Retraction

Retraction: A Survey of image pre-processing techniques for medical images (J. Phys.: Conf. Ser. 1911 012003)

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This article has been retracted by IOP Publishing following an allegation that this article may contain tortured phrases [1].

IOP Publishing has investigated in line with the COPE guidelines and have found tortured phrases to be masking overlap of other work [2] and agrees this work should be retracted.

IOP Publishing wishes to credit PubPeer commenters and the Problematic Paper Screener for bringing this issue to our attention.

The corresponding author neither agrees or disagrees to this retraction.

[1] Cabanac G, Labbe C, Magazinov A, 2021, arXiv:2107.06751v1
[2] R. Beaulah Jeyavathana, R Balasubramanian, A. Anbarasa Pandian, 2016, A survey: Analysis on pre-processing and segmentation techniques for medical images, IJRST 3 6
[3] https://pubpeer.com/publications/EA9E107FC9BE280DBAAABDB0BA2CEFE

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A Survey of image pre-processing techniques for medical images

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Abstract - Medical Images cannot be utilized similarly it was procured. The obtained images must be Pre-Processed and Segmented. Real confinements are there in medical image preprocessing as far as multifaceted nature when contrasted with preparing different kinds of images. Confinements in image acquisitions make image division a repetitive procedure. The most significant objective of segmenting medical images is in performing activities on medical images for distinguishing designs and in recovering data. This survey speaks primarily about medical image handling. At that point many methods have been proposed to deal with portions of Medical images. The similar investigation of different processing procedures has been analysed. The overview thus gives subtleties of mechanized division strategies, explicitly talked about with regards to scanned medical images. The rationale is in analysing the issues experienced in dividing the scanned medical images, and the respective benefits and confinements techniques as of now accessible for segmentation of medical images.

1. Introduction

With Image processing today, we are going past the two-dimensional images and going further to perceive what is entirely in the image. The measure of information is growing quicker than the way it is stored. The major challenge in Image processing is adapting to this information storm, while proceeding to fabricate sensors with more up-to-date modalities and ideal calculations to deal with the majority of this. The most pressing issue arises while comparing the image processing between the human eye and an image processing method. What looks as a common thing for the human vision, such as finding an object in a photo loaded with countenances and structures, is a noteworthy obstacle for image preprocessing. Image processing has just started to move our reality. Be that as it may, for it to move the hub, PCs should see the manner in which we do.

The advances occurring in broadband remote gadgets and in mobile environments utilized for handheld gadgets have a few applications in the field of picture handling. The Web is empowered with obtaining and delivering instant data with request from the end users. The greater part of this data is intended for visual utilization as content, illustrations, and images. Image processing basically implies algorithmic upgrade, control, or examination of the digital image. Image processing is provided with images as information. The output of a processed image can be either a image or a lot of qualities parameters identified in the medical image. Each method of calculation takes an image or a succession of images and delivers a yield, which might be an altered image and additionally a portrayal of the image. Image Processing extricates data from images and coordinates it for a few applications. There are a few fields where image processing applications are significant. medical imaging, mechanical applications, remote detecting, space applications, and military applications are a couple of precedents.
Medical imaging has a significant role in medicinal diagnosis and treatment. A large portion of strategies have been created based on CT and MRI scan images. Images taken from X-Ray, CT lays the foundation for radiation treatment medicines. A vast majority of medical specialists’ incline toward CT imagery and is additionally utilized for evaluating heart parameters and stenosis nearness veins.

In medical imagery therapeutic image preparation, four key issues are discussed about.

a) Segmentation of Medical Images
b) Registration of Medical Images
c) Visualization of Images
d) Simulation of Images

The significant testing issue that comes to the foray is "Image Segmentation". The Region of Interest (ROI) was removed either automatically or semi automatically [1]. Unique Segmentation techniques are utilized in various applications to section body, nerves, muscles and tissues. Various pre-processing applications are used in planning surgeries, surgical simulation and tumor discovery.

2. Image Pre-processing Techniques
In Image preprocessing, information acquired from medical images control blunders identified with geometry and splendor pixel estimations. These blunders are adjusted using required numerical models which come under distinct or real models. Image enhancement focuses on the alteration of an image by changing pixel values. Image enhancement includes procedural accumulation used to improve the visual quality of the image as well as changing the image format fit for human or system translation.

