

A BRIEF REVIEW ON VARIOUS IMAGE SEGMENTATION TECHNIQUES FOR DETECTION OF ARTHRITIS

A Survey report

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ABSTRACT: Arthritis is generally a joint disorder that causes inflammation or often painful feeling in joints, joint is an area of our body that have a common meeting point which makes it easier to move our body parts in several directions. It is said to be the systematic disease that can also affect other parts of our body if it happens once. Arthritis is a common disease that people miss work which results in a decreased quality of life There are some symptoms which may occur such as one can feel unusually fatigued, joint stiffness, joint pain, minor joint swelling etc. Although losing weight and exercise can be helpful and medicines for pain relief. With the passing of time, the realm of human knowledge is ever expanding. Further, with each passing day, we witness the explosion of information which is evident in life style, social events and breakthrough in science. Magnetic Resonance Images provides the early detection of the arthritis so that patient will get prepare for it and soon doctor will be able to find a way to cure it. Typically, Magnetic Resonance Images are complex and noisy. This hints to the need of process which reduces difficulties in analysis and increases quality of output. However this paper will focus on all the aspects which are related to the arthritis and presents the more appropriate method required to detect arthritis in medical imaging. In this paper, we take images for analysis from the large dataset which may contain symptom of such disease. Such an algorithm is explained which can be a lot more useful than any other algorithms to detect arthritis.

Keywords: - Arthritis, Image Processing, Magnetic Resonance imaging, Segmentation, Image Segmentation, Computer Aided Diagnosis, Detection Techniques.

INTRODUCTION

The term arthritis is derived from arthr- means joint and -itis means inflammation which means any disorder which affects joints. The general symptoms are joint pain and stiffness. In arthritis, beginning can be gradual or sudden. Arthritis has a major impact on people of all ages and has been known to us since ancient times. There are more than 100 types of arthritis. Other symptoms may include redness, warmth, swelling, and decreased range of motion of the affected joints. In some types of arthritis other organs are also affected. The most common forms are osteoarthritis and rheumatoid arthritis. Osteoarthritis usually occurs with age and affects the fingers, knees, and hips. It affects more than 3.8% of people while rheumatoid arthritis affects about 0.24% of people. It is a degenerative disease that includes pain, stiffness, and loss of mobility of the joint [1]. Most importantly, it is required to understand the treating doctor's perception of pain relief among the arthritis affected patients [13]. Rheumatoid arthritis is a disorder that often affects the hands and feet. Other types of rheumatoid arthritis are gout, lupus, fibromyalgia, and septic arthritis etc. Gout affects approximately 1–2% of the Western population at some point in their lives. In Australia almost 15% of people are affected, while in the United States more than 20% have a type of arthritis. Overall the disease becomes more common with age.

1.1. DETECTION TECHNIQUES OF ARTHRITIS

Diagnosis should be made by clinical examination from a certified health professional, and must be supported by other tests such as radiology and blood tests etc., counting on the type of suspected arthritis. Physical examination may confirm the diagnosis, or may indicate disease. All types of arthritis eventually features pain. Pain patterns may differ depending on the arthritis and the location. Rheumatoid arthritis is generally worse in the morning and associated with stiffness. In the early stages, patient typically have no symptom after a morning shower. Osteoarthritis, on the other hand, tends to be worse after exercise. In the aged and kids, pain may not be the most presenting feature; the aged patient simply moves less, the infantile patient refuses to use the affected limb. Some of the important features are pattern of joint involvement, symmetry of symptoms, early morning stiffness, and tenderness, gelling or locking with inactivity, aggravating and relieving factors and other symptoms. [1]Radiographs are often used, Blood tests and X-rays of the affected joints often are performed to make the diagnosis. Screening blood tests are indicated if certain arthritis is suspected. These might include: rheumatoid factor, antinuclear factor (ANF), extractable nuclear antigen, and specific antibodies.

Blood Tests: A blood test is a laboratory analysis performed on a blood sample that is usually extracted from a vein in the arm using a hypodermic needle, or via finger pick. Multiple tests for specific blood components, such as a glucose test or a cholesterol test, are often grouped together into one test panel called a blood panel or blood work. Blood tests are often used in health care to determine physiological and biochemical states, such as disease, mineral content, pharmaceutical drug effectiveness, and organ function [8].

