

## Biomedical Image Analysis for Osteoporosis using fuzz logic Detection, Diagnosis and Prediction Model

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### ABSTRACT

Our Invention medical specialty Image Analysis for pathology victimization fuzz logic Detection, Diagnosis associated Prediction Model could be a progressive bone illness that's characterized by a decrease in bone mass and density which may cause a multiplied risk of fracture. pathology could be a state of getting brittle and fragile bone that arises because of aliment deficiency, tissue loss, secretion changes. distinctive pathology is expeditiously detected by scheming varied options like Bone mineral density (BMD), applied mathematics options from varied trabeculae region like hip, toe, elbow, etc. Detection of bone disorders square measure finished the assistance of bone densitometer. The Invention could be a bone densitometer uses a way that the bone density is measured in-terms of Score. Bone Mineral density activity is achieved by varied segmentation ways like K-means, Fuzzy segmentation. The invention machine /deep learning to diagnose pathology from hip radiographs, and whether or not adding clinical knowledge improves diagnostic performance over the image mode alone. For objective labeling, we tend to collected a dataset containing +1131 pictures from patients World Health Organization underwent each skeletal bone mineral density activity and hip radiography at one general hospital between 2014 and 2019. within the analysis of the 5 CNN models victimization solely hip radiographs, Google internet and economical internet b3 exhibited the most effective accuracy, precision, and specificity. Among the 5 ensemble models, economical internet b3 exhibited the most effective accuracy, recall, NPV, F1 score, and terrorist organization score once patient variables were enclosed. The CNN models diagnosed pathology from hip radiographs with high accuracy, and their performance improved any with the addition of clinical covariates from patient records.

**KEYWORD:** Biomedical, Image Analysis, Osteoporosis, Fuzz Logic, Detection, Diagnosis, Prediction Model.

## RESERCH FIELD

Our Invention is related to a Biomedical Image Analysis for Osteoporosis using fuzz logic Detection, Diagnosis and Prediction Model.

## RESEARCH BACKGROUND

The osteoporosis is a widespread disease characterized by the loss of bone mass and deterioration of bone complex micro-architecture, resulting in the risk of bone fractures and also all parameters involve, low bone mass is the most important factor determining bone brittleness and fracture risk, particularly of the hip, spine and wrist. The osteoporosis affects more than +26 million persons in the India/United States alone, less than +10% of women with the disease and only +1% of men are diagnosed and receive treatment.

The osteoporosis or slow it down after it starts, it must first be known whether a person is at risk. The tracing of persons at risk in an asymptomatic population is termed screening. A number of radiological screening tests have been proposed to detect low bone mass in asymptomatic persons.

Fracture in the waist and spinal cord are particularly the most affected because it causes often surgery. Easily measured risk factors can be advantages when there is an absence of BMD measurements. Authors apply the theory of fuzzy measures considering risk factors like (Age, BMD, smoking, fall, corticosteroid use-age, alcohol intake) which are easy for medical practitioners to measure. Boolean gives only two answers i.e. [0,1] but fails to explain anything that comes between them.

The classifier is better than Boolean because it explains things which come in between [0,1] but it fails to explain the at what degree does it lie. Fuzzy measures give us flexibility and explain the degree of the thing, which is been, measured. The main motive is to propose a fuzzy framework for the diagnosis of osteoporosis in the medical field.

This higher helps the doctors to treat numerous sorts of pathology unwellness. The complexness of the unwellness is analyzed by a fuzzy system associated an X-ray image process technique. Thus, each of them is combined to create a result. The image process technique is employed to calculate bone density.

Approximately five hundreds of girls and two hundreds of men can expertise osteoporotic fractures in their time period. the quality takes a look at for designation pathology is that the estimation of bone mineral density (BMD) within the proximal leg bone and body part spine with dual-energy X-ray absorptiometry (DXA).

The USA Preventive Services Task Force has counseled screening for pathology with BMD Type equation here.to forestall osteoporotic fractures in girls sixty-five years and older. the first identification of pathology is very important for the hindrance of osteoporotic fractures as a result of therapeutic drug treatments fractures, as a result of treatments are more practical within the early stages of the condition, before fractures have appeared.

