ISSN No. 0976-5697
Volume 4, No. 5, May 2013 (Special Issue)
International Journal of Advanced Research in Computer Science
RESEARCH PAPER
Available Online at www.ijarcs.info

A Semi Automated Method for Identification of Arthritis Using Statistical Features

Mr.M.Subramoniam
Research Scholar
Sathyabama University
Chennai,India subu_viruthika@rediffmail.com

Dr.V.Rajini
Dept. of EEE, SSN Engg. College
Chennai,India
rajiniv@ssn.edu.in

Abstract: Arthritis is a kind of disorder which takes occurs in bone joints. The cause for the disease is unknown. This disease cannot be cured, but can be controlled if it gets diagnosed at the earlier stage. Radiography is the conventional method **followed** for analysing the erosions caused by arthritis. However analysing such images depends on the knowledge of the radiographer who analyse the image. A computer aided analysis can be an alternate approach to the problem. One such method has been discussed in this paper. This method use the features extracted from the digital x-ray image of the joint under study using Local Binary Pattern(LBP) and classifying them through Bayes classifier. The specificity and the sensitivity produced by the algorithm are satisfactory.

Keywords: Arthritis; Pattern recognition; Bayes classifier; Local Binary Pattern; Semi automated method

I. INTRODUCTION

The protein substance that is in between the bone joints is called as cartilage. This cartilage is covered by the synovial lining in which synovial fluid is placed. Arthritis starts with the erosion of synovial lining which results in the reduction of joint spacing in bone joints. An infra red imaging camera is used to obtain accurate measurements of the erosions in bone joints affected by Rheumatoid arthritis in [1]. Temperature measurements of hands are analyzed with first order statistics and significant temperature differences between control subjects and patients for every joint and hand portion measured. Novel patient specific gait modifications that achieve knee OA rehabilitation without changing the foot path is proposed in [2]. The modified gait motion is designed for a single patient with knee Osteoarthritis using dynamic optimization of a patient specific full-body gait model. The algorithm developed using 3-D ground reaction force (GRF) provided an automatic computer method to distinguish between asymptomatic and Osteoarthritis knee gait patterns in [3]. The coefficients of a polynomial expansion and the coefficients of wavelet decomposition are the two different features are investigated. A systematic computer aided image analysis method is used to analyze pairs of weight bearing knee x-rays in [4]. Image processing techniques like Histogram equalization, thresholding and edge detection applied on the Region of interest of the magnetic resonance images on knee segments cartilage from femur, tibia and menisc [5]. Machine vision systems for Osteoarthritis assessment in [6] is designed to help doctors to determine the region of interest of visual characteristics found in knee Osteoarthritis , and to provide accurate measurement of joint space width. Edge detection operator and its enhanced algorithm are used to detect edges for human knee osteoarthritis images in different critical situations in [7]. It is shown that the algorithm is very effective in case of noisy and blurs images. An image computing based method for quantitative analysis of continuous physiological processes that can be sensed by medical imaging and demonstrate its application to the analysis of morphological alterations of the bone structure which correlate with the progression of osteoarthritis is proposed in [8]. A fully automatic segmentation method of bone compartments in a knee joint on MR images from the osteoarthritis initiative a huge database for research on knee Osteoarthritis is proposed in [9].An automated technique for the visualization and mapping of particular cartilage in magnetic resonance images (MRI) is described in [10]. This paper discusses a semi automated method for the diagnosis of arthritis form digital x-ray images from the extracted feature using Local Binary Pattern and classifying them using Bayes classifier . This paper is organized as follows. Section (II) discuss about the type of data used in the algorithm and the modification done on those data. Section (III) discuss the proposed method for the automated method for the diagnosis of arthritis. The results obtained were discussed in section (IV).

II. DATA

The Knee X-ray images used in this algorithm are obtained classified as follows. The actual images are in Digital Imaging and Communications in Medicine (DICOM) fromat and they are converted into Joint Pictures Experts Group(JPEG) format. The joint spacing in knee joints which fall under grade –I and grade-II of Kell –gren Lawrence grading are considered as normal cases,grade-III is considered as medium and grade IV is considered as worst case for the algorithm.The Kellgren Lawrence grading is given in Table.1.The medium and the worst cases are considered as the abnormal cases for the final stage of classification which is discussed in section(III).All those images were maually analysed and reported by a radiographer for the development of training set.These images were used to construct the training set for the classification stage discussed in section(III).The algorithm compares the features of the unknown input image with the features of the trained pre-stored data.

