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A Hybrid Classification and Prediction Methodology for the Diagonosis of Osteoporosis

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Abstract:- ***With the advent of technology medical science is growing very fast . Disease diagonosis using machine learning technique is quite cumbersome. But efforts are made by the innovative minds to develope an optimal and efficient prediction model for the prediction of the disease viz, bone disease . Bone disease prediction is also a broad area of research where machine learning techniques can be used. Better prediction and analysis can be helpful to cure such disease . Osteoporosis is an osteo- metabolic disease characterized by low bone mineral density (BMD) and deterioration of the micro- architecture of the bone tissues, causing an increase in bone fragility and consequently leading to an increased risk of fractures.. Machine learning algorithms play important role for predicting and analyzing such disease using available algorithms and by modifying them . There are many algorithms such as SVM (Support vector machine), Genetic Algorithm, Naive bayes classifier and other tree based classifiers which are proposed in traditional scenario for prediction of expected data from an image. The goal of this paper is to discuss about a proposed hybrid analysis and prediction approach for diagonosing osteoporosis. This paper also discuss about various prediction models viz, svm prediction model as the efficient one while processing the textual data for symptoms analysis. Here symptoms are called predictors . A comparison using the Accuracy and training time is performed. The approach shows the efficiency of proposed model over textual data as well as graphical image data analysis.***

Keywords: Bone disease, Osteoporosis, Image processing, Machine Learning, Prediction model.

I. INTRODUCTION

Osteoporosis literally means porous bones. The bones become more fragile, increasing the danger of cracks, particularly in the hip, spinal vertebrae, and wrist. Bone tissue is always being recharged, and new bone replaces old, harmed bone. Along these lines, the body keeps up bone thickness and the uprightness of its precious stones and structure. Bone thickness tops when an individual is in their late 20s. At the age of around 35 years, bone begins to become more fragile. As we age, bone separates quicker than it fabricates. On the off chance that this happens exorbitantly, osteoporosis results [1]. Osteoporosis may happen because of lower-than-typical most extreme bone mass and more noteworthy than ordinary bone misfortune. Bone misfortune increments after menopause because of lower dimensions of estrogen. Osteoporosis may likewise happen because of various illnesses or medications, including liquor abuse, anorexia, hyperthyroidism, kidney malady, and careful expulsion of the ovaries [2-3]. Certain medicines increase the rate of bone adversity, including some adversary of seizure remedies, chemotherapy, proton siphon inhibitors, specific serotonin reuptake inhibitors, particular serotonin reuptake inhibitors, and gluco-corticosteroids. Smoking and too little exercise are additionally hazard factors. Osteoporosis is characterized as a bone thickness of 2.5 standard deviations underneath that of a youthful grown-up. This is regularly estimated by double vitality X-beam absorptiometry [4-5].

A. CAUSES OF OSTEOPOROSIS

• Osteoporosis is bound to create on the off chance that you didn't achieve ideal pinnacle bone mass amid your bone-building years.
• You achieve your greatest bone thickness and quality around the age of 30, at that point bone resorption gradually overwhelms bone arrangement.
• Osteoporosis creates when there's an unusual imbalance between bone resorption and arrangement that is, resorption happens too rapidly, or develope too gradually.
• Anything that makes your body demolish excessively bone can make your bones weak or delicate.
• Women experience the most bone misfortune amid the initial couple of years after menopause, and they keep on losing bone starting here on.

Thus the disease analysis and its prediction requirement is an important aspect due to increasing cases in present generation. As per the study solutions provided by various approaches are limited with accuracy as well as other parameters. This paper discuss about an efficient approache performed by authors which gives the improved results with better accuracy. Section II of this paper contains the literature review which comprises the detailed study of different papers on comparison analysis. Section III discuss about the problem formulation of discussed approach, whereas Section IV discuss about the proposed work with its advantage followed by section V as conclusion of the research work.

II. LITERATURE REVIEW

In paper [1] the author has proposed another strategy for identifying osteoporosis using Weighted Fuzzy ARTMAP using dental radiographs.

