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Fuzzification Based Osteoporosis Prediction Model

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Abstract: ***Osteoporosis is a disease in which bones become fragile and more likely to break. Osteoporosis can progress painlessly until it causes a bone fracture or a bone break. Dual Energy X-ray Absorptiometry (DEXA) is more costly and not accessible easily so we are using Fuzzy Inference system to predict osteoporosis. In this fuzzy logic, we collect risk factors and rules for osteoporosis and build a interface which take inputs and predicts if a person has osteoporosis. In the following Literature survey, we will take risk factors, rules, and ways to implement them. Around the world, 33% of women and 20% men over the age of 50 will suffer a fracture caused by Osteoporosis. Osteoporosis is a disease in which Bones become shallow and are fractured. If predicted before, quality of life will increase and severe surgery may be avoided.***

Keywords- Osteoporosis, Fuzzy-logic, Risk-Factors, Rules

I. INTRODUCTION

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 [1]. The main motive is to propose a fuzzy framework for the diagnosis of osteoporosis in the medical field. This better helps the doctors to treat various forms of osteoporosis disease. The complexity of the disease is analyzed by a fuzzy system and an X-ray image processing method. Thus, both of them are combined to form a result. The image processing technique is used to calculate bone density. Following Fuzzy Edge Directed Image Interpolation (FEDI) helps to frame an efficient osteoporosis detection. The proposed algorithm can overtake existing, expensive and extraordinary bone density calculation technique.

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Proposed diagnosis system performs well to treat osteoporosis. Degree of disease is equated inefficient manner. These algorithms help to predict disease and contribute to improving the quality of health [2].

In this paper, authors have proposed an Intelligent Medical Diagnostic System (IMDS) accessible through common Web-based interface, to on-line, perform initial screening for osteoporosis.

The fundamental approaches, which construct the proposed system, is mainly based on the fuzzy-neural theory, which can exhibit superiority over other conventional technologies in many fields. In the diagnosis process, users simply answer a series of directed questions to the System and then they will immediately receive a list of results, which represents the risk degrees of osteoporosis.

According to clinical testing results, it is shown that the proposed system can provide the public or even health care providers with a convenient, reliable, an inexpensive approach to osteoporosis risk assessment.

Advantages of the IMDS are four-fold: Automatically generating diagnostic rules without medical Experts' active participation can significantly reduce the construction cost of the system.

The Learning-from-example ability of the IMDS can extract implicit, previously unknown, and potentially useful medical knowledge from considerable patient's data or medical history sing a questionnaire of osteoporosis risk factors rather than Other invasive methods or laboratory measurements to assess Osteoporosis risk not only can considerably reduce the cost of Mass screening, but can also speed up the screening process.

The convenient, interactive, web-based user interface can effectively increase the accessibility of the system. Moreover, it should be noted that the reliability of the System mainly depends on the information supplied by the users; in other words, entering incorrect or misleading information will cause erroneous or unreliable diagnosis results [3]. In this paper, authors developed a new system for AOs pathological classification for diagnosis based on cervical radiography images by medical professionals. Authors give us points that act as a tool for creating a perception of vertebral shape structure. Authors got vertebrae shapes using ASM technique using 9 – AP shape boundary representation. The angle descriptors and FDT algorithms were effective in identifying and recognizing the AOs in Cervical dataset using 9-APR. In this article, we came to know that, after surveying 1122 women who had brittleness fractures. Using fuzzy theory, this paper proposes a new methodology for AO's classification of the cervical radiography and designing a fuzzy decision tree model. We were able know that this can be successfully used in medical applications [4].

In this paper author, explain fuzzy inference model in which medical practitioners give input to fuzzy model based on two factors Patients linguistic inputs measuring from patients body and using those input, fuzzy inference model takes rules from knowledge base of experts (osteoporosis experts) and use fuzzy logic to give output.

The output may not be considered accurate but it will speed up the process of detecting osteoporosis and also it is very cheap as compared to DEXA.The best part about fuzzy inference is the ability to deal with uncertainty in patents inputs and computing it for accurate output. [5].

In this paper author focuses on encoding common intuition of doctor who deal with Osteoporosis. Fuzzy inference system involves fuzzification (representation of crisp input) and defuzzification (output to crisp set).

Fuzzy logic is primarily on the observations that humans take decisions on imprecision and non-numerical knowledge. Fuzzy sets are mathematical models of representing vague and imprecise information. These models have the abilities of reconsidering, manipulative, interpreting, and using data and information that are obsolete and lack certainty. [6].