The cortical-thickness index has been found to be considerably related with the BMD at the limb neck and with predictions of the fracture-risk assessment tool. Moreover, the canal bone quantitative relation exhibits a powerful correlation with the T-score and has the most effective overall performance in diagnosis pathology with receiver in operation characteristic (ROC) curve analysis.

The clinicians have diagnosed pathology exploitation the bone morphology of hip radiographs. computer science (AI) has been used as AN adjunct technology for imaging interpretation, And as an initial screening tool. A-2019 literary criticism reported that recent developments in AI have semiconductor diode to palmy applications aiding pathology identification. the subsequent modalities are used: dental radiographs [16,17], spine radiographs hand and gliding joint radiographs DXA imaging and spine computed axial tomography. However, 2 reports are accessible on pathology identification from hip radiographs exploitation machine learning. To our information, no study has nonetheless reported on pathology identification supported hip radiographs exploitation deep learning (DL).

Image-only models may be wont to augment human interpretations. though deciliter studies on varied image-based osteoporosis-prediction strategies are printed, these failed to think about patient covariates, that clinicians use once estimating the pre-test chance throughout the choice method. Patient and aid method variables impress patterns into experimental aid knowledge, and these patterns may be learned by applied math learning algorithms. Hip fracture identification was foreseen moderately well from pictures alone (area below the curve (AUC) = zero.78), and therefore the prediction was improved by combining image options with patient knowledge (AUC = zero.86). The direct extension of deciliter image models with famous covariates will improve the model performance, which might be very helpful during a clinical setting.

Studies with titles in some way associated with the analysis topic and older knowledge that reported perennial methods were excluded. The search was meted out with the descriptors in German, Spanish, French, Italian, Mandarin, Portuguese and English; however solely studies written in English were found to satisfy the established criteria. Articles covering the amount 2000–2017 were selected; but, articles before this era with nice connection were enclosed during this study.

## RESEARCH OBJECTIVES

1. the target of the invention is to a medical specialty Image Analysis for pathology exploitation fuzz logic Detection, Diagnosis associate degreed Prediction Model could be a progressive bone illness that's characterized by a decrease in bone mass and density which might result in an enlarged risk of fracture. pathology could be a state of getting brittle and fragile bone that arises thanks to sustenance deficiency, tissue loss, secretion changes.
2. the opposite objective of the invention is to a novel pathology will be expeditiously detected by conniving numerous options like Bone mineral density (BMD), applied math options from numerous trabeculae region like hip, toe, elbow, etc. Detection of

bone disorders area unit through with the assistance of bone densitometer. The Invention could be a bone densitometer uses a way that the bone density will be measured in-terms of Score.

3. the opposite objective of the invention is to a Bone Mineral density activity is achieved by varied segmentation strategies like K-means, Fuzzy segmentation. The invention machine /deep learning to diagnose pathology from hip radiographs, and whether or not adding clinical information improves diagnostic performance over the image mode alone.
4. the opposite objective of the invention is to a 5 CNN models victimization solely hip radiographs, Google web and economical web b3 exhibited the simplest accuracy, precision, and specificity. Among the 5 ensemble models, economical web b3 exhibited the simplest accuracy, recall, NPV, F1 score, and terrorist organization score once patient variables were enclosed.
5. The other objective of the invention is to a CNN models diagnosed pathology from hip radiographs with high accuracy, and their performance improved additional with the addition of clinical covariates from patient records.
6. The other objective of the invention is to a gather and describe in an exceedingly systematic approach the most techniques want to determine risk teams on pathology, recognizing their challenges and trends.
7. The other objective of the invention is to a computing idea advanced algorithm, input parameters—as vital factors to reason risk groups—were highlighted together with exams already performed like QUS, DEXA, DXA, TQC, QUA and digitized pictures.

### RESEARCH SUMMARY

The Mathematical Morphological Approach of osteoporosis detection by a mathematical morphology a is based on a process of quantification of the advanced micro-architecture state which is done. In this operation, they consider the grey-level skeletonization to the binary one {0000111} the latter can cause a loss of data/ information when binarizing the image and a network of strongly connected segments.

