A Survey: Medical Image Pre-Processing Algorithms and Comparisons

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Abstract- *Medical image processing plays a crucial role in medical images. The image processing techniques are used to observe the abnormal functions, noise inconsistence and incomplete data preprocessing . It is an improvement in image data which avoids unnecessary distortion and improves image features. Image processing can be defined by four major steps which involves image formation, image visualization, image analysis and image management. The different techniques used for image preprocessing includes Gabor filter, adaptive median filter, mean filter, morphological operations and image normalization. The medical image preprocessing methods are contrast stretching , noise filtering and histogram modification. This works concludes on the analysis of these techniques in image processing. Finally,we predict the development trends of image preprocessing with the combination of these algorithms.*

Keywords- Medical image preprocessing, Gabor filter, adaptive median filter, morphological operations, mean filter, image normalization, contrast stretching, noise filtering, histogram modification.

I. INTRODUCTION

In recent years, Medical Image Pre-processing has developed as a crucial part in scientific imaging. This is because of the rapid improvement in computerized medical image visualization, advances in analysis method and automatic diagnosis. Medical image pre-processing is an improvement of image data that defeat undesired distortion, removes noise and increases some image features that are important for future processing. By using this method images can be effectively processed.

Image processing involves four major steps. ***Image formation*** consists all the steps from capturing the image to formation of a digital image matrix. ***Image visualization*** is a process of manipulating the matrix which results in an expanded output of the image. ***Image analysis*** consists of all the steps which are used for accessible measurements as well as abstract interpretation of medical images. ***Image management*** involves techniques that provide the efficient storage, communication, transmission, achieving and access of image data.

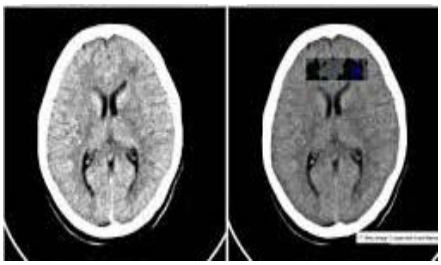

Figure: preprocessing a)before b)after

Contrast stretching is one of the mostly used image processing technique over a wide area. Low contrast images outcomes are poor illumination, lack of dynamic range in imaging sensor. Contrast stretching increase the range of grey levels in image being processed.

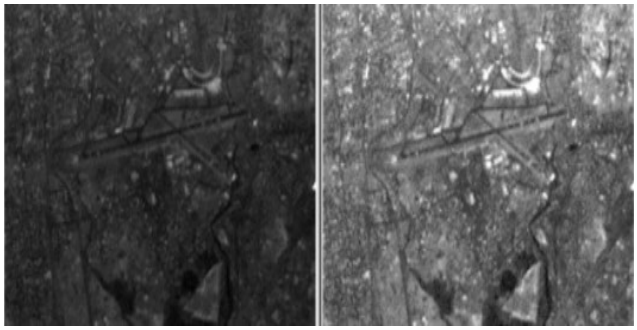

Figure1: Contrast stretching

Noise filtering is an important and widely used process in all image processing systems. Filters are used for removal of noise from medical images while preserving details of images. Filters can be selected based on type of data, filter behavior and task performed by filter.

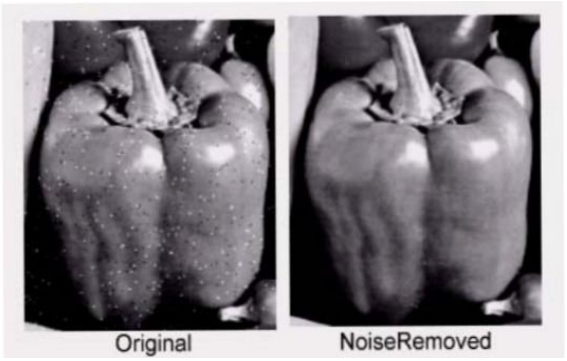

Figure2: noise filtering

Histograms have a lot of importance in image enhancement. The characteristic of image can be modified by modifying the histogram. Histogram equalization is a non-linear stretch that re-distributes pixel values so that there is around the same number of pixels with each value with in a range. It results in a flat histogram by this contrast is increase at peaks and less at tails.