X-Rays: X-rays is a form of electromagnetic radiation. Most X-rays have a wavelength range from 0.01 to 10 nanometers, corresponding to frequencies in the range 30 petahertz to 30 exahertz. The wavelengths are shorter than those of Ultraviolet (UV) rays and longer than gamma

rays [11]. It uses a very small dose of ionizing radiation to produce pictures of any bone in the body. It is commonly used to analyze fractured bones or joint dislocation. Bone x-rays are the fastest and easiest way for doctor to view and assess bone fractures, injuries and joint dislocation.

Magnetic Resonance Images: Magnetic resonance imaging is a medical application of nuclear magnetic resonance. MRI is a very useful technique which is used to detect the diseases which in future may affect human bodies, also to cure and treat those diseases. It provides complete images of internal happenings that include bones, ligaments, tendons muscles and blood vessels from different sides. It is widely used in hospitals and clinics for medical diagnosis, staging of disease and follow-up without exposing the body to radiation [11].

2. TECHNIQUES INVOLVED IN DETECTION OF ARTHRITIS THROUGH MRI IMAGES

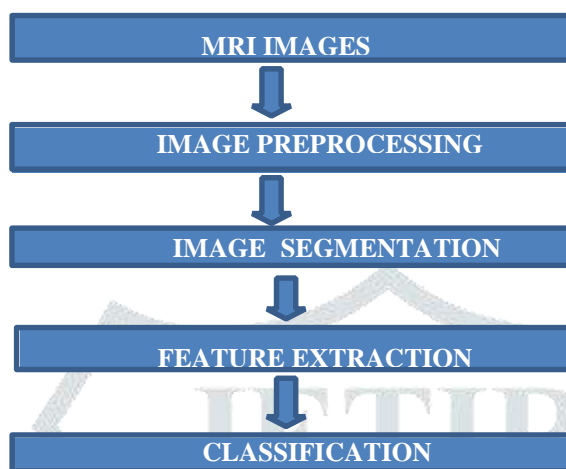


Figure 1.1: Detection of Arthritis through MRI Images.

2.1 IMAGE PREPROCESSING: There are two types of methods used for image processing namely, analog and digital image processing. Analog image processing can be used for the hard copies like printouts and photographs. Image analysts use various fundamentals of interpretation while using these visual techniques [17]. In computer science, Digital image processing is the use of computer algorithms to perform image processing on digital images. As a subcategory or field of digital signal processing, digital image processing has many advantages over analog image processing. It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and signal distortion during processing. Since images are defined over two dimensions digital image processing may be modeled in the form of multidimensional systems. Image processing basically includes the three steps (1) Importing the image via image acquisition tools; (2) Analyzing and manipulating the image; (3) Output in which image result can be altered or report that is based on image analysis.

2.2. IMAGE SEGMENTATION: The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image. Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristics. When applied to a set of images, specifically in medical field, this results in bounding the image after that image segmentation can be used to create 3D reconstructions with the help of interpolation algorithms like marching cubes. Various applications of image segmentation are Machine vision, Automatic traffic controlling system, face recognition, medical imaging. [5] The techniques involves in image segmentation are: Thresholding; Otsu method, Histogram segmentation; Edge Based Segmentation: Gray Histogram, Gradient based method; Region based Segmentation: Region Growing, Splitting and Merging, Watershed Segmentation, Level Set Method, Active Contour Model [9].

2.3. FEATURE EXTRACTION: Feature extraction is related to dimensionality reduction. In machine learning, pattern recognition and image processing, feature extraction starts from an initial set of measured data and builds derived values (features) intended to be informative and non-redundant, facilitating the subsequent learning and generalization steps, and in some cases leading to better human interpretations The data is classified into parts when using a feature selection technique and that are the redundant or irrelevant which we can say can be removed without causing much loss of information. Redundant or irrelevant features are two distinct notions, since one relevant feature may be redundant in the presence of another relevant feature with which it is strongly correlated. There are techniques used for feature extraction which includes Multifactor dimensionality reduction, Nonlinear dimensionality reduction, Multilinear Principal Component Analysis, Multilinear subspace learning. Feature selection techniques are used for four reasons. (a)Simplification of models to make them easier to interpret by researchers/users, (b)Shorter training times, (c) To avoid the curse of dimensionality, (d) Enhanced generalization by reducing over fitting (formally, reduction of variance)[8].