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The strategy built up an initiation coordinate capacity by incorporating Simplified fluffy ARTMAP and symmetric Fuzzy ART. Fourier strategy and division preparing were connected for getting highlights of a radiograph in recurrence and spatial space. The trial results for osteoporosis identification demonstrate that the new strategy accomplished accuracy of 87.88%, sensitivity of 93.33%, and specificity of 83.33%.

In paper [3], they have worked with the relation finding and disease analysis. They have taken three factors bone mineral density, diet and lifestyle of person. An SVM approach is taken for the analysis algorithm purpose. Performing a proper hiperplane division of data, working with linear regression is taken with high accuracy kernel parameters. They have further worked with regression tree and shown the efficiency as finding training and testing error with deviation values.

The state of the proximal femur has been exhibited to be vital in the event of the femoral neck. J.S. Gregory et al proposed another strategy called dynamic shape displaying (ASM) to evaluate the morphology of the femur. An extent of hip break chance not caught by BMD might be because of the geometric extents of the femoral neck. The review contemplate, demonstrate that ASM is a promising strategy for portraying these and, later on, may give a quick, mechanized technique for dissecting the gross morphology of the hip from radiographs or, conceivably, imaging DXA [6]. Bone mass is an imperative determinant of protection from breaks. Regardless of whether bone mineral thickness (BMD) in subjects with a crack of the proximal femur (hip break) is not quite the same as that of age-coordinated controls is still discussed.

This study [7] Main factors which are obtained by the combination of the porous trabecular schema along with the anthropometric highlights for osteoporosis screening. The examination test has their bone mineral thickness (BMD) estimated at the proximal femur/lumbar spine utilizing double vitality X-beam absorptiometry (DXA). Morphological permeable highlights, for example, porosity, the span of permeable, and the introduction of permeable are gotten from every dental radiograph utilizing computerized picture handling. The anthropometric highlights considered are age, tallness, weight, and weight list (BMI). Choice tree (J.48 technique) is utilized to assess the precision of morphological permeable and anthropometric highlights for choice information. The investigation demonstrates that the most imperative component is age and the considered highlights for osteoporosis screening are porosity, vertical pore, and diagonal pore. The choice tree has significantly high exactness, affectability, and specificity.

In paper [8], an extraction methodology for trabecular structures from dental widely inclusive radiographs using logical morphological undertakings is proposed. It can remove trabecular excepting basic establishments of teeth and engages the assessment of tooth extraction for trabecular model. An estimation strategy for the lengths and headings of trabecular areas is furthermore proposed in this paper. It is recommended that the estimations of sound and osteoporotic models support our hypothesis that the trabecular parallel to the roots are diminished more than those inverse to the roots by osteoporosis.

In paper [9] author has proposed a review to create and describe two new districts of intrigue (ROIs) for DXA at the hip, one concentrating on cortical and other for trabecular bone. Magnetic resonance imaging (MRI) is a promising therapeutic imaging procedure that is utilized to survey femoral neck cortical geometry.

In Discussion [10] examined the horizontal edge of the femoral head and stretched out medially to the lesser trochanter of the femoral neck district and they found that MRI proportions of the femoral neck cortical bone geometry are very connected with disappointment heap of the proximal femur.

In paper [11], the author has presented his own model which he called as GN-model. This model is Net Model of Asymptomatic Osteoporosis Diagnosis which is working with an extreme computation along with the network and thus the experiment is helpful in further implementation.

In paper [12], Author discussed image texture analysis, Quantitative computed tomography (QCT) are the approaches presented by author. An automatic detection of ROI is detected using a commercial software over bone mineral density measure. Further texture image analysis using the power spectrum and computation was performed. Result computed with the parameter of mean and standard deviation.

In paper [13], a fuzzy interference framework was provided which help working with image processing and proper prediction. The algorithm computes the degree of disease using the fuzzy interference. The process starts with the fuzzification of all input parameters and then followed by region boundary finding of image given at points. A decision based on combination of Edge region and boundary based method is provided as final prediction over the data. This paper discuss about the fuzzy rules and set of rules determine the final fuzzification prediction analysis. An experiment performed on taking various behavior analysis on 20 patient's record. The experiment was performed on MATLAB with parameter improvement in % of Mean, Correlation and energy.

