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Rheumatoid arthritis using Machine Learning-A Review

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Abstract-- Rheumatoid Arthritis (RA) is an auto immune disease and it affects the smaller regions of joints like fingers, feet and wrist. If the RA disease become severe, the person can loss their normal life and lead to suffer more. But pre-diagnosis of rheumatoid arthritis (RA) is difficult one now a days. Pre- diagnosis of rheumatoid arthritis disease will help to treat the patient before it attains to severe stage. There are several research have done using machine learning techniques and artificial intelligence methods to produce automatic pre-diagnosis of RA disease for better accuracy. Medical images as X-ray and ultrasound images are taken as input data to train the model. In this study, we have reviewed about the diagnosis of RA disease and compared with existing research using deep learning methods and it helps to check the possibility of applying diagnosis method using machine learning techniques. The advantages and limitations of rheumatoid arthritis with different machine learning techniques are discussed.
Keywords: Rheumatoid Arthritis; Machine learning; Medical images; Artificial intelligence.

I. INTRODUCTION

Rheumatoid arthritis is a severe disease caused by immune system which affects the healthy tissues in our human body which leads to severe pain and swelling in the joints of entire human body. The rheumatoid arthritis also called as RA. Such disease cause between the age group of 30 to 50 and the regretted thing about RA, it is uncurable disease. Taking early treatment for RA will leads to avoid swelling, joint pain, weight loss, etc., but taking treatment will never take off the disease permanently. If the affected one stop taking treatment for rheumatoid arthritis, it will come back to active state, which we cannot completely destroy from our human body [1]. Consumption of limited alcohol, stop smoking, eating sea foods, actively maintaining the healthy weights and additional care taking of oral health will prevent our body from the causing rheumatoid arthritis. World health organization (WHO) state that the quality of human life will be decreasing day by day due to several diseases affecting human healthy life. Among such diseases rheumatoid arthritis and osteoarthritis place a second rank among chronic diseases [2]. The rheumatoid arthritis or RA will have some symptoms like swelling in joints, pain, disfunction of tissues and deformity of joint as major symptoms. To cure RA in earlier stage using anti-drugs called SJC, ESR and CCP is the medicines preferred for treating rheumatoid arthritis in past. With the help of machine learning, RA is predicted with higher accuracy using K- means algorithm. Machine learning plays a major role in medical field to predict several diseases with the help of different algorithms like clustering, etc., presently ML can be used widely by Google alpha, IBM, Azure and Tensor flow [3]. In this paper, we have done a review about the different study done by various researchers about rheumatoid arthritis and how they used various techniques and methods to predict the diseases.

II. EXISTING STUDY

Aloke, Tang et.al., stated that the RA is endured disease which severely cause the joint and bone. It should cause severely female than men in elder population, the tissues get damaged because of imbalance between the auto immune cells, where the anti-immune system will damage the tissues of human body [4] [5].

Jayasree, et.al., done a study and concluded that the presence of RA disease is occurred in adult population at 1% and it becomes 42nd place among major diseases. RA relate to diseases in cardiac and associate with pulmonary disease as 10 – 20% and 60 – 80%. A persons affected by rheumatoid arthritis also have cancer as parallel disease while treatment or after completion of treatments of RA [6] [7].

Nithyasree, et.al., had done a discussion about RA which include etiology, pathology, signs and symptoms, treatments and therapy to patients for rheumatoid arthritis. The patients are treated with innovative techniques by the managements to cure the rheumatoid arthritis disease [8].

Krishna Sailaja, did a broad review about the rheumatoid arthritis disease and studied about the causes, limitations, symptoms, complications of RA, etc., also author studied about the diagnosis techniques for RA disease with different testing methods [9].

Jacquiline, et.al., studied about rheumatoid arthritis in brief and the treatment undertaken for cure of this disease, but the study concluded that there is no cure for RA disease and the goals of treatment will help to reduce the pain of damage. The researcher presented the study in exist and present treatment modalities for expressing the complications to treat the RA patients [13].

Toshiko, et.al., proposed research for RA detection named rheumatoid arthritis detection support system and it helps to visualize the results provided by the doctors with some consuming the time and developed a model for automatic diagnosis system using image diagnosis method to the community of medical.