The vertical segments allow to locate the compression spans that is the patient weight and also the horizontal segments locate the tension spans which will be the first degraded in the event of osteoporosis and also the skeleton is done by set of nodes decomposition and connecting them with segments.

The invention is a diagnose osteoporosis, an efficient method is BMD calculation and also the radiographic images obtained from several specimens of varying categories are implemented and tested.

### Region of Interest (ROI)

An urban center could be a portion of a picture to perform another operation on that. ROI is outlined by making a binary mask. within the mask image, the pixels that outline the ROI square measure set to one and every one different pixels set to zero. Pre-processing of ROI: The aim of preprocessing is Associate in Nursing improvement of the image knowledge that

suppresses unwanted distortions or enhances some image options important for any process.

### Thresholding

After all preprocessing steps, the preprocessed image must be regenerate to binary for applied math feature extraction. Otsu's methodology is employed for binarizing the preprocessed image. it'll calculate foreground and background object's threshold and thus calculate the ultimate optimum threshold from them. Finally, the required threshold is given by,  $(T1+T2)/2$  wherever  $T1$  is threshold1 is that the foreground threshold and  $T2$  is threshold2 is the background threshold.

### Feature Extraction

Once the region is binarized, options are to be extracted from it for more classification analysis. This calculates numerous applied math options beside BMD from the binary pre-processed region. It involves options like energy, entropy, contrast, homogeneity, correlation, eccentricity, hogged hull, area, boundness, solidity, etc. pathology is diagnosed by mensuration bone mineral density (BMD), thereby shaping thresholds. the edge will be known by distribution of bone density values. Bone mineral density is outlined as bone mineral content (BMC) divided by the projected space of the scanned image.  $BMD=BMC/area$  (g/cm<sup>2</sup>) (1).

the realm of the trabeculate structure will be known by changing the grey image into binary. so as to get, applied math and texture options, grey Level Co-Occurrence Matrix (GLCM) is computed. For the grey level co-occurrence matrix, applied math options are calculated exploitation following equations.

Energy could be a live of native homogeneity and thus it represents the other of the Entropy. additionally, referred to as angular moment. primarily this feature can tell North American nation however uniform the feel is. the upper the Energy price, the larger the homogeneity of the feel. The vary of Energy is [0, 1], wherever Energy is one for a relentless image.  $Energy = P_{ij}$  a pair of a pair of a pair of.  $j=0$  (2) wherever  $P_{ij}$ = part imp of the normalized symmetrical GLCM and  $N$ =Number of grey levels thought of for computing GLCM.

### Fuzzy Expert System

The Fuzzification is a process of mapping all real-world items into fuzzy world using different types of curve that shows degree of belongingness called membership function. As an expert predicts the disease after examining risk factors, a final decision is made by defuzzification unit with the help of fuzzy reasoning and rules.

The primary steps in osteoporosis diagnosis system are

- (a) Fuzzification of risk factors.
- (b) Acquiring knowledge from experts and studies to form rules that makes final decision in the fuzzy domain with fuzzy inference technique.
- (c) Defuzzification process that helps us get back values from fuzzy world to real world.

Fuzzy inference system is characterized by membership functions.

A membership function is a curve that shows degree of belongingness of each element in the range of zero to one. The process of fuzzification converts risk factors into combination of fuzzy sets  $trimx, a, b, c = \max \min x - ab - a, c - xc - b, 0$  (4).

$trimfx, a, b, c, d = \max \min x - ab - a, l, d - xd - c, 0$  (5).

Where  $x$  is that the coordinate that represent risk factors and parameters  $a, b, c, d$  verify the  $x$  coordinates of the corners of membership operate. Description on fuzzy rules and inference: Rules are elect among the potential combination of fuzzy sets that describes risk factors of pathology. the best kind of fuzzy rule base system is that if  $x$  then wherever  $x$  is thought as antecedent and  $y$  as sequent. There are four rules that depict the degree of pathology.

The specific aspect of this invention relates to a computer program product adapted to carry out the method of this invention when run on a computer. The invention further relates to a computer readable carrier medium such as a CD-ROM comprising computer executable program code adapted to carry out the steps of the method of the present invention.

