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Support Vector Machine Approach for the Diagnosis of Arthritis From Digital X-Ray Images Using Local Ternary Pattern

KEYWORDS: Local Ternary Pattern, Support Vector Machines, Arthritis diagnosis

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ABSTRACT *A set of conditions which causes damages to the joints of the human body is called as Arthritis. This disease can lead to early disability and joint deformities. Radiography of the joint under study can be used to examine the erosion level caused by arthritis and it is the conventional method followed for the diagnosis of arthritis however the analysis of the erosions mainly depends upon the knowledge of the radiographer. There are a number of computer aided diagnosis methods was developed by the researcher to provide an alternate approach to this problem and to provide better diagnosis. One such computer aided approach has been discussed in this paper. The algorithm was developed by extracting the features from digital x-ray images using Local ternary Pattern (LTP) and classifying them by using support Vector Machine Classifier. 50 X –ray samples was used to evaluate the performance of the algorithm. The sensitivity and the specificity of the developed algorithm were satisfactory.*

INTRODUCTION

Arthritis starts with the erosions of the synovial membrane. These erosions will lead to the reduction in the periarticular spacing in the bone joints. This reduction in spacing in bone joints leads to pain, stiffness and joint immobility. The exact cause of the disease is not known (1).The studies done by using the thermo graphic images showed a significant difference between the normal and the abnormal joint spacing in bones. The studies done on these thermo graphic images by Euclidean segmentation method showed that the pixel area of the images will vary abnormality. The thermo graphic imaging studies done on bone joints showed an significant difference between the normal person and the also stiffness in bone joints due to arthritis and physical strain. The study doesn't provide any useful information regarding the extent of abnormality in bone joints. (2).Kellgren–Lawrence (KL) grading is used to classify the disease based on the abnormality. An automated method of developed by extracting the features by using compound image transformation and classifying them based on KL grade has provided better results. The analysis is done by assigning fisher sores to the informative features in the radiographic images and classifying them by using nearest neighbor algorithm. The method has poor classification rate over normal case images (3). The analysis done on infra red images showed a significant temperature change between normal and abnormal joints. The studies were done by applying non parametric methods on the temperature obtained between the normal and the abnormal cases of bone joints. This method of study can be focused towards the early diagnosis of arthritis (4). An algorithm developed using Ground Reaction Force (GRF) patterns and nearest neighbor classifier showed the significant difference between the gait patterns in arthritis. The coefficient of polynomial expansion and the coefficients of the wavelet decomposition are used in the analysis. The extracted features are classified using nearest neighbor classifier. The features extracted by wavelet decomposition produced better classification rate than the other (5).The segmentation done on 2-D MRI images provide an semi automated method for the diagnosis of arthritis from the cartilage variations. The various image processing techniques like Histogram equalization, thresholding. Edge detection was applied on the region of interest in MRI images. This method showed the significant difference between the change in the cartilage volume of the abnormal bone joints and normal bone joints (6).The analysis done using the optical contrast between the intra and extra articular tissue showed a significant difference in the soft tissue changes in bone joints when the imaging studies are done with photo acoustic tomography (PAT). This imaging technique can be used for used for early diagnosis of arthritis (7). The algorithm developed using active appearance models provided a novel approach for the segmentation of hand radiographic images. The image pixel value in the normal and the abnormal bone joint space width are taken for analysis and a training set is constructed for the analysis of the unknown image. The method can be extended for the automated method for the diagnosis of arthritis. (8). The classification done by using SVM classifier on the Electrocardiogram signals has produced significant results. The classifier provided a successful classification rate for the classification of normal waveforms from five different types of abnormal waveforms (9). The features extracted by using Local Binary pattern when combined with SVM Classifier have produced satisfactory results for the analysis of the expressions due to facial paralysis. This method also provided a quantitative method of analysis (10). On the other hand SVM has produced unsatisfactory results when applied for the classification of imbalance data sheets of Eukaryotic genomes (11).

PROPOSED METHOD

The proposed algorithm was developed by extracting the features from digital X-ray images using Local Ternary Pattern and classifying them using Support Vector Machine (SVM) classifier. The block diagram of the proposed system is shown in Figure (1).The brief description of each block is described in the subsequent sections.