2.4. CLASSIFICATION: Many techniques have been proposed for classification of MR images such as Fuzzy Clustering Means (FCM), Support Vector Machine (SVM), Artificial Neural Network (ANN), knowledge-based techniques, and Expectation-Maximization (EM) etc. which are used to extract the important information from the medical imaging. Further classifying them Clustering: K-Means, Fuzzy C- means, Ant Tree Algorithm; Artificial Neural Network: Feed Forward Network, Feedback network; Classifiers (Supervised method): Support Vector Machine, Bayes Classifier [2].

3. LITERATURE REVIEW

A review over the various techniques which are used for MRI images for detection of arthritis is presented in this section.

Lior Shamir et al [1] have proposed image computation primarily based strategy for quantitative investigation and morphological changes within the bone structure that is useful in the movement of Osteoarthritis. The authors have utilized surface examination and WND-CHRM arrangement methodology for the investigation of ill health. The highlights pattern were high differentiation highlights, Haralick highlights, Tamura highlights, factual highlights and polynomial disintegration of image. The change utilized are Fourier, Chebyshev, Wavelet and edge change.

In this paper author proposed K-implies image division: K-Means calculation 2010 [2] is an unsupervised, apportioning based bunching procedure within which the centroid is chosen and contrasted. Therefore the data focuses in light of the force, qualities and separations. The information indicates out closest group which separates typical and RA subjects utilizing thermography. In any case, the utilization of this division is constrained by manual determination of veil without fail. Consequently, this doesn't hold useful for programmed arrangement of infection. In this manner, another division calculation, to be specific, shading image division is executed. In k-implies image division, the shading image is isolated by pixel names relying upon the quantity of groups speaks to the huge bunches for RA subjects utilizing K-implies. The amount of groups utilized as a part of k-implies image division is five. The fifth bunch is white in shading showing the problem area district portrays the k-implies image division yield of ordinary thermography image with no white group. Therefore, K-implies image division is effectively used to separate RA and standard IR image. Although, within the second strategy or shading image division, powerful division was unrealistic because of the proximity of false positives, though in the last technique, k-implies image division, the image is bunched in view of the separation between them. From the test comes about, obviously that k-implies image division can be utilized to precisely section the problem area district. Hence, in examination with manual and RGB image division, k-implies image division calculation is observed to be the best appropriate calculation for successful division of heat images. Besides, in accordance with the after effects of the present investigation, it is explained about thermogram utilizing k-implies image division. Accordingly, in the present examination, k-means image division is observed to be the best reasonable image division calculation for the finding of rheumatoid arthritis. Be that because, the consequences of the present examination are constrained by small size of the data test. Subsequently, future investigations will center around testing the division calculation with large information test. Additionally, measurable and GLCM include extraction needs to done and fake neural system approach will be used within the programmed order of typical and abnormal RA subjects.

Dian Pratiwi et al [3] have used manufactured neural back proliferation strategy for estimating the seriousness of arthritis sickness. In their work the entire preparing is divided into 3 stages, image handling, include extraction and order utilizing counterfeit neural system method. They have closed with 66.6% of grouping rate.

Prafull Sharma et al [5] 2013 have used various distinct Image division calculations on X-beam bone images. The discrete advance, Watershed division and Otsu's division space are utilized to break down the variations from the norm and problems related with bone structures. They have presumed that discrete advance calculation provides fast and productive outcomes.

K. Dewan and El-Saadany [8], proposed a method where three image division calculations area are talked about. They are: 1) Manual image division: This is often a kind of edge based image division [8] within an ideal edge esteem is physically chosen by experimentation technique and seeable of that problem area district is portioned. In this image division, the problem area space is fragmented by physically deciding the power estimation of the problem space. A veil is created to expel the problem area space from the foundation. The portioned image is superimposed on the primary image by recombining the individual shading channels into a RGB image. RGB (red, green, and blue) refers to representing the colors to be used on a computer display. Levels of R, G, and B can each range from 0 to 100 percent of full intensity.