The system for winding up the strategy of this invention. Such a system includes a laptop programmed to hold out the steps of this invention upon input of BMD measure results and values of risk factors collected e.g. by a form or through routine physical examination.

**Caffeine**-Up to four hundred milligrams of alkaloid on a daily basis thought-about safe for many adults. Moderate occasional consumption (3 cups/d) is suggested in adults with pathology.

**Vitamin D**-Many consultants advocate tier between twenty and forty ng/mL. Others advocate tier between thirty and fifty ng/mL. The pathology recommends associate degree intake of 800 to one thousand international units (IU) of alimentation D3 per day for adults over age fifty.

#### **Exercise**

at least 100–300 minutes of low-intensity workout a week. A minimum of 75–150 minutes of High-intensity, aerobic activity. For osteoporosis 40 minutes to one hour of aerobic activity two to three times per week.

#### **Bone Mineral content**

measures the projected bone mass. A Tscore of -1.0 or higher than is traditional bone density. Examples square measure zero.9, 0 and -0.9. A Tscore of -2.5 or below could be a designation of pathology. Examples square measure Tcores of -2.6, -3.3 and -3.9.

#### **Osteocalcin**

Bone gamma-carboxylation acid containing macromolecule. measure of osteocalcin is accustomed monitor medical aid with antiresorptive agents. The reference intervals for osteocalcin are concerning one.2–12 ng/mL (male) and zero.7–6.5 ng/mL (female).



## Materials and Methods

### Study Design

The purpose of this study is to classify the presence or absence of pathology from hip radiographs of the articulationspheroidal. we tend to use a segmental dataset to mimic the diagnostic vary of pathology within the DXA methodology. additionally, clinical covariates extracted from clinical records were additional to the dataset. many completely different convolutional neural networks (CNNs) were accustomed diagnose pathology from hip radiographs. we tend to investigated the accuracy of the prophetic identification of pathology from the mix of clinical covariates with the varied CNN models.

### Data Acquisition

We retrospectively used clinical and image knowledge from March 2014 to December 2019. This study was approved by the Institutional Review Board of the Kagawa administrative division Central Hospital (Approval No. 894). This study concerned 1223 consecutive patients sixty years more matured or older World Health Organization had hip photos and World Health Organization underwent DXA at our hospital six months before and when the date that the hip radiograph was performed.

The term “hip fracture” refers to a leg bone neck or trochanteric fracture. we tend to excluded the subsequent pictures: fifty images of degenerative joint disease with leg bone head deformity, thirty-two unclear or poor pictures, seven pictures showing artificial objects made from materials like metal, two showing leg bone format following previous fractures, and one showing pathological fracture. Thus, 1131 hips (708 broken and 423 non-fractured) remained for additional analysis.

### Data Preprocessing

Simple hip radiographs of every patient were accustomed acquire the photographs. All pictures were output in fuss format (size:  $2836 \times 2373$  pixels) from the Kagawa territorial division Central Hospital PACS system (HOPE Dr ABLE-GX, FUJITSU Co., Tokyo, Japan). For the photographs, we have a tendency to performed segmentation of the hip space. Six orthopaedic surgeons manually placed and cropped areas of interest on the X-ray pictures victimization Photoshop components (Adobe Systems, Inc., San Jose, CA, USA) beneath the superintendence of associate degree orthopaedic specialist.

### RESEARCH BRIEF DESCRIPTION OF THE DIAGRAM

FIG.1: biomedical image analysis.