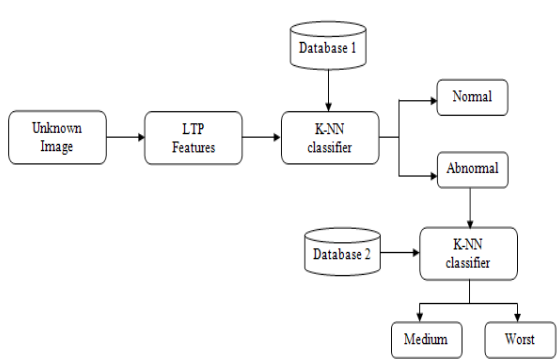

Figure 1: Block diagram of the proposed system.

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DATA:
The data used in this algorithm are the digital X-ray images of the knee joints. The actual image is in the Digital Imaging and Communications in Medicine (DICOM) format and they are converted to Joint Pictures Experts Group(JPEG) format. This is done for easy processing of images with MATLAB which is the platform in which the algorithm is developed. One more advantage with this conversion is the memory space utilized by the image is less and its pixel value remains unaltered. The actual size of the image after conversion is around 1000 X 1000 and the small portion which is Region Of Interest(ROI) is extracted from those images to s size of 200 X 200. The actual image and the ROI image are shown in the Figure(2). The Kellgren Lawrence grading is the grade used for the classification of images in this algorithm.

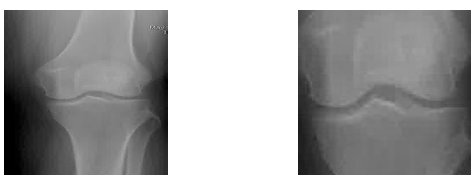

Figure 2(a): Actual Image (b) ROI Image

Table (2).KL grade for classification of arthritis

Grade I	Unlikely narrowing of the joint space possible Osteophytes
Grade II	Small Osteophytes, possible narrowing of the joint
Grade III	Multiple, moderately sized Osteophytes, definite joint space narrowing, some sclerotic areas, possible deformation of bone ends
Grade IV	Multiple large Osteophytes, severe joint space narrowing, marked sclerosis and definite bony end deformity

LOCAL TERNARY PATTERN (LTP)
Local ternary operator works over a 3X 3 window over the selected region of interest. Local ternary pattern uses a threshold constant to threshold pixels into three values whereas Local Binary Pattern uses only two values to threshold the pixels (either 0 or 1). The LTP operator can be expressed as

Where
k -threshold value of the pixel
c- Center pixel value
p- Neighboring pixel value

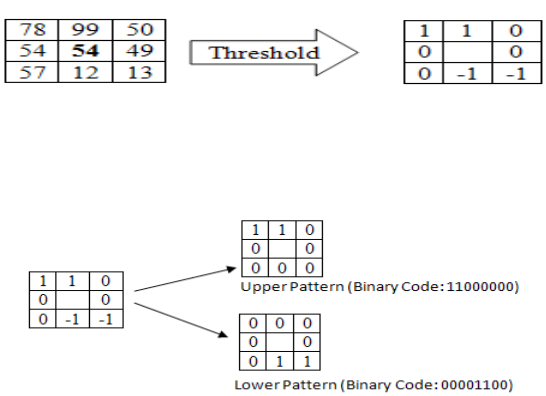

Fig (3.).Illustration of LTP operator.

SUPPORT VECTOR MACHINES
The data is classified by constructing hyper planes in a multi dimensional space by the Support vector machines. This hyper plane is used for the classification of data of different types of classes. Support vector machine is can be used for classification as well as for regression. The advantage of this SVM classifier is that it doesn't need the prior knowledge for classification. Both linearly separable and non-linearly separable data can be classified with this classifier. The linearly separable data can be classified easily in the two dimensional space whereas the non-linearly separable data are classified by transforming them to the higher dimensional space. The Vectors that forms near the boundary of the hyper planes form the support vectors. For better classification results the number of support vector has to be kept as minimum as possible. The support vector machines need an optimum input. The optimum input for the classification is decided by the Kernel Functions. This algorithm is tested with four kernel functions. The brief explanation of each kernel function is explained in the following sections.

