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BONE OSTEOPOROSIS USING IMAGE PROCESSING WITH MACHINE LEARNING

S.K. Mydhili Department of ECE, Professor KGISL Institute of Technology Coimbatore, Tamilnadu, India myura2u@gmail.com
R.Poornimaa Department of ECE, PG Student KGiSL Institute of Technology Coimbatore,Tamilnadu,India poornimaacms@gmail.com
R.Ramitha Devi Department of ECE, PG Student KGiSL Institute of Technology Coimbatore,Tamilnadu,India ramithadevi@gmail.com
T.A.Benazir Department of ECE, PG Student KGiSL Institute of Technology Coimbatore,Tamilnadu,India arbenazir22@gmail.com

ABSTRACT

Osteoarthritis is a major cause of disability in the adult population. As a progressive degenerative joint disorder, OA is characterized by cartilage damage, changes in the subchondral bone, osteophyte formation, muscle weakness, and inflammation of the synovium tissue and tendon. Although OA has long been viewed as a primary disorder of articular cartilage, subchondral bone is attracting increasing attention. It is commonly reported to play a vital role in the pathogenesis of OA. Subchondral bone sclerosis, together with progressive cartilage degradation, is widely considered as a hallmark of OA. Despite the increase in bone volume fraction, subchondral bone is hypo mineralized, due to abnormal bone remodeling. Some histopathological changes in the subchondral bone have also been detected, including microdamage, bone marrow edema-like lesions and bone cysts. This review summarizes basic features of the osteochondral junction, which comprises subchondral bone and articular cartilage. Importantly, we discuss risk factors influencing subchondral bone integrity. We also focus on the microarchitectural and histopathological changes of subchondral bone in OA, and provide an overview of their potential contribution to the progression of OA. A fuzzy extraction model for the pathogenesis of OA is proposed.

Keywords: Osteoporosis, Subchondral Bone, Pathogenesis.

Introduction

Osteoarthritis (OA) is a common leading cause of pain and disability in the aging population. As a slowly progressive degenerative joint disorder, OA is characterized by cartilage damage, changes in the subchondral bone, osteophyte formation, muscle weakness, and inflammation of the synovial tissue and tendon. Although OA has long been considered as a primary disorder of articular cartilage, the contribution of subchondral bone to the physiopathology of OA is arousing interest. Subchondral bone deterioration is commonly associated with articular cartilage defects, and subchondral bone sclerosis, together with progressive cartilage degradation, is widely considered as a hallmark of OA. Despite the increase in the number of trabeculae and bone volume, subchondral bone is hypo mineralized and of inferior quality, as a consequence of abnormal local high bone turnover. Some histopathological changes in the subchondral bone have also been detected, including microdamage, bone marrow edema-like lesions and bone cysts. In this review, we summarize basic features of a functional joint unit comprised of subchondral bone and articular cartilage. We also discuss factors that influence the integrity of subchondral bone. Importantly, we focus on the microarchitectural and histopathological changes of subchondral bone in OA, and provide an overview of their potential contribution to the progression of OA.

II. METHODOLOGY

The input layer represents the input membership functions for the fuzzy rules, with sufficient input causing a rule in the hidden layer to fire. The weights between the layers represent the fuzzy sets, with membership in each set determined by the relative weights – these can be altered using particular

training algorithms as per a normal neural system. Transfer functions are usually continuous and pass real values through the network to the output layer to be interpreted as degrees of membership in fuzzy sets based on the firing of fuzzy rules in the hidden layer.
Fuzzy neural networks combine the strengths of both neural networks and FL, making them a very powerful hybrid tool. They allow the integration of expert knowledge into the system, and are considered inherently more understandable because of their use of human-like fuzzy inference.

III. LITERATURE MODEL

The segmentation of bones in the knee region is one of the first essential steps to perform further analysis, classification and osteoarthritis imaging biomarkers discovery. In this paper, an efficient graph-cut based segmentation algorithm is proposed. One of the challenges in current graph-cut schemes is properly distinguishing between regions of interest (ROI) and background regions with features very similar to those of the ROI. Since obtaining a very discriminative cost function is not always feasible, many algorithms require user interaction to provide an extensive number of seed points. In this paper, a new approach is proposed which uses efficient content-based features to achieve segmentation without the need for any user interaction.