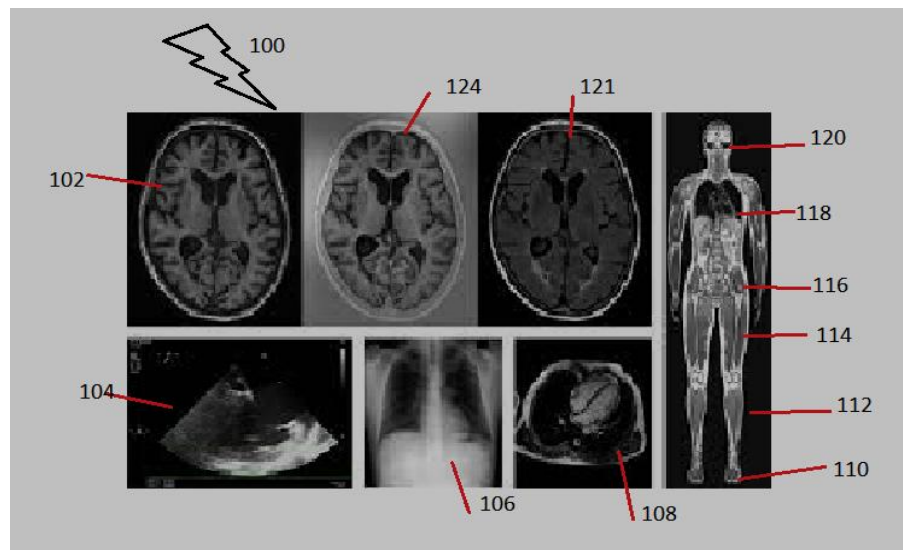


FIG.2: Disease using fuzz logic Detection.

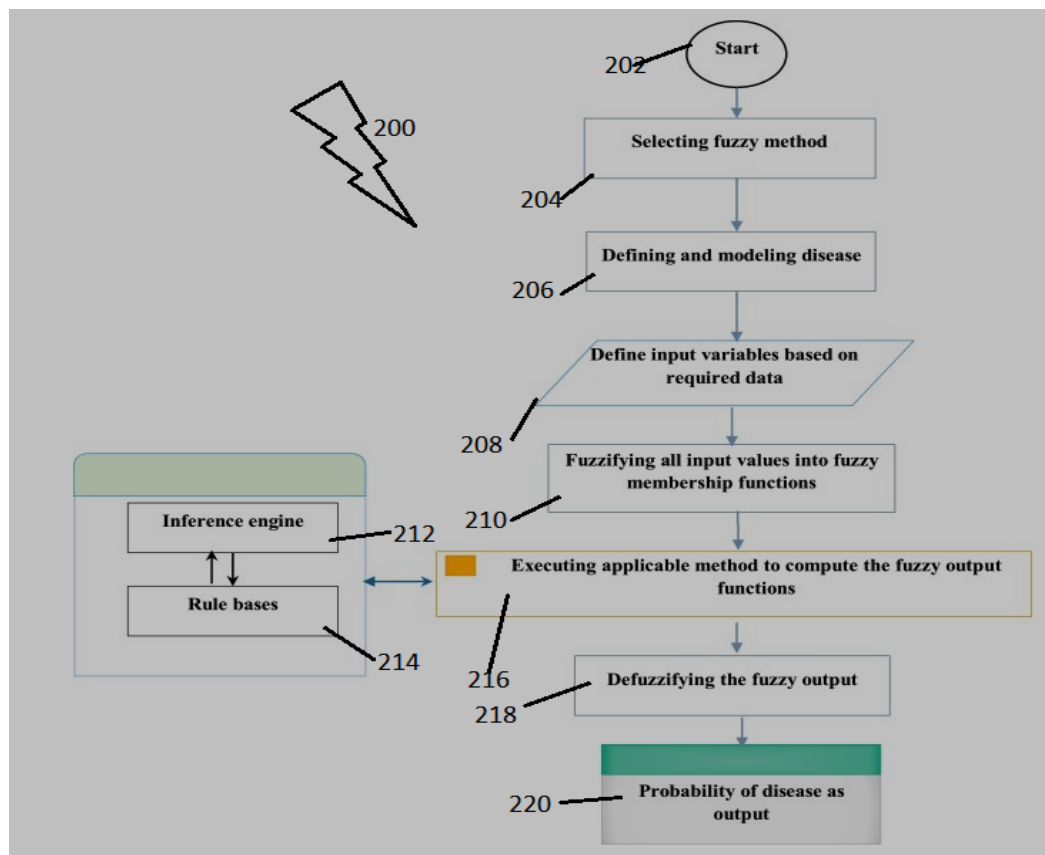


Fig.3: Diagnosis of a Medical Patient and relative data based.



