A NOVAL DATA MINING APPROCH FOR DETECTION OF KIDENEY DISEASE

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Abstract

Kidney disease is a standout amongst the most risky disease happening ordinarily among individuals. The chances of survival can be expanded if the tumor is identified effectively at it s beginning period. X-ray kidney imaging method is generally used to envision the life systems and structure of the brain. The pictures created by MRI are high in tissue difference and have fewer antiquities. It has a few focal points over other imaging strategies, giving high complexity between delicate tissues. Be that as it may, the measure of information is to an extreme degree a lot for manual examination, which has been one of the greatest obstructions in the viable utilization of MRI. Kidney pictures for the most part contain clamor, in-homogeneity and now and again deviation. Subsequently, exact division of kidney pictures is an exceptionally troublesome assignment. In any case, the procedure of exact division of these pictures is imperative and urgent for a right conclusion by clinical devices. To address the multifaceted nature and difficulties of the kidney MRI division issue, we initially present the essential ideas of picture division. In our proposed paper we preprocessed the image, then segmentation is performed on that image, after that classification is done by the use of KNN mechanism. The obtained results are better in term of proposed methodology is better in terms of MSE and PSNR.

Keywords: MSE, PSNR, KNN, Segmentation, Preprocessing

Introduction

Image segmentation assumes a vital part in medical image preparing, and is a key strategy to investigation, comprehend and portray medical images with a specific end goal to analyze inquisitive diseases. At show kidney magnetic resonance imaging (MRI) segmentation has turned out to be prominent in medical image investigation due to non-intrusive detection and high-contrast. Precise kidney tissue segmentation can enhance reliability of kidney disease finding and adequacy of treatment. But kidney MRI images for the most part contain noise, power non-consistency, and so on, in this way, exact segmentation of kidney MRI images is an extremely troublesome task. Since grouping techniques needn't bother with an extensive number of preparing tests and earlier learning, and utilize the separation and dispersion of tests to class, bunching calculation turns into a well-known kidney MRI image segmentation tool. Grouping techniques normally receive the advancement emphasis strategy that keeps up the greatest separation between various classes and inside the most extreme comparability in a similar class to get the best image segmentation comes about. The K-means calculation as a sort of great unsupervised learning clustering algorithm has been generally utilized on account of its points of interest, for example, simple, proficient, and simple to actualize.

[1]Image processing applied to field of health care is always vital since this mechanism can provide on the go information to the users. Like any other digital media, MRI images can be prone to noise. Hence noise handling mechanisms must be incorporated with the image processing phases to extract information out of

available resources. Noise within the image can occur due to variety of reasons. The source of noise could be sensor, camera or malfunction of circuit. Noises introduced due to this problem are categorised as

1.1 Types of Noise

Salt and Pepper Noise

Salt and pepper noise is also known as impulse noise. This noise introduces white dots within the image and image clarity is lost. To solve the problems of salt and pepper noise, median filtering is commonly used.

Gaussian noise

Gaussian noise is introduced due to thermal or heat emitted through devise used to capture the image. The medium through which image is transferred could also cause the problem. Contrast related problem occurs due to this type of noise. Gaussian filtering mechanism is used to tackle the issues of Gaussian noise.

Shot Noise

This noise occurs due to malfunction of sensors. The sensor failure hence result this kind of noise that occurs n the darker regions of the image. adaptive median filtering could be used to tackle such a noise.

Anisotropic Noise

This noise appears within the image through the orientation of image. in other words if image is scaled than such noise appears within the image.

The noise removal is generally accomplished within pre-processing phase. After the pre-processing phase, generally segmentation takes place. Segmentation is used to divide the image into segments through which critical and non critical regions are identified. The last step in image processing to determine the problem in images is classification. In this process actual problem present within the image is identified. Rest of the paper is organised as under: section 2 describes the phases of image segmentation and classification, section 3 gives the literature survey, section 4 gives the comparison table and problem definition, section 5 present the conclusion and future scope and last section gives the references.

1.2 PHASES ASSOSIATED WITH IMAGE SEGMENTATION

Image segmentation is the mechanism in which image is partitioned into segments. The objective is to transform the image into more meaningful parts which can be easy to analyse. In health care environment image is generally transformed into gray scale levels at first place. From the gray scale image, image is partitioned into black and white regions. Black regions indicate non critical parts and white regions indicate critical parts. In general the parts associated with segmentation are listed as under

Pre-Processing

[2]This phase is critical in case image is prone to noise. The corruption within the image hinders the result. Pre-processing ensures the removal of noise and hence segmentation can be performed with accuracy. Pre-processing hence is associated with the filters. Commonly encountered noise in MRI images is salt and pepper noise and to tackle that noise, median filter is needed. Pre-processing can also be incorporated with the contrast enhancement strategies. Once the clarity of image is improved first phase terminates.