While acquiring medical images there are restrictions in imaging sub frameworks and conditions for brightening. Images have various noise associated with it. The objective here is to highlight certain image features for investigation. The enhancement procedure does not expand the inalienable data content in the source image. It underlines predetermined attributes of images.

2.1 Histogram Equalization
This technique builds the worldwide complexity of numerous images, particularly when the useful information in a image is explicitly extracted by nearby values that are opposite to each other. The zones of lower neighborhood differentiation are taken into consideration to pick up a higher difference. Histogram balance achieves this by adequately spreading out the most regular values of high intensity.

\[ s = T(i), 0 \leq i \leq L - 1 \]  

\[ CDF(i \leq k) = \sum p_k \]  

\[ s = T(i) = \text{floor}(L - 1) \ast \sum_{k=0}^{i} p_k = \text{floor}(9 \ast \sum_{k=0}^{i} p_k) \]  

This strategy is valuable in images with bases and frontal areas which are either bright or dark. Specifically, the technique can provide better views on the internal structure in X-ray images.

2.2 Weighted Median Filter
Weighted Median (WM) channels have a place with the wide class of nonlinear channels called stack channels. WM channels have edge capacities which permits the utilization of neural system to get versatile WM channels. It is utilized in expelling salt and pepper commotion from MRI scans [1]. It has the capacity to protect edges. It also equips the user with ability to weaken noise in images. For unique numbered elements \( x_1, x_2, \ldots, x_n \) with weights \( w_1, w_2, \ldots, w_n \) that are positive so that , the weighted median filter is the element \( x_k \) that satisfies
2.3 Weiner Filter
The purpose of Wiener channel is in processing a factual estimation of a signal that is obscure as well as utilizing a signal as an information and using that referred signal to provide the estimated signal as a yield. It is a kind of non-straight channel that is utilized for reclaiming obscure noise in images. It is utilized to channel a dark scale image. For instance, the real signal may comprise of a signal of intrigue that is adulterated by additional commotion. The channel is utilized to extract commotion from the undermined signal to give an idea of the signal that is hidden [3].

\[ W(f_1, f_2) = \frac{H^*(f_1, f_2)S_{xx}(f_1, f_2)}{|H(f_1, f_2)|^2S_{xx}(f_1, f_2) + S_{nn}(f_1, f_2)} \]  

(5)

where \( S_{xx}(f_1, f_2) \) is the power spectra of the original picture and the noise is additive, and \( H(f_1, f_2) \) is the blurring filter.

2.4 Gabor Filter
Gabor channel is a straight channel utilized for surface investigation, which essentially breaks down and identifies whether there is a particular recurrence content explicitly in the image within a confined area around the point of examination. It is a non-straight channel utilized for edge identification. The portrayals of Gabor channel are indistinguishable from the human visual framework and they are suitable for surface segregation and portrayal. Gabor Filters are appropriate for surface portrayal and segregation.

\[ g(x, y; \lambda, \theta, \psi, \sigma, \gamma) = \exp \left( -\frac{x'^2 + y'^2}{2\sigma^2} \right) \exp \left( i \left( 2\pi \frac{x'}{\lambda} + \psi \right) \right) \]

(6)

A 2-Dimensional Gabor channel is modified by a sinusoidal wave and is given above.

2.5 Adaptive Median Filter
This filter performs spatial handling and finds out the necessary pixels in a picture influenced by commotion. It is utilized to cancel the interference contained in an essential signal, with the enhancement of crossing out. The essential signal fills as the ideal reaction. The referential signal is utilized as a contribution to the median filter.
The flowchart of Adaptive median filter is given above. This Filter characterizes the pixels as commotion by contrasting every picture pixel with its encompassing neighboring pixels. The area size is movable, similar to the limit for examination. A pixel that is not the same as a larger part of its neighbors, just as being not basically lined up with the pixels with which it is compared. These commotion pixels are supplanted with the middle pixel estimation that has finished the commotion marking test. It decreases indiscreet noise in an image with no impact to the source.