II. METHODOLOGY

A) Risk Factor

Risk Factors	Range
Coffee consumption	(0-400mg),(400mg-800mg)
Vitamin D	(800-1000IU),(30-50ng/ml)
Exercise	(2.5-5 hours),(0.75-1 hours)
Bone Mineral content	(-1 to 4),(-2.6 to -4)
Age	(0-40),(41-80)
Osteocalcin	(0.7–6.5 ng/mL),(18-27.8ng/ml)
serum calcium	-
Calciuria	-
alkaline phosphatase	-
Hydroxiprolinuria	-
duration of amenorrhea	-
thin body habitus (weight, height)	-
Smoking	-
prolonged use of corticosteroids	-

Fig 1.Risk factors

1. **Caffeine**-Up to 400 milligrams of caffeine a day considered safe for most adults. Moderate coffee consumption (3 cups/d) is advised in adults with osteoporosis.
2. **Vitamin D**-Many experts recommend a level between 20 and 40 ng/mL. Others recommend a level between 30 and 50 ng/mL.The Osteoporosis recommends an intake of 800 to 1000 international units (IU) of vitamin D3 per day for adults over age 50.
3. **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.
4. **Bone Mineral content** -measures the projected bone mass. A Tscore of -1.0 or above is normal bone density.

Examples are 0.9, 0 and -0.9. A Tscore of -2.5 or below is a diagnosis of osteoporosis. Examples are Tscores of -2.6,-3.3 and -3.9.

5. **Osteocalcin**-Bone gamma-carboxyglutamic acid containing protein. Measurement of osteocalcin can be used to monitor therapy with antiresorptive agents. The reference intervals for osteocalcin are about 1.2–12 ng/mL (male) and 0.7–6.5 ng/mL (female). Osteocalcin level in mild osteoporosis cases was 21.37±3.6ng/ml and in severe osteoporosis cases it was 22.8±4.9 ng/ml.
6. **Age Range**-
   a. Babies (0-2 years): very rare
   b. Toddlers (3-5 years): very rare
   c. Children (6-13 years): very rare
   d. Teenagers (14-18 years): rare e. Young adults (19-40 years): rare
   f. Adults (41-60 years): common
   g. Seniors (60+ years): very common

B) RULES

If	Then
Age is young AND Bone Mineral content is Decreased AND Serum Calcium is Normal AND Alkaline Phosphatase is Normal AND Hydroxiprolinuria is Normal AND Osteocalcin is Very Decreased	Definite Postmenopausal Osteoporosis is Very High AND Possible Postmenopausal Osteoporosis is Very Low AND Excluded Postmenopausal Osteoporosis is Very Low AND
Age is Old AND Duration of Amenorrhea is High AND Bone Mineral Content is Very Decreased AND Serum Calcium is Normal AND Alkaline Phosphatase is Normal AND Hydroxiprolinuria is Increased AND Osteocalcin is Normal	Definite Senile Osteoporosis is Very High AND Possible Senile Osteoporosis is Very Low AND Excluded Senile Osteoporosis is Very Low
Age is Not Very Young AND Duration of Amenorrhea is Not Very Low AND Bone Mineral Content is Decreased AND Serum Calcium is Normal AND Alkaline Phosphatase is Normal AND Hydroxiprolinuria is Increased AND Osteocalcin is More Or Less Decreased AND Thin Body Habitus is High AND Smoking is Yes AND Lack of Exercise is Yes AND Prolonged use of Corticosteroids is No Low Dietary Intake of Calcium And VitaminD is Yes AND High caffeine Use is Yes	Definite Senile Osteoporosis is Medium AND Possible Senile Osteoporosis is High Excluded Senile Osteoporosis is Low

Fig 2. Rules

C) FUZZY LOGIC SOLUTION APPROACH

Fuzzy logic is the technique that allows the control of a complex system without knowledge of its logical description. In fuzzy logic, we represent the degree to which an element belongs to a given set.

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Fuzzy logic is a way of computing that provides a mathematical tool for dealing with uncertainty and the imprecision typical of human reasoning. A major characteristics of fuzzy logic is to represent linguistic terms as patients do are not precise about risk factors like smoking exercise.

i) Block-Diagram

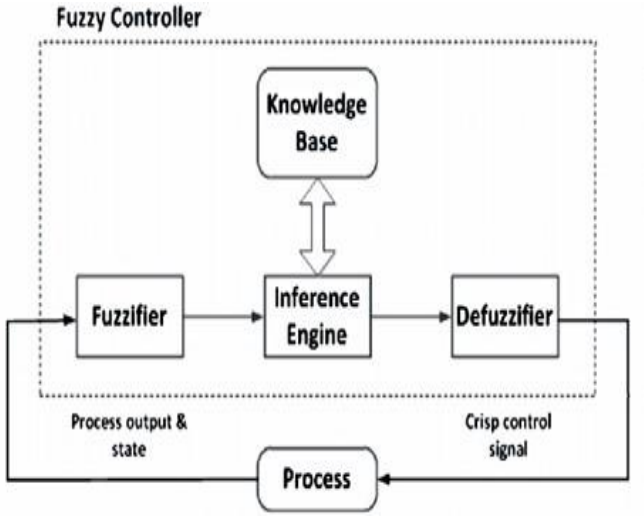

Fig 3. Block diagram

ii) Initialization

1. Linguistic variables and terms are defined.
2. Construction of the member functions.
3. Construction of the fuzzification decision tree, Extraction of the fuzzy rule base.

iii) Fuzzification

This step converts crisp input data to fuzzy values using the membership functions.

iv) Fuzzy inference

1. Evaluate the rules in the fuzzy rule base.
2. Combine the results of each rule.

v) Defuzzification

This step converts the output data to non-fuzzy values or real values.