Segmentation

It is the process of driving the necessary region from entire image. [3]The image segmentation generally requires conversion from any format image to gray scale image. The image parts which are critical are converted to white region and unnecessary part is converted to black region. The analysis of whitish region is done only. Thus the process of segmentation will reduce the image into critical segments that can be easily analyzed.

Classification

[4]The classification process identifies the problems within the segmented regions. Classification accuracy is depicted by comparing the actual result with the simulation result. Training set is generated from the dataset. From the training set image is selected. The training set is that in which image problems are already detected. The result obtained from the segmented image is than compared against the result obtained from the simulation. Error approximation is obtained by comparing the result obtained from the simulation against the actual result.

Medical image segmentation is a key undertaking in numerous medical applications, for example, surgical arranging, post-surgical evaluation, irregularity recognition etc. There are bunches of techniques for programmed and self-loader image segmentation, however, a large portion of them fall flat as a result of obscure noise, poor image differentiation, inhomogeneity and week limits that are common in medical images. Medical images generally contain confused structures and their exact segmentation is fundamental for clinical conclusion.

One of such is mind image segmentation which is much entangled and testing yet its precise segmentation is imperative for recognizing tumors, edema, and necrotic tissues. Exact discovery of these tissues is imperative in symptomatic frameworks. Additionally, magnetic resonance imaging (MRI) is a vital imaging procedure for identifying strange changes in various parts of the cerebrum in beginning period. MRI imaging is a prevalent approach to acquire an image of mind with high complexity. MRI securing parameters can be changed in accordance with give distinctive dim levels for various tissues and different sorts of neuropathology. MRI images have great differentiation in contrast with computerized tomography (CT). Consequently, the vast majority of research in medical image segmentation utilizes MRI images.

The recognizable proof of kidney structures in magnetic resonance imaging (MRI) is essential in neuroscience and has numerous applications such as: mapping of practical initiation onto kidney life structures, the investigation of kidney advancement, and the examination of neuroanatomical fluctuation in typical brains. Kidney image segmentation is likewise helpful in clinical finding of neurodegenerative and mental issue, treatment evaluation, and surgical arranging. There are heaps of strategies for programmed and self-loader image segmentation, however, the greater part of them fall flat as a result of obscure noise, poor image differentiate, and frail limits that are normal in medical images.

1.3 MR Imaging (MRI)

MR imaging (MRI), developed in 1970, is a prominent technique in restorative imaging. X-ray examining is generally sheltered and not at all like other restorative imaging modalities, can be utilized as regularly as necessary. Moreover, it can be adjusted to image brain. Clinical MRI depends on the hydrogen core because of their wealth in the human body and their magnetic reverberation affectability. For image arrangement, an expansive static magnetic field is utilized to irritate magnetic snapshots of proton that exist in the hydrogen core from their balance and watching how bothered minutes unwinds back to their balance. Normally, the protons are arranged arbitrarily. Yet in presence of a static magnetic field, they line up with the field and the net charge of protons inclines toward the heading of the field. In presence of enough vitality, it is conceivable to influence the net polarization to zero. In the unwinding procedure an instigated electronic flag is recorded.

2. Literature Survey

[5] Image segmentation is a standout amongst the most imperative assignments in therapeutic image examination and is often the first and the most basic advance in numerous clinical applications. In cerebrum MRI examination, image segmentation is ordinarily utilized for estimating and envisioning the mind's anatomical structures, for breaking down mind changes, for outlining neurotic districts, and for surgical arranging and image-guided mediations. Over the most recent couple of decades, different segmentation strategies of various exactness and level of many-sided quality have been created and revealed in the writing. In this paper we survey the most popular methods normally utilized for mind MRI segmentation. We feature contrasts amongst them and talk about their capacities, favourable circumstances, and confinements. To address the multifaceted nature and difficulties of the cerebrum MRI segmentation issue, we initially present the fundamental ideas of image segmentation. At that point, we clarify distinctive MRI pre-processing steps including image enlistment, inclination field remedy, and expulsion of non-kidney tissue. At long last, after checking on various mind MRI segmentation techniques, we examine the approval issue in cerebrum MRI segmentation.

