



PREDICTION OF RHEUMATOID ARTHRITIS USING CORRELATION TECHNIQUE

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ABSTRACT

Rheumatoid arthritis (RA) is a chronic inflammatory diseases occurring in patients with autoimmune disorders. Erosion formation typically occurs in early disease at the proximal enthesis, but in later stages, spur formation occurs at the distal end of the ligament attachment site. The frequency and size of the abnormalities and the number of affected joints are associated with poor clinical outcomes. Some individuals exhibit extremely destructive and disfiguring forms of the disease with erosions and periosteal bone formation leading to disability. Radiographic imaging is the most common modality to identify and assess characteristic features for RA including joint erosions, joint space narrowing, bony proliferation and formation. However, radiography has relatively low sensitivity for the detection of degenerative features in early disease stages, and these features are often poorly defined due to the progression of periosteal bone formation adjacent to erosions. Computed tomography (CT), magnetic resonance imaging (MRI) and ultrasound imaging are gaining clinical popularity. These technologies are capable of detecting early stages of disease and monitoring joint changes during disease progression with greater sensitivity than that of plain radiographs.

The most prevalent form of arthritis, Osteoarthritis has been affecting 15 million adults annually with a prevalence ranging 22% to 39% in India. Other common joint conditions affecting Indians are gout and rheumatoid arthritis.

Osteoarthritis is more commonly observed in women and more prevalent with ageing. Studies have observed that nearly 45% of women over the age of 65 years have symptoms while radiological evidence is found in 70% of those over 65 years.

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1. INTRODUCTION

Rheumatoid Arthritis (RA) is a general disease characterized by inflammation, discomfort, and tenderness of the joints and might involve additional body part organs in severe cases. Leading to increased vascular disorder in the zone of inflammatory tissue, joint autoimmune lesions are associated with elevated fever. The detection of RA usually involves blood sample tests. This thesis proposes a novel methodology of detection by processing the Xray images. This automated system requires clear Xray images, which after preprocessing and segmentation using Support Vector Machine implemented via MATLAB gives a clear classification about the abnormal and normal images. Different output parameters were used to assess separation tasks. The accuracy of the model section has improved to the use of an optimized SVM network. The proposed model was effective in accurately separating the samples.

The term (RA) is used to describe more than 100 rheumatic diseases and conditions affecting the bones and tissues. Alarmingly, India will emerge as the capital of Osteoarthritis by 2025 with more than 60 million to be likely affected. Ironically, one of the main reasons is the increasing longevity of India's population, another being fast-rising obesity.

1.1 LITERATURE SURVEY

1. The application of abstract set theory to obtaining various geographical parameters of Xray images has been introduced by Sankar K. Pal and Robert A. King. Prior enhancement of variation between regions (with minor variations in gray levels) using intensification (INT) efficiency and shifting on a non-slip material plane before gaining its edges are used in the algorithm. Using the functions S, π and $(1 - \pi)$, as well as fuzzifiers, the cargo plane was ejected from the local domain. A max or min operator is used to detect the final end. A radiograph of the wrist is used to demonstrate the accuracy of a device with several parameters.
2. P. Thangam, K. Thanushkodi, and Thushika Mahendiran have created a curriculum that includes endocrinological disorders in children that are seen in many countries worldwide and vary in diameter and severity in various age ranges and races. Changes in diet and eating habits also correlate to endocrine disorders, necessitating the development of a device that can predict those issues ahead of time. In the treatment and diagnosis of endocrine diseases, osteoporosis is a popular technique. It may also be seen as a sign of a medicinal effect. In pediatric medicine, it's important for identifying growth hormone or even genetic abnormalities. The left-hand connector was used to determine bone age, which was then applied to time. The disparity between the two demonstrates the irregularity.
3. Sungroh Yoon and Taehoon Lee have introduced a sequencing software to delete unwritten areas from pre-messenger ribonucleic acid (RNA) copies. Finding target sequences is a crucial machine learning activity that aids in the identification of basic genes as well as the understanding of how various proteins are made. Existing prediction repetition approaches have shown good results, but they are also moderately stable and inaccurate. A comprehensive theory of a mechanism based on a predictive network of computational splice junction is presented in this article. The idea involves a novel method of training Boltzmann's equipment collection for horizontal inequality prediction. The proposed method overcomes the limitations of distinct variants and allows for the construction of datasets with distinct features. Using individual social data sets, this approach was shown to have greatly increased accuracy and decreased running time as compared to other methods. The suggested approach is more efficient at handling false interaction signals and is less vulnerable to the duration of the input chain.
4. Y. Lecun, L. Bottou, Y. Bengio, and noP. Haffner have created a software that exhibits several neural networks trained using a back-distribution algorithm, demonstrating an efficient gradient learning technique. Gradient-based learning algorithms can be used to implement dynamic decision-making environments that can discern high-quality symbols, such as handwritten characters, with limited computation if the network layout is sufficient.
5. Dr Avinash Phadke, President - Technology & Mentor (Clinical Pathology), SRL Diagnostics, said, "Although the word 'arthritis' means joint inflammation, the term is used to describe more than 100 rheumatic diseases and conditions affecting the bones and tissues. Alarmingly, India will emerge as the capital of Osteoarthritis by 2025 with more than 60 million to be likely affected. Ironically, one of the main reasons is the increasing longevity of India's population, another being fast-rising obesity. Early signs should not be ignored; early diagnosis and treatment can save the joints. Maintaining joint health lifelong should be a goal of everyone's life.

