathematician whose theory used in signal processing
10. Device used to protect against radiation

DOWN

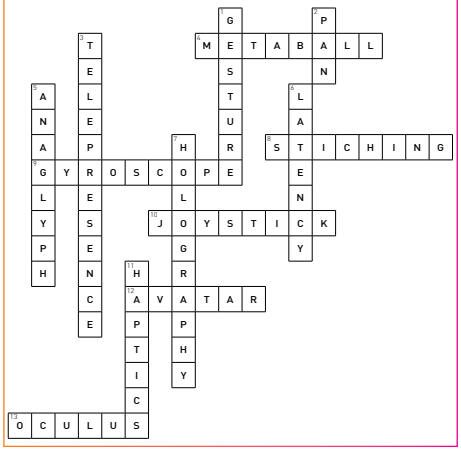
2. Study and treatment of cancer
4. A small telescope like viewing instrument
5. X-Ray of spinal cord
7. X-Ray device movement to view body details

We are overwhelmed by the response and solutions received from our enthusiastic readers

Congratulations!

All nearby Correct answers to August 2016 month's crossword received from the following reader: **Dr. Sandhya Arora**, Professor, Cummins College of Engineering for Women, Pune.

Solution for August 2016 Crossword



Report on Colombo Visit of Dr. Anirban Basu

Dr. Anirban Basu, President CSI visited Colombo from August 8-10 at the invitation of Computer Society of Sri Lanka (CSSL) to deliver a keynote talk in their Annual Conference NITC 2016. The conference was held in Galadari Hotel, Colombo and attended by about thousand delegates including researchers from Australia, Bangladesh, Malaysia, India etc.. The theme of the Conference was "Enhancing Sri Lanka Through Digital Disruption". The Conference was inaugurated by Sri Lanka's Minister in presence of Prof Ashu Marasinge, Member of Parliament, Sri Lanka. The delegates were from Sri Lanka and other parts of South East Asia who did not have a clear idea about the advances India has made in the field of IT and the changes happening in India. In his talk, Dr. Basu gave a glimpse of India's financial prowess, diverse culture and several recent initiatives of the Government of India. He presented the role of Computer Society of India in catalyzing the growth of IT in India before delivering talk on "IoT, Big Data and Analytics" which was very well appreciated.

Dr. Basu discussed several areas where India and Sri Lanka can work together as the Government of Sri Lanka was also looking at ways for growth of IT and taking several initiatives like Smart City project etc.. He also interacted with the President of CSSL, Dr Dayan Rajapakse and the Vice President Mr Yasas Abeywickrama on how CSSL and CSI can work together and how CSI can play a more effective role in SEARCC.

ALLAHABAD CHAPTER

CSI Allahabad chapter conducted an expert lecture on "Recommender System" by Dr. Pragya Dwivedi on Saturday, 30-07-2016 at 5 PM at MNNIT Allahabad (Venue: Design Center Seminar Hall). In this lecture, Dr. Dwivedi focused on recommender system, recommendation techniques are mainly Collaborative Filtering, content based filtering and hybrid filtering. She also gave a light on various domains like E-learning, multi-criteria and cross domain recommender system. The next day of lecture (31-07-2016), chapter conducted young talent search programming contest in UPTECH Allahabad where four colleges' teams of Allahabad were participated.

BHOPAL CHAPTER

CSI Bhopal Chapter supported two week Faculty Development Programme on BIG DATA from 1-10 August 2016 organized at Sagar Institute of Research and Technology, Bhopal. The programme was sponsored by Department of Science and Technology (DST), Govt. of India and technically supported by CSI Bhopal Chapter and ACM Bhopal Chapter.

Eminent personalities like Dr. P K Chande (Former Professor IIM Indore) from Indore, Dr. S Sampath from Madras University, Dr. K K Shukla from IIT Rourkee, Dr. R Bala Venkat Subramanium from NIT Warangal, Dr. Indranil Mukherjee from ISI Kolkata, Dr. T Vijay Kumar from JNU New Delhi, Dr. Parag Kulkarni CEO from Pune, Dr. P K Singh from IIITM Gwalior, Dr D S Tomer from MANIT Bhopal, Dr. R S Thakur from MANIT, Bhopal, Dr. Vivek Tiwari from IIIT Raipur and Dr. S Prajapat from IIPS Indore Mr Sunil Jain from National Informatics Centre Bhopal and others from different Established Organization of India graced this programme.

