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A Survey Conducted on Different Methods for The Detection of Arthritis.

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ABSTRACT

Arthritis is a chronic disease which causes inflammation of one or more joints, causing pain and stiffness that can worsen with age. It is very common in elder people. It is caused due to reduction of Cartilage thickness present between the bone joints. In this paper, an analysis has been done on several methods conducted for early detection of Arthritis. By the early diagnosis and treatment of the arthritis, the damage to the joints can be reduced.

Keywords: Arthritis, Cartilage thickness, early detection of Arthritis

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INTRODUCTION

Now-a-days, arthritis is the most common disease among aged people. Between the bone joints there will be a transparent layer present, called "Cartilage". Due to the continuous use of the joints, this cartilage will be reducing continuously, and at a certain level it will fade away. Then the bones will encounter each other. Whenever the body joints tend to move, rupturing take place resulting in severe pain. Arthritis is the one among the most painful diseases afflicted to the bones and generally comes with the onset of Age. It causes deformation in joints as well as leads to inflammation also causing incapacitation in motion. Once it goes beyond a certain stage it cannot be reverted and causes impairment in motion.

Thus, many researches has took place and various techniques have been introduced for the analysis and detection of Arthritis such as 'Abnormality detection from Medical Thermographs',[2] in which the affected region is detected by using heat indications present in the Thermographs. Sheela Rao's [3], method is based on Image Enhancement followed by Edge Detection.

In this paper, a detailed survey for the detection of Arthritis has been presented. In section-II various techniques involved in analysis of the Image with noise along with the advantages and disadvantages involved in that particular technique has been discussed. In section-III a comparative table has been presented describing the techniques used, and the issues involved.

SURVEY DONE BY VARIOUS EXPERTS ON ARTHRITIS USING IMAGE PROCESSING

RESEARCH DATABASE

In M. Lakshmi Kumara and N. Prabakaran (2015), proposed a method for detection of Cartilage Thickness. Initially Knee joint images of the patient affected with Arthritis are collected. This image is undergone to Contrast Enhancing followed by Adaptive Histogram Equalization which increases the intensity level of input image for better image processing. After this Gaussian filter is used to remove random noise and other noises present in the image then the images are converted into black and white pixels to find the edge of cartilage area. Otsu- Thresholding Algorithm is used for converting grey scale image properties into white and black values using threshold value. Edge detection is done by adding mask layer to the original input to derive the edge properties. The Region of interest is found out and the original image is mapped with this binary image(Masking). Each normal is extended to meet the cartilage interface, and the cartilage thickness is calculated as the distance between the points of intersection of the normal to the two interfaces. With the help of the distance obtained thickness is calculated [1].

N.M. Nandhitha, et al (2010), proposed a method to find Arthritis by using Thermographs of Abnormal regions in the human body. Thermal Imaging is non-invasive, painless, hazardless application and its output is easy to interpret. Initially they took the thermograph of the affected region. These graphs are in uniform and symmetrical pattern for a normal healthy person, whereas for an abnormal person it can be hot spots or as cold spots. These Thermograph images are converted to grey scale to reduce the computational complexity. Then they applied Discrete Wavelet Transform(DWT) with Haar Wavelets to these Grey Scale Thermographs. After this they retained the Approximation image and the detailed images were zeroed for reconstruction of thermograph. From this reconstructed thermograph, they extracted the hotspot. The main advantage of this method is that it is completely Non-Invasive [2]. 'Sheela Rao N,Bhavyashree K G'(2014), proposed that, the abnormality of Arthritis can be found by analyzing the thickness value of cartilage. Initially they took the MRI image of the body part as input. The image is preprocessed and a random curve called Bezier splines is generated. Then the image is smoothened using non-linear anisotropic diffusion. Edges are enhanced by applying Canny and Log Edge detection methods. Finally, the thickness is measured by finding the number of pixels present between the edges [3].

Pradeep Kumar, et al (2010), developed a new technique for evaluating Arthritis by segmenting the thermal image using EM(Expectation-Maximization) and Fuzzy C-Means algorithm. Previously they found that 'Syaiful Anam' has proposed automatic bone boundary detection in hand radiographs by using modified level set method and diffusion filter. This method has shown good extraction performance, but the mask operation in this method could not work well for some images because the pixel intensities of bone and pixel intensities of other areas are similar in some parts which makes it difficult to identify. Whereas in this proposed method

their aim is to evaluate Rheumatoid Arthritis based on skin temperature measurements and to automatically segment the abnormal regions of thermogram using Fuzzy C-Means and EM algorithm. This technique is less expensive and involves non-invasive testing procedures with less time in processing the results this testing methodology is useful in detection of Rheumatoid Arthritis. Avoiding the routine diagnostic process like MRI, CT scan and Ultra sound which are of high cost [4].

