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Mammogram of Breast Cancer Detection Based Using Image Enhancement Algorithm

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Abstract: Principle objective of Image enhancement is to process an image so that result is more suitable than original image for specific application. Digital image enhancement techniques provide a multitude of choices for improving the visual quality of images. A frequency domain smoothing sharpening technique is proposed and its impact is assessed to beneficially enhance mammogram images. This technique aims to gain the advantages of enhance and sharpening process that aims to highlight sudden changes in the image intensity, it is usually applied to remove random noise from digital images. The already developed technique also eliminates the drawbacks of each of the two sharpening and smoothing techniques resulting from their individual application in image processing field. The selection of parameters is almost invariant of the type of background tissues and severity of the abnormality, giving significantly improved results even for denser mammographic images. The proposed technique is tested breast X-ray mammograms. The simulated results show that the high potential to advantageously enhance the image contrast hence giving extra aid to radiologists to detect and classify mammograms of breast cancer.

Keywords: Fourier transform, Gabor filter, Image processing, Image enhancement, Mammogram, Segmentation.

I. INTRODUCTION

Cancer is a significant public health problem in the world today. According to the IARC (International Agency for Research on Cancer) of the WHO (World Health Organization), 8.2 million deaths were caused by cancer in 2012 and 27 million of new cases of this disease are expected before 2030. In particular, breast cancer (BC) is one of most common type of cancer among women. Mortality of BC is very high when compared to other types of cancer. Detection and diagnosis of BC can be achieved by imaging procedures such as diagnostic mammograms (x-rays), magnetic resonance imaging, ultrasound (sonography), and thermography. Imaging for cancer screening has been investigated for more than four decades. However, biopsy is the only way to diagnose with confidence if cancer is really present. Among biopsy techniques, the most common are fine needle aspiration, core needle biopsy, vacuum-assisted and surgical (open) biopsy (SOB). The procedure consists in collecting samples of cells or tissue, which are fixed across a glass microscope slide for subsequent staining and microscopic examination.

Histopathological analysis is a highly, time consuming specialized task, dependent on the experience of the pathologists and influenced by factors such as fatigue and decrease of attention. There is a pressing need for computer-assisted diagnosis (CAD) to relieve the workload on pathologists by filtering obviously benign areas, so that the experts can focus on the more difficult-to-diagnose cases. A considerable amount of efforts has thus been devoted to the field of BC histopathology image analysis, and in particular to the automated classification of benign or malignant images, for computer-aided diagnosis.

Pathology labs have started to move towards a fully digital workflow, with the use of digital slides being the main component of this process. This was made possible by the introduction of scanners for whole slide imaging (WSI) that enable cost effective production of digital representations of glass slides. In addition to many benefits in terms of storage and browsing capacities of the image data, one of the advantages of digital slides is that they enable the use of image analysis techniques that aim to produce quantitative features to help pathologists in their work. An automatic mitosis detection method with good performance could alleviate both the subjectivity and the tediousness of manual mitosis counting, for example, by independently producing a mitotic activity score or guiding the pathologist to the region within the tissue with highest mitotic activity. Automatic feature selection is achieved using a novel feature weighting scheme. Feature weights are based on the importance of a feature and we reject features with low weights. A new generation of forest (new population of trees) is created which operates on a reduced feature set. During the test phase, each tree of the trained forest votes with their corresponding weights to perform the classification.

II. RELATED WORK

Dan C. Ciresan and Jurgen Schmidhuber, describes in that mitosis detection is very hard. In fact, mitosis is a complex process during which a cell nucleus undergoes various transformations. In addition, different image areas are characterized by different tissue types, which exhibit highly variable appearance.

A large amount of different structures can be observed in histology images stained with Hematosin & Eosin, and in particular many dark-blue spots, most of which correspond to cell nuclei. Only a subset of them is in a mitotic phase and must be detected. In most stages a mitotic nucleus looks very much like a non-mitotic one, or like other dark-blue spots, to the point that a human observer without extensive training cannot differentiate them [1].