Experimental results on actual knee MR images demonstrate the effectiveness of the proposed scheme with an average accuracy of 95% using the Zijdenbos similarity index.[1] Digital image processing comprises varieties of applications, where some of these used in medical image processing include convolution, edge detection as well as contrast enhancement. Efficient edge detection depends on choosing the threshold; the choice of threshold directly determines the results of edge detection. In this paper, Sobel edge detection operator and its enhanced algorithm are first discussed in terms of optimal thresholding in C language under Linux platform. It is implemented a competent execution time for this new enhanced algorithm to detect edges for human knee osteoarthritis images in different critical situations.

The proposed method is able to exhibit discernible view of salient features of most osteoarthritis images with approximately 50% better execution time compare to classical Sobel method. Also, it is shown that the algorithm is very effective in case of noisy and blurs images**[2]** Segmentation of bony structures in CT scans is a crucial step in knee arthroplasty based on personalized surgical instruments (PSI). As a matter of fact, the success of the surgery depends on the quality of the matching between the patient-specific resection jigs, manufactured exploiting the patient bony surfaces attained by segmentation, and true patient surfaces. Severe pathological conditions as chronic osteoarthritis, deteriorating the cartilages, narrowing the intra-articular spaces and leading to bone impingement, complicate the segmentation making the recognition of bony boundaries sub-optimal for traditional semi-automated methods and often extremely difficult even for expert radiologists.

Deep convolutional neural networks (CNNs) have been investigated in the last years towards automatic labeling of diagnostic images, especially harnessing the encoding-decoding U-Net architecture. In this article, we implemented deep CNNs to encompass the concurrent segmentation of the distal femur and the proximal tibia in CT images and evaluate how segmentation uncertainty may impact on the surgical planning. A retrospective set of 200 knee CT scans of patients was used to train the network and test the segmentation performances. Tests on a subset of 20 scans provided median dice, sensitivity and positive predictive value indices greater than 96% for both shapes, with median 3D reconstruction error in the range of 0.5mm. Median 3D errors on both PSI femoral and tibial contact areas and surgical cut alignments were less than 2mm and 2°, respectively, which can be considered clinically acceptable.

These results substantiate that deep CNN architectures can disclose the opportunity of segmenting bone shapes in CT scans for PSI-based surgical planning with promising accuracy. However, we observed that segmentation scores alone cannot be taken as representative of the 3D errors at the contact areas of the PSI. Therefore when comparing segmentation algorithms of PSI-based surgical**[3]** Established knee cartilage assessment technique to differentiate those in different osteoarthritis grades. We construct atlas for each grade and each atlas represents an average size of cartilage thickness. We build the atlas using manual segmentation of patellar cartilage following group wise registration.

We assign thickness value at the voxels in bone-cartilage interface in ahead. The thickness atlas is used for t-test to see how our method is accurate. T-test result shows our method finds significant difference between osteoarthritis grade 0 and 4 with p less than 0.001[4] To effectively diagnose and monitor the treatment of diseases such as osteoarthritis, the segmentation, processing and analysis of mass volumes of medical images is gaining high importance. In this paper, a new fully automated content-based segmentation framework is proposed. The framework is designed to be compatible with a wide variety of segmentation techniques. To this end, a novel content-based two-pass block discovery mechanism is proposed to provide full automation for image segmentation. The proposed framework uses both training and local image data and disjoint block-wise image scanning to achieve ROI and background block discovery. The detected object and background blocks are then used to initialize and support the segmentation process. [5].

IV. EXISTING MODEL

Osteoporosis is an asymptomatic bone condition that affects a large proportion of the elderly population around the world, resulting in increased bone fragility and increased risk of fracture. Previous studies had shown that the vibroacoustic response of bone can indicate the quality of the bone condition.

The method is described that uses a reflex hammer to exert testing stimuli on a patient's tibia and an electronic stethoscope to acquire the impulse responses. The signals are processed as frequency cep strum coefficients and passed through an artificial neural network to determine the osteoporosis from the tibia's impulse responses.