Subramoniam.M (2015), proposed a Non-Invasive method for analysis of Arthritis by using Image Segmentation Algorithm. Initially noise is removed from the image by using a median filter. After this he took the histogram of the image to estimate the required seed value. Then grouping is done by Region Growing Algorithm. After grouping is done, the Edges are detected and extracted by Canny's Edge detection method. By doing this the periarticular spacing is located clearly. the pixel in the region of interest at some localized points is represented in terms of inches. The main advantage of this method is that it is completely Non-Invasive [5].In this method, Hari Krishna, et al (2013), initially took 20 image samples of tissue known as Biopsy of patients with different stages of Rheumatoid Arthritis. The images are taken using cybernetics camera which is viewed from the microscope. The stained Biopsy image is given as input and is converted to gray scale image. The entropy and highest gray of the grayscale values of the input image was calculated to measure the number of specific ways in which a system may be arranged, often taken to be a measure of disorder in image. The excess kurtosis of grayscale values of input image is calculated using Kurtosis Cal tool. The electrical property of synovial tissue can be obtained by measuring the developed voltage due to applied electrical signal. The synovial fluid level varies from normal patient to arthritis patient as disease prolongs due to weakening of synovium and surrounding muscle tissues. For arthritis affected patient's synovial fluid density increases based on disease condition rather than age and gender. This result indicates that synovial fluid density increases uniformly as age increases for normal patients and for arthritis patient synovial fluid volume change depends on arthritis disease level. Under study we conclude both image processing and non-invasive method can be used for diagnosis of RA. Under image processing different stages of RA can be diagnosed [6].

Arpita Mitta, Noida Sanjay Kumar Dubey (2012), proposed the image Enhancement of MRI Images Using Morphology technique for detection of arthritis. There are basically four operations in Morphology technique: Dilation, Erosion, Opening an Image and closing an Image. Basically, Dilation and erosion operations of the Morphology Technique are used for Image Enhancement. Previously Histogram Technique was used for enhancing image clarity by collecting Various MRI images of a normal person and a Rheumatoid Arthritis patient, including reading and writing images, performing histogram equalization on an image, and getting information about an image. The quality of image will be better with greater details which are beneficial for doctors for diagnosis purpose. Basically, a radiographic Image processing based methodology is presented to accurately and reliably diagnosis of the presence of disease Rheumatoid arthritis. The results presented here are preliminary and focused only the reproducibility aspects of the technique. This technique is being applied towards monitoring early stage rheumatoid arthritis patients in an ongoing clinical trial. Results obtained from the clinical trial data should provide a better understanding [7].

Monique Frizea, Cynthia Adéaa (2011), developed a method to detect arthritis using Infrared (IR) imaging .IR imaging offers a potential approach to detect changes in degree of inflammation. Thermal images were collected from joints of hands, wrists, palms, and knees. Regions of interest (ROIs) were manually selected from all subjects and all parts imaged. For each subject, values were calculated from the temperature measurements: Mode/Max, Median/Max, Min/Max, Variance, Max-Min, (Mode-Mean)2, and Mean/Min. The data sets did not have a normal distribution, therefore non-parametric tests (Kruskal-Wallis and Ranksum) were applied to assess if the data from the control group and the patient group were significantly different. Results indicate that: (i) thermal images can be detected on patients with the disease; (ii) the best joints to image are the metacarpophalangeal joints of the 2nd and 3rd fingers and the knees; the difference between the two groups was significant at the 0.05 level; (iii) the best calculations to differentiate between normal subjects and patients with RA are the Mode/Max, Variance, and Max-Min. We concluded that it is possible to reliably detect RA in patients using IR imaging [8].

SP.Chokkalingam, K.Komathy (2008), proposed intelligent assistive methods for detecting arthritis with more accuracy. In this, the image first undergoes histogram smoothing and specification, morphing operation, boundary detection by edge following algorithm and finally image subtraction to determine the presence of rheumatoid arthritis in a more effective way. Using preprocessing technique noises are removed from images and using segmentation, region of interest is found and Histogram smoothing is applied for a specific portion

of the images. Gray level co-occurrence matrix (GLCM) features like Mean, Median, Energy, Correlation, Bone Mineral Density (BMD) etc. After finding all the features it stores in the database. This dataset is trained with inflamed and non-inflamed values and with the help of neural network all the new images are checked properly for their status and Rough set is implemented for further reduction [9].