1.2 MOTIVATION

Rheumatoid Arthritis affects about 0.92% of the adult population in India. A fully understanding of the disease can provide room for research on developing new therapy models exactly catered to rheumatoid arthritis.

As per a 2021 news report, 1.3 crore people in India suffer from rheumatoid arthritis. The US CDC defines rheumatoid arthritis as an autoimmune and inflammatory disease, which means that your immune system attacks healthy cells in your body by mistake, causing inflammation (painful swelling) in the affected parts of the body.

1.3 PROBLEM STATEMENT

Rheumatoid Arthritis (RA) is a chronic, deforming, and debilitating disease that does not discriminate and attacks women, men, and children at any age. RA is an autoimmune disease of unknown etiology and is characterized for attacking the joints in the entire body. RA is such a chronic deforming disease that eventually, without the proper treatment, can disable anyone. RA is most commonly diagnosed/present in middle age women with family

history of RA, but sometimes there is no apparent reason. Currently, there is not enough research that can tell us the causes, way to prevent, or support any lifestyle changes that can improve a patient's way of life. Therefore, more and more people are facing the reality of this diagnosis with the uncertainty of what is going to happen with their health and their bodies in the future

1.4 OBJECTIVE

- To develop an algorithm which can predict Rheumatoid Arthritis using image processing
- The algorithm should be effective and highly efficient.
- Process should be easy to use and does not require any external support.

Fig 2 space between joints



2. METHODOLOGY

The Fourier transform is a mathematical function that takes a time-based pattern as input and determines the overall cycle offset, rotation speed and strength for every possible cycle in the given pattern. The Fourier transform is applied to waveforms which are basically a function of time, space or some other variable. The Fourier transform decomposes a waveform into a sinusoid and thus provides another way to represent a waveform.

The Fourier transform is a mathematical function that decomposes a waveform, which is a function of time, into the frequencies that make it up. The result produced by the Fourier transform is a complex valued function of frequency. The absolute value of the Fourier transform represents the frequency value present in the original function and its complex argument represents the phase offset of the basic sinusoidal in that frequency.

The Fourier transform is also called a generalization of the Fourier series. This term can also be applied to both the frequency domain representation and the mathematical function used. The Fourier transform helps in extending the Fourier series to non-periodic functions, which allows viewing any function as a sum of simple sinusoids.

The Fourier transform of a function $f(x)$ is given in Figure 4

Where $F(k)$ can be obtained using inverse Fourier transform.

Some of the properties of Fourier transform include:

- It is a linear transform – If $g(t)$ and $h(t)$ are two Fourier transforms given by $G(f)$ and $H(f)$ respectively, then the Fourier transform of the linear combination of g and t can be easily calculated.
- Time shift property – The Fourier transform of $g(t-a)$ where a is a real number that shifts the original function has the same amount of shift in the magnitude of the spectrum.
- Modulation property – A function is modulated by another function when it is multiplied in time.
- Parseval's theorem – Fourier transform is unitary, i.e., the sum of square of a function $g(t)$ equals the sum of the square of its Fourier transform, $G(f)$.
- Duality – If $g(t)$ has the Fourier transform $G(f)$, then the Fourier transform of $G(t)$ is $g(-f)$.