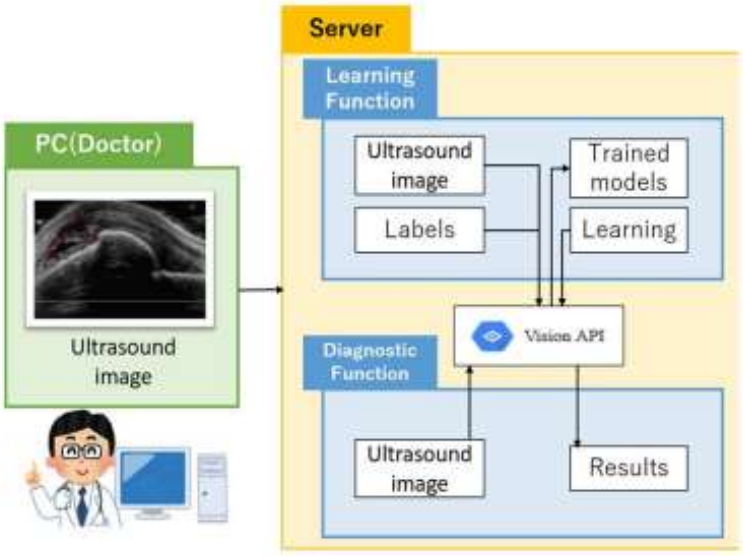

Figure 1. Configuration of model.

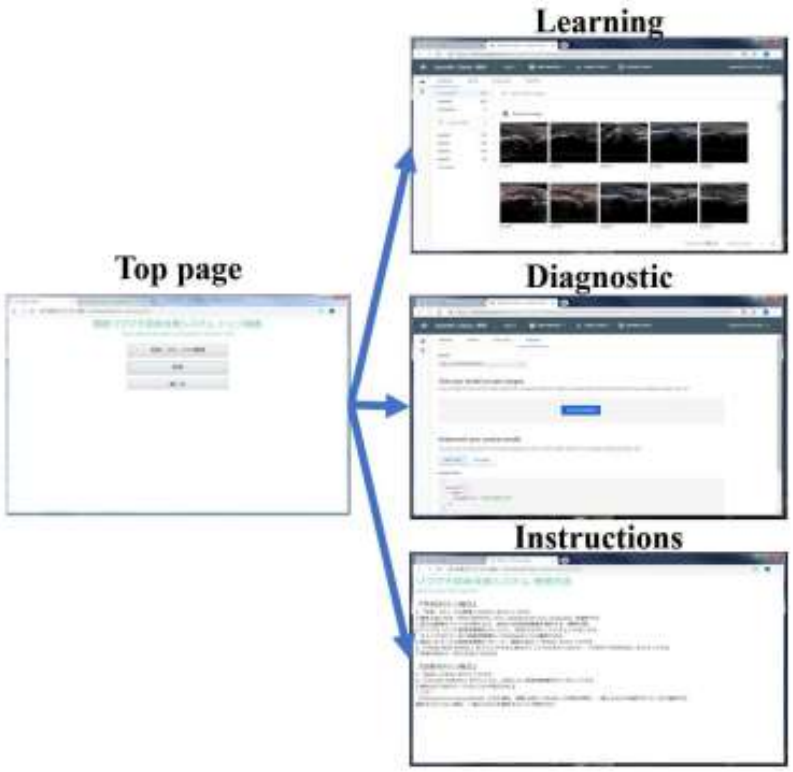

Figure 2. Prototype of the research proposed by the researcher

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The author proposed the model using machine learning system for diagnosing the RA disease and train the images collected from the real time clinics and diagnosed through web using auto machine learning API by evaluating the experiments in figure 1, 2. [14]

III. RHEUMATOID ARTHRITIS USING ML

Rheumatoid arthritis occurred with severe joint pain and the symptoms like stiffness will appear for more than a week and moreover lot of patients affected with RA will experienced fatigue and swelling symptoms which is difficult to find at early stage. Machine learning help us to predict the occurrence of RA using K-Means clustering algorithm which is more preferred by various researchers.