M.Vinoth and B. Jayalakshmi (2009), proposed a method for detection of arthritis which involves steps such as de-noising, histogram smoothing, segmentation and edge detection in order to enhance the given image. The strength of a bone depends on Bone Mineral Density (BMD) which is a major factor in identifying bone diseases. The mathematical relationship between Bone Mineral Content and Volume by Region of Interest will helps in calculating Bone Mineral Density and various features of bone images such as area, mean, standard deviation and variance. The Gray Level Co-occurrence Matrix (GLCM) is one of the image analysis techniques that can be used for extracting features (Energy, Entropy, Contrast, Homogeneity, and Correlation) of a bone image. A dataset is created from both the normal and eroded bone images by applying BMD and GLCM features. Whenever a new bone image is given as an input, the features of the image are extracted and compared against the dataset. The input image is classified as whether infected or not infected using neural network which achieved classification accuracy of about 96.66% [10].

Jizhou Li, et al (2014), proposed a method for the detection of Quadriceps muscle thickness changes in Cross-sectional plane using Ultrasonography. Ultrasonography is widely used in the field of measuring morphology changes of skeletal muscles due to its advantages, such as being stable, easy to use and low cost. In this method eight subject's knee images are taken and their sensitivity and efficiency are evaluated. The results are compared with those obtained from traditional manual measurement and the well-known normalized cross relation method, and the effect of the size of tracking window is evaluated [11].Masato Shimizu, et al (2015), proposed a method called "Super-Resolution for X-Rays", an efficient way for finding the cartilage thickness in Arthritis. X-Rays have low resolution and a significant amount of noise, because radiation levels are minimized to maintain patient safety. In this paper, they proposed a novel super-resolution method for X-ray images, and a novel measurement algorithm for treatment of rheumatoid arthritis. Initially they took X-Ray images of the patient and it is undergone to Total Variation(TV) Regularization, followed by a shock filter and a median filter. In addition to this they also proposed a measurement algorithm for measuring the joint space distance i.e. the distance between the two joints. 20 measurement values are taken in this way and variance value is calculated. This method gives better results than the normal X-Ray method, because the noise levels are reduced and the image resolution is increased. But, the process takes much time and lengthy [12].

David Maresca, et al (2014), proposed a method to find Arthritis using Ultrafast Doppler. In this method, they show that ultrafast Doppler imaging characterizes metacarpophalangeal joint microvasculature with an accuracy, making it an efficient micro angiography method for the early diagnosis of RA. They used a 15 MHz probe (256 elements linear array, 0.125 mm pitch) connected to a programmable ultrafast ultrasound scanner. They took the second metacarpophalangeal joint of 13 healthy volunteers with a dedicated ultrafast Doppler imaging sequence consisting of 41 plane wave transmissions at a pulse repetition frequency of 20 kHz during one second. They imaged microvascular blood flow in 12 out of 13 healthy joints, with Doppler signal to noise ratios of the order of 5dB. In addition, they computed for every individual a functional capillary density (defined as the length of perfused capillaries in mm per tissue area in mm2) and obtained values of the order of 0.6 ± 0.1 mm micro vessel/mm2 tissue. The method, which can be readily implemented on ultrafast ultrasound scanners, shows strong potential for the early diagnosis of RA. It has the advantage of being fully non-invasive. But the quantification of inflammation stages is currently limited by the coarse resolution and sensitivity of conventional Doppler imaging [13].

Sanjeevakumar Kubakaddi (2013), proposed a method for the measurement of Cartilage Thickness for Early Detection of Knee Osteoarthritis(KOA). Initially he collected MRI images of the patents suffering from Arthritis. These images are subjected to contrast enhancement for the better view of boundaries. The contrast stretched image is then histogram equalized adaptively. The histogram is plotted to understand the grey level of the image. Histogram equalization distributes pixels to different grey levels. After Adaptive histogram equalization, the image is subjected to Gaussian low-pass filtering to remove unnecessary high frequency edges around the cartilage, so that it eases the zero-crossing detection to find the thickness of cartilage. The image is further contrast enhanced for making the boundaries of knee more clearly before thresholding. After thresholding, canny edge detection is applied to it to find the boundaries of cartilage. The masks are generated

since the cartilage is always situated at the center of the Knee MR image. Then Zero Crossing detectors are used to find the dimensions of cartilage in the image. Finally, these image dimensions are used to find actual thickness of image in millimeter. The thickness obtained was compared with normal cartilage thickness. Advantage of this is that the early detection of KOA could aware people to retard the progression of the ailment [14].