Ueli Meier and Jurgen Schmidhuber explain that biologically plausible deep artificial neural network architectures can. Small (often minimal) receptive fields of convolutional winnertake-all neurons yield large network depth, resulting in roughly as many sparsely connected neural layers as found in mammals between retina and visual cortex. Only winner neurons are trained. Several deep neural columns become experts on inputs preprocessed in different ways; their predictions are averaged. Graphics cards allow for fast training. On the very competitive MNIST handwriting benchmark, our method is the first to achieve near-human performance [2].

Chao-Hui HUANGet and Hwee-Kuan LEE describes the approach for automated mitosis detection, which provides critical information during performing breast cancer prognosis. Essentially, the problem of mitotic detection involves irregular shape object classification. It is a very challenging task. In this paper, a novel algorithm, named eXclusive Independent Component Analysis (XICA) is proposed.
The XICA is an extension of a generic ICA, but focusing the components of differences (called exclusive basis set) between two classes of training patterns rather than the major (independent) components. Based on the residuals obtained from the relative computing involving the exclusive basis set of the relative training patterns, the automated mitosis detection is performed. By computing the residual of the relative exclusive basis set, we are able to classify the given testing patterns. We introduced an approach for mitosis detection [5].

Kunihiko Fukushima explains that the network is self-organized by "learning without a teacher", and acquires an ability to recognize stimulus patterns based on the geometrical similarity (Gestalt) of their shapes without affected by their positions. This network is given a nickname "neocognitron".

After completion of self-organization, the network has a structure similar to the hierarchy model of the visual nervous system proposed by Hubel and Wiesel. The network consists of an input layer (photoreceptor array) followed by a cascade connection of a number of modular structures, each of which is composed of two layers of cells connected in a cascade. The first layer of each module consists of "S-cells', which show characteristics similar to simple cells or lower order hypercomplex cells, and the second layer consists of "C-cells" similar to complex cells or higher order hypercomplex cells [6].

III. PROBLEM STATEMENT

Breast cancer is the second leading cause of cancer affecting females in women, exceeded only by lung cancer. Earlier detection and diagnosis of breast cancer increases the chances for successful treatment and complete recovery of the patient. There are several ways in which breast cancer is diagnosed, including Breast Self-Examination (BSE), Clinical Breast Examination (CBE), imaging or mammography, and surgery. Mammography is the most effective technique for breast cancer screening and earlier identification of masses or abnormalities; it can detect 85% to 90% of all breast cancers. To diagnose breast cancer we need to find abnormalities like masses and calcifications that indicate breast cancer Mammogram image enhancement is the process of manipulating mammogram images to increase their contrast and reduce the noise present to facilitate radiologists in the detection of abnormalities. The methods used to manipulate mammogram images are divided into four main categories; the conventional enhancement techniques, the region-based enhancement technique.

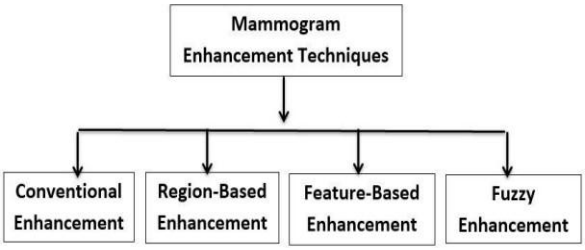


Fig. 1.Mammogram Image Enhancement Techniques

IV. METHODOLOGY

A. Image processing

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. It is a type of signal dispensation in which input is image, like video frame or photograph and output may be image or characteristics associated with that image. Usually Image Processing system includes treating images as two dimensional signals while applying already set signal processing methods to them. It is among rapidly growing technologies today, with its applications in various aspects of a business. Image Processing forms core research area within engineering and computer science disciplines too.

Image processing basically includes the following three steps are

a) Importing the image with optical scanner or by digital photography.
b) Analyzing and manipulating the image which includes data compression and image enhancement and spotting patterns that are not to human eyes like satellite photographs.

c) Output is the last stage in which result can be altered image or report that is based on image analysis.

B. Image enchancement

The principal objective of image enhancement is to process a given image so that the result is more suitable than the original image for a specific application. It accentuates or sharpens image features such as edges, boundaries, or contrast to make a graphic display more helpful for display and analysis. The enhancement doesn't increase the inherent information content of the data, but it increases the dynamic range of the chosen features so that they can be detected easily.
The greatest difficulty in image enhancement is quantifying the criterion for enhancement and, therefore, a large number of image enhancement techniques are empirical and require interactive procedures to obtain satisfactory results. • Image enhancement methods can be based on either spatial or frequency domain techniques.