In paper [15], they have worked with an approach which worked with the frequency separation and fractional Brownian motion. The approach work well with the high classification accuracy of 94% which further classification is done by SVM classifier. The process they have followed was pre-processing, feature extraction and final classification with SVM. They have shown that polynomial SVM kernel function based algorithm got high accuracy, FPR, FNR and F-Score.

Thus the discussion of various literature study shows the analysis view of algorithm presented by each author. Further an improvement can achieve better efficiency over traditional solution.

III. PROBLEM DEFINITION

As per discussion of previous work, there are multiple problems definition which arises and can be overcome in further implementation of proposed solution. Some of them are given below.

1. A proper availability of real time dataset for the analysis of such scenario, the ability of obtaining current dataset is challenging task.
2. Finding the accurate and meaningful features from the CT images of particular disease, which can be used for prediction.
3. Bayes approach works with the assumption and perform the accuracy based on probability, which need enhancement as precision manner.
4. ROI selection and further working with particular segment is not yet performed, which can improve the accuracy.
5. Minimization of error rate is needed. The existing solution having high error rate due to not proper inputs.

Thus the given problem formulation is needed to work out for providing effective algorithm for better prediction.

IV. PROPOSED SOLUTION & ITS ADVANTAGE

A hybrid prediction model which is presented as proposed model. The model is unique because it incorporates hybrid approach for the classification and prediction.

B. A hybrid methodology for Osteoporosis Diagnosis and prediction.

An approach process using the sample dataset as input and further steps for processing is used. The algorithm uses linearization and binarization of input image. Further thresholding over the image is performed. Minutia point extraction and false removal. Pentagon based ROI selection and feature extraction for computation of score for disease prediction.

The proposed methodology and its steps which are followed are presented below:

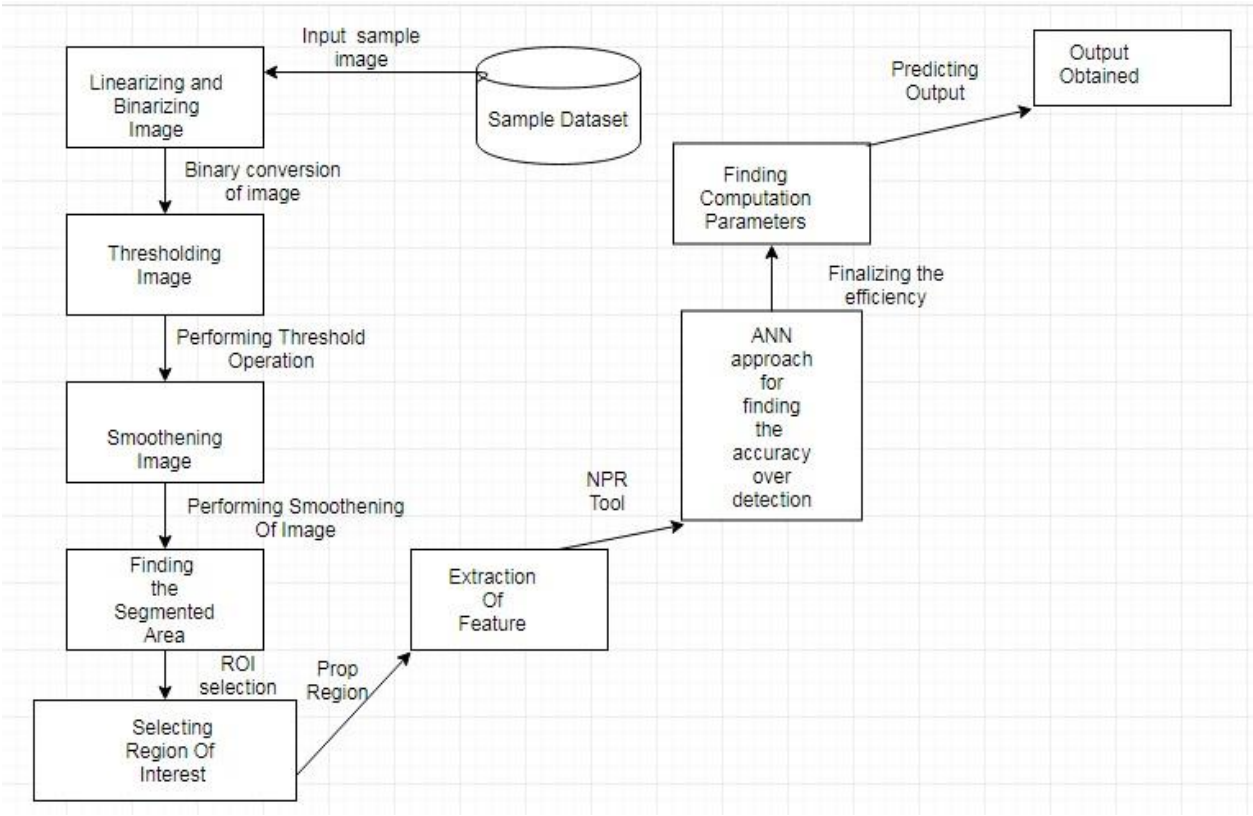

Figure 1: Flowchart of proposed algorithm for the disease prediction from the image dataset.

C. IMAGE PROCESSING STEPS:

1. Dataset extraction from the resources NCBI which is related to the osteoporosis.

2. Pre-processing the image where the binarization and thinning is applied over the selected image for better smoothing.

3. Finding the minutia points where the bifurcation and termination is extracted from the image from the thinning area image extracted.

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4. Removal of the false minutia points from the image and finding the appropriate data pre-processing.

5. Region of interest selection and feature extraction from the image for further processing.

6. Apply the Neural Network using the NPRtool. The Neural network approach classify the image data.

7. Finally classification disease score analysis and disease prediction is perform over image data.

C. PREDICTION MODEL PERFORMANCE:

Further a prediction model is presented for disease prediction using the characteristic of input data. Prediction model using the latest prediction model, linear based and SVM based models are performed over the dataset. Thus finally a SVM based model found performing well and network is obtain as efficient.

Dataset: A CSV file is build using the data available on public website https://medpix.nlm.nih.gov/ and various characteristics are formed as dataset.

Result parameter to evaluate the efficiency of analysis and prediction model is taken as RMSE and training time are taken. Thus the proposed approach found as best while comparing with other data approaches.

V. EXPERIMENTAL & RESULT ANALYSIS

In order to perform experiment for the discussed approach, MATLAB 2018a software and system with minimum 4 GB RAM configuration is required.

D. DATASET:

Real time Images dataset from the authenticated medical centre will be taken for the analysis purpose. Universal images available over the internet NCBI resources is also going to be a part of simulation analysis.

Medpix nlm website is also taken as dataset source for the purpose of prediction, where the various charachterstics of the symptoms are listed.

Symptoms which are taken for disease analysis are: Modality, Plane, Age, Gender, Fracture, Weight, History and ACR codes. Also two class classification is performed.

E. TOOLS:

In order to perform the simulation analysis, following tools are going to be taken and further comparative analysis will be performed.

MATLAB2018a Tool with updated library and classification learner tool.

NPR Tool: It is utilized for the system creation and examination reason.

SVM Library: Learner library with the end goal of order and forecast.

chart Library: For plotting pie charts, bar graphs for statistical representation of data.

F. RESULT ANALYSIS

In order to show the efficiency of approach, the parameter taken as Efficiency analysis, the model having the least error rate produces the best result and hence providing the better evaluation while testing.

The parameter as rmse and training time is compared.

Following graph and tabular analysis shows the comparative analysis over approaches.

Table 1: Analysis of rmse.

Prediction Model	Rmse
Linear regression	3.0851
Interactions linear	3.8279
Fine tree	3.0262
SVM	2.3151
Squared exponential	2.4705

The above table represents the number of prediction models and corresponding rmse values.