Lior Shamir, et al (2009), proposed an X-Ray Image analysis method for detection of Osteoarthritis. In this method, the detection is based on the Kellgren–Lawrence(KL) classification grades, which correspond to the different stages of OA severity. The classifier was built using manually classified X-rays, representing the first four KL grades (normal, doubtful, minimal, and moderate). Image analysis is performed by first identifying a set of image content descriptors and image transforms that are informative for the detection of OA in the X-rays and assigning weights to these image features using Fisher scores. Then, a simple weighted nearest neighbor rule is used to predict the KL grade to which a given test X-ray sample belongs. The dataset used in the experiment contained 350 X-ray images classified manually by their KL grades. Experimental results show that moderate OA(KLgrade3) and minimal OA (KL grade 2) can be differentiated from normal cases with accuracy of 91.5% and 80.4%, respectively. Doubtful OA (KL grade 1) was detected automatically with a much lower accuracy of 57%. The main limitation of this methodology is that it is less perfect i.e. it does not give accurate values [15].

Table 1: Summary of Literature Survey

Authors	Techniques Used In Detection of Arthritis	Conclusion
M.LAKSHMI KUMARA et al (2015)	Contrast Enhancement Histogram Equalization Gaussian Filtering Thresholding Masking Mapping	Efficient Less complex Potentially suitable for Non-Invasive measurement of articular cartilage.
N.M.NANDHITHA et al (2010)	Grey Scale Conversion Discrete Wavelet & Harr transform Estimation of Seed value Grouping by Region Growing Algorithm Edge detection using Canny's Edge detector	Dependent on parameters Efficient Gives accurate values Time consuming
BHAVYASHREE K G et al (2014)	MRI image of the body part Generation of Bezier spline curves Non-Linear Anisotropic diffusion Canny and Log Edge detection	Simple and efficient Improved by automated technique for threshold selection
M.SUBRAMONIAM (2015)	Median Filtering Histogram Estimation Seed point selection Region growing Edge detection & Edge extraction	Semi-automated method. Provides a non-invasive tool for the diagnosis. Efficiency is high Segmentation process needs more time.
ARPITA MITTAL et al (2012)	Image Acquisition Compression Segmentation Representation Recognition	Radiographic Image processing based methodology is present Accurate Reliable This article provides thought of

	Image Enhancement Image Restoration	better understanding towards the disease in comparative way.
MASATO SHIMIZU et al (2015)	Total Variation(TV) Regularization Shock filter Median filter Measurement algorithm for Joint Space Distance(JSD)	Gives better results than the normal X-Ray method Noise levels are reduced Image resolution is increased. Process takes much time and lengthy.
JIZHOU LI, et al (2014)	Coarse to fine method Data Acquisition and Data Processing Coarse Locating Fine-Tuning	Low cost Easy to use outperform the cross-correlation method
M.VINOTH, et al (2014)	Image denoising Histogram smoothening Image segmentation Edge detection Grey level co-occurrence matrix calculation of Bone mineral density	Accurate Robust Efficient Low cost Quick comparison Highly sensitive
MONIQUE FRIZE, et al (2011)	Image collection Grey scale conversion Max, Min, Mean distribution Comparison	Early detection Efficient Expensive Lengthy process More time
DAVID MARESCA, et al (2014)	Image acquition Ultrafast Doppler imaging Perfused micro vessel density Vasodilatation	Early diagnosis Non-invasive Less efficient Less time Less cost
LIOR SHAMIR, et al (2009)	Data acquition Image classification Joint detection Median filtering Edge detection	Less than perfect Automated method Greater radiation exposure
HARI KRISJNA, et al (2010)	Grey scale conversion Kurtosis Cal tool Electrical property Synovial fluid Comparison	Non-invasive Accurate Expensive More time Lengthy
SANJEEVAKUMAR KUBAKADDI et al (2013)	Contrast Enhancement Histogram Equalization Gaussian Filtering Thresholding Canny Edge detection Masking	Early detection of KOA could aware people to retard the progression of the ailment. Highly efficient way Time consuming Lengthy process.

CONCLUSION

Arthritis is a disease which causes inflammation in body joints. This disease is caused when the Cartilage disappears completely. The two joints encounter each other and rupturing takes place which results in severe pain. This study enables us to establish the concept of ultrasonic imaging and can detect the presence of Arthritis in human body. In this study, we went through several methods of detecting Arthritis.

With the help of this study we came to know that, Early Detection of this disease can help to prevent the complete damage of Cartilage.

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