Bindushree R et al [10] 2015 have used distinctive image preparing methods to quantify the joint space width in knee x-beam images. Diverse procedures utilized are differentiate improvement, histogram evening out, vigilant edge recognition calculation and thresholding for extraction and calculation of highlights. The authors have inferred that the Joint Space Width of the knee x-beam image is contrasted and therefore the standard Width (4.8 for women and 5.7 for men) and that image is said to be normal case or arthritis case.

Subromoniam M et al [11] have utilized PC supported finding for the identification of OA utilizing X-beam images. Haralick include extraction method for calculation and SVM classifier with the part capacities are utilized for the location and grouping of arthritis. They have reasoned that the calculation had an adequate decent outcome with precise value 99%.

In [12], the author presents Osteoarthritis disease detection with the help of processing technique, the cartilage of knee is segmented with the pixel based segmentation method, then the cartilage area is calculated and based on that the image is classified as normal or osteoarthritis affected.

In this paper [15], A detailed survey is conducted on different methods for the detection of arthritis. The paper explores various perspectives of detection of arthritis. It explains the techniques used by different authors and what were their advantages, disadvantages and conclusion. Such as 'Abnormality detection from Medical Thermographs', in which affected region is detected using heat indications present in the Thermographs. Moreover, the distinction of depth of coral images is sometimes so much lower than for other images, leading to minimum miserable proposition, and less smoothness report. Key face who are well utilized in the processing of obvious images can't be recycled loyally howbeit managing rose images, so the separation of one's final presents unique demanding situations and is dependent a great deal at the appeal regarded as. For part, techniques advanced for automatic tracking of defense force targets or for manufacture of pc don't carry out properly just as transliterated to pharmaceutical.

3. COMPARISON

The given table shows summary among all the literatures we have studied.

Table1.Summary Chart

Authors	Algorithm/Technique	Advantages	Drawbacks	Result
Lior Shamir et al [1]	Computing based method quantitative analysis	The authors have utilized surface examination	The highlights figured were high differentiation highlights	The transform used are Fourier, Chebyshev, Wavelet & edge transform
Dr.S.N Geethalakshmi, T.Jothi [2]	Segmentation Based On Enhanced Morphological Watershed Algorithm	Best reasonable image division calculation for the finding of rheumatoid arthritis	The consequences of the present examination are constrained by small size of the data test.	Future investigations will center around testing the division calculation with huge information test.
Dian Pratiwi et al [3]	Artificial Neural Back Propagation method	Utilized manufactured neural back proliferation strategy for the seriousness.	The entire preparing is isolated in three steps.	They have closed with 66.6% of grouping rate.
Sanjeevakumar Kubakaddi et al [4]	Measurement of Cartilage thickness for Early detection of Knee Osteoarthritis (KOA).	Contrast Enhancement, Histogram Equalization, Gaussian Filtering, Thresholding, Canny Edge detection, Masking.	Time Consuming, Lengthy process.	Early detection of KOA could aware people for treatment.
Prafull Sharma et al [5]	Image-segmentation algorithm	Algorithm provides fast and productive outcomes.	Time consuming.	Discrete step algorithm provides efficient results.
Bindushree R et al [10]	Canny edge detection algorithm	This algorithm have used distinctive image preparing methods to quantify the joint space width in knee x-beam images.	Image is said to be ordinary case or osteoarthritis case.	Image said to be Normal or osteoarthritis case with the standard Width (4.8 for women and 5.7 for men) and that image is said to be normal case or arthritis case.
Subromoniam M et al [11]	OA affected using X ray images.	Outcome with precise value 99% of bone issue caused by OA.	Have utilized only PC supported finding for the identification of OA utilizing X-ray beam images.	The calculation had an adequate decent outcome with precise value 99%.
Bhagyashri L. Wagaj and M.M. Patil [12]	Pixelbased Segmentation, Texture Filter.	Osteoarthritis is diagnosed using texture filter method.	Intermediate level is not detected so early detection of Osteoarthritis is not possible.	16 normal and 16 osteoarthritis affected images. Out of 16 OA affected 1 image is misclassified. Statistical analysis shows