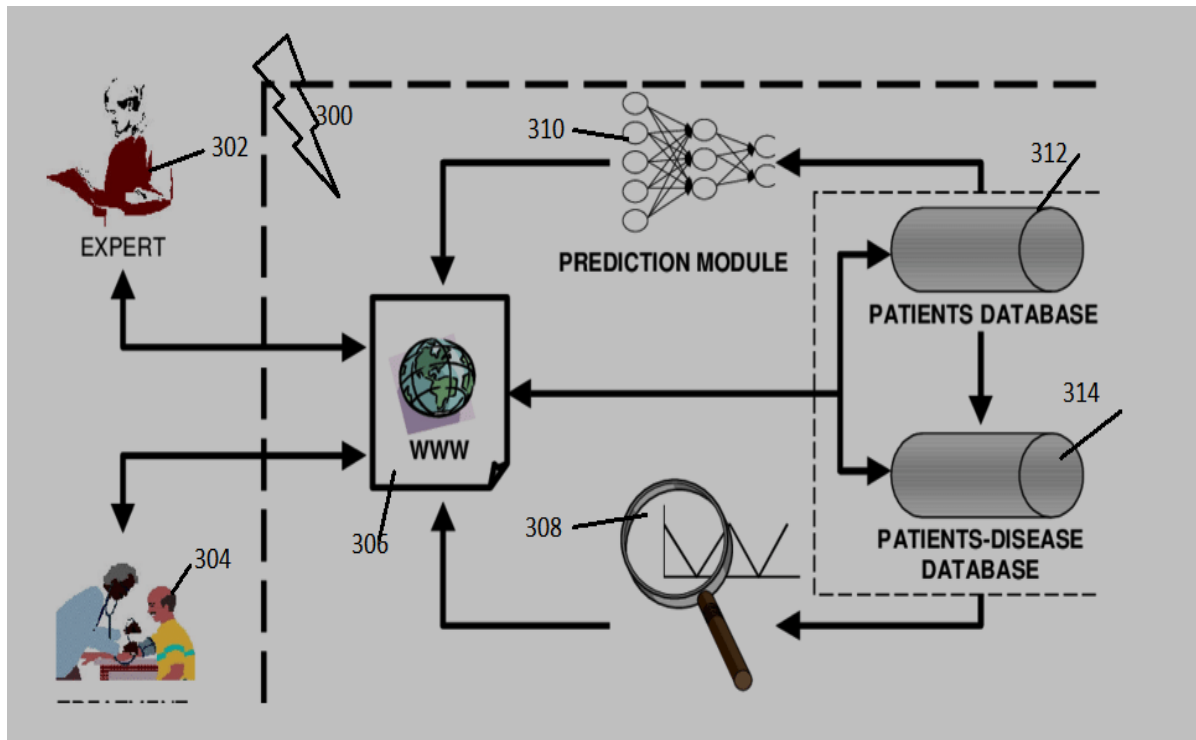


FIG.4: Prediction Model medical data.

### RESEARCH DESCRIPTION OF THE INVENTION

The goal of this paper is to gift a literary criticism on the most systems that use computing to spot teams in danger for pathology or fractures. The systems thought-about for this study were those who consummated the subsequent requirements: vary of coverage in diagnosing, low price and capability to spot a lot of important physical factors.

For this review, a listing search has been conducted victimization the net databases PubMed—US National Library of drugs National Institute of Health, IEEE Explorer—Digital Library and Science Direct, Spanish American and Caribbean Center on Health Sciences data (LILACS), Medical Literature Analysis and Retrieval System on-line (MEDLINE), accumulative Index to Nursing and Allied Health Literature (CINAHL), Scopus, internet of Science, for articles revealed between Gregorian calendar month 2000 and will 2017. Some antecedently revealed papers are utilized in this review thanks to its high index of citations and connectedness in reference to the theme. The search restricted to the terms “Neural Network”, “Osteoporosis Machine Learning” and “Osteoporosis Neural Network”. 2294 articles were found and 2232 titles that weren't directly associated with the analysis topic were excluded. a 3rd screening was performed once reading the abstracts, applying criteria like variety of citations, technique used for processing, study teams (men, women, race, age group), variety of people utilized in the analysis and quantitative variables of those things are removed.