Prof. Rajesh Shukla (Coordinator) and vice president of CSI Bhopal Chapter enlightened that more than sixty participants from different corners of India like Hyderabad, Bengaluru, Pune , Jaipur, Chennai and different institutions of Madhya Pradesh participated in this prestigious programme. In this momentous occasion Er Sanjeev Agrawal (Chairman SGI), Dr Prashant Jain (Vice-Chairman) congratulated all the Dr. Akhilesh Upadhyay (Director SIRT) focused that this kind of programme will be organized in future also.

COIMBATORE CHAPTER

Computer Society of India, Coimbatore Chapter organized a seminar on "It's a 'polymath'world - success secrets for an emerging world" on 12.08.2016, 5.00 pm at CSI Hall, Coimbatore. More than 70 participants from various organizations in and around Coimbatore attended the seminar session.

Ms. Devadarshini and Mr. Jelix Johnson from SNS College of Engineering (Partner) have addressed the committee members. Mr. Vishnu Potty, Chairman, CSI Coimbatore Chapter welcomed the gathering and also briefed the session topics of the seminar and introduced the keynote speaker Mr. Subramaniam to the participants.

The Chief Guest explained about the "Generation of polymath world" and also he demonstrated the polymath pattern in the form of wave pattern in three ways such as Internet connection and their applications, apple, Ios, apps and Internet of things, automation etc. He explained in detail structure about the way of Generation changes by the OLA taxi app and he gave us an idea about the android development for automation. The session helped the participants to invoke the concept to their future generations. The seminar was well received by the participants and ended with Q&A session. Finally, vote of thanks was given by Dr. G. Radhamani, Secretary, CSI CBE Chapter.

CSI Coimbatore Chapter monthly seminar was organized on 18 July 2016. The meeting started with the welcome address by Mr. Vishnu Potty, Chairman, CSI, Coimbatore Chapter and introduction of the chief guest. Mr.Brijraj Singh addressed the audience and discussed the following:

Evolution of Azure, Open Source Initiative in IAAS, Open Source Initiative in PAAS, Open Initiative in Tools and frameworks

The seminar was well received by the participants and ended with Q & A session. Finally, vote of thanks was given by Dr. G Radhamani, Secretary, CSI CBE Chapter.

Computer Society of India (CSI), Coimbatore Chapter and Department of MCA, Hindusthan College of Arts and Science, Coimbatore jointly conducted the first level regional competition for "CSI Young Talent Search Computer Programming" on 31-07-2016 at Hindusthan College of Arts and Science. Dr. A. V .Senthilkumar, Director, Dept. of MCA, Hindusthan College of Arts and Science acted as a Chief Superintendent for the examination, Dr. G. Radhamani, Secretary – CSI-Cbe Chapter, Mr. A.Sivabalan, CSI-Cbe Chapter, Mr. C. Thirumoorthi, Assistant Professor, Dept. of MCA , Hindusthan college of Arts and Science were Present. More than 20 school students from various parts in and around Coimbatore region participated in the competition.

HARIDWAR CHAPTER

On 22nd August, 2016 a cloud computing workshop was held at Faculty of Engineering & Technology, Gurukula Kandgri Vishwavidyalaya, Haridwar by CSI Haridwar Chapter. The workshop had total 3 sessions started with the "Introduction of the Cloud Computing" taken by Abhigyan and Vivek Ji. Later the chief guest of the workshop Mr. Mani Madhukar, IBM India, talked about the block-chain technology and method to implement by using IBM Cloud Bluemix, also made us aware about few other technology GLAN, Importance on node.js in cloud. Later he discussed various issues of cloud computing with the students. The third session was the implementation of IBM insights and Bigsheets taken by Mohit. The whole day was very informative. Total 103 students took part in the workshop and on this occasion Dr. Krishna Kumar, Chairman CSI Hairdwar Chapter, Dr. Mayank Aggrawal, Vice-Chairman CSI Hairdwar Chapter, Mr. Nishant Kumar, Secretary CSI Hairdwar Chapter and Mr. Manish Aggrawal, Treasurer CSI Hairdwar Chapter was present. Organizing secretary for the workshop was Mr. Nishant Kumar.