C. Image segmentation

Image segmentation is a mid-level processing technique used to analyze the image and can be defined as a processing technique used to classify or cluster an image into several disjoint parts by grouping the pixels to form a region of homogeneity based on the pixel characteristics like gray level, color, texture, intensity and other features. The main purpose of the segmentation process is to get more information in the region of interest in an image which helps in annotation of the object scene. Image segmentation aims at domain-independent partition of the image into a set of visually distinct and homogeneous regions with respect to certain properties. The main goal of segmentation is to clearly differentiate the object and the background in an image.
Edge detection techniques are generally used for finding discontinuities in gray level images. To detect consequential discontinuities in the gray level image is the important common approach in edge detection. Image segmentation methods for detecting discontinuities are boundary based methods.

If R represents an image, then the image segmentation is simply division of R into subregions R1,R2…..Rn , such that and is governed by following set of rules:
a) Ri is a connected set, i=1,2,…..n.
b) Ri ∩ Rj = Ø for all i and j, i ≠ j
c) Q(Ri) = True for i= 1,2,…n.
d) Q(Ri U Rj) = False for adjoint regions, Ri and Rj
Where Q(Rk) is a logical predicate[42]. The rules described above mentions about continuity, one-to-one relationship, homogeneity and non-repeatability of the pixels after segmentation respectively.

D. Morphological operations

Morphological image processing is a collection of non-linear operations related to the shape or morphology of features in an image. According morphological operations rely only on the relative ordering of pixel values, not on their numerical values, and therefore are especially suited to the processing of binary images. Morphological operations can also be applied to greyscale images such that their light transfer functions are unknown and therefore their absolute pixel values are of no or minor interest.
Morphological techniques probe an image with a small shape or template called a structuring element. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neighbourhood of pixels. Some operations test whether the element "fits" within the neighbourhood, while others test whether it "hits" or intersects the neighbourhood:
A morphological operation on a binary image creates a new binary image in which the pixel has a non-zero value only if the test is successful at that location in the input image.

The structuring element is small binary Image,i.e. a small matrix of pixels, each with a value of zero or one:
a) The matrix dimensions specify the size of the structuring element.
b) The pattern of ones and zeros specifies the shape of the structuring element.
c) An origin of the structuring element is usually one of its pixels, although generally the origin can be outside the structuring element.

A common practice is to have odd dimensions of the structuring matrix and the origin defined as the centre of the matrix. Stucturing elements play in moprphological image processing the same role as convolution kernels in linear image filtering.

V. ALGORITHM USED

A. Gaussian filter algorithm

Gaussian filter is a filter whose impulse response is a Gaussian function (or an approximation to it). Gaussian filters have the properties of having no overshoot to a step function input while minimizing the rise and fall time.
The most general function formula is

$$G(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-a)^2}{2\sigma^2}}$$

In our case we can suppose parameter a — which called distribution mean or statistical expectation — responsible for distribution shifting along x axis to be zero: a=0; and work with simplified form

$$G(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{x^2}{2\sigma^2}}$$

B. Gaussian filter algorithm

Steps of Gaussian filter algorithm are,

Step 1:Given window size 2N+1 calculate support points x_n=3n/N, n=-N, -N+1, ... , N;

Step 2: Calculate values G''_n;

Step 3: Calculate scale factor k'=$\sum G''_n$;

Step 4: Calculate window weights

$G'_n=G''_n/k'$; Step 5: For every signal element

C. Canny edge detection algorithm

The algorithm runs in 5 separate steps:

Step 1: Smoothing: Blurring of the image to remove noise.

Step 2: Finding gradients: The edges should be marked where the gradients of the image has large magnitudes.

Step 3: Non-maximum suppression: Only local maxima should be marked as edges.

Step 4: Double thresholding: Potential edges are determined by thresholding.

D. Algorithm for Median filter

To remove salt and pepper noise from the corrupted image the below algorithm is used.