Correlation determines how much two signals or vectors are similar or different in phase and magnitude. There are two types auto correlation and cross correlation. Correlation is maximum when two signals are similar. Correlation is equivalent to multiplying the complex conjugate of frequency spectrum of one signal by the frequency spectrum of the other.

In auto correlation same signal is correlated to itself or with shifted version of it. In cross correlation two different time series signals are correlated. The example below is for cross correlation. If one set both $in1$ and $in2$ as same vectors (or append zeros initially in one) then it becomes auto correlation.

correlation output $z[n] = \sum X[k] * Y[n+k]$

Matlab code:

```

if length(in1)>length(in2)
pad = length(in1)-length(in2);
in2 = [in2 zeros(1,pad)];
elseif length(in1)<length(in2)
pad = length(in2)-length(in1);
in1 = [in1 zeros(1,pad)];
end

out_len = length(in1);
out = zeros(1,out_len);

tmp = in2;
for k = 1:out_len
out(k) = in1 *tmp';
tmp = [0 tmp(1:end-1)];
end

y=xcorr(in1,in2); % matlab built in function
len=length(y);
index=len/2;
z=y(index:1:end); %extacting one side of the result
figure;plot(z);title('MATLAB xcorr function OUTPUT'); % output plot as per matlab function
[m1,n1]=max(z) % max value in the correlation and its index

```

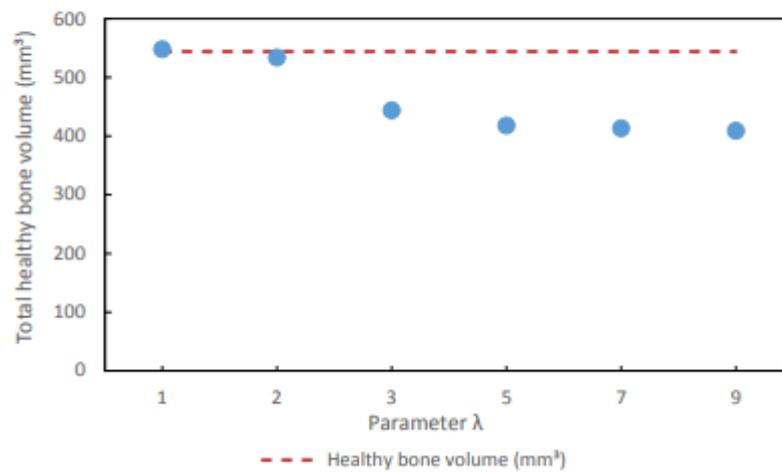
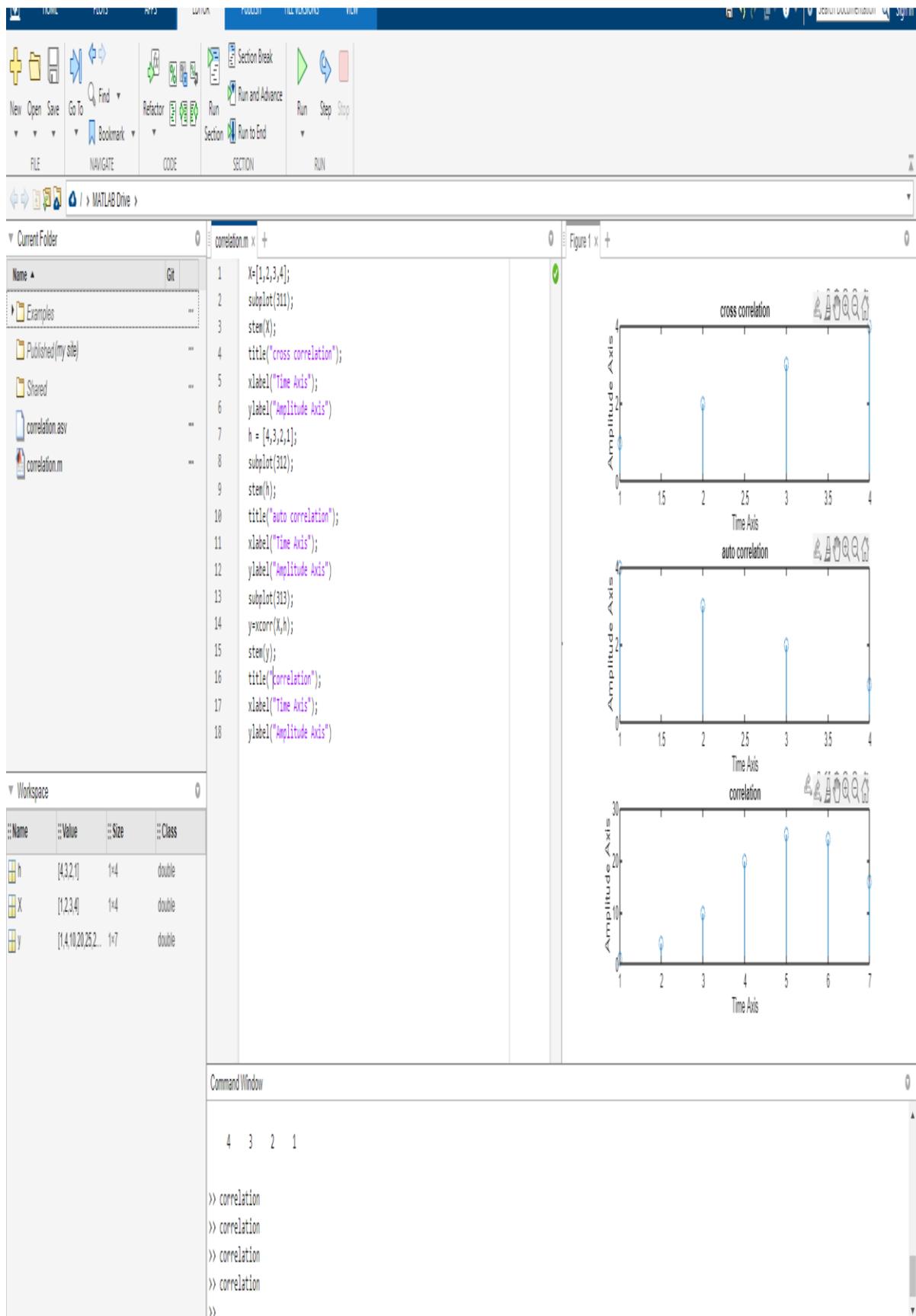