HYDERABAD CHAPTER

CSI Hyderabad Chapter conducted Two day Workshop on Analytics using R was organized in CSI Hyderabad Chapter (Regd) Office Hyderabad during 2-3 July 2016. Twenty participants from different organizations such as Indian Statistical Institute. Calcutta, INFLIBNET Centre, Gandhinagar Gujarat, NTT Data Hyderabad, S.V.Subba Rao Chartered Accountant & Co. Hitachi Consulting, Hyderabad, Adama Science and Technology University,Ethiopia, Thrinaina Informatics Ltd. Secundrabad , VNR Vignana Jyothi Institute of Engg & Technology, Geethanjali College of Engg & Technology, Loyola Academy - Degree and PG college, Nalla Malla Reddy Engg.College Hyderabad and Wissen Infotech, Hyderabad

Valedictory was addressed by Shri Sudhakar Chairman and Managing Director ECIL Hyderabad, Mr. Raju Kanchubatla RVP-V CSI India, Mr. Chandra Dasaka, Director-Mobile Digiconverse Private Limited, briefed about the Workshop details and Dr DV Ramana Wissen Infotech, Hyderabad provided the Workshop Summary and Prof Krishna Prasad AV, KL University Concluded with the Vote of Thanks. Resource persons from Prof Sudhakar, Raskey Software Solutions (P) Limited, Osmania University, Indian Institute of Public Health, Hyderabad and Prof.Rajesh Prabhakar Kaila, Visiting Faculty, Symbiosis Institute Of Business Management - Symbiosis International University, Hyderabad shared their extensive knowledge on the topics covered during the workshop were: Introduction to Analytics, Descriptive Statistics – Measures of Central Tendency, Measures of Dispersion and Measures of Association. Importance of R and Basics of R Data Manipulation & Data Handling, Data Visualization – I- Line Plots, Bar Plots, Stacked Bar plots, Pie chart, scatter charts, box plots, histograms, heat maps, Tabulation of data, Hypothesis Testing – One Sample T test, Two Sample T test, One Way Anova, Multiple Linear Regression – Procedure, Model Fitting and Predictive Modelling, Excel and R Integration.

The Workshop was completed successfully with a good rating and the participants were very much appreciated by knowledge sessions and the hospitality.

KOLKATA CHAPTER

CSI, Kolkata Chapter's Fifth Lecture of Lecture Series was held on 06.08.2016 at 4.30 pm in the CSI Kolkata Chapter office. Mr. Supratik Gupta, CIPSP® CLIP, deliverd his expert lecture on "Technology in Old Age Care".

CSI Kolkata Chapter organized one-day course on "Research Methodology", on Saturday, 30th July, 2016. The lectures addressed issues related to motivation and approach to research. The course has been conducted by Dr. Dipti Prasad Mukherjee, Professor of Electronics and Communication Sciences Unit, Indian Statistical Institute. 22 participants attended the course

Eastern Regional Student Convention has been organized on 20th August at MCKVIE institute of Technology, Liluah, Hourah. Prof.(Dr.) A. K. Nayak, Secretary, Computer Society of India was the Chief Guest on the occasion. Students from various colleges and universities attended the convention. Sixteen officials/members CSI of Kolkata Chapter attended the conference. Among the activities, twelve papers were presented by the students of various institute like Jadavpur University, Kalyani University etc. There was quiz contest and extempore competition. More than 60 students participated in the convention. Regional meet was also held on the same day where participants from different chapters of this region participated like Patna, Kolkata etc.

First level student programming contest was held on 31st July 2016 at BIT Meshra Campus, Kolkata Center. Seventeen schools were participated in the competition.

RAJKOT CHAPTER

Computer Society of India – Rajkot Chapter, has organized a two hour Seminar on "Introduction to Linux Programming Environment" on 30 July 2016. Total 25 participants attended this Seminar.