Pilot testing with 12 patients achieved over 80% sensitivity with a false positive rate below 30% and accuracies in the region of 70%. An extended dataset of 110 patients achieved an error rate of 30% with some room for improvement in the algorithm. By using common clinical apparatus and strategic machine learning, this method might be suitable as a large population screening test for the early diagnosis of osteoporosis, thus avoiding secondary complications.

V.PROPOSED MODEL

Digital image processing comprises varieties of applications, where some of these used in medical image processing include convolution, edge detection as well as contrast enhancement. Efficient edge detection depends on choosing the threshold; the choice of threshold directly determines the results of edge detection. In this paper, Sobel edge detection operator.

5.1 Digital Image Processing Networks

and its enhanced algorithm are first discussed in terms of optimal thresholding in C language under Linux platform. It is implemented a competent execution time for this new enhanced algorithm to detect edges for human knee osteoarthritis images in different critical situations.

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BLOCK DIAGRAM:

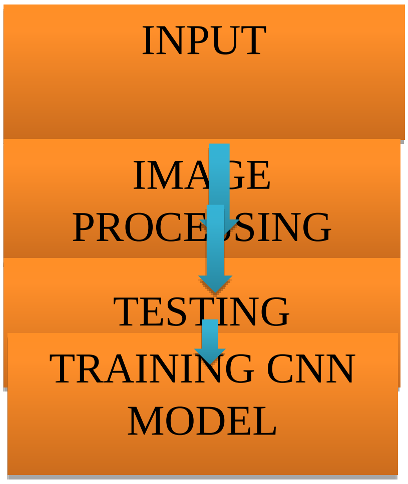
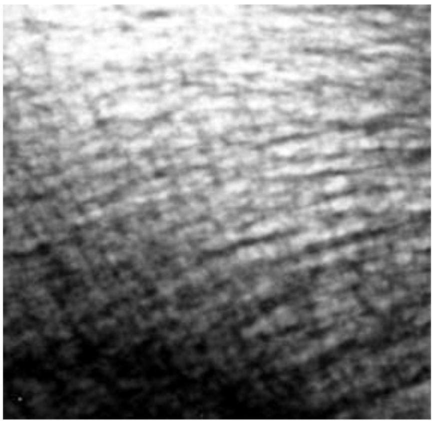
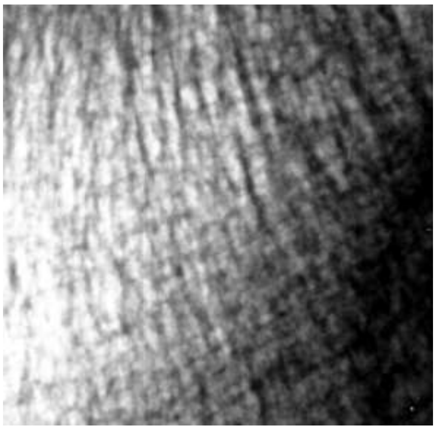


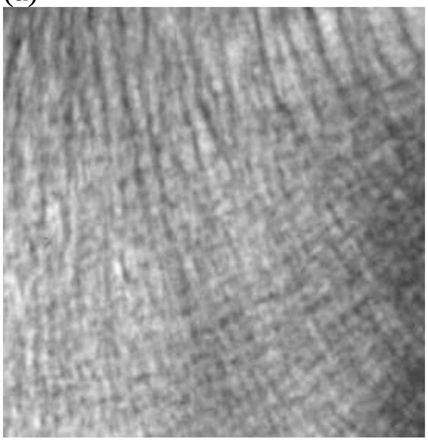
Fig 5.1:BLOCK DIAGRAM FOR BONE OSTEOPOROSIS VALIDATING STAGES The proposed method is able to exhibit discernible view of salient features of most osteoarthritis images with approximately 50% better execution time compare to classical Sobel method. Also, it is shown that the algorithm is very effective in case of noisy and blurs images. In fig 1.2 Block diagram states that image processing components.