[6] Restorative image handling is a standout amongst the most invigorating and developing field in therapeutic diagnosing framework. Handling of MRI Human cerebrum images is one of these field. This paper portrays the real conclusion relying upon the variation from the norm removed from the MRI (Magnetic Resonance Image) cut images. Anomaly extraction is the arrangement of image preparing steps. For example, Image improvement, Segmentation, Morphological tasks and grouping. Here, the paper chiefly centers around the segmentation part to section the influenced area appropriately. Area based segmentation and multilevel limit segmentation methods are utilized for variation from the norm extraction, which gives the improved outcomes contrasted with other segmentation systems. After the anomaly extraction the determination is performed in view of the metric estimations of images. Anomaly can be of Kidney disease, Homeomorphage (stroke), Edema (Kidney swelling) and Hydrocephalus (water on the mind). These groupings of various anomalies are recognized in view of metric esteems and the arranged district obviously gives an outcome on the kind of variation from the norm.

[7] The technique for mind tumor segmentation is only the separation of various tumor territory from Magnetic Resonance (MR) images. There are number of strategies as of now exhibited for segmentation of mind tumor proficiently. However it's as yet basic to distinguish the cerebrum tumor from MR images. The segmentation procedure is extraction of various tumor tissues, for example, dynamic, tumor, corruption, and edema from the typical mind tissues, for example, white issue (WM), dim issue (GM), too cerebrospinal

liquid (CSF). According to the review think about, the cerebrum tumors the vast majority of time identified effectively from mind MR image, however required level of precision, reproducible segmentation, irregularities order isn't unsurprising and direct. The segmentation of cerebrum tumor is made out of numerous stages. The manual procedure of doing the segmentation of mind MR images is extremely time utilization and repetitive assignment, and henceforth it is related with numerous difficulties. In this way, we require computerized segmentation strategy for mind images. There are numerous procedures exhibited to explore the execution of robotized automated cerebrum tumor identification for the medicinal examination reason. In this survey paper, our fundamental objective is to introduce the audit of various cerebrum tumor segmentation strategies utilizing the MR images. The diverse techniques for segmentation are examined with their favourable circumstances and disservices in this paper.

[8] with the exceptional development in image handling for talking about restorative imaging is one of the developing field and the necessities for progressions in medicinal imaging is constantly new and testing. X-ray based mind restorative imaging are utilized for therapeutic analysis since it display the inward parts of the human cerebrum and Kidney disease is the extreme life changing sicknesses. Image segmentation assumes key part in image preparing as it encourages in the extraction of suspicious locales from the MR Images. Watershed strategy is one of the ordinary utilized segmentation system for cerebrum MRI and fundamentally valuable for dark scale image segmentation connected on scientific morphology and district identification. The comparable research results show the change in mind MRI segmentation by joining different strategies and procedures. All things considered the precise outcomes are not been proposed and shown in the tantamount inquires about. Subsequently, this work shows the unrivalled precision for mind tumor location in contrasted with the displayed procedures. Additionally the major recognized bottleneck of the current research results are constrained to recognition of cerebrum tumor and the general examinations of inward structure of the mind is for the most part overlooked being a standout amongst the most essential factor for clutter discovery. This work additionally investigates the conceivable outcomes of distinguishing the mind areas with potential issue.

[9] Cerebrum tumor is a standout amongst the most risky malady happening regularly among people. The odds of survival can be expanded if the tumor is recognized accurately at its beginning period. X-ray cerebrum imaging system is broadly used to envision the life structures and structure of the mind. The images delivered by MRI are high in tissue differentiate and have less ancient rarities. It has a few preferences over other imaging systems, giving high difference between delicate tissues. Be that as it may, the measure of information is to an extreme degree a lot for manual examination, which has been one of the greatest obstructions in the successful utilization of MRI. The identification of tumor requires a few procedures on MRI images which incorporates image pre-processing, highlight extraction, image improvement and arrangement. The last arrangement process presumes that a man is infected or not. Albeit various endeavours and promising outcomes are acquired in medicinal imaging territory, reproducible segmentation and arrangement of irregularities are as yet a testing errand on account of the diverse shapes, areas and image powers of various sorts of tumors. In this paper, different methodologies of MRI cerebrum image segmentation calculations are looked into and their focal points, weaknesses are talked about.

[10] Image segmentation plays an important role in diagnosis and treatment of diseases. Image segmentation locates objects and boundaries with in images and the segmentation process is stopped when region of interest is separated from the input image. Based on the application, region of interest may differ and hence none of the segmentation algorithm satisfies the global applications. Thus segmentation still remains a challenging area for researchers. This paper emphasis on comparison study of segmentation techniques for segmenting kidney tumour from MRI images. The tumour area is identified by using different algorithms like seeded

region growing and merging, K-Means, KNN, fuzzy C-Means and a comparative study of all this methods is presented here.