				accuracy of 100% in normal case and 96.87% in osteoarthritis affected.
S.K.Nayak, Y.Karali, C.S.Panda [14]	Image Segmentation, Region based approach, Edge based approach.	Noisy and irrelevant data removal.	The techniques are not significantly satisfactory	A robust technique is required to be developed which will have high precision and be helpful.
Swati A.Bhisikar, Sujata N. Kale [17].	Image processing based algorithm.	The success rate of proposed method is compatible.	Fails to detect joints, joint space is no longer seen in the X-ray image, major drawback is to accurately measure joint space width.	The paper introduces a fully automated system to detect and measure the joint space width. Joint Location Success Rate by proposed method is 91.66 %.
Ali Nouri, Rasoul Amirfattahi, Hamidreza Moussavi [17].	Mutual information based detection of thermal profile in hand joints of rheumatoid arthritis patients using Non-parametric windows.	There were limitations in previous studies such as low resolution, large size of sensors and low speed of computers which are removed.		Result can be distinguished with the p-value of 0.0124 at the significance level of 5%.
Kento Morita, Atsuki Tashita, Manabu Nii, Syoji Kobashi[18].	Computer-aided diagnosis using machine learning	It is suggested that the image patch based method improves the estimation accuracy on increase of the number of subjects.	This method failed to detect 6 out of 28 of finger joints of severe Rheumatoid Arthritis patient.	The proposed method detects finger joints with accuracy of 81.4 %.

Table 3.1: Some existing recent algorithms are discussed, their advantages, disadvantages, limitation and further extension is discussed.

4. CONCLUSION

Today, Image segmentation is used in various fields such as Bio-medical imaging (like diagnosis, treatment, planning and computer integrated surgery), traffic control system, machine vision, face recognition etc. Image segmentation also has a significant role in Medical imaging. However an efficient technique is required in medical imaging which can enhance the image and remove the noisy, irrelevant data from the system. In this paper, a review is conducted on various approaches for image segmentation on MR images which will be helpful in detection of arthritis. This paper also discuss about the advantage and disadvantage of the many techniques proposed by various authors. Image segmentation includes algorithms such as Edge Based Segmentation, Region based Segmentation, Watershed Segmentation, Level Set Method, Active Contour Model etc. Though the research in this area is being done since decades still there is no one such segmentation technique that can be applied to every kind of image or which is universally accepted. There are various factors that affect the image segmentation process such as: homogeneity of images, spatial characteristics of the image continuity, texture, image content. Due to all the above factors this segmentation problem still remains a major concern in the image processing and computer vision fields. With the help of this study we came to know that an improvement in approach is still required that is going to be implemented in future work which can overcome the current work limitations.

REFERENCES

- [1].Lior Sharmir, Salim Rahimi, Nikita Orlov, Luigi Ferrucci, Ilya G. Goldberg, "Progression Analysis and Stage Discovery in Continuous Physiological Process using Image Computing", Hindawi Publishing Corporation, EURASIP Journal on Bioinformatics and Systems Biology, 2010, pp. 1-7.