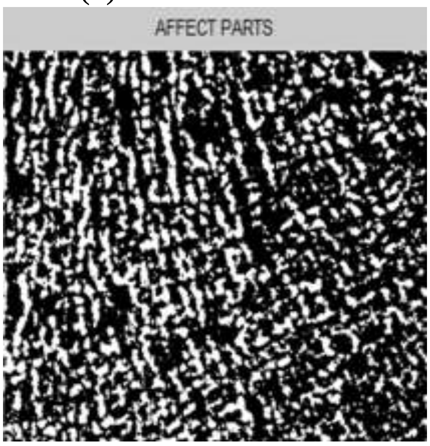
5.2 DATA CUMULATION


(a)


(b)


(c)


(d)



(e)

FIG 5.2: (a) Normal Skin ,(b) Osteopenia , (c) Osteoporosis,(d) Severe Osteoporosis,(e) Affected Parts with thickness of skin.In this work, an efficient, automatic method of classifying Osteoporosis has been done which is cost-effective and robust. The proposed method here was tested on diseased and non-diseased patients. Hence, this algorithm can be implemented to classify and detect In fig1.3 consolidated the disease with increased accuracy which can be implemented at local hospitals to detect Osteoporosis.

5.3 CNN MODEL FOR TRAINING STAGES OF BONE OSTEOPOROSIS

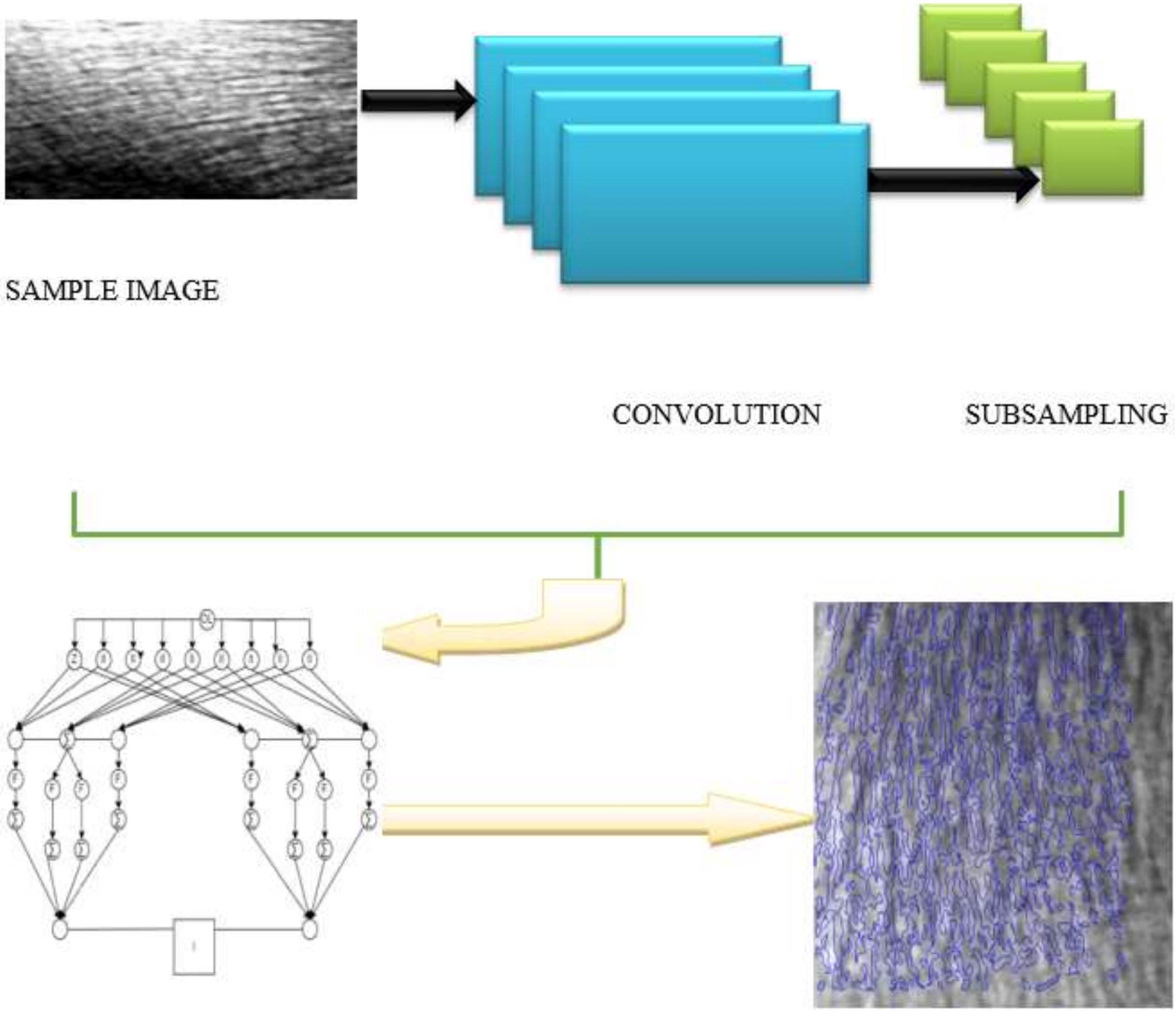


Fig 5.3: DIGITAL IMAGE PROCESSING NETWORKS CONTRAST SEGMENTED IMAGE

The layers in a CNN include convolutional layers, sampling layers, and fully connected layers. In a typical CNN architecture of Fig 3 Evaluated through digital images refining Analysis , the input layer gets raw picture data, which is then sent through a sequence of convolutional and osteochondral Junction to obtain final classification of connected layers after these layers have been fully traversed.