**2.6 Morphological Operations**

Morphological Techniques explores the image with "structuring element". This component is situated at all potential areas in an image and contrasts with neighborhood pixels. The morphological tasks are "Disintegration and Dilation". Disintegration decreases the size of ROI and likewise it expels little subtleties in the source image. The enlargement extends the various shapes contained in the source image.

**2.7 Mean Filter or Average Filter**

The Median Filter is a non-direct separating procedure, regularly used to expel commotion from a picture or sign. Median Filtering is in all respects broadly utilized in computerized image preprocessing. Median filter traverses the image by going through each pixel, supplanting each an incentive with the middle benefit of every nearby pixel. neighbors are termed as the "window". Under specific conditions, it expels commotion. It helps with the replacement of every value of a pixel with the normal estimation of the neighboring pixels. It helps expel the value of pixels that does not represent the environment.

\[
y(n) = x(n - 1) \cap x(n) \cup x(n - 1) \cap x(n + 1) \cup x(n) \cap x(n + 1)
\]

(7)

Here \(x(n)\) and \(y(n)\) are variables which are called as binary and the Boolean operations AND is given by \(\cap\) and OR is given by \(\cup\).

**2.8 Image Normalization**
Normalization modifies the intensity of a pixel. The fundamental inspiration driving this is to accomplish consistency for a lot of information. The motivation behind normalization is to get the image into the range that increases naturally. Frequently, the inspiration is to accomplish consistency in unique range for a lot of information, flag, or images to maintain a strategic distance from mental diversion or exhaustion. The normalization of digital picture is given by the formulae

\[
\text{Output\_channel} = 255 \times \frac{\text{Input\_channel} - \text{min}}{\text{max} - \text{min}}
\]

If a picture is used in grayscale mode, only one channel needs to be normalized. For 3 channels (RGB) each channel needs to be normalized using the same formula for all 3 channels.

### Table 1. Comparison of Preprocessing Techniques.

| Pre-processing Technique       | Advantages                                      | Disadvantages                                                                 |
|--------------------------------|-------------------------------------------------|-------------------------------------------------------------------------------|
| Gabor Filter                   | ➢ Unique                                        | ➢ FFT requires image size to the power of 2                                  |
|                                | ➢ Specific to a Period                           | ➢ Boundary condition problems are well identified but undefined              |
|                                | ➢ Fast Fourier Transform is Efficient            | ➢ Time and frequency domain signal description are related inversely         |
| Adaptive Median Filter         | ➢ Smoothen non repulsive noise without edge blurs | ➢ Poor performance with a threshold more than 0.2 impulse noise              |
| Morphological Operations       | ➢ Edge information retained                     |                                                                               |
|                                | ➢ Detects lesions of different complex shape and sizes | ➢ Relying on notion of infimum and supremum morphological operators         |
| Mean Filter                    | ➢ Reduces Variance                               | ➢ Averaging blurs images which in turn affects localization                |
| Image Normalization            | ➢ Size and locations of normalized endorsements consistent in dataset | ➢ Poor Normalization degrades image quality                                |
| Histogram Equalization         | ➢ Simple to use                                  | ➢ Fails if grey values are spaced far away from each other                  |
| Weighted Median Filter         | ➢ Image contrasts are enhanced                  | ➢ Mapping texture region and rounding corners to a uniform shade            |
| Weiner Filter                  | ➢ Efficient Mean Square                         | ➢ Degradation not effective                                                |

3. Analysis of Image Pre-processing Techniques

The analysis of various image pre-processing techniques is done to show the effectiveness of various filters on grey scale images. This image is filtered by using noise filters like Average Filter, Adaptive Filter and Standard Median Filter at different noise densities varying from 10% to 60%. The performance comparison among the filters is done with respect to MSE and PSNR parameters [1].

In figure 2, the PSNR values are arrived for Average Adaptive and Median filters. The graph clearly shows that the adaptive filter is more efficient in handling noise at various density levels.[1]

In figure 3, the MSE values are arrived for Average Adaptive and Median filters. The graph clearly shows that the average filter is more efficient in handling noise at various density levels.[1]
Figure 4 draws a comparison of MSE values across five filters namely adaptive filter, mean filter, median filter, weighted median filter and weiner filter. The values were arrived from experimental outputs of various papers. The graph clearly indicates that adaptive median filter and median filter are more efficient in removing noise [2][3].