The session was taken by a very renowned personality, Prof. Rajesh Nagawade, Corporate Manager, Marwadi University. The program has started with the welcome note by Prof. Dipali Thakkar, Marwadi University by welcoming Prof. Sunil Bajeja, Immediate Past Chairman, CSI Rajkot Chapter and guest faculty Prof. Rajesh Nagawade..

The vote of thanks was presented by Prof. Jobi Jose, Secretary CSI Rajkot Chapter. He has played a key role in arranging a successful seminar and made all arrangements related to session.

Certificates were distributed to all the participants by the founder Chairman of the chapter Dr. R. Sridaran.

VELLORE CHAPTER

CSI Vellore Chapter organized a one day Workshop on "Apps for GRE & TOEFL" on 27/7/2016 at VIT University. Ms. Pavithra Srinivasan, MS.,Stanford University, USA. Conducted a diagnostic test for CSI students and explained how to solve difficult questions, mapping scores to jog opportunities, life culture in US, around 90 CSI life members attended the workshop, organized by Prof. G. Jagadeesh and Prof. K. Govinda

Congratulations

Prof. Jayesh M. Solanki, Chairman - CSI Ahmedabad Chapter has been appointed as a Technical Advisor in Gujarat University for implementing online centralised admission process. Currently, he has been appointed as an Officer on special duty and Co-ordinator for BA/MA programs for implementing this project in most challenging environment. More than one lakh candidates have been processed through this online portal successfully.He received an honour from the Hon'ble Vice chancellor of Gujarat University on August 15, 2016.

REGION-III

School of Computer Studies, Ahmedabad University

30-7-2016 – Prof. Bipin V. Mehta & Dr. Nirav Thakkar during inaugural session on ICT in Education for Digital India seminar

Report Submission

Student branches are requested to send their report to sb-activities@csi-india.org with a copy to admn.officer@csi-india.org.

Chapters are requested to send their activity report to chapter-activities@csi-india.org.

Kindly send high resolution photograph with the report.

Contact **Dr. Vipin Tyagi**, Editor – CSI Communications at dr.vipin.tyagi@gmail.com for any query.

G H Patel College of Engineering & Technology, Vallabh Vidyanagar

8-8-2016 – Seminar on Tips and Tricks for Competitive Coding

12-8-2016 – Event on Qriosity : A General Quiz

REGION-V

Geethanjali Institute of Science & Technology, Nellore

19-8-2016 – Dr. Ch Pradeep Reddy during Guest Lecture on IOT and Cloud Computing

Rajarajeswari College of Engineering, Bengaluru

19-7-2016 to 25-7-2016 – Faculty Development Program on Bridge the Gap-VTU CBCS Scheme

Anurag Group of Institutions, Hyderabad

30-7-2016 – Workshop on Web Development

3-8-2016 – Orientation program

REGION-V

Vasavi college of Engineering, Hyderabad

27-7-2016 - Contest on DIGBUG-DEBUG

MLR Institute of Technology, Hyderabad

16-6-2016 – Awareness program by Mr. Pattabiraman, TCS

CMR Technical Campus, Hyderabad

28-6-2016 - Guest Lecture on Big Data Analytics

28-6-2016 - Guest Lecture on Intellectual Property Rights

Sphoorthy Engineering College, Hyderabad

4-8-2016 – Mr. Raju Kanchibhotla, RVP-5 inaugurated the Student Branch

G Pullaiah College of Engineering & Technology, Kurnool

29-7-2016 – Mr. Anil Kumar, Dr. Nageswara Rao, & Dr. Prem Kumar during Student Branch inauguration

Lendi Institute of Engineering & Technology, Vizianagaram

13-8-2016 – Workshop on Web Designing

GSSS Institute of Engineering and Technology for Women, Mysuru

6-8-2016 – Mr. Girish presenting Technical talk on Architecture and Structure of DMBS and RDMBS