D) DESIGN

We are using Fuzzy Logic Toolbox, which is in-built into MATLAB.

1. Fuzzy Logic Designer - To handle high-level issues.
2. Membership Function Editor - To define membership function of each variable.
3. Rule Editor - To define rules and delete rules.
4. Rule Viewer - To give inputs to fuzzy inference system and to give output.
5. .Fis file - To store everything in the form of a file.

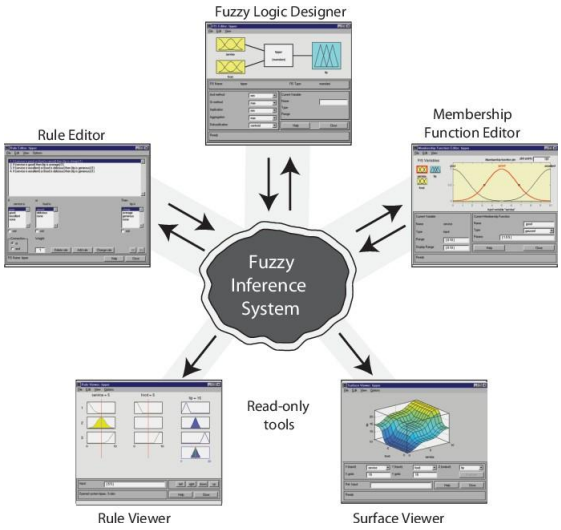

Fig 4.Matlab Fuzzy tool box

III. RESULTS

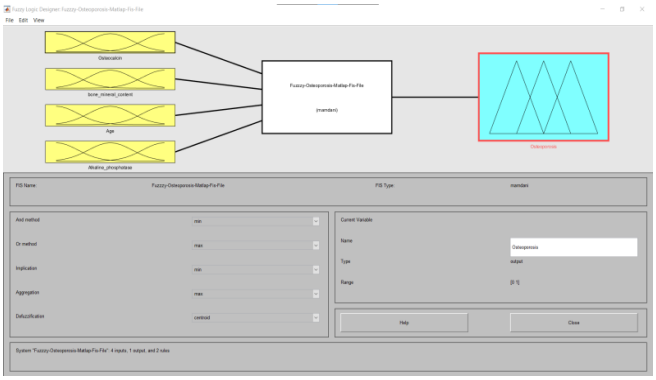

Fig 5.Fuzzy-Logic-Designer

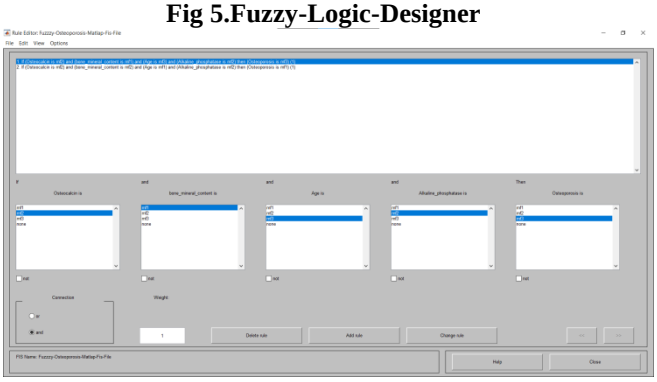

Fig 6.Rules-Editor

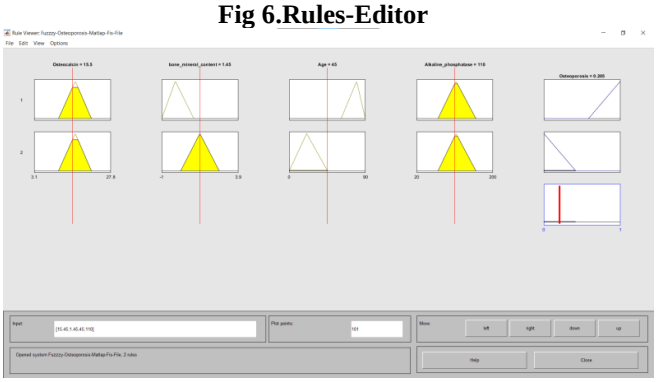

Fig 7.Rule-Viewer

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IV. CONCLUSION AND FUTURE WORK

A. Conclusion

In this project we have tried to predict osteoporosis using fuzzy logic in which we take inputs from a patient with the help of physicians and run those parameters using rules from the knowledge base and predict if a person has low, medium, high osteoporosis.

B. Future Work

1. Talk to Doctors and get more knowledge base to increase accuracy by adding more rules and more risk factors.
2. Test Fuzzy inference system with real data and based on the result and alter the rules or membership functions.

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