[11] Following of the skin sickness is an essential advance of symptomatic also the measure of the injury's surface is exceptionally helpful in recuperating's report. To defeat the challenges of the skin sickness' estimation, experienced with the as of now utilized estimation systems, we propose a novel approach meaning to lessen the tedious and the mistake rate. The proposed technique depends on two stages; the initial step is a pre-processing one which comprises in image segmentation to distinguish the edge of the tainted skin locale. In the second one, another proposed technique is connected to quantify the injury 'size' and control the sickness advancement. In this work, a relative report was acknowledged to choose the most reasonable segmentation system alluded to a proposed standard in view of 'edge precision' EAC. The new standard was contrasted and the 'surface precision' in light of ROC1 space. The examinations demonstrate the execution of the proposed paradigm and the adequacy of the estimation method.

[12] A tumor is a strange development of cells inside the cerebrum, which is one of the real reasons for death among individuals. Odds of survival is high if the tumor are recognized in the beginning periods in this way, there is a requirement for a quick and precise technique for identification of cerebrum tumor. For recognizing the tumor MRI or CT examine is utilized. Attractive reverberation image is a troublesome errand due to the area, powers and shapes. For examining the image MRI or CT check is utilized. Checking of the mind is done to affirm the nearness of tumor and to distinguish the area. Segmentation is required for mind tumor identification. This is one of the critical parts in an image handling. It subdivides an image into areas or items. The fundamental objective of segmentation is to make image less demanding and significant. This paper gives audit on near investigation of segmentation methods for dividing mind tumor from Magnetic Resonance Image.

[13] As of late, biomedical imaging and restorative image handling have turned out to be a standout amongst the most difficult fields of designing and innovation. Imaging methodology like MRI gives itemized data about the life systems, it likewise helps in checking infection, and it is advantageous for successful determination. It likewise assumes a key part in the following of the infection and its dynamic treatment. Image segmentation is an essential advance for additionally post-preparing of therapeutic images. This paper gives a prologue to the field of image handling and gives insights about how image segmentation systems might be appropriate to the distinctive imaging modalities accessible. On account of MRI of cerebrum, image segmentation constitutes an essential advance for location of tumor. This paper gives a study of different image segmentation strategies that have been connected to cerebrum MRI images, to section the mind into its constituent parts, including the tumor.

3. Problem Definition

The existing literature constructed on segmentation to extract region of interest. Region of interest extraction reduces the image analysis region or in other words complexity of image analysis is considerably reduced. Image enhancement procedure considers only specific type of noise. In order to enhance the overall procedure, image enhancement must consider multiple noises filtering mechanism to form universal filtering. The parameters to be enhanced in future work includes

- **Mean Square Error**: In insights, the idea of mean squared blunder is a vital standard that is used with a specific end goal to quantify the execution of an estimator. The mean squared blunder, shortened as MSE, is very imperative for handing-off the ideas of exactness, inclination and precision amid the measurable estimation.

The measure of mean squared blunder requires an objective of expectation or estimation alongside an indicator or estimator which is said to be the capacity of the given information. MSE is characterized as the normal of squares of the "blunders".

Here, the mistake is said to be the distinction between the ascribe which is to be assessed and the estimator. The mean squared mistake might be known as an a hazard work which relates to the normal estimation of the loss of squared blunder. This distinction or misfortune could be produced because of the haphazardness or because of the estimator does not portray the data which could give a more precise gauge. The mean squared error can be alluded to the second snapshot of the mistake estimated about the birthplace. It fuses both the change and predisposition of the estimator. On the off chance that an estimator is impartial estimator, at that point its mean squared mistake is same as the change of the estimator. The unit of MSE is the same as the unit of estimation for the amount which is being evaluated.

- **Peak Signal to noise ratio**: The term top flag to-commotion proportion (PSNR) is an articulation for the proportion between the greatest conceivable esteem (control) of a flag and the energy of mutilating clamor that influences the nature of its portrayal. Since numerous signs have a wide powerful range, (proportion between the biggest and littlest conceivable estimations of an alterable amount) the PSNR is generally communicated regarding the logarithmic decibel scale.

Picture upgrade or enhancing the visual nature of an advanced picture can be subjective. Saying that one technique gives a superior quality picture could shift from individual to individual. Consequently, it is important to build up quantitative/observational measures to think about the impacts of picture upgrade calculations on picture quality.

4. Proposed Work

I. Input the kidney diseased image.

Figure 1: Colonoscopy of kidney disease

II. Extract the entire feature from image and perform intensity statistics and texture entropy on the image

III. Perform the KNN on image.

K-Nearest Neighbors

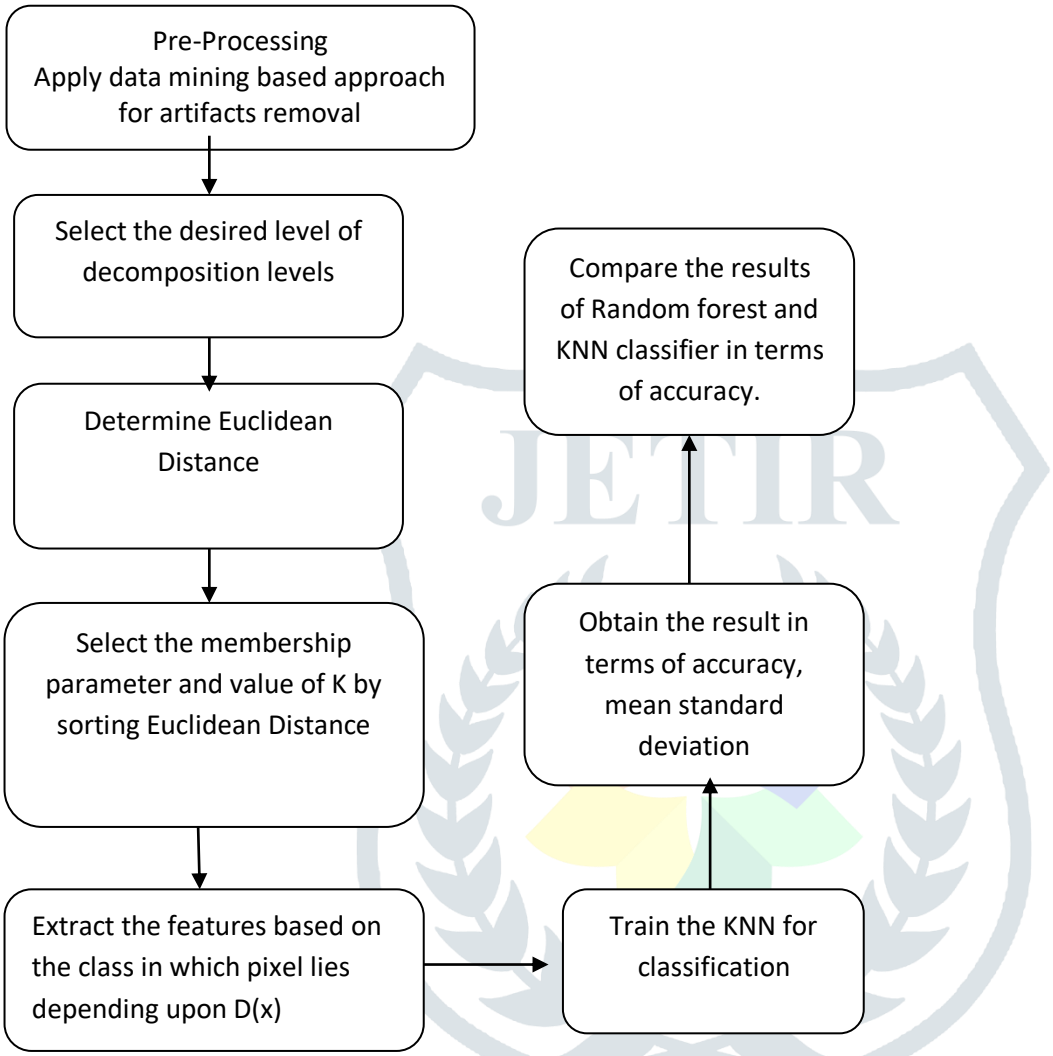
K-Nearest Neighbors is a standout amongst the most fundamental yet basic order calculations in Machine Learning. It has a place with the managed learning area and finds extreme application in design acknowledgment, information mining and interruption recognition. It is broadly dispensable, all things considered, situations since it is non-parametric, which means, it doesn't make any basic suppositions about the dispersion of information.

Algorithm:

Let m be the number of training data samples. Let p be an unknown point.

1. Store the training samples in an array of data points arr[]. This means each element of this array represents a tuple (x, y).
2. for i=0 to m:
3. Calculate Manhattan distance d(arr[i], p).
4. Make set S of K smallest distances obtained. Each of these distances corresponds to an already classified data point.
5. Return the majority label among S.

2.5 FLOW OF PROPOSED WORK



5. Objectives

In our proposed paper we took the MRI of kidney to get the image. After getting the image preprocessing is applied on that image. The preprocessed image is then passed through segmentation which gives the extracted image of defected area. The main objective of our paper is discussed below which helps us in achieving better results.

I. False positive rate has to be reduced in future.
II. MSE has to be decrease and PSNR to be increase.
III. Entropy has to be enhanced.

6. Results

DATASET DESCRIPTION

In our proposed work the dataset that is utilized is taken from the UCI website. The images are gathered from the website and it is stored in folder. In this we gathere total 50 images to work the proposed methodology. The dataset is given as

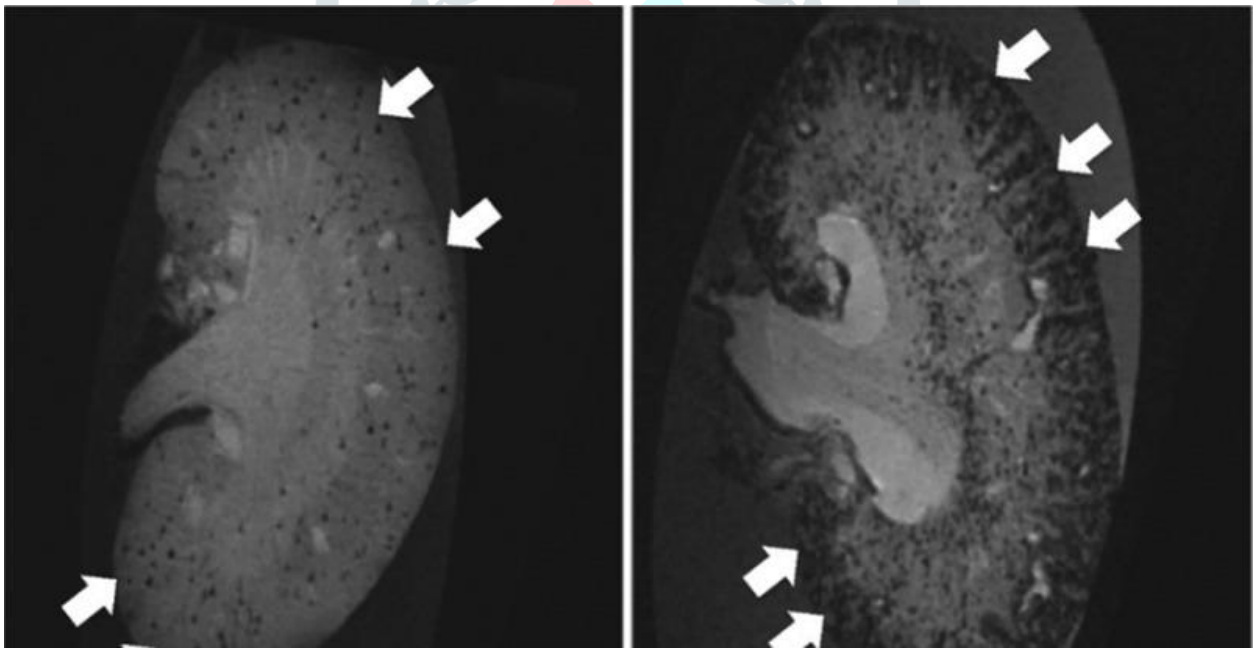


Figure 5: MRI dataset derived from the internet.

Image set derived from the internet is described as under

Image Set	No. of Images	Description	Size	Type
Normal	25	.jpeg	320x240	Black and White
Abnormal	25	.jpeg	320x240	Black and White

Table 1:- Description of image set

In our proposed paper we resize the images that introduce uniformity As the image derived from internet so some improvement is needed that make it better for understanding. Dataset is collection of images which is derived from UCI website. The fetched data set larger in size and hence more noise is present to detect the kidney disease accurately. So preprocessing phase becomes critical in this case.

The steps associated with the proposed approach are described in this section.

PRE-PROCESSING

The image is loaded from image set and the noise is given by the use of PSE. The image is displayed with noise and also the original image is retained. This is used for comparison in the later phases. Result is produced in terms of accuracy.

Figure 6:-First image shows original MRI image and second image shows image after noise introduction

WEINER FILTERING FOR IMAGE RESTORATION

Overlapping pixels that are introduced are required to restore the image so it must be reduced. We utilized wiener filter for the purpose of restoration The wiener filtering mechanism [14] as discussed in detail is implemented in this section using the equations

$$E(x,y) = \frac{H(x,y)P(x,y)}{|H(x,y)|^2 * P(x,y) + P(x,y)}$$

In this the Partitioning of image is done to reduce the complexity of image. Partitioning is represented with P. H(x,y) is the degradation function. Most of the noise from the signal is removed and image is restored. The signal to noise ratio is observed in this case.

Figure 7: Images used from dataset for demonstration

In order to obtain desired level of accuracy Weiner filtering is applied multiple times to image after buffer mechanism.

The proposed system generates parameters such as CPU_Time, F-score and Tanimoto distance. The proposed technique gives better result than normal wiener filtering mechanism in terms of listed parameters.

Image	Parameter	Weiner Filter	Modified Weiner Filter
Image1	CPU Time	5.5365	2.5658
	F-Score	0.756	0.9234
	Tanimoto Distance	0.9635	0.0826

Table 2:- Result Comparison in terms of various parameters

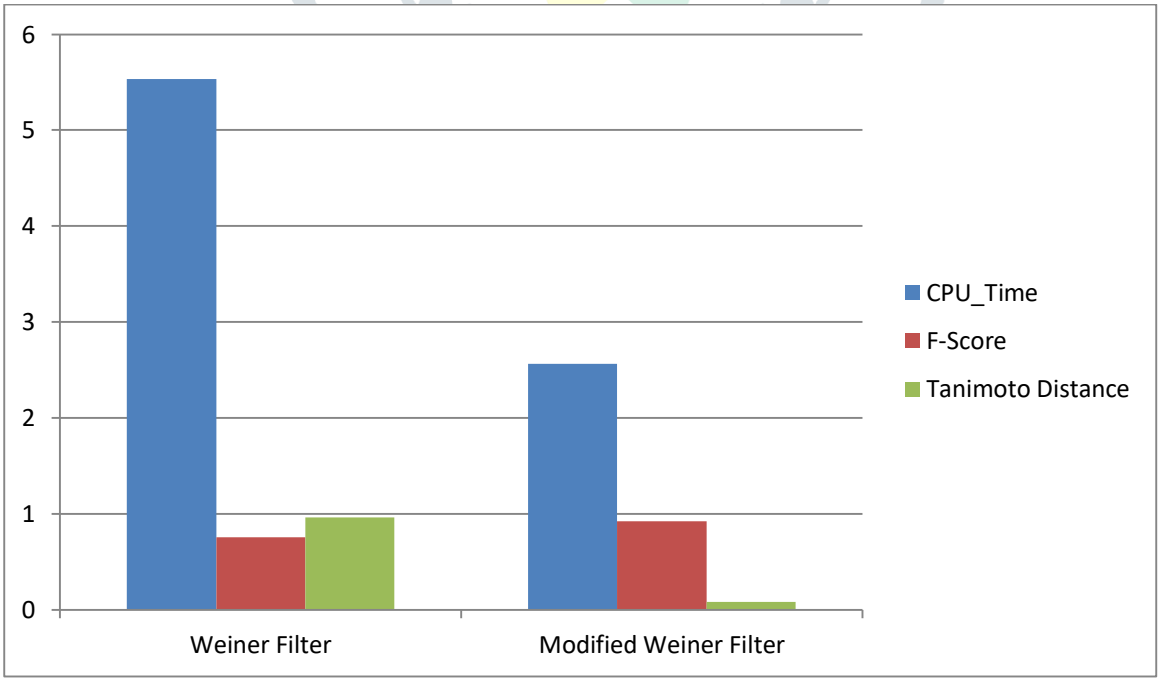


Figure 2:- Comparison in terms of CPU_Time, F-Score and Tanimoto Distance

Result shows the variation as image is changed. However modified Weiner filter still shows better result as compared to existing Weiner filter.

Image	Parameter	Weiner Filter	Modified Weiner Filter
Image2	CPU Time	5.9658	2.4568
	F-Score	0.8569	0.94576
	Tanimoto Distance	0.95632	0.72562

Table 3:- Comparison in terms of parameter values

The plots of table 3 are shown as follows

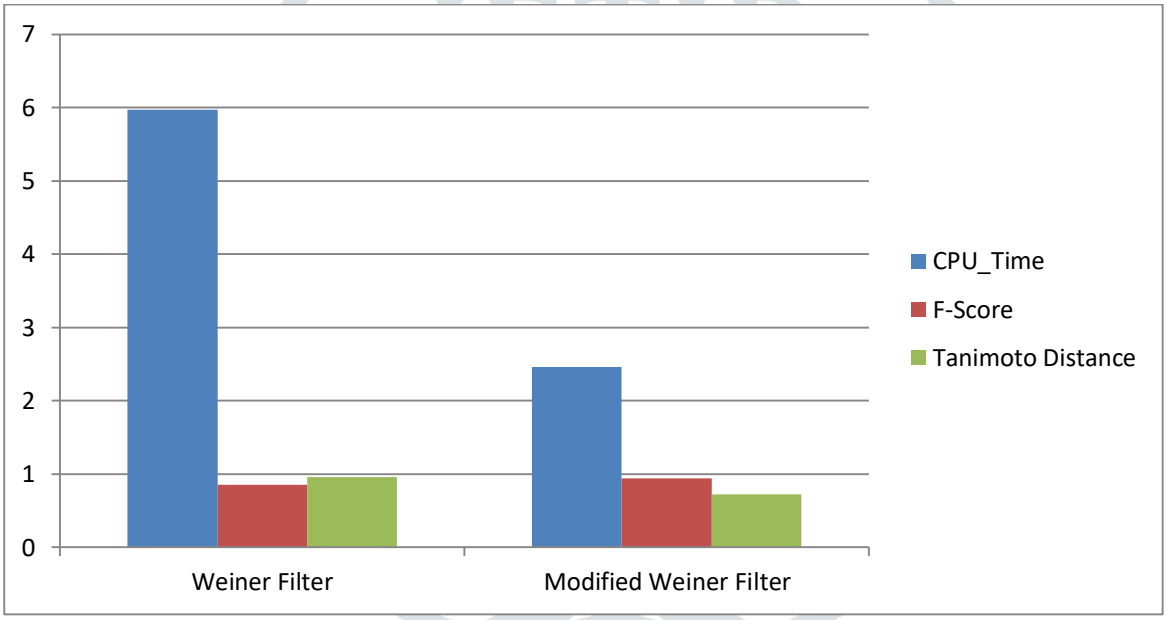


Figure 3:- Comparison in terms of parameter values

The comparison of results indicates the modified Weiner filter gives better result as compared to existing Weiner filter as used with MRI image.

7. Conclusion

Segmentation procedure is critical in the analysis of defects present within the image. The pre-processing phase play a critical part in the process of segmentation since clarity within the image is introduced by the application of pre-processing. The existing literature is capable of handling singleton noise from within the presented image. The segmentation procedure suffers in case multiple noise sequences appear within the image. In order to tackle the situation universal filter implication in the image pre-processing phase can be proposed in future.

8. References

[1] K. Selvanayaki and P. Kalugasalam, "Available Online at www.jgrcs.info INTELLIGENT BRAIN TUMOR TISSUE SEGMENTATION FROM MAGNETIC RESONANCE IMAGE (MRI) USING META HEURISTIC ALGORITHMS," vol. 4, no. 2, pp. 13–20, 2013.

[2] N. Singla, "A Comparative Study of Noising And Denoising Technique In Image Processing," vol. 4, no. 3, pp. 38–42, 2016.

[3] A. Nagarajan, "An Enhanced Approach in Run Length Encoding Scheme (EARLE) Abstract : Image Compression :," pp. 43–47, 2011.

[4] P. Naraei, V. Street, V. Street, and V. Street, "Application of Multilayer Perceptron Neural Networks and Support Vector Machines in Classification of Healthcare Data," *IEEE Access*, no. December, pp. 848–852, 2016.

[5] I. D. T, B. Goossens, and W. Philips, "MRI Segmentation of the Human Brain : Challenges , Methods , and Applications," vol. 2015, 2015.

[6] A. M. Lal and D. Aju, "Abnormality Extraction of MRI Brain Images Using Region Growing Segmentation Techniques," vol. 3, no. 8, pp. 76–82, 2014.

[7] R. D. Deshmukh, "Study of Different Brain Tumor MRI Image Segmentation Techniques," vol. 4, no. 4, pp. 133–136, 2014.

[8] K. Bhima and A. Jagan, "Analysis of MRI based Brain Tumor Identification using Segmentation Technique," pp. 2109–2113, 2016.

[9] D. Selvaraj, "MRI BRAIN IMAGE SEGMENTATION TECHNIQUES - A REVIEW," vol. 4, no. 5, pp. 364–381, 2013.

[10] D. Manju, M. Seetha, and K. V. Rao, "Comparison Study of Segmentation Techniques for Brain Tumour Detection," vol. 2, pp. 261–269, 2013.

[11] O. Trabelsi, "Skin Disease Analysis and Tracking based on Image Segmentation."

[12] P. Tambe, "Comparative Study of Segmentation Techniques for Brain Tumor Detection," vol. 5, no. 02, pp. 269–271, 2016.

[13] N. Tirpude and R. R. Welekar, "A Study of Brain Magnetic Resonance Image Segmentation Techniques," vol. 2, no. 1, 2013.

[14] N. V. S. Malothu Nagu[1], "Image De-Noising By Using Median Filter and Weiner Filtering," *Int. J. Innov. Res. Comput. Commun. Eng.*, pp. 5641–5649, 2014.