REGION-V

NBKR Institute of Science and Technology, Nellore

3-8-2016 - One Day Workshop on Presentation Skills

Malla Reddy Inst. of Technology & Science, Secunderabad

19-7-2016 – Student Branch 3rd Annual Day Celebrations

REGION-VI

Vishwakarma Institute of Information Technology, Pune

21-7-2016 & 22-7-2016 - Arduino Workshop

22-7-2016 – Expert Lecture, Best Coding Practices in Data Structure

Institute of Management Research & Development, Shirpur

9-8-2016 – Event on Opportunities in Government Sector for Fresh Graduates

Zeal Institute of Business Administration, Computer Application and Research, Pune

6-8-2016 – Guests and Participants during National Seminar on Digital Assistance

All India Shree Shivaji Memorial Society's Institute of Information Technology, Pune

11-8-2016 – One day workshop on Software Testing

12-8-2016 – One day workshop on Latest Trends in Cloud Computing

REGION-VII

Knowledge Institute of Technology, Salem

25-7-2016 & 26-7-2016 – Mr. Prateek Gupta during two day workshop on Internet of Things (IoT)

Sri Sai Ram Institute of Technology, Chennai

13-7-2016 to 15-7-2016 – Mr Bhaskaran, Past Chairman, CSI Chennai Chapter speaking on the EDC camp

National Engineering College, Kovilpatti

22-7-2016 – Event on BUG-D (C-debugging contest)

Syed Ammal Engineering College, Ramanathapuram

23-7-2016 – One day workshop on Appdhoom-3 - Internet of Things development

Valliammai Engineering College, Kattankulathur

26-7-2016 – Guest Lecture on Issues in Network Security

29-7-2016 – Dr. Vanathi, Head CSE addressing the gathering during Seminar on Android Application Development.

VIT University, Vellore

10-8-2016 – One day coding competition on Crackerjack

Einstein College of Engineering, Tirunelveli

8-8-2016 – Dr Ramar, Dr Velayutham & Prof Suresh Thangakrishnan during Motivational Talk

REGION-VII

Velammal Engineering College, Chennai

20-7-2016 - Student Branch Inauguration

MEPCO Schlenk Engineering College, Sivakasi

25-7-2016 - CSI Student Branch Office Bearers interacting with the Freshers during the event on Quiz

Nehru College of Management, Coimbatore

19 & 20-7-2016 - Two Days Workshop on PHP

29-7-2016 - Industry Institute Interaction

CSI Chapter Elections 2017-2018/2019

Chapter Nomination Committee shall invite nominations for the following positions from their respective eligible voting members. In case you wish to update your details, please write to CSI HQ for updation.

For the term 2017-2018 (April 1, 2017 - March 31, 2018)

1) Vice Chairman-cum-Chairman Elect- One Post
2) Nomination Committee (3 members)- 3 Posts.
3) Managing Committee:(4 / 6 / 8 members as per class/category of chapter)
   Category A – (Chapters having more than 500 members) – 8 MC Members.
   Category B – (Chapters having 250 – 500 members) – 6 MC Members.
   Category C – (Chapters having less than 250 members) – 4 MC Members.

For the term 2017-2019 (April 1, 2017 – March 31, 2019)

4) Hon. Treasurer - One Post

Chapter election process must be completed by 15th November 2016 i.e. the election slate/ results must be communicated to CSI HQ at nc@csi-india.org by chapters by this date. If the chapter opts to go for online voting with National ExecCom elections, all details of the nominees must be sent to CSI-HQ/ National NC by 31st October 2016.The election process in such cases would be completed by 31st January 2017.

All queries/ doubts pertaining to chapter elections can be mailed to respective Chapter NC. In case of any difficulty you can also write to National NC at nc2016_2017@csi-india.org with a copy to CSI-HQ at nc@csi-india.org

National Nomination Committee (2016-2017)

e-mail: nc2016_2017@csi-india.org

Mr. Ved Parkash Goel	Dr. Santosh Kumar Yadav	Mr. Sushant Rath
Chairman	Member	Member

INDIACom-2017

11th INDIACom; 2017 4th IEEE International Conference on

"Computing for Sustainable Global Development"

(01st – 03rd March, 2017)

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Institution of Engineering and Technology (UK), Delhi Local Networks and
Guru Gobind Singh Indraprastha University (GGSIPU), New Delhi