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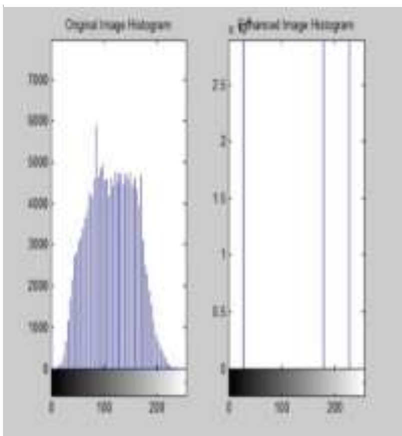

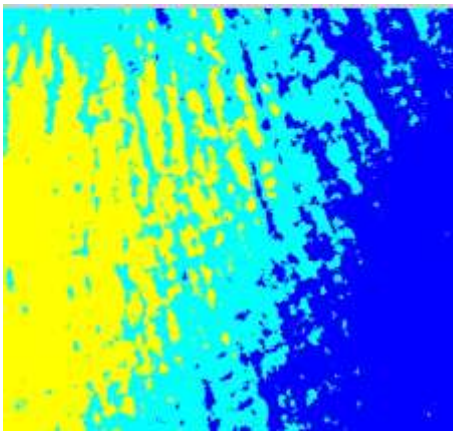

(f) (e)

Fig 3 . Original Image and Enhanced Image Histogram Representation

We integrated through histogram-based clustering (HBC)algorithm with our previously-designed computer-aided diagnosis system.In this figure Analyzed the stages and Bone medical density of patients The extracted moment-based features (mean, instance value) of the Osteoporosis stages width for the radial basis function were employed. We also compared the diagnostic efficacy of the SVM model with the back propagation (BP) neural network model. In this study, ROF of the patients (aged >50 years), with no previous record of osteoporosis, were randomly selected for inclusion.

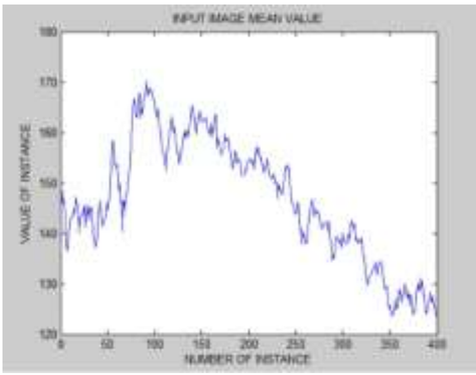

Fig 5.4 Mean value and instance value Representation

Mean Value and Instance Value Cumulative Analysis

MEAN VALUE	INSTANCE VALUE
6.1	1.395036286
7	1.42327799
7.1	1.497417952
7.3	1.395036286
8.2	1.42327799

FIG:5.5 Graphical Representation of Mean and Instance value of Diagnostic Efficacy of the SVM Model

