Implementation of Hybrid Error Model Using Super Resolution for Medical Images

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***Abstract* —In pattern recognition, for various domains different models or combination of models can be used. In case of noisy patterns, choice of statistical model is a good solution. Practical importance of structural model depends upon recognition of simple pattern primitives and their relationships represented by description language. Hybrid model is combination of both statistical and structure model. So it is best method to solve the many problems. In hybrid model, we use hybrid error model for super resolution of images Conventional X-ray imaging is the fastest, most common, and least expensive diagnostic imaging system available. The aim of this paper is to present a model using super resolution for removing the noise in digital X-ray images .The resulting X-ray images are more visible ,noise is reduced from X-ray images. We implement the model using frequency domain instead maximum likelihood because it gives better results in medical images.**

With the help of super resolution, we increase the resolution of the image that also increases the detail of the image. When we remove the noise from the image, image quality also increases that helps us to find the clearly symptom of any diseases.

Keywords— Super-resolution, Frequency domain, X-ray imaging, Gaussian and Laplacian distribution .

I. INTRODUCTION

Pattern Recognition defined as a classification of input data via extraction important features from a lot of noisy data[8]. The identification or interpretation of the pattern in an image can be described effectively with the help of Pattern Recognition (PR). It aims to extract information about the image to classify its contents. Pattern recognition encompasses two fundamental tasks: description and classification. Given an object to analyze, a pattern recognition system first generates a description of it i.e., the pattern and then classifies the object based on that description i.e., the recognition. The essential problem of pattern recognition is to identify an object as belonging to a particular group. Assuming that the objects associated with a particular group share common attributes more so than with objects in other groups, the problem of assigning an unlabeled object to a group can be accomplished by determining the attributes of the object (i.e., the pattern) and identifying the group of which those attributes are most representative (i.e., the recognition). Pattern recognition is the assignment of some sort of output value to a given input value according to some specific algorithm. Three processes take place in pattern recognition task. First step is data acquisition. Data acquisition is the process of converting data from one form (speech, character, pictures etc.) into another form which should be acceptable to the computing device for further processing. Data acquisition is generally performed by sensors, digitizing machine and scanners. Second step is data analysis. After data acquisition the task of analysis begins. During data analysis step the learning about the data takes place and information is collected about the different events and pattern classes available in the data. This information or knowledge about the data is used for further processing. Third step used for pattern recognition is classification. Its purpose is to decide the category of new data on the basis of knowledge received from data analysis process. Data set presented to a pattern recognition system is divided into two sets: training set and testing set. System learns from training set and efficiency of system is checked by presenting testing set to it. The performance of the pattern recognition techniques is influenced by mainly three elements (i) amount of data (ii) technology used(method) (iii) designer and the user [15].

Applications of pattern recognition include the following:

- Computer vision
- Computer aided diagnosis
- Character recognition
- Speech recognition
- Safety
- Bioinformatics
- Agriculture

II Pattern Recognition Methods

Pattern recognition include a lot of methods which impelling the development of numerous applications in different filed. On the basis of survey, pattern recognition techniques can be categorized into fifth methods. These includes [1]:

2.1Statistical Model
2.2Structural Model
2.3 Neural Network Based Model
2.4 Fuzzy Based Model
2.5 Hybrid Model

2.1 Statistical Model

In Statistical method of Pattern Recognition each pattern is described in terms of features. Features are chosen in such a way that different patterns occupy non-overlapping feature space. After analyzing the probability distribution of a

pattern belonging to a class, decision boundary is determined. Here patterns are projected to pre-processing operations to make them suitable for training purposes. Features are selected upon analyzing training patterns [3].

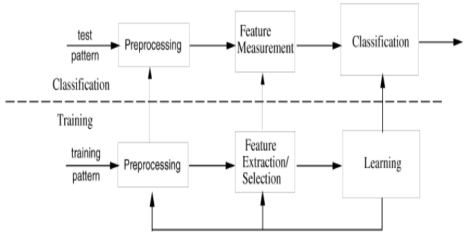

Fig 1: Model for Statistical Pattern Recognition

2.2 Structural Model

These systems are based on the relation between features. In this approach, patterns are represented by structures which can take into account more complex relations .In structural approach of pattern recognition a collection of complex patterns are described by a number of sub-patterns and the grammatical rules with which these sub patterns are associated with each other[9].

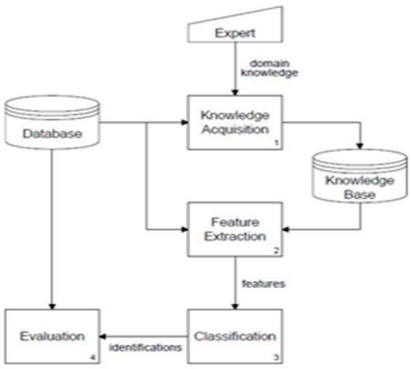

Fig 2: The process of knowledge acquisition for developing domain and Application specific feature extractors for structural pattern recognition.

2.3 Neural Network Based Model

Neural networks are the massively parallel structures composed of "neuron" like subunits .Neural networks provide efficient result in the field of classification. The performance of the neural networks enhances upon increasing the number of hidden layers up to a certain extent. Increased number of neurons in hidden layer also improves the performance of the system. A trade-off must be maintained between size of network and complexity resulted because of network size[14].

2.4 Fuzzy Based Model

The importance of fuzzy sets in pattern recognition lies in modeling forms of uncertainty that cannot be fully understood by the use of probability theory. Kandel states, "In a very fundamental way, the intimate relation between theory of fuzzy sets and theory of pattern recognition and classification rests on the fact that most real world classes are fuzzy in nature"[15].

2.5 Hybrid Model

Statistical and Structural models can be combined together to make hybrid model. In such cases statistical approach is utilized to recognize pattern primitives and structure approach is then used for the recognition of sub-patterns and pattern itself. To enhance system performance one can use a set of individual classifiers and combiner to make the final decision [2].

III Need of Hybrid Model & Super Resolution Image

In most of the applications, it is clear that a single model used for classification doesn't behave efficiently, so multiple methods have to be combined together giving result to hybrid models. Primitive approaches to design a pattern recognition system which aims at utilizing a best individual classifier have some drawbacks. It is very difficult to identify a best classifier unless deep prior knowledge is available at hand. Structural pattern recognition systems are difficult to apply to new domains because implementation of both the description and classification tasks requires domain knowledge. Knowledge acquisition techniques necessary to obtain domain knowledge from experts are tedious and often fail to produce a complete and accurate knowledge base. Consequently, applications of structural pattern recognition have been primarily restricted to domains in which the set of useful morphological features has been established in the literature (e.g., speech recognition and character recognition) and the syntactic grammars can be composed by hand (e.g., electrocardiogram diagnosis). To overcome this limitation, a domain independent approach to structural pattern recognition is needed that is capable of extracting morphological features and performing classification without relying on domain knowledge. A hybrid system that employs a statistical classification technique to perform discrimination based on structural features is a natural solution. While a statistical classifier is inherently domain independent, the domain knowledge necessary to support the description task can be eliminated with a set of generally useful morphological features. Super Resolution (SR) is a class of techniques that enhance the resolution of an imaging system. Super resolution reconstruction produces one or a set of high-resolution images from a set of low-resolution images [12].

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we remove the noise from the image, image quality also increases that helps us to find the clearly symptom of any diseases.

IV Related Work

A number of studies showing the advantages of super resolution images & also about the hybrid and other models that have appeared in the literature. Seema Asht,Rajeshwar Dass [15] said that in case of noisy patterns, choice of statistical model is a good solution. Practical importance of structural model depends upon recognition of simple pattern primitives and their relationships represented by description language. Hybrid model is combination of both statistical and structure model.Lihong Zheng ,Xiangjian He[10] gives the basic idea we get is the more relevant patterns at your process, the better features subsets you obtain, the more simple your classifier will be applied, finally the better your decisions will be. They should suggest to attempt to design a hybrid system combining with multiple models.

Sameer Antania, Rangachar Kasturia, Ramesh Jain [5] noted that pattern recognition thus plays a significant role in content based recognition and has applications in more than one sub-system in the database. It is not only necessary to develop better pattern recognition methods to capture the visually important features from the image, but also to develop them such that they are simple, efficient and easily mapped on human queries.

M.Subba Rao, Dr.B.Eswara Reddy[2] find that pattern recognition is generally categorized according to the type of learning procedure used to generate the output value. In simple sense pattern recognition is the heart of all scientific inquiry, including understanding ourselves and the real-world around us. Now a day the development of pattern recognition is increasing very fast. In this paper we navigate pattern recognition in the round, include the definition of PR, the methods of PR, the composition of PR system and figures related to PR.

Jie Liu,Jigui Sun,Shengsheng Wang[8] noted that in its broadest sense pattern recognition is the heart of all scientific inquiry, including understanding ourselves and the real-world around us. And the developing of pattern recognition is increasing very fast, the related fields and the application of pattern recognition became wider and wider. In this paper we expatiate pattern recognition in the round, include the definition of PR, the methods of PR, the composition of PR system, the related fields of PR and the application of pattern recognition.

Huihui Song, Lei Zhang , Peikang Wang, Kaihua Zhang and Xin Li[7] presented a novel hybrid error model for SR reconstruction, which combines the advantages of Gaussian model and Laplacian model. The hybrid error model integrates the Gaussian and Laplacian models by their corresponding membership functions, which are varying according to the noise intensity distribution during the iteration procedure. Moreover, an adaptive convergence criterion (ACC) was proposed, which can effectively and efficiently end the iteration.

Jianchao Yang, Thomas Huang [4] said that it is hard to draw consistent conclusions for different SR techniques,in terms of performance evaluation, some benchmark and realistic datasets are needed for fair comparison and algorithm understanding.

Sina Farsiu, M. Dirk Robinson, Michael Elad, and Peyman Milanfar [6] presented an algorithm to enhance the quality of a set of noisy blurred images and produce a HR image with less noise and blur effects. We presented a robust super-resolution method based on the use of L1 norm both in the regularization and the measurement terms of our penalty function. They showed that their method removes outliers efficiently, resulting in images with sharp edges. Even for images in which the noise followed the Gaussian model L1 norm minimization results were as good as L2 norm minimization results, which encourages using L1 norm minimization for any data set. The proposed method was fast and easy to implement.

V. Proposed Scheme Using Hybrid Model On Super Resolution Images

A hybrid system that employs a statistical classification technique to perform discrimination based on structural features is a natural solution to some problems. Like Primitive approaches to design a pattern recognition system which aims at utilizing a best individual classifier have some drawbacks. It is very difficult to identify a best classifier unless deep prior knowledge is available at hand. Structural pattern recognition systems are difficult to apply to new domains because implementation of both the description and classification tasks requires domain knowledge. So, a hybrid model is used in this work with super resolution images. As Image resolution describes the details contained in an image, the higher the resolution, the more image details.

5.1 Proposed Model

The proposed modal focuses on following four objectives which are helpful to remove noise from the image & also increases image quality which helps us to find the clearly symptoms of any disease.

a. Understanding of Image patterns.

b.Understanding and comparison of pattern recognition techniques.

c. Implementation of hybrid error model.

d.Implementation of hybrid technique for edge preservation and noise smoothing for medical image.

In this proposed work, Hybrid model is used with super resolution of images to improve the quality of image. Then we add Structural noise & apply Laplace Gaussian Filter to remove the noise. It results as noise free image with high

quality & provides better results which are helpful in the medical field to detect the symptoms of any disease.

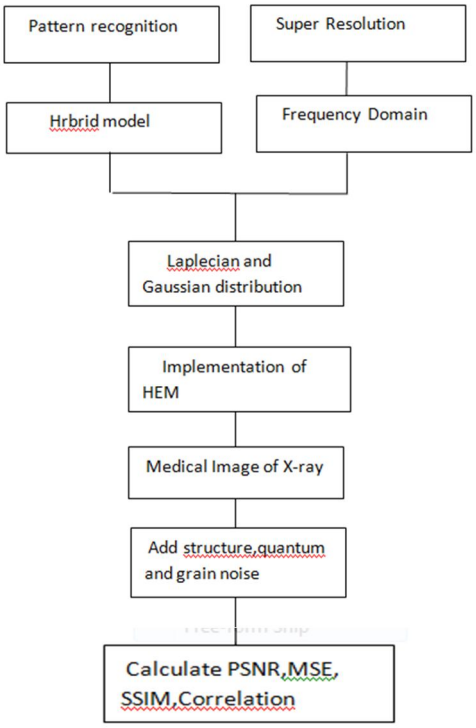


Fig 3: Flow Chart of Proposed Scheme

5.2 Images:

An image is essentially a 2-D signal processed by the human visual system. The signals representing images are usually in analog form. However, for processing, storage and transmission by computer applications, they are converted from analog to digital form. A digital image is basically a 2-Dimensional array of pixel.

Types of an image

- Medical images
- Still images
- Satellite images

Medical imaging is the technique and process used to create image of the human body (or parts and function thereof) for clinical purposes (medical procedures seeking to reveal, diagnose, or examine disease) or medical science. Medical imaging, a branch of digital imaging that seeks to assist in the diagnosis and treatment of diseases, is growing at a rapid rate.

5.*3 Hybrid Model*

Statistical and Structural models can be combined together to make hybrid model. In such cases statistical approach is utilized to recognize pattern primitives and structure approach is then used for the recognition of sub-patterns and pattern itself. To enhance system performance one can use a set of individual classifiers and combiner to make the final decision.

5.4 Super Resolution in the Frequency Domain

Frequency domain is the domain for analysis of mathematical functions or signals with respect to frequency. Frequency is the number of occurrences of a repeating event per unit time. It is also referred to as temporal frequency. The period is the duration of one cycle in a repeating event, so the period is the reciprocal of the frequency and its harmonics. Another way of saying this is that a periodic signal can be analyzed using a discrete frequency domain. A discrete time signal gives rise to a periodic frequency spectrum. Combining these two, if we start with a time signal which is both discrete & periodic, we get a frequency spectrum which is both periodic & discrete. This is usual context for a discrete Fourier transform.

5.5 Noise

Image noise is random variation of brightness or color information in images. There are factors, however, that tend to produce variation in the brightness of a displayed image even when no image detail is present. All medical images contain some visual noise. The presence of noise gives an image a mottled, grainy, textured, or snowy appearance. No imaging method is free of noise, but noise is much more prevalent in certain types of imaging procedures.

Quantum Noise

X-ray photons impinge on a surface, such as an image receptor, in a random pattern. No force can cause them to be evenly distributed over the surface. One area of the receptor surface might receive more photons than another area, even when both are exposed to the same average x-ray intensity.

Structure Noise

Although the quantum structure of the x-ray beam is the most significant noise source in most x-ray imaging applications, the structure of the film, intensifying screens, intensifier tube screens, or digital receptors can introduce noise into images. An image recorded on film is composed of many opaque silver halide crystals, or grains. The grains in radiographic film are quite small and are not generally visible when the film is viewed in the conventional manner. The grainy structure sometimes becomes visible when an image recorded on film is optically enlarged, as when projected onto a screen.Whenever it is visible, film grain is a form of image noise.

Film-grain noise is generally a more significant problem in photography than in radiography, especially in enlargements from images recorded on film with relatively

high sensitivity Image-intensifying screens and the screens of intensifier tubes are actually layers of small crystals. An image is formed by the production of light (fluorescence) within each crystal. The crystal structure of screens introduces a slight variation in light production from point to point within an image. This structure noise is relatively insignificant in most radiographic applications.

5.6 Effect On Visibility

Although noise gives an image a generally undesirable appearance, the most significant factor is that noise can cover and reduce the visibility of certain features within the image. The loss of visibility is especially significant for low-contrast objects. The visibility threshold, especially for low-contrast objects, is very noise dependent.

5.7 Effect Of Contrast On Noise

The noise in an image becomes more visible if the overall contrast transfer of the imaging system is increased. This must be considered when using image displays with adjustable contrast, such as some video monitors used in fluoroscopy, and the viewing window in CT, MRI, and other forms of digital images. High contrast film increases the visibility of noise.

5.8 Effect Of Blur On Noise

The visibility of image noise can often be reduced by blurring because noise has a rather finely detailed structure. The blurring of an image tends to blend each image point with its surrounding area,the effect is to smooth out the random structure of the noise and make it less visible.

The use of image blurring to reduce the visibility of noise often involves a compromise because the blurring can reduce the visibility of useful image detail.

5.9 Laplace Gaussian Filter

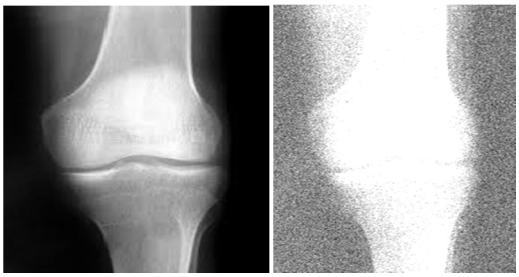
In probability theory a statistics, the Laplace distribution is a continuous probability distribution. It is also sometimes called the double exponential distribution, because it can be thought of as two exponential distributions (with an additional location parameter) spliced together back-to-back.

Gaussian distributions are extremely important in statistics, and are often used in the natural and social sciences for real valued random variables whose distributions are not known. One reason for their popularity is the central limit theorem, which states that, under mild conditions, the mean of a large number of random variables independently drawn from the same distribution is distributed approximately normally, irrespective of the form of the original distribution. Thus, physical quantities that are expected to be the sum of many independent processes (such as measurement errors) often have a distribution very close to normal [7]. Another reason is that that a large number of results and methods (such as propagation of uncertainty and least squares parameter fitting) can be derived analytically, in explicit form, when the relevant variables are normally distributed. The normal distribution is also the only absolutely continuous distribution all of whose cumulants beyond the first two (i.e. other than the mean and variance) are zero. It is also the continuous distribution with the maximum entropy for a given mean and variance.

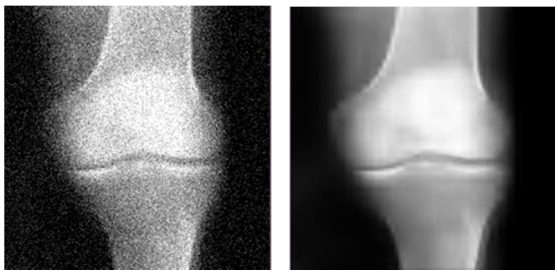
VI. RESULTS

The proposed hybrid error model have been implemented using MATLAB 7.0. The performance of various hybrid error model is analyzed and discussed. The measurement of medical image enhancement is difficult and there is no unique algorithm available to measure enhancement of medical image. We use statistical tool to measure the enhancement of medical images. The Peak Signal-to-Noise Ratio (PSNR), correlation,and structural similarity index measure (SSIM) are used to evaluate the enhancement of medical images. If the value of RMSE is low and value of PSNR is high then the enhancement approach is better. We have applied this purposed work on Medical X-ray images which are corrupted by structurel,quantum and grain niose.

Results of implementation of HEM shows below:



(a) (b)



(c) (d)

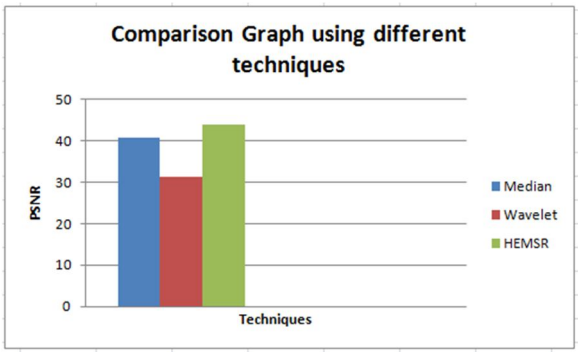
Fig 4 (a). Shows original image, (b) shows noise image,(c) shows noise remove with median filter, (D) shows noise remove with hybrid error model.

Table-1 shows the proposed hybrid error model that are compared with some existing techniques namely,wavelet denoising and Median Filtering with regard to medical images for X-ray.

Table-1 shows the RMSE and PSNR values for noisy image of variance 0.2, after 7th iteration.

Parameter	Median filter	Wavelet Denoising	HEM
PSNR	38.8017	40.395	47.0565
Correlation	0.99962	0.99898	0.99980
SSIM	0.13659	0.13697	0.26235
MSE	2.49335	2.09513	0.54808

Table -1



VII. CONCLUSION & FUTURE SCOPE

In this work, we have introduced hybrid error model for removal of noise from medical images. To demonstrate the performance of the proposed techniques, the experiments have been conducted on X-rays image to compare our methods with many other well known techniques. The performance of structure noise removing hybrid error model is measured using quantitative performance measures such as RMSE and PSNR. The experimental results indicate that the one of the proposed hybrid error model, performs significantly better than many other existing techniques and it gives the best results after successive iterations.

In this paper, we proposed a new approach using hybrid model & Super resolution images to improve the quality of images which helps in detection of symptoms of any type of disease clearly. Similarly, this proposed approach can achieve better results than the previous approaches that uses other techniques.

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