Paper Submission Deadline: 24th October, 2016 [No Further Extension]

Paper submission Link: http://bvicam.ac.in/indiacom/submitPaper.asp

Conference Website: http://bvicam.ac.in/indiacom/

Announcement and Call for Papers

INDIACom-2017 is aimed to invite original research papers in the field of, primarily, Computer Science and Information Technology and, generally, all interdisciplinary streams of Engineering Sciences, having central focus on sustainable computing applications, which may be of use in enhancing the quality of human life and contribute effectively to realize the nations' vision of sustainable inclusive development using Computing. ***INDIACom-2017*** will be an amalgamation of four different Tracks organized parallel to each other, in addition to the 3rd International Workshop on Information Engineering and Management (IWIEM-2017) and few theme based Special Sessions, as listed below:-

- **Track #1: Sustainable Computing**
- **Track #2: High Performance Computing**
- **Track #3: High Speed Networking & Information Security**
- **Track #4: Software Engineering & Emerging Technologies**
- **Track #5: Theme Based Special Sessions**

Instruction for Authors

Authors from across different parts of the world are invited to submit their papers. Authors should submit their papers online at http://www.bvicam.ac.in/indiacom/loginReqSubmitPaper.asp. New authors should first sign up and create an account on http://www.bvicam.ac.in/indiacom/addMember.asp to log in and submit paper. Only electronic submissions will be considered. Paper submission, as E-Mail attachment, will not be considered.

Important Dates

Submission of Full Length Paper	24th October, 2016	Paper Acceptance Notification	14th January, 2017
Submission of Camera Ready Copy (CRC) of the Paper	23rd January, 2017	Registration Deadline (for inclusion of Paper in the Proceedings)	23rd January, 2017

Accepted Papers will be published in **IEEE Xplore,** which is indexed with world's leading **Abstracting & Indexing (A&I)** databases, including **ISI, SCOPUS, DBLP, EI-Compendex, Google Scholar,** etc. Further details are available at www.bvicam.ac.in/indiacom. All correspondences, related to ***INDIACom-2017,*** must be addressed to:

Prof. M. N. Hoda
General Chair, ***INDIACom-2017***
Director, Bharati Vidyapeeth's Institute of Computer Applications and Management (BVICAM)
A-4, Paschim Vihar, Rohtak Road, New Delhi-110063 (INDIA)
E-mails: conference@bvicam.ac.in, indiacom2017@gmail.com
Tel.: 011-25275055 • TeleFax: 011-25255056, Mobile : 09212022066

CSI CALENDAR 2016-17

Sanjay Mohapatra, Vice President, CSI & Chairman, Conf. Committee, Email: vp@csi-india.org