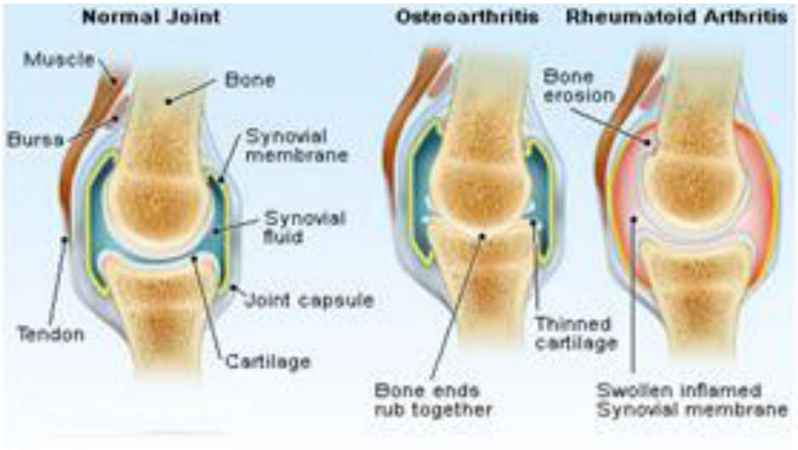

Figure 3. Normal vs Arthritis joint

3.1 Symptoms:

To increase the life healthier pre diagnosis about RA is necessary for elder persons. Accordingly, 1% of world population people will caused by rheumatoid arthritis and this disease is find higher in counts in the countries like America and less in occurrence in the countries like Japan, China, etc.,

- Depression
- Infections- due to usage of steroids
- Malignant
- Cardio diseases, etc.,

3.2 Diagnosis:

Diagnosing rheumatoid arthritis includes shrinkage of muscles and swelling, etc., in the joints of whole human body. Initial diagnose stage have various factors about the RA and sedimentation which are C reactive in nature. Tests done with renal and base functions of hepatic will be made.

It can be very tough to identify the occurrence of rheumatoid arthritis. Once the patient felt joint pain, they can predict the presence of RA using blood test and X-ray test. The stiffness at morning, subcutaneous nodule or regions and positive factors of rheumatoid will change the values of x-rays.

3.2.1 Blood test:

To diagnose rheumatoid arthritis by taking various blood test samples to determine the complications of RA and severity stage are identified with greater accuracy. The factors of RA are measured with the help of calculating the count of antibodies in blood which collects the synovium present in joint are called as rheumatoid factor.

From the diagnosis of patient, nearly 80% of patient using blood test samples are identified the presence of rheumatoid factors. Arthritic pain at both sides of body will indicates the presence of rheumatoid arthritis. While x-ray testing, the presence of rheumatoid factor (RF) and bone damage will strongly lead to have a chance of joint damage.

3.2.2 ESR test:

Erythrocyte sedimentation rate (ESR) will help to track the RBC sedimentation process, how fast the cells are settled down to the bottom of patient blood. It only used for the determination of condition state, not for diagnosis of RA.

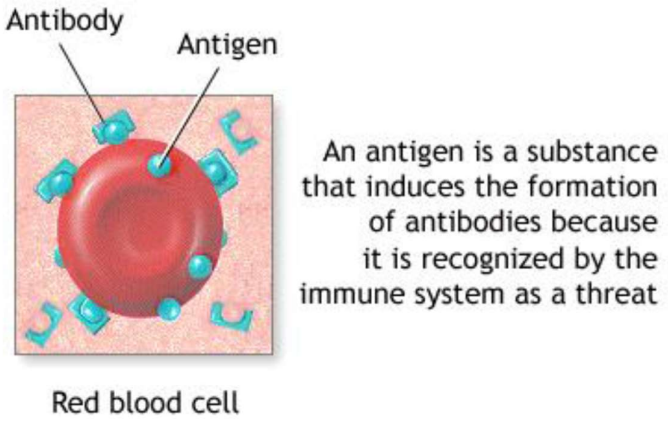

Figure 4. RBC with antibody and antigen

In existing research, the RA will be classified using machine learning models and algorithms with broad investigation with RA identified data collected from the database for the research and it execute the outputs with values calculated for temperature from the thermal image of hand joints. The data collected from the database is consist of eight different attributes and 32 instances for determining the performance of classification process using various algorithms. The algorithms such as Adaboost, random space and bagging algorithms are proposed with classifier called random forest and SVM to train the data for better execution of the data. Parameter like accuracy, precision and sensitivity are taken as final classification conclusion of the results [15].

Table 1. Performance analysis of classification models

	Predicted Class		
Actual classes	YES	TP	FN
	NO	FP	TN
	TOTAL	P	N

Support vector machine (SVM) algorithms will be more useful for performing the binary operations to classify the functions with choice limits and it will separate the fata with various sections and it can be expressed as,

H (x) = K (xi, x) + b……..(1)

Base classifier and method	**Performance evaluation methods**			
	Accuracy (%)	**Precision(%)**	**Recall(%)**	**ROC**
(SVM)				
Bagging	82.5%	82.1%	82.5%	0.790
Adaboost	80.0%	78.4%	80.0%	0.638
Random Subspace	80.0%	79.2%	80.0%	0.632

Figure 5. Performance of dataset for classification using SVM algorithm

The above image 5 and table 1, will be used with Adaboost algorithm along with random forest classifier and executed with accuracy of 87.5% and the proposed datasets are produced highest recall by comparing with neighbour algorithms.