RESULTS AND DISCUSSION
The developed algorithm was evaluated by using the digital X-Ray samples of knee images. A total of 50 samples were used to evaluate the algorithm. The specificity and sensitivity is the parameter used for evaluation. The results obtained are as follows.

Table (3). Specificity and Sensitivity Table

Kernel Functions	**Number of Normal case Images** (15)		**Number of Abnormal case Images** (35)		Specificity *(Probability of positive test stating that the given patient is ill)*	**Sensitivity** *(Probability of positive test stating that the given patient is well)*
	TP	FP	TN	FN		
Linear	33	03	12	02	91.66	80
Polynomial	33	03	12	02	91.66	80
RBF	35	05	10	00	94.59	66.66

Where,

TP-True positive: Abnormal joint identified as abnormal Joint.

FP- False positive: Normal joint identified as abnormal Joint.

TN-True negative: Normal Joint identified as normal Joint.

FN-False negative: Abnormal joint identified as normal Joint.

From the above results it can be concluded that SVM classifier has produced good specificity and sensitivity with the radial basis functions. However for other applications the classification rate has varied with the variation in the kernel functions. So proper choice of kernel function has to be done for better classification rate.

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REFERENCE

[1]. Firestein GS, Zvaifler NJ: "Rheumatoid Arthritis: A Disease of Disordered Immunity". New York: Raven Press; 1992. | [2]. N.Selvarasu, Alamelu Nachiappan and N.M.Nandhitha, "Euclidean Distance Based Color Image Segmentation of Abnormality Detection from Pseudo Color Thermographs", International Journal of Computer Theory and Engineering, Vol. 2, No. 4, August, 2010 1793-8201 | [3]. Lior Shamir and et.al "Knee analysis method for automated detection of osteoarthritis".IEEE transactions on Bio-Medical Engineering, Vol 56,No 2,Feb 2009,407-415 | [4]. Monique Frize and et.al "Preliminary results of severity of illness measures of rheumatoid arthritis using infrared imaging" International workshop on Medical Measurements and applications Cetraro,Italy,May 2009,187-192. | [5]. Neila Mezghani and et.al,Automatic Classification of Asymptomatic and Osteoarthritis Knee Gait Patterns Using Kinematic Data Features and the Nearest Neighbor Classifier, IEEE Transactions on Biomedical Engineering, VOL. 55, NO. 3, March 2008. | [6]. Malikarajuna swamy and M.S.Holi, "Knee Joint Cartilage Visualization and Quantification in Normal and Osteoarthritis," Proceedings of 2010 International Conference on Systems in Medicine and Biology"16-18 December 2010, IIT Kharagpur, India | [7]. Xueding Wang, David L. Chamberland, and David A. Jamadar ," Noninvasive photoacoustic tomography of human peripheral joints toward diagnosis of inflammatory arthritis", Optics Letters, Vol. 32, Issue 20, pp. 3002-3004 (2007). | [8]. J.A. Kauffman, C.H. Slump, H.J. Bernelot Moens, "Segmentation of Radiographs of Hands with Joint DamageUsing Customized Active Appearance Models" ProRISC 2004, 15th Annual Workshop on Circuits, Systems and Signal Processing, 25-26 Nov 2004. | [9]. Farid Melgani ,2008, "Classification of Electrocardiogram with support vector machines and particle swarm optimization" IEEE Transactions on Information Technology In Biomedicine,12,667-677 | [10]. John J.Soraghan, Brian F.O'Reilly and Dongshan Xing,(2009),"Quantitative analysis of facial paralysis using local binary patterns in biomedicine videos",IEEE Transactions Of Biomedical Engineering,56,1864-1870. | [11]. Mohd.Faheem Khan. Gaurav Chauhan and A.K.Jaitly ,(2011),An apporoach to overcome datasheets of eukaryotic genomes during the analysis by machine learning technique"Indian Journal Of Science And Technology,4,520-524.