Date	Event Details & Contact Information
SEPTEMBER **10-11, 2016**	**Workshop on Analytics using R** http://csihyderabad.org Contact : analyticsusingr@gmail.com
16-17, 2016	**2016 International Conference on Frontiers of Intelligent Computing: Theory and applications (FICTA),** KIIT University, Bhubneswar. www.fi cta.in Contact : fictaconf@gmail.com
OCTOBER **04-05, 2016**	**National Conference on "Recent Advances in Computer Science & Technology",** RACST-2016, Department of Computer Engineering, G H Patel College of Engineering & Technology, Vallabh Vidyanagar, Gujarat, www.gcet.in Contact : Dr. Maulika Patel, maulikapatel@gcet.ac.in
06-08, 2016	**International Conference on "Computational Systems and Information Technology for Sustainable Solution [CSITSS-2016]"** Organized by CSE & ISE & MCA - R.V. College of Engineering, Bengaluru -560059. www.rvce.edu.in; Contact : csitss2016@rvce.edu.in; Ph: 080-67178183, 8180;
NOVEMBER **05-06, 2016**	**Third International Conference on Computer & Communication Technologies (IC3T - 2016)** at Devineni Venkata Ramana & Dr. Hima Sekhar MIC College of Technology, Vijayawada, Andhra Pradesh, India. http://www.ic3t.mictech.ac.in/ Contact : Dr. S.C. Satapathy, 9000249712, sureshsatapathy@ieee.org, Dr. K. Srujan Raju, 91-9246874862, ksrujanraju@gmail.com Prof. Vikrant Bhateja, 91-9935483537, bhateja.vikrant@ieee.org
11-12, 2016	**International Conference on Advances in Computing and Data Sciences (ICACDS-2016). Proceedings by Springer CCIS/LNCS** Organized by Krishna Engineering College (KEC), Ghaziabad. http://icacds2016.krishnacollege.ac.in/ Contact : Dr. Mayank Singh, icacds2016@krishnacollege.ac.in. Mob: 09540201130 **National Conference on Smart And Innovative Technologies in Engineering And Sciences (SITES 2016)** Gyan Ganga College of Technology, Jabalpur, MP. www.ggct.co.in Contact sites: 2016@ggct.co.in
17-19, 2016	**Interntional Symposium on Acoustics for Engineering Applications :** Acoustics for Quality Improvement in Life at KIIT, Gurgaon http://www.nsa2016india.org/ Contact: Prof. (Dr.) S. S. Agrawal, Chairman, OC – NSA-2016, Director General KIIT Group of Colleges, Gurgaon Formerly: Emeritus Scientist CEERI/CSIR,Advisor CDAC-Noida. Email: nsa2016india@gmail.com
18-20, 2016	**2nd International Conference on Communication Control and Intelligent Systems,** at GLA University, Mathura . www.gla.ac.in/ccis2016 Contact: ccis@gla.ac.in
22-25, 2016	**Special session on "Smart and Ubiquitous Computing for Vehicle Navigation Systems"** at IEEE TENCON 2016, Marina Bay Sands, Singapore (http://site.tencon2016.focalevents.sg/) Contact : Dr. P.K. Gupta pkgupta@ieee.org, Prof. Dr. S. K. Singh sks.cse@itbhu.ac.in
DECEMBER **07-09, 2016**	**National Symposium on "Recent Advances in Remote Sensing and GIS with Special Emphasis on Mountain Ecosystems" and their Annual Conventions at Dehradun.** www.isrs2016.iirs.gov.in Contact: Dr. S. K. Srivastav, Organising Secretary & Group Head, RSGG, Indian Institute of Remote Sensing, Indian Space Research Organisation, Department of Space, Government of India , Dehradun, India - 248 001. email : isrs2016@iirs.gov.in
08-10, 2016	**CSI Annual Convention (CSI-2016): Theme: Digital Connectivity - Social Impact;** Organized by CSI Coimbatore Chapter; Pre-Conference Tutorial on 7th Dec. 2016 Venue: Hotel Le Meridien, Coimbatore Contact : Dr. Ranga Rajagopal, Convener, 9442631004 convener@csi-2016.org **CeBIT INDIA 2016 – Global Event for Digital Business in association with CSI Venue: BIEC, Bengaluru** www.cebit-india.com Contact : Mohammed Farooq, farooq@hmf-india.com, +91 9004691833
23-24, 2016	**8th Annual IEEE International Conference on Computational Intelligence and Communication Network CICN-2016**. Venue : Gyan Ganga Institute of Technology & Sciences, Jabalpur Contact : Dr. Santosh Vishwakarma santoshscholar@gmail.com
FEBRUARY **11-12, 2017**	**International conference on Data Engineering and Applications-2017 (IDEA-17)** at Bhopal (M.P.), http://www.ideaconference.in Contact : conferenceidea@gmail.com
MARCH **01-03, 2017**	**INDIACOM 2017,** Organized by Bharati Vidyapeeth's Institute of Computer Applications and Management (BVICAM), New Delhi http://bvicam.ac.in/indiacom/ Contact : Prof. M. N. Hoda, conference@bvicam.ac.in, indiacom2017@gmail.com, Tel.: 011-25275055
MAY **08-10, 2017**	**ICSE 2017** - International Conference on Soft Computing in Engineering, Organized by : JECRC, Jaipur, www.icsc2017.com Contact : Prof. K. S. Raghuwanshi, hod.it@jecrc.ac.in, Mobile : 9166016670

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