3.2.3 Image test:

X-rays test can help only progression about the damages in joint and it does not detect the presence of RA in early

stage. Image testing like MRI test, to check the presence of signs about the density loss in bone.
There are some stages are differentiated for the occurrence of rheumatoid arthritis.

Stage 1:

- Only thinning of bone are predicted instead of prediction of damages.

Stage 2:

- X-ray helps to predict the bone damage around joint.
- Cartilage damage also possible in slight cause.
- Joint deformity does not observe and mobility is limited.
- Soft tissue abnormalities around joint are possible while prediction.

3.2.4 Functionality of people with RA as follows:

- ***Class 1 RA:*** people can live their daily life casually.
- ***Class 2 RA:*** able to live casual life but activities become limited.
- ***Class 3 RA:*** usual performance activity with limited work and other activities.
- ***Class 4 RA:*** limited usual self-care, other activities and work.

3.3 Treatment:

As beginning of treatment, patient should get aware about the details of rheumatoid arthritis.

- RA includes three most approaches like NSAID, DMARD and biologics.
- **NSAID (drug)**: It helps to reduce the joint and swelling pain.
- **Steroids**: it will help to slow down the joint damage and join pain will be reduced.
- **DMARD (drug):** it helps to reduce the process of growing disease and help to predict the occurrence faster.

- **Biologics: it will target the cytokines and send a signal to molecule and affected cells for demolition of joints.**

3.4 Therapy:

- **Doing certain exercise under the guidance of therapist regularly helps to retain the joint flexibility.**
- **Different and daily tasks should be performed by patients.**
- **With the help of assistance device provided to the patients for relief from stress [11].**

Table 1. Review of Patient Compliances Vs Incompliances

S.No.	*Drugs*	*Compliances*	*Incompliances*
1	***Methotrexate***	Drugs activity is improved and quantity of folic acid is increased.	After intake of drug diarrhoea, headache, hair fall, severe stomach pain, fatigue, etc., will cause.
2	***Adalimumab***	No side effects	After intake of drugs headache, depression and respiratory symptoms may occur.
3	***Tocilizumab***	Better to intake drug 5 weeks once, helps to improve the blood level and stiffness in bone will become normal.	Swelling in lower leg, nausea in severe stage, morning sick, hip and knee joint discomfort, breathing difficulties, etc.,
4	***Certolizumab Pegol***	Better drug for RA, it will decrease the pain, immediate relief, freely move hands from stiffness without any pain.	Raise in blood pressure, thyroid nodules developed, liver enlargement, weight gain, etc.,

3.5 Machine Learning (ML) in RA:

Machine learning plays a major role in disease prediction and classification with different algorithms and methods. ML has successfully predicted the RA disease in minimum number of rheumatoid arthritis patients by

using different machine learning algorithms and among that only few data will exist on the deep learning methods. It is a specialized field within the machine learning by generating the data on neural networks and execute the higher flexibility and productivity with machine learning techniques. The datasets are collected from the various databases and trained to classify the disease stage. For rheumatoid arthritis (RA) machine learning help to classify the stages of disease in human body using various classification algorithms like K-means, Support vector machine (SVM), random forest algorithms. For better classification result execution ROC, accuracy, error rate is considered as parameters from the datasets implemented by the researchers [12]. Among various machine learning algorithms K-means clustering algorithm preferred a lot for several researchers for classification of the RA disease, because it divides the nodes presence nearby and form it as a cluster to classify the stage of disease as faster for prediction than any other algorithm.

IV. CONCLUSION

Rheumatoid arthritis is a uncurable disease and there is no permanent treatment to cure it. It should be controlled manually by diet, limitations while intake of alcohol, stop smoking and healthy diet maintaining, etc., will leads to control of rheumatoid arthritis disease. Researchers and scientist have to concentrate more for alternative medicinal systems to improve the health conditions of patients affected with rheumatoid arthritis. Machine learning plays a major role in predicting the diseases using various algorithms like K-Means clustering algorithm successfully.

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