Figure 3. The effects of parameter λ on the measured erosion volume. Ideally, the parameter should help the transformation predict a healthy surface with the same volume as the original bone surface. Therefore, a predicted bone volume close to the value of the original bone volume is desirable.

$$f(x) = \int_{-\infty}^{\infty} F(k) e^{2\pi i k x} dk$$

$$F(k) = \int_{-\infty}^{\infty} f(x) e^{-2\pi i k x} dx$$

Fig 4 Fourier transform of a function f(x)



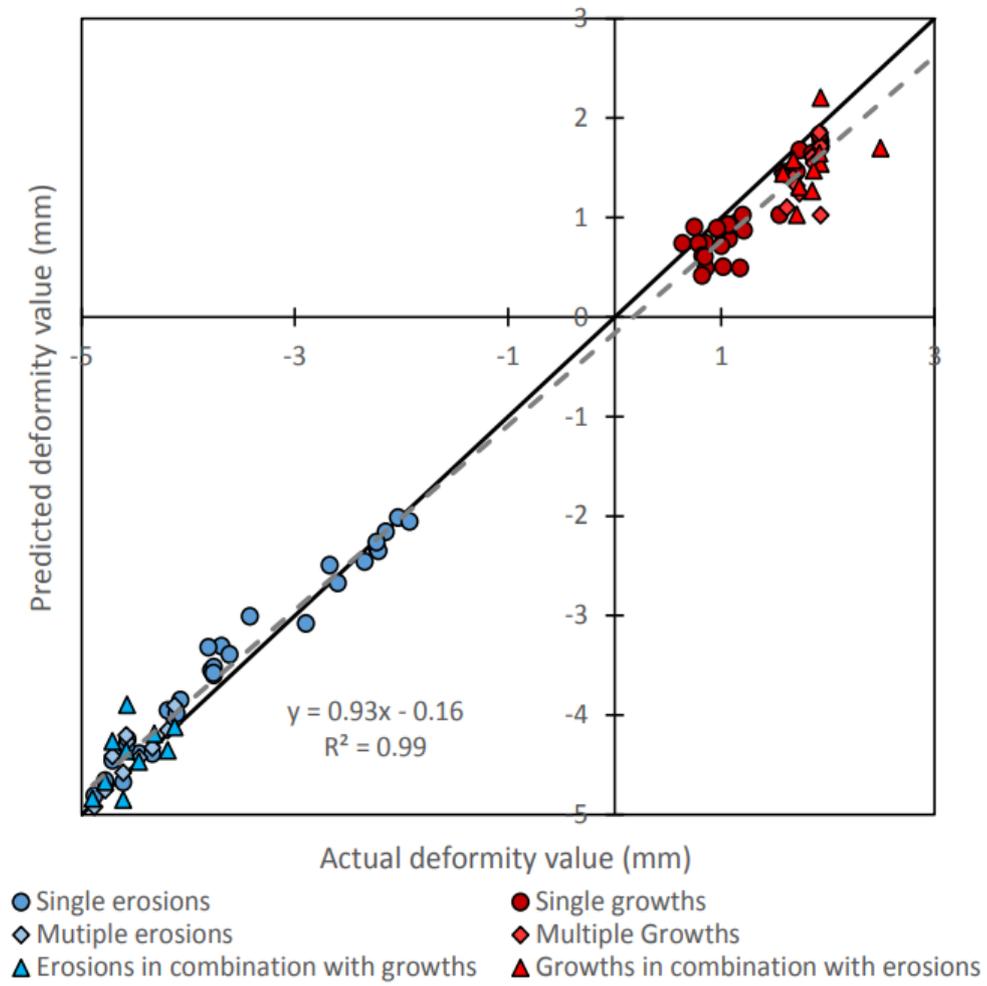
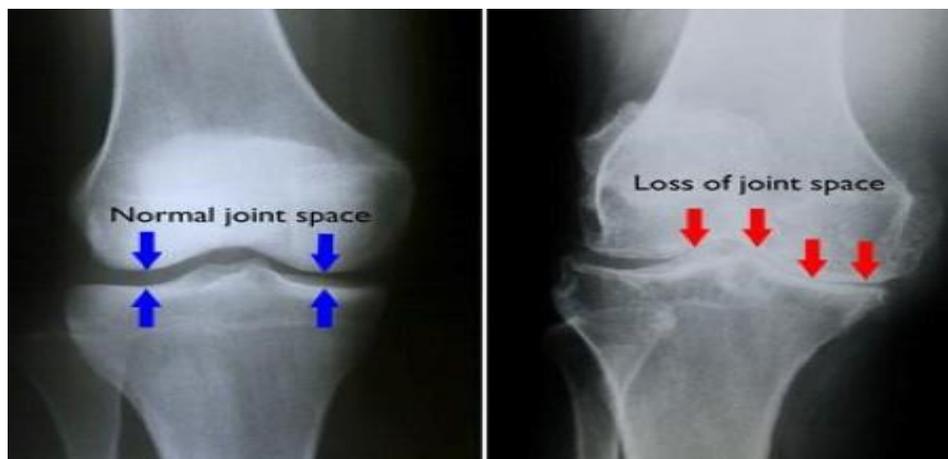


Figure 6 Results from a one-to-one comparison of the predicted deformity values to the actual deformity values. Erosion depths are illustrated in blue and periosteal bone growths in red. The black line represents a perfect prediction to the actual value equivalent and the dashed grey line shows the linear regression of all predicted data points

Fig 7 Space Between two joints



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Fig 8 Movement of different bones

3. CONCLUSION AND FUTURE SCOPE

- There's no cure for rheumatoid arthritis (RA), but early treatment with medications, known as disease-modifying antirheumatic drugs (DMARDs), may be effective in pushing RA symptoms into remission.
- RA is an autoimmune disease, so most of the current research on treating RA focuses on the immune system.
- Researchers are looking at ways to disrupt the faulty immune response that causes RA inflammation at both the cellular and microcellular level. A primary goal of most current RA treatments is to force the disease into remission.
- Scientists also have experimented with vaccines that target the immune system's underlying response in RA.
- There's currently no cure for RA, and no way to know when or if there will be a cure in the future. At this time, treatments involving both medications and physiotherapy can help manage pain and prevent joint damage.
- Researchers are exploring a variety of emerging therapies for RA — new medications, vaccines, and medical devices — to treat RA and push it into remission

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