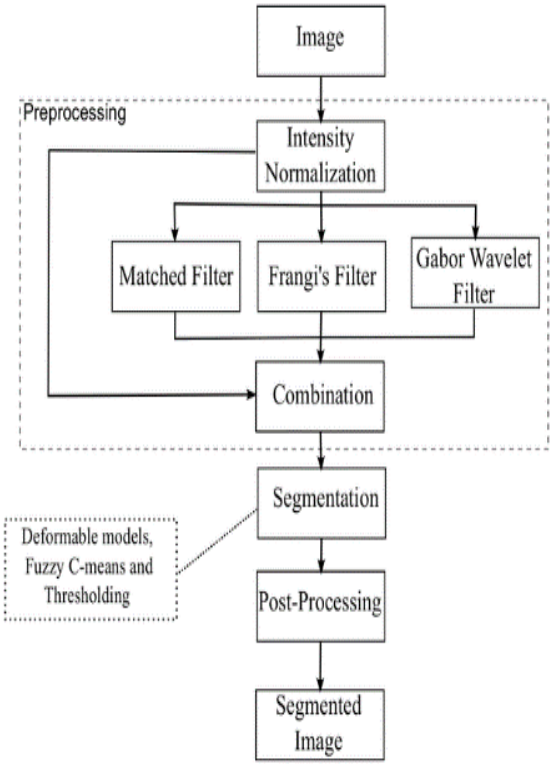

Figure: preprocessing block diagram

II. MEDICAL IMAGE PREPROCESSING MODALITIES

COMPUTED TOMOGRAPHY(CT):

Computed tomography, is a medical imaging method that collaborates many x-ray projections from different angles to give a detailed cross sectional images of areas in the body. CT scan is used diagnosing presence of tumors, organs in chest and abdomen, bone injuries and cardiac issues.

MAGNETIC RESONANCE IMAGING(MRI):

MRI forms a two dimensional image of a thin slice of body and modern MRI instruments can produce images in form of 3D blocks. It is used radio waves and magnetic fields for creation of human organ images. It is used to evaluate abnormal tissues, blood vessels, breasts, bones and joints.

ULTRASOND:

ULTRASOUND is a medical imaging technology which uses high point frequency sound waves in order to produce internal view of body. They can show the movement of internal body parts. They are used in diagnosis of pregnancy, abnormalities in heart and blood vessels, organs in pelvis and abdomen and symptoms of swelling, infection and pain.

POSITRON EMISSION TOMOGRAPHY(PET):

PET, is used in clinical oncology as it is the effective means of diagnostic imaging methodology. It gives detailed and digitalized pictures of areas in the interior of the body. It is used to evaluate cancer, heart condition and neurological diseases such as Alzheimer's and multiple Sclerosis.

X-RAY:

It is one of the most widely used medical image diagnosis technique. In this a beam of x-ray is passed through a patient onto a film. The film provides a measure of the ray attenuation in a tissue. It is used in diagnosis of broken bones, cavities, swallowed objects, lungs and blood vessels.

OPTICAL CHARACTER RECOGNITION(OCR):

OCR is a software that pre-processes images to improve chance of successful recognition. This includes De-skew and Despeckle techniques. It is used in maintaining patient records, test results and active and historical medical records.