## Discussion

This study incontestable that CNNs will diagnose pathology from hip radiographs with comparatively high accuracy. Moreover, together with patient variables concerned in routine clinical setting improved the accuracy of predictions compared to those exploitation the image model alone. The economical internet b3 network exhibited the very best performance (accuracy: eighty-eight.5%; recall: eighty-eight.7%; F1 score: zero.8943; and AntidefenseUnidos de Colombia score: zero.9374) in identification pathology from proximal limb cropped pictures from entire hip radiographs among the 5 networks.

the benefits of our study over previous studies that diagnosed pathology exploitation metric capacity unit area unit that it absolutely was supported a bigger range of cases, and enclosed a lot of clinically suspicious cases and patients thought-about in danger of developing pathology within the future for pathology. The addition of patient variables offered vital info, that improved the sensitivity and AntidefenseUnidos de Colombia score particularly.

Our classification model combines image options and patient factors with the assistance of a neural network. we tend to conclude that the diagnostic accuracy improved as a result of we tend to may create inferences whereas at the same time considering very important info associated with clinical covariates that can't be extracted from pictures alone. To the most effective of our data, this was the primary study to match the relative pathology diagnostic efficiencies of metric capacity unit systems that use pictures alone and people that conjointly use patient variables. The results with relative high sensitivity recommend that the model of the image with patient variables offers a superior tool for screening pathology in an exceedingly clinical setting.

## RESEARCH CLAIMS

- 1.The pathology could be a malady within which bones become fragile and additional probably to interrupt. pathology will progress painlessly till it causes a bone fracture or a bone break. twin Energy X-ray Absorptiometry (DEXA) is costlier and not accessible simply therefore we tend to square measure victimization Fuzzy illation system to predict pathology. The invention could be a symbolic logic we tend to collect risk factors and rules for pathology and build an interface that take inputs and predicts if someone has pathology. within the following Literature survey, we are going to take risk factors, rules, and ways in which to implement them. round the world, +33% of ladies and +20% men over the age of +\_50 can suffer a fracture caused by pathology. The pathology could be a malady within which Bones become shallow and square measure broken. If expected before, quality of life can increase and severe surgery is also avoided. The pathology was assessed from the hip radiographs victimization 5 convolutional neural network (CNN) models. we tend to additionally investigated ensemble models with clinical covariates further to every AI primarily based CNN. The accuracy, precision, recall, specificity, negative prophetic price (NPV), F1 score, and space beneath the

curve (AUC) score were calculated for every network. For objective labeling, we tend to collected a dataset containing +1131 pictures from patients United Nations agency underwent each skeletal bone mineral density measuring and hip radiography at one general hospital between 2014 and 2019.

2: According to claim1#the invention is to a medicine Image Analysis for pathology victimization fuzz logic Detection, Diagnosis associated Prediction Model may be a progressive bone malady that's characterized by a decrease in bone mass and density which might cause a raised risk of fracture. pathology may be a state of getting brittle and fragile bone that arises because of sustenance deficiency, tissue loss, secretion changes.

3: According to claim1,2# the invention is to a novel pathology will be expeditiously detected by shrewd numerous options like Bone mineral density (BMD), applied math options from numerous trabeculae region like hip, toe, elbow, etc. Detection of bone disorders are finished the assistance of bone densitometer. The Invention may be a bone densitometer uses a way that the bone density will be measured in-terms of Score.

4: According to claim1,2,3# the invention is to a Bone Mineral density measurement can be achieved by various segmentation methods such as K-means, Fuzzy segmentation. The invention machine /deep learning to diagnose osteoporosis from hip radiographs, and whether adding clinical data improves diagnostic performance over the image mode alone and also the invention is to a 5 CNN models exploitation solely hip radiographs, Google web and economical web b3 exhibited the most effective accuracy, precision, and specificity. Among the 5 ensemble models, economical web b3 exhibited the most effective accuracy, recall, NPV, F1 score, and FTO score once patient variables were enclosed.

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