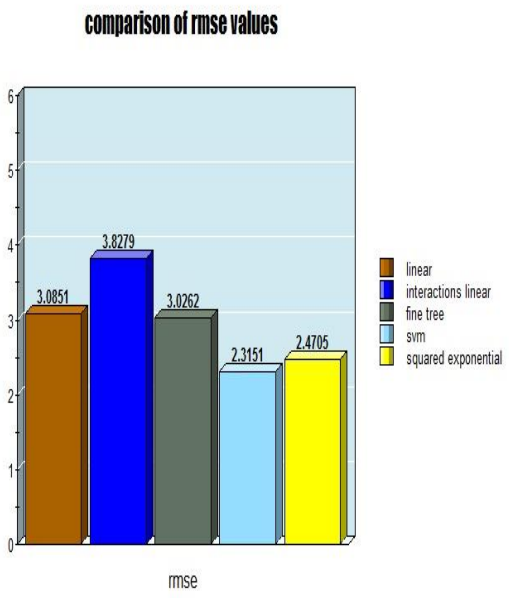

Figure 1: Comparison of RMSE value

Table 2: Training time analysis.

Prediction Model	Training Time in ms
Linear regression	5.2915
Interactions linear	6.8808
Fine tree	7.5863
SVM	10.899
Squared exponential	68.383

The above table represents the number of prediction models and associated training time of the model.

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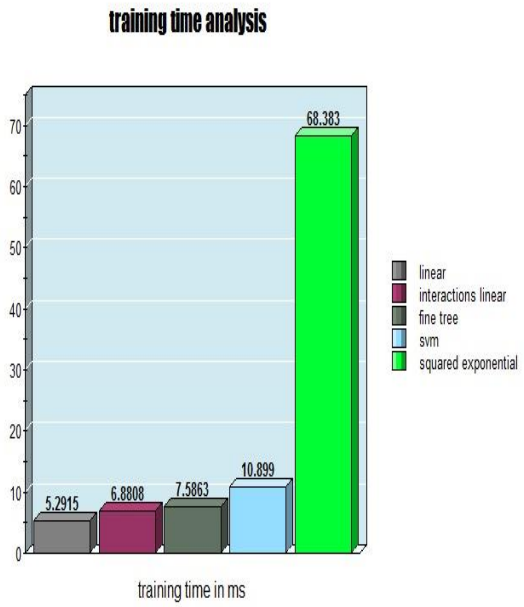

Figure 2: Trainining time

Thus the comparison made using the different parameters shows the efficiency of SVM model which compute the less rmse value.

G. ADVANTAGES & OUTCOMES

1) Simple models can prompt exact and solid expectations of finding picture execution. An abnormal state of expectation with various picture information is relied upon to perform.

2) Selecting the correct highlights and understanding social insurance area explicit parts of information prompts better outcomes.

3) A half breed learning can improve information investigations and accomplish higher exactness results than straightforward ANN arrange because of the expanded number of shrouded units and system layers that spread information focuses by gauging them in each layer.

4) Effective feature selection and analysis based on the given selection is going to perform.

5) A detail visualize analysis of the given data statistic using the real time images with the efficiency parameter is going to be shown in simulation.

6) Finding an efficient approach for the processing and getting least error model for the prediction of disease classification purpose.

VI. CONCLUSION AND FUTURE WORK

Many algorithms are discovered which uses medical input image data and provide a prediction on them. Osteoporosis is a disease which deals with bone and weakness in them. Early detection and treatment can help out to get permanent damage or other injury. There are different approaches which is proposed by the authors for the discussion, many are based on different feature extraction analysis. A proper disease analysis from the image can help in giving a proper treatment to the patient. Thus an NN based approach is worked to find a proper prediction over image. This paper also shows the efficiency of svm which worked as prediction model over the data symptom analysis and working on the disease prediction over textual dataset.

Thus working with such model and technique shows that the high reliability with speedup process can increase the medical treatment experience in medical science.

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