Table.1. KELLGREN LAWRENCE GRADING FOR 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

III. PROPOSED METHOD

The main scope of the algorithm is to automatically identify the extent of abnormality in bone joints from the digital X-ray image. The Block diagram of the proposed system is shown in Fig.1. It consist of two stages . They are feature extraction stage and classification stage

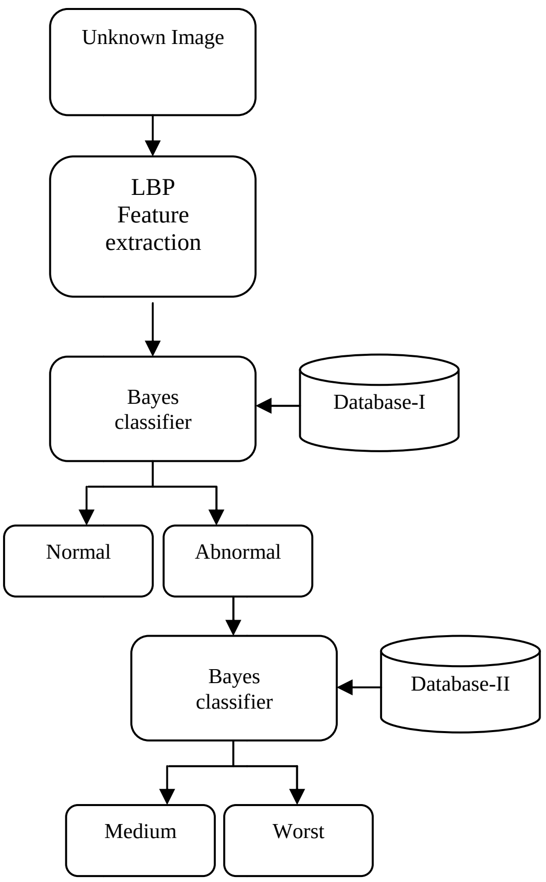


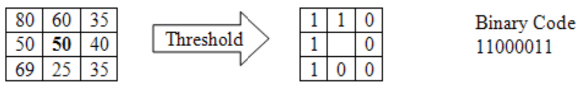
Fig.1.Block diagram of proposed system.

A. *Feature Extraction stage*

Arthritis results in the reduction of joint spacing in between the bones. So the features in the joint spacing are used for classification. The Region Of Interest (ROI) is selected over the joint spacing in the bone joints and the ROI is cropped manually from the actual digital X-ray image. The features in the ROI are extracted by Local Binary Pattern(LBP) method.

B. *Local Binary Pattern*

The Local Binary pattern uses the grey level structure of the image. In this method a 3X3 window is selected over the selected region of the given image. The center pixel value of the window is chosen as the threshold value .The threshold value is compared with all the other pixels in the window. Based on the deviation of the other pixels from the threshold value a binary code is generated. This process is applied for the whole image to obtain LBP of the given image. A 3x3 window size consists of 8-pixels, so that a total of 2^8 = 256 different patterns can be obtained. The histogram for the LBP features are generated and stored in Data Base-I which comprises the features of normal joint spacing and abnormal joint spacing and in Data Base -II which comprise of the abnormal features of medium joint spacing and worst joint spacing of bone joints. The operation of LBP is illustrated in Fig.2.



The LBP operator is given in Eq.(1).

$$LBP(x_c, y_c) = \sum_{n=0}^{7} 2^n s(i_n - i_c) \qquad (1)$$

where

ic - Center pixel value in the window

i_n - Eight pixels surrounding the center pixel

$$Sx = \begin{cases} 0, & x < 0 \\ 1, & x \geq 0 \end{cases}$$

C. *Classification Stage*

The classification stage is comprised of two stages . They are Initial Classification stage and Final Classification stage. The initial classification stage classifies the given input image with unknown joint spacing into normal and abnormal joint spacing width. The extent of abnormality is given by the final stage classifier . This classifier will classify the images with abnormal joint spacing into medium and worst joint spacing width. The classification is done by Bayes classifier.