Figure 5 draws a comparison of RMSE values arrived from experimental conclusions of various papers. It shows that weighted median filter is more efficient in removing noise [2][3].
Figure 6 draws a comparison of PSNR values arrived from the experimental results of various papers. It is evident that weiner filter is more efficient in removing noise [2][3].

The graphical analysis made above shows that different filters efficiently reduce noise for MSE, RMSE and PSNR parameters. Thus it is evident that a single filter could not efficiently reduce noise. It is suggested to use a combination of these filters while handling noise

4. Segmentation Techniques
It is the method of separating an image to relatively smaller pieces along with attributes. The contribution to the procedure is an advanced dark scale image. The utilization of division is to give more prominent data which exists in medicinal images. Different methods like neural systems, choice tree, principle-based calculation and Bayesian systems are utilized to get wanted yield information.

4.1. Pixel Thresholding
Thresholding is an intrinsic technique for division where pixels meet given standards. It is the least difficult quickest division techniques. The image histograms isolate the images into various sections having various pinnacles and valleys. It can be calculated as follows:

\[
\text{If } f(a, b) > T \text{ then } f(a, b) = 0 \text{ else } f(a, b) = 255
\]

4.2. OTSU’S Thresholding
When choosing the edge value, there are a few issues that prompt poor outcomes. For a threshold programmed choice OTSU’s technique is utilized. It picks the necessary threshold and lessens the fluctuation inside the highly contrasting group of pixels. The mathematical representation is given by

\[
\mu_T = \sum_{i=0}^{L-1} i P_i, \mu_T = \sum_{i=0}^{t} i P_i, \mu_0 = \frac{\mu_T}{\omega_0}, \mu_1 = \frac{\mu_T - \mu_T}{1 - \mu_0}
\]

Where p( i) is probability of occurrence of the pixel value.
4.3. Versatile Thresholding
Here every pixel is contrasted with an average of the neighboring pixel. In particular, the estimated moving average of the pixels last seen is determined when the picture is crossed. In case of estimation of the present pixel is lower than normal, at that point it is preset to dark; else preset to white. This strategy will work since contrasting a pixel with the normal of close-by pixels will safeguard hard difference lines and disregards delicate angle changes.

4.4. Region based Methods
Region is an accumulation of pixels, among themselves in pairs is neighbors and the limit is contrasts in between the two regions. All segmentation techniques depend over regions and limit properties. Two famous locale-based methodologies are proposed namely: Region developing and Region split and Merge Method.

4.5. Region Growing
There are two components that follows the algorithm by Region- Growing methods

a) Principle of growth
b) Seed Point Selection

The Principle of development depicts the pixel values in neighbor are within the limit. Seed point determination requires human PC communication technique. The disadvantage is an outcome that relies upon the seed point choice. The shape that is being removed relies upon the client. This strategy is utilized in mammograms to remove the injuries from its experience.

4.6. Region Split and Merge
This strategy is the best possible comparable technique to section the medical image dependent on the criteria called homogeneity. This technique deals with premise of quad trees. These highlights can likewise be delegated first-request insights by applying administrators straightforwardly on dim pixel esteems, second-request measurements by ascertaining the enlightenment contrast for pixels fixed at a separation d from one another. Strategies dependent on second-request insights have appeared to accomplish greater segregation rates compared to the power range (change based) and auxiliary techniques. Third-request minutes require intentional intellectual exertion.

4.7. Structural Based
These represent surfaces made out of surface components. Here surface is characterized by methods for well-characterized natives called small scale surface and a chain of importance of spatial courses of action of those natives called as full-scale surface. To depict the surface, one must characterize the natives and the situation rules. The benefit of the basic methodology is that it gives a decent emblematic
Artificial Neural Network based Methods

Neural Network is only fake exhibition of human mind that endeavors to mirror its learning methodology. Fake Neural Network, much of the time known as a neural system or simply neural net. Forward-thinking, neural nets are comprehensively used to answer the emergency of picture division in medical imaging stream. It is subject to life impersonation, especially learning procedure of human minds, contains an immense number of parallel hub learning procedure can be practiced through moving the hub associations and loads of association. The noteworthy advantage is that it isn't reliant on the capacity called as likelihood thickness dissemination work.