Step 1: A two dimensional window (denoted by 3×3 W) of size 3x3 is selected and centered around the processed pixel p(x, y) in the corrupted image.

Step 2: Sort the pixels in the selected window according to the ascending order and find the median pixel value denoted by Pmed), maximum pixel value (Pmax) and minimum pixel value (Pmin) of the sorted vector V0. Now the first and last elements of the vector V0 is the Pmin and Pmax respectively and the middle element of the vector is the Pmed.

Step 3: If the processed pixel is within the range Pmin < P(x, y) < Pmax , Pmin > 0 and Pmax < 255,it is classified as uncorrupted pixel and it is left unchanged. Otherwise p(x, y)is classified as corrupted pixel.

Step 4: If p(x, y) is corrupted pixel, then we have the following two cases:

Case 1: If Pmin < Pmed < Pmax and 0 < Pmed < 255, replace the corrupted pixel p(x, y) with Pmed

Case 2: If the condition in case 1 is not satisfied then Pmed is a noisy pixel. In this case compute the difference between each pair of adjacent pixel across the sorted vector V0 and obtain the difference vector VD .Then find the maximum difference in the VD and mark its corresponding pixel in the V0 to the processed pixel.

Step 5: Step 1 to step 4 are repeated until the processing is completed for the entire image .

E. Image segmentation using K-means

In this algorithms are calculating the distance between each pixel and centre of the cluster. The algorithmic steps are as follows,

Step 1: calculate the cluster means,

$$M = \frac{\sum_{i:c(i)=k} x_i}{N_k} \quad ,k=1,\ldots,K$$

k = number of cluster

Step 2: calculate the distance between the pixel and the cluster center,

$$D(i) = \arg\min \left\| x_i - M_k \right\|^2 \text{ , i=1,.....,N}$$

Step 3: If the distance is near to the center then move to the cluster. Otherwise move to the next cluster.

Step 4: Re-estimate the center. Repeat the process until to calculate the center.

VI. EXPERIMENTAL RESULTS

A. Pre-Processing

In that pre-processing task there are two works is done first noise can be removed using the median filter. Then the mammogram image enhancement using the Gaussian filters. Noise refers to the unwanted area of the mammogram image. The pre-processing has been divided two phase.

B. Noise Removal

The noise can be removed using four filtering technique, the techniques are Mean filter, Median filter, Wiener filter and Linear filter. In that above filtering technique Median filter is the best one compare to another. The Mean filter is a simple sliding-window spatial filter that replaces the cancer value in the window with the average of all the pixel value in the image window. The window is usually square but can any shape. The Median filter is a nonlinear digital filtering technique; it is used to remove the noise. The reduction is a typical pre-processing step to improve the results.