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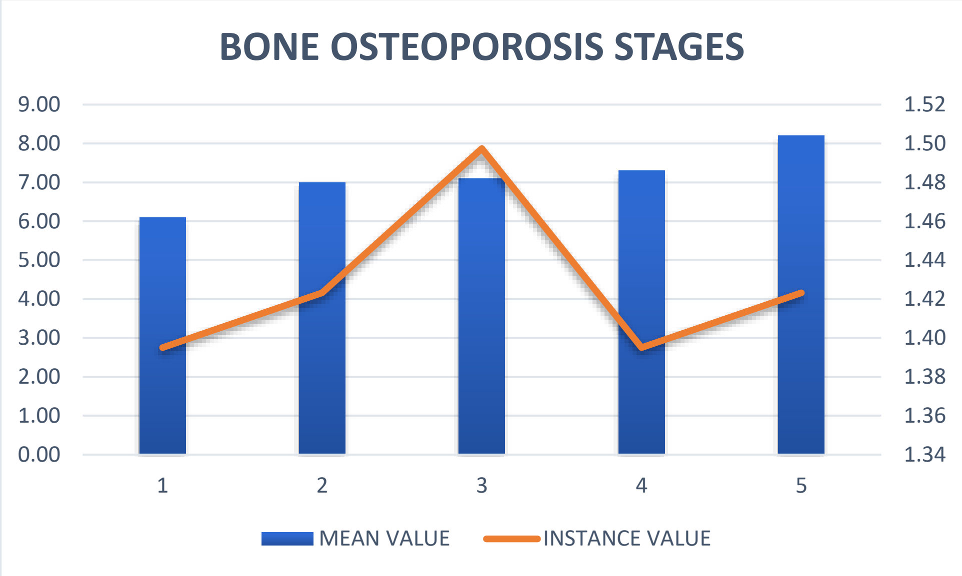
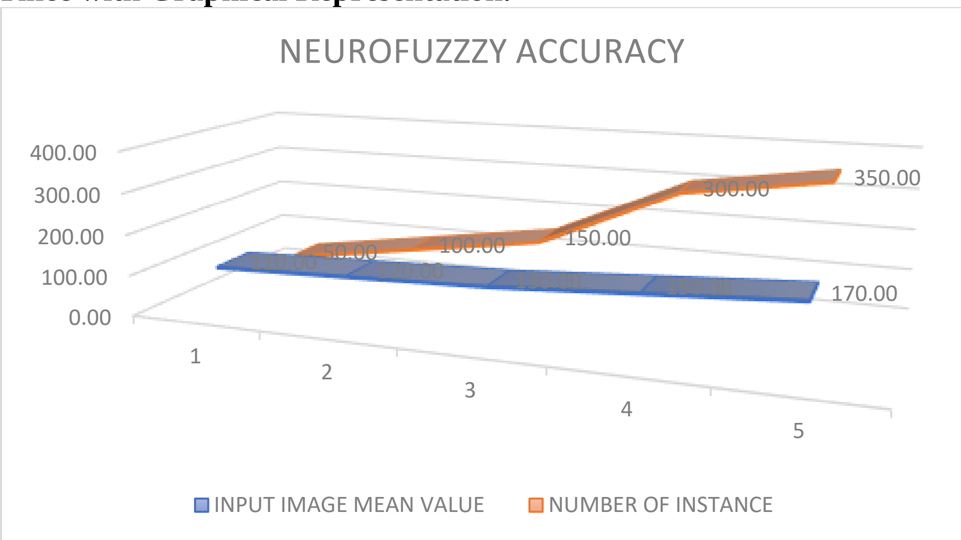


ACCURACY RANGE

INPUT IMAGE MEAN VALUE	NUMBER OF INSTANCE
110.00	50.00
120.00	100.00
130.00	150.00
150.00	300.00
170.00	350.00

FIG:5.6 Neuro fuzzy classification Accuracy to enhance the ranges of femur and tibia bone in Knee with Graphical Representation.



VI . CONCLUSION

The effectiveness of the is demonstrated by performing automatic segmentation of the femur and tibia bones in knee osteoarthritis MR images with 96% accuracy. Experimental results are provided which show the effectiveness of the proposed framework.

FUTURE WORK

This research work will be extended to future where the disease is prod in elderly with a better approach Subsequent work is to be done for applying this in a standalone open-source software which will be all the way more beneficial for medical analysis for grading of osteoporosis with the availability of more datasets.

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