4.8. Artificial Neural Network based Methods

The strategy was effectively connected in drug, particularly for discovery of changes in bone miniaturized scale structure.

**Figure 10.** Structural based Image Segmentation Architecture.

![Diagram](image-url)
Fuzzy set hypothesis is utilized so as to break down images, and give exact data from any DICOM medical image. Fuzzification capacity is utilized to expel unwanted noise from images. Fluffy k-Means and Fuzzy C-implies (FCM) are generally utilized strategies in picture handling.

4.9. Genetic Algorithm based Methods
Genetics is a piece of transformative figuring, that quickly develops a territory for computerized reasoning.
It produces answers for enhancement issues utilizing methods that are motivated by normal development. Calculation begins with various arrangements or chromosomes likewise called as population. At that point the arrangements from one group are taken care of and utilized to shape another group superior to the former. The arrangements are chosen to shape arrangements (posterity). The methodology is rehashed until the required condition is fulfilled.

**Table 2. Comparison of Segmentation Techniques.**

| Segmentation Technique       | Advantages                                                                 | Disadvantages                                                                 |
|------------------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Pixel Based Approach         | ✓ Works well when the region homogeneity criterion is easy to define         | ✓ Very expensive in computational time and memory                              |
|                              |                                                                            | ✓ There may be under and over segmentation holes present in the region         |
| Edge Based Approach          | ✓ No prior knowledge required regarding image content                       | ✓ Cumbersome process in case of too many edges                                 |
|                              | ✓ Computationally Quicker                                                  |                                                                            |
| Region Based Approach        | ✓ Better Classification and easier Implementation                           | ✓ Identifying the number of Clusters is tough                                |
|                              |                                                                            | ✓ Difficult to understand feature Selection                                    |
| Deformable Model Based Approach | ✓ Robust to Noise and Irregular Edges                                       | ✓ Manual approach is required to place as initial model                      |
|                              | ✓ Able to generate surfaces with source images                            | ✓ Difficult to choose parameters                                              |
| Texture Based Approach       | ✓ Easy to solve complex problems using training data                        | ✓ Costly training process and human error prone                               |
|                              | ✓ Easier to detect Errors                                                  | ✓ Analysis needed for different image types                                  |
| ANN Based Approach           | ✓ Need not write tedious programs                                          | ✓ Extended training period                                                    |
|                              | ✓ Could entirely exploit the parallel neural net                          | ✓ Initialization might affect outcome                                          |
| Fuzzy Theory Based Approach  | ✓ Single fuzzy rule applied to stress the importance of feature based and spatial information in the image | ✓ Sensitive to Noise                                                          |
|                              | ✓ The Skeleton of membership functions and associated parameters are automatically derived | ✓ Computationally Expensive                                                  |
|                              |                                                                            | ✓ Determination of fuzzy membership is difficult                             |
| Genetic Algorithm Based Approach | ✓ Proved to be effective in coming out of local optima but also brings considerable flexibility | ✓ In complex design simple GA may converge extremely slowly or it may fail due to convergence to an unacceptable local minimum |
|                              | ✓ Effective in contrast enhancement and produces image with natural contrast |                                                                            |
|                              | ✓ Provides a simple and generic method to solve complex optimization problems |                                                                            |
5. **Conclusions**

In this paper different processing and division strategies are compared and contrasted. It is a well-known fact that all techniques function admirably for various purposes. The favorable circumstances and detriments of the strategies adopted are examined in the table. Preprocessing channels have been utilized which improves the different imaging methods which are additionally utilized in better processing of the image. Division strategies depend on dark dimension methods like thresholding. For example, pixel and district like strategies are the easiest techniques yet with less area of application. Be that as it may, by incorporating with different procedures, the exhibition of all systems was improved. Neural system-based calculations are doable for surface-based division and order. Hereditary Algorithm based division is being utilized to discover estimated answers for streamlining issues. Fuzzy Based division is generally utilized in restorative imaging. The vast majority of these calculations need orderly supervision and preparing. They are precise, solid, and hearty in execution and furthermore they ought to be least reliant on the person using these techniques.

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