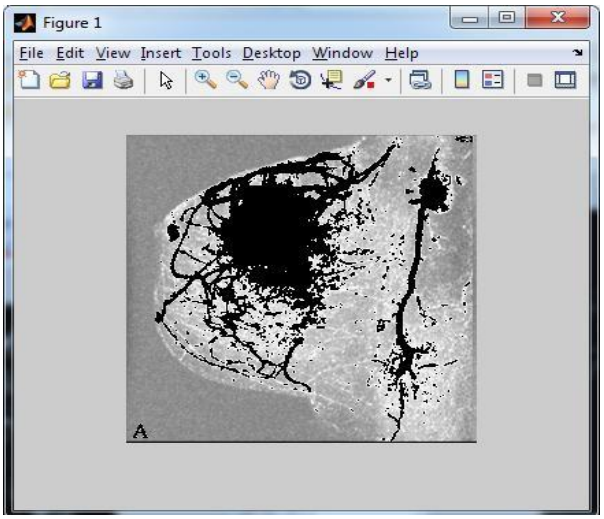


Fig.1. Input Image

Fig.2. Noise Removal image

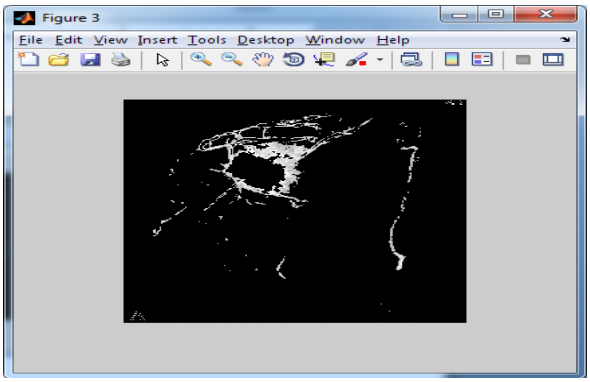


Fig. 3.Mammogram Enhancement image

C. Segmentation and edge detection

Image segmentation is the process of partitioning the digital image into multiple segments. The aim of segmentation is to simplify the representation of an image into more meaningful and easier to analyse. Image segmentation is done using the Thresholding technique. The mammogram image can be segmented and then edge can be detected using canny edge detection technique. We can get the clear border of the mass using edge detection.

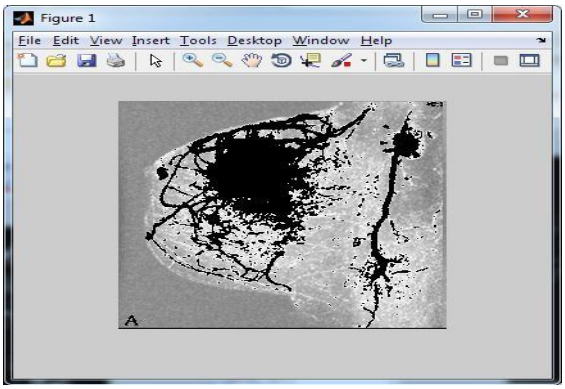


Fig.4. Input image

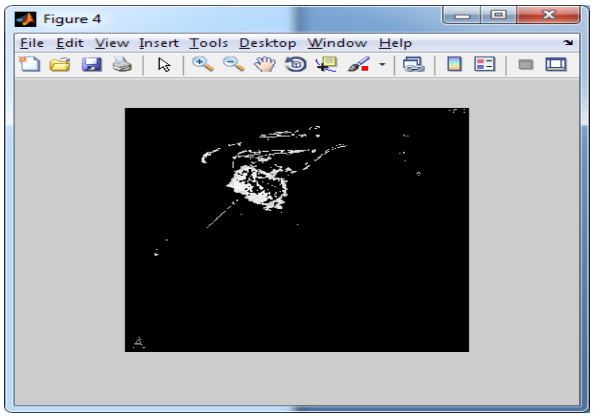
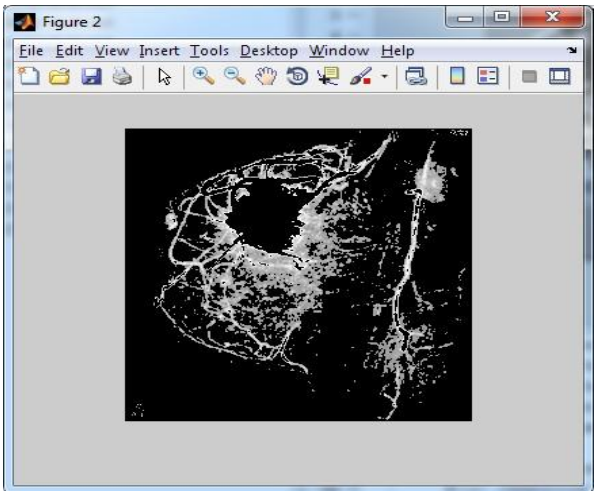


Fig. 5 .Edge detected image



The edge detection technique is used to find out the discontinuities in the images. There are two categories of edge detection, thus they are gradient and Laplacian. Three fundamental steps of Edge Detections are image smoothing, detection of edge points, edge localization. The best edge detection is canny edge detection technique.

D. Morphological operation

The morphological operation is done to get the clear view of the mass. Erosion, hole filling and dilation is done. Finally the erode image can be overlapped with the original image. In that grayscale dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries.