D. *Bayes classifier*

The Bayes classifier is also called as independent feature model because the classification is done on independence assumptions. It is a model based approach which offers a useful conceptual frame work. This classifier works well even with small amount of training data to estimate the parameters. All the model parameters can be approximated with relative frequencies from the training set. These are maximum like hood estimates of the probabilities. The Baysian classifier is given by

$$p(c_j|d) = \frac{p(d|c_j)p(c_j)}{p(d)} \qquad (2)$$

Where

p(cj/d)=Probability of instance d being in class cj

CONFERENCE PAPER
"National Conference on Networks and Soft Computing"
On 25-26 March 2013
Organized by
Vignan University, India

p(d/cj)= probability of generating instance d given class cj

p(cj)=Probability of occurrence of class cj

p(d)=probability of instance d occurring.

The advantage with Bayes classifier is that the prior knowledge and the observed date can be combined. Based on the probabilistic model specification any kind of objects can be classified. In this algorithm the Bayes classifier classifies the extent of abnormality based on the distribution of features computed by Local binary pattern. Kernel distribution method is used in this algorithm for finding the distribution of features of the given input image with the stored features in Data base-I and in Data base-II. The Kernel distribution is described in the following section.

E. Kernel Distrubution

This distribution is a non parametric way to estimate the probability density function of a random variable. In this any factors that are not the functions of any of the variables in the domain are omitted. In the classification using bayes classifier the normalization factors are generally ignored and only the kernel is considered. The results of the given un known data for kernel distribution is based on the finite data sample. Let (x1,x2,…xn). the density estimator f is given by.

$$f(x) = \frac{1}{n}\sum_{i=1}^{n}(K_h(x - x_i) = \frac{1}{nh}\sum_{i=1}^{n}K(\frac{x - x_i}{h}) \qquad (3)$$

Where k is the kernel is the smoothening function x and xi are the known and unknown vectors in training space respectively. Based on the closeness of the vectors the unknown data is classified into Normal and abnormal cases. To diagnose the extent of abnormality, the abnormal features are trained with the pre-stored features in database-II . The results obtained are given below

IV. RESULTS AND DISCUSSION

To check the developed algorithm, the experiments were done using digital X-ray image of Knee. A total of 50 samples were used to test the algorithm. Of this 15 images with normal joint spacing and 35 images with abnormal joint spacing are used for testing. The 35 Abnormal joint spacing include a total of 19 images with medium affected joints and 16 images with worst affected Joints. The specificity and sensitivity of the initial stage classification and final stage classification is listed in Table II and in Table III respectively.

TABLE II . INITIALSTAGE CLASSIFICATION

Parameter	Normal	Abnormal
Classification Rate	66.67	97.14
Sensitivity	97.10 (Probability of positive test given that the joint is affected)	
Specificity	67.10(Probability of negative test given that the joint is not affected)	

The extent of abnormality is given by the final stage classification and the classification rate of final stage classifier is listed out in Table II.

TABLE III. FINAL STAGE CLASSIFICATION

Parameter	Medium	Worst
Classification Rate	87.50	89.40

V. CONCLUSION

This algorithm produced satisfactory specificity sensitivity and classification rate. Therefore this algorithm can be used as a diagnosing tool which can assist the radiographer for better diagnosis of arthritis from digital X-ray images. however the algorithm has be further developed to increase the sensitivity and decrease the specificity by considering the other distribution methods which is considered as the future part of the work

References

[1] Firestein GS, Zvaifler NJ: "*Rheumatoid Arthritis, A Disease of Disordered Immunity"*. New York: Raven Press; 1992.

[2] Iwakura Y: "Roles of IL-1 in the development of Rheumatoid Arthritis", consideration from mouse models". *Cytokine Growth Factor Rev 2002 13:341-355*.

[3] N.Selvarasu,AlameluNachiappan,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

[4] Alexander .K.Scheel and et.al "Assessment of proximal finger joint inflammation in patients with Rheumatoid arthritis using a novel laser based imaging technique": Arthritis and Rheumatism vol. 46,No.5May 2002,1177-1184

[5] en.wikipedia.org

[6] S.J.Sandy and et.al.: "Measurement of cartilage volumes in rheumatoid arthritis using MRI".British Journal Of Radiology.

[7] B.M.Moores:"Digital X-ray imaging" IEEE proceedings ,Vol 134,no2,February 1987 115-125

[8] 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

[9] 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.

[10] M.Subramoniam,V.Rajini,B.Sowmya, "Segmentation Of arthritis Inflammated joints from X-Ray images" NCRTCPT 2010,Conference proceedings.