- [2]. Dr.S.N Geethalakshmi, T.Jothi, "Segmentation Based On Enhanced Morphological Watershed Algorithm", Journal of Global Research in Computer Science (JGRCS), 2010, pp. 1-8.
- [3].Dian Pratiwi, Diaz D.Santika, Bens Pardamean, "An Application of Back propagation Artificial Neural Network Method for Measuring the Severity of Osteoarthritis", International Journal of Engineering & Technology (IJET) , 2011, pp. 102-105.
- [4].Sanjeevakumar Kubakaddi, KM Ravikumar, "Measurment of Cartilage Thickness for Early Detection of Knee Osteoarthritis (KOA)", IEEE Point-of-Care Healthcare Technologies (PHT) Bangalore, India, 2013, pp. 16-18.
- [5].Prfull Sharma, Joshua Madhukar Singh, "A Novel Approach towards X-ray Bone Image Segmentation using Discrete Step Algorithm", International Journal of Emerging Trends & Technology in Computer Science (IJETT), 2013, pp. 191-195.
- [6].Ying Ying Leung, Yong Hao Pua, Julian Thumboo, "A Perspective on Osteoarthritis Research in Singapore", Proceedings of Singapore Healthcare, 2013, pp. 31-39.
- [7]. Sivasundari S, R. Siva Kumar, M. Karnan, "Review of MRI Image Classification Technique", International Journal of Research Studies in Computer Science and Engineering (IJRSCSE), 2014, pp. 21-28.
- [8].Khaled Dewan, Hanan EI-saadany, "Dynamic contrast enhanced MRI of wrist as a useful diagnostic tool in early rheumatoid arthritis", The Egyptian Journal of Radiology and Nuclear Medicine, 2014, pp. 803-810.
- [9].Bhavyashree K G and Sheela Rao N, "Determination and Analysis of Arthritis using Digital Image Processing Techniques", International Journal of Electrical, Electronics and Data Communication (IJEEDC), 2014, pp. 46-49.
- [10].Bindushree R, Sanjeev Kubakaddi, Nataraj Urs, "Detection of Knee Osteoarthritis by Measuring the Joint Space Width in Knee X ray Images", International Journal of Electronics & Communication (IJEC), 2015, pp. 18-21.
- [11].Subromoniam M, Barani S & Rajini V, "A Non-invasive Computer Aided Diagnosis of Osteoarthritis from Digital X-ray Images", Biomedical Research, 2015, pp. 721-729.
- [12].Bhagyashri L. Wagaj and M.M. Patil, "Osteoarthritis Disease Detection with the Help of Image Processing Technique", International Journal of Computer Applications (IJCA), 2015, pp. 1-4.
- [13].Jose Austine, Shoba Nair and Kiyana Mirza. "Perspective of Orthopedists on Pain Management in Osteoarthritis: A Qualitative Study", Indian J Palliat Care (IJPC), 2016, pp. 410-415.
- [14].S.K. Nayak, Y. Karali, C.S Panda, "A Study on Brain MR Image Segmentation Techniques", International Journal of Research Studies in Computer Science and Engineering (IJRSCSE), 2015, pp. 4-13.
- [15].S. Jaydeep, V. Achuth, and Rekha Chakravarthi, "A Survey Conducted on Different Methods for the Detection of Arthritis", Research Journal of Pharmaceutical, Biological and Chemical Sciences (RJPBCS), 2017, pp. 1577-1583.
- [16].Swati A. Bhisikar, Sujata N. Kale, "Automatic Joint Detection and Measurement of Joint Space Width in Arthritis", 2016 IEEE International Conference on Advances in Electronics, Communication and Computer Technology (ICAECCT), Pune, India, 2016, pp. 429-432.
- [17].Ali Nouri, Rasoul Amirfattahi, Hamidreza Moussavi, "Mutual Information Based Detection of Thermal Profile in Hand Joints of Rheumatoid Arthritis Patients Using Non-parametric Windows", 2016 IEEE Canadian Conference on Electrical and Computer Engineering (CCECE), Vancouver, BC, 2016, pp. 1-4.
- [18].Kento Morita, Atsuki Tashita, Manabu Nii, Syoji Kobashi, "Computer-Aided Diagnosis System for Rheumatoid Arthritis Using Machine Learning", 2017 IEEE International Conference on Machine Learning and Cybernetics, (ICMLC), Ningbo, China, 2017, pp. 357-360.
- [19].T. Zhang, "An optimized fuzzy clustering algorithm for brain magnetic resonance image segmentation," 2017 13th International Conference on Natural Computation, Fuzzy Systems and Knowledge Discovery (ICNC-FSKD), Guilin, China, 2017, pp. 1999-2005.
- [20].Jessica W.T. Leung, "Current MR Imaging", Magnetic Resonance Imaging Clinics, 2018, pp. 179-314.
- [21].M. Khandelwal, S. Shirsagar and P. Rawat, "MRI Image Segmentation Using Thresholding with 3-class C-means Clustering," 2018 2nd International Conference on Inventive Systems and Control (ICISC), Coimbatore, India, 2018, pp. 1369-1373.