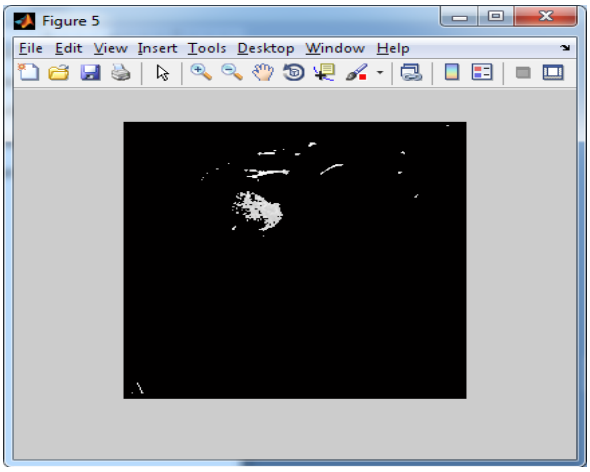


Fig. 6 .Errosion image

E. K-Mean segmentation

K mean clustering detail: K- mean is one of the unsupervised learning algorithms for the clusters. Clustering the image is grouping the pixels according to some characteristics. It may be colour, texture or gray scale. In this method segmentation is done on the basis of gray scale. The procedure follows a simple way to classify the

given datasets through a certain number of clusters.

Fig.7.Performance analysis of various segmentation algorithms on MR brain image

Assume K number of clusters. The main idea is to define the K number of centroids. One for each cluster. The next step is to take the each pixel value belonging to a given dataset and associate it to the nearest centroid. This process continues till all the pixels of given image are assigned to the nearest centroid.

F. Feature extraction

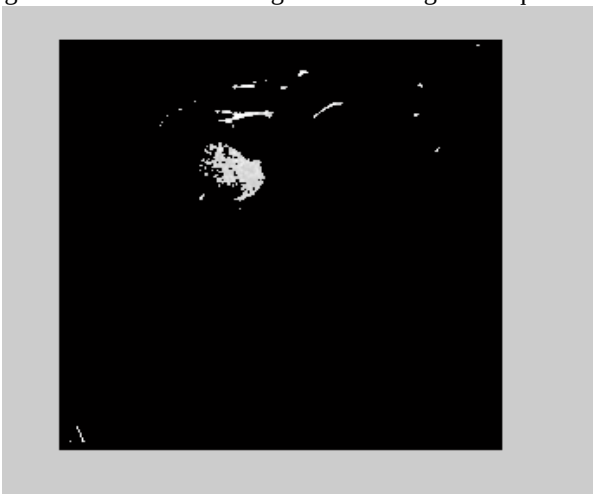
The cluster which shows the predicted tumor at the k mean output is extracted in feature extraction. The extracted cluster is applied to the thresholding process. It applies binary mask over the entire image. In this process the binary mask is applied over the entire image. In threshold coding, each transform coefficient is compared with a threshold. If it is less than the threshold value then it is considered as zero. If it is larger than the threshold, it will be considered as one. The thresholding method is an adaptive method where only those coefficients whose magnitudes are above a threshold are retained within each block. Let us consider an image 'f that have the k gray level. An integer value of threshold T, which lies in the gray scale range of k. The thresholding process is a comparison. Each pixel in 'f 'is compared to T. Based on that, binary decision is made. That defines the value of the particular pixel in an output binary image 'g'.

$$g(n) = \begin{cases} '0' \, if \; f(n) >= T \\ '1' \, if \; f(n) < T \end{cases}$$

Fig. 8 Output Image of Thresholding

VII. CONCLUSION AND FUTUREWORK

The proposed method identifies the tumor level based on the count of pixel values in the region of tumor. This work is done using K-means algorithm to detect the breast cancer in early stage. The pre-processing task is performed first to remove noise and enhance the mammogram. Then the segmentation is done using Thresholding technique. After



that edge detection is applied to get a clear border of the mass. To get a clear view of the mass morphological filtering is done which includes grayscale dilation, hole filling and erosion. To overlap the original image with erode image for getting a clear view of the tumor. This proposed technique is performed well and identify tumor level in the earlier stage itself. The proposed algorithm showed great success in identifying the region of interest and correctly segmenting all of the input test images.

The next step might take the proposed algorithm as one module of a larger algorithm that continues the work presented here. As with all optimization methods, given a larger database to work with will result in a higher accuracy range for the neural network results, and further work on the image processing coding might give efficiency boosts and a shorter CPU time for the calculations.

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