DIFFERENT TECHNIQUES OF IMAGE PREPROCESSING:

1. Gabor filter
2. Adaptive median filter
3. Morphological operations
4. Mean filter (or) average filter
5. Image normalization

GABOR FILTER:

It is the basic method of removing the noise blurs and keeping the important and necessary structures for subsequent steps. It is a continuous filter used for the edge detection. Gabor filter have similar frequency and orientation n of human visual system and they are observed to be particularly suites for medical images. Gabor filters are widely used in image preprocessing to enhance texture analysis, stereo disparity estimation, feature extraction. The impulse output of these filters is formed by accumulatingan Gaussian envelope function with a toughest oscillation. Gabor showed that these micro functions lessens the space –uncertainty product. By elaborating these functions to two dimensions it is possible to create filters which are selective for orientation. In some situations phase of response of Gabor filters is approximately linear, this property is oppressed by stereo approaches which will use the phase- difference of the left and right filter output to conjecture the disparity in the stereo images. The Gabor function is defined as:

$$\lambda, \theta, \varphi, \sigma, \gamma(x,y) = \exp\left((x^2 + \gamma^2 y^2)/2\ \sigma^2\right)\cos(2x*(x'/y)+\boldsymbol{\varphi})$$

x'= x$\cos\theta$+y$\sin\theta$

y'=-x$\sin\theta$+y$\cos\theta$

ADAPTIVE MEDIAN FILTER:

Adaptive median filter is an effective algorithm for removing salt and pepper noise in image preprocessing which is the result of image sensors, channel transmission and decoding processes. Images are sometimes spoiled by positive and negative impulses arising from decoding errors or noisy channels. They could be easily detected by eye and they can also degrade the image quality.The non linear median filters cannot remove positive and negative impulses so median filters are used but they fail when the probability of impulse noise increases. To overcome such situations we make use of adaptive median filters. Some of the algorithms for adapting median filters are ranked order based adaptive median filter(RAMF) and size based adaptive median filters(SAMF).RAMF is based on a two level test. First test checks for the presence of residual impulses in median filter output and the second level tests whether the center pixel is corrupted by any impulse or not. SAMF is a superior adaptive median filter technique as it simpler and performs better in eliminating the high level of impulsive noise andnon impulsive noise and it is also used in preserving all thedetails. Simulations on constant images confirm that these algorithms are higher to standard median filters.

MORPHOLOGICAL OPERATIONS:

Morphology is a branch of biology which deals with anatomy and structure of animals and plants. **Mathematical morphology** works as a tool for bringing out image components that are useful in delegation and confession of region space. It is based on set theory. It is a very effective and powerful approach to numerous image processing problems. Morphological operations are used to obtain image components that are useful in the delegation and confession of region shape, such as boundaries extraction skeletons convex morphologicalfilter, thinning and pruning.

MEAN FILTER(or) AVERAGE FILTER:

MEAN FILTERING is a simple method to implement on smoothing images which means decreasing the amount of high pitch variations between one pixel and next one. It is frequently used for decreasing the noise in images. The main aim of mean filtering is to reposition everypixel value of an image with mean value of its neighbor, i.e. with the average value including itself. This is helpful for eliminating the pixel values which are unnecessary of their surroundings. Mean filter is usually considered of as a convolution filter. Similar to other convolutions is targeted around a kernel,which gives the shape and size of the neighborhood to be simplified when calculating the mean. Seldom a 3*3 square kernel is used, a larger kernel(5*5) can also be used for more smoothing. A minute kernel can be applied more than once it produces a similar effect as a single pass with a large kernel.

IMAGE NORMALIZATION:

Normalization is often referred asprocess that modifies the range of pixel intensity values. Normalization can also be non linear.Normalization is sometimes called contrast stretching or histogram stretching. It is used for pictures with less contrast due to disturbances. It is termed as dynamic range expansion in fields of data processing such as digital signal processing. The term normalization is used as the purpose of normalization mostly include bringing the image or different type of signals inside a range that is highly accustomed to the senses the main aim of normalization is to gain consistency in dynamic range for a group of data,signals or images to reduce mental distraction of fatigue. For example a newspaper will take care that all images of a similar issue share a same grayscale.

III. OVERVIEW OF THE METHODS

S.no	Method name	Advantages	Disadvantages
1	Gabor filter	➢ Directional selectivity. ➢ Invariants to shift and notations. ➢ Robust to change in facial expressions. ➢ Resistivity to illumination variations.	➢ Time consuming. ➢ High computational complexity. ➢ Requires more memory capacity. ➢ Vector dimensions are extremely large.
2	Adaptive median filter	➢ Suitable for higher level of salt and pepper noise. ➢ Less loss of information. ➢ Different threshold is selected for each pixel. ➢ Provides fast recovery.	➢ Cannot deal with sudden, drastic lightning changes. ➢ Difficulty in selecting many parameters.
3	Morphological operations	➢ Applied to binary images and gray images ➢ It is robust and accurate. ➢ It is numerically stable in computation of bias field. ➢ Independent of initialization.	➢ It many separate the imaging to different regions.
4	Mean (or) average filter	➢ Uses all data values. ➢ Algebraically defined. ➢ It is based on mathematical calculations andaccurate. ➢ Provide large filtering area in relatively small space. ➢ Reduce the variants and easy to carry out.	➢ Distorted by outliers. ➢ Distorted by skewness. ➢ It gives equal weight age to the data related to different observations. ➢ It is non-specific in nature for use by various agencies. ➢ Affects mean values of all pixels in neighborhood.
5	Image normalization	➢ Eliminate modification anomalies. ➢ Reduced duplicate data and eliminate data integrity. ➢ Correct image density and contrast. ➢ Remove noise and help to store and retrieve the data easily.	➢ More complicated multi-table queries and slower applications. ➢ Time consuming and more data is inefficient. ➢ Maintaining large data is a bit messier and nested query are tricky. ➢ Time consuming and lack of professional consumed.

IV. CONCLUSION

This is the review of some of the image preprocessing algorithms and methods are described. All these algorithms are suitable for medical image preprocessing applications.In the medical image preprocessing future research will strive forward improving the efficiency and removes the noise and well understood that all methods work for different purposes. The different methodologies are used in the medical image preprocessing are CT, MRI, PET, X-RAY and so on. The advantages and disadvantages of the methods are described above: Gabor filter, mean, adaptive median, morphological operations and image normalization. These algorithms have some features that are accuracy, robustness and reliability.

REFERENCES

[1] https://www.ijceronline.com/papers/Vol4_issue01/version-3/E0413024026.pdf
[2] http://www.ijetjournal.org/Volume2/Issue2/IJET-V2I2P7.pdf
[3] https://link.springer.com/content/pdf/10.1007%2F978-3-540-74658-4_62.pdf
[4] http://www.medicalimaging.org/about-mita/medical-imaging-primer/
[5] http://www.icst.pku.edu.cn/F/course/ImageProcessing/2017/resource/Hwang.pdf
[6] http://www.academia.edu/5624617/Chapter 9 Morphological Image Processing Digital Image Processing Gonzalez
[7] http://www.ijctee.org/files/VOLUME2ISSUE2/IJCTEE_0412_01.pdf
[8] http://research.ijcaonline.org/volume112/number10/pxc3901511.pdf
[9] https://topics.revolvy.com/topic/Normalization%20(image%20processing)&item_type=topic.
[10] https://www.researchgate.net/publication/305502844 A Survey analysis on preprocessing and segmentation techniques for medical images.
[11] https://www.sciencedirect.com/science/article/pii/S1877705814034249
[12] Shameena N"A study of preprocessing and segmentation techniques on cardiac medical images" readings in image processing-April 2014.
[13] SonaliPatil "preprocessing to be considered for MR and CT images containing tumors" Dr. V. R. Udipi. 2012.
[14] K.M.M.Rao"OVERVIEW OF IMAGE PROCESSING" Readings in image processing fundamentals of digital image processing-Anil K. Jain, Prentice-Hall,1989.
[15] Dhawan P, A. (2003). Medical Imaging Analysis. Hoboken, NJ: Wiley-Interscience Publication.