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Identification of Noise in an Image using Artificial Neural Network

Prof. Shilpa Hiremath
Department of ECE,
BMS Institute of Technology & Management,
Bangalore, Karnataka, India

Dr. A. Shobha Rani
Department of ECE,
BMS Institute of Technology & Management,
Bangalore, Karnataka, India

Abstract - An image is a three-dimensional scene viewed in two-dimension. Any unrequired information present in an image can be called as an image noise. Noise can be introduced in an image during various steps like during capturing an image, processing an image, transmission of an image etc. Introduction of the noise into an image is independent of the content present in it. In order to remove this noise, understanding of the noise is very essential, if the noise pattern is understood then a suitable filtering technique can be applied to eliminate the unwanted information and also retaining the essential information of an image. Work has been carried out in this field of identifying noise by several authors but still there are few constrains which are briefed out in our work. In our work we have considered two forms of noises namely Impulse noise and Electronic noise.

Keywords: Image noise, Electronic noise, Impulse noise, ANN.

I. INTRODUCTION

Noise in an image can lead to the variation in the brightness of the image or change in the color pattern. This process can occur during any of the procedure that is followed to capture an image or process an image or transmit an image. During acquition process it can be either because of camera defect (sensor heat, amount of light absorption by camera), or even environment issues (insufficient brightness, dust, humidity) can also lead to addition of the noise. Occurrence of noise effects the original image content which can mislead the person viewing and studying it. Hence, removal of this undesirable information which is being added in the image is very significant, instead of simply applying the filter to the image it's better to identify the noise and then apply suitable filter depending upon the noise existence in an image. There is various noise which can be added in an image namely, electronic noise, Rayleigh noise, impulse noise, speckle noise, Photon noise, Periodic noise etc. In general, many algorithms are highlighting towards removal or either reducing only a single type of noise such as, additive noise [1], multiplicative noise [2] and data drop noise [3]. Identification of single noise present in an image is a very useful technique when there is a consideration of manual image restoration is required but when automated image restoration is considered these techniques do not work. For any image processing technique to be applied to an image to either restore the image or segment the image or to identify the objects in an image, the very first step is to remove the noise in an image so that further any technique can be applied and better results can be obtained. In order to remove the noise, we need to understand what type of noise is present in it so that a suitable filtering technique can be applied to remove a particular noise. Present-day, the feature evidence of images in digital form is handled by region segmentation and also by fusing an image, and also noise is identified by connected domain recognition and by applying neighbourhood procedure of an entire image and convinced research results have been showed by few researchers by using these techniques. Yet, algorithms developed for noise identification is still facing many challenges, such as: noise rate mis-judgment, Truth rate mis-judgment, mis-calculation, etc.

Our survey on literature gave us information that work has been carried out in identifying the noise by considering the statistical parameters in the given image [4], work has also been carried out by considering the soft computing method [5], graphical based methods are also used in identifying the noise [6] and noise identification techniques based on gradient function methods [7] are also used.

In our work we used the neural network concept for identifying the types of noise present in an image. Currently we worked on considering two types of noises and classified based on whether the noise is gaussian or salt & pepper noise. The experimental results show that the False Alarming Ratio (FAR) of the proposed algorithm is less, which means that we can accurately identify type of noise present and also the noise point.

II. NOISE MODEL

Noise is an unwanted by-product of image capture that complements non-essential data into the image [8]. Two forms of noise like Electronic noise and Impulsive noise have been considered for our study. If original image is represented by O(x,y), noise is represented by N(x,y) and degraded image is represented by D(x,y) then mathematically it can be shown as

$$D(x,y)=O(x,y) + N(x,y) \qquad 0 \le x \le m,\ 0 \le j \le n$$

where m represents the number of rows in an image and n represents the number of columns in an image hence m*n is the size of the image.

Electronics noise sometimes also called as Gaussian or amplifier noise is a statistical noise. The probability density function (Pdf) of gaussian noise is same as that of the normal distribution function. It can be mathematically represented as below:

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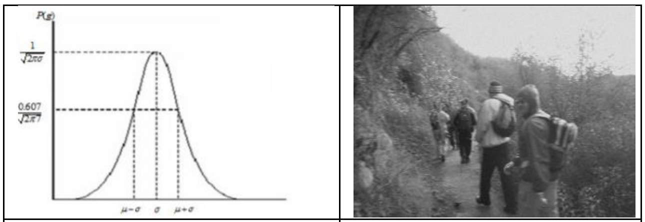
$$P(g) = \frac{1}{\sqrt{(2\pi)}\sigma} e \wedge \frac{-(g-\mu)2}{2\sigma 2}$$

Where g indicates gray level value, σ indicates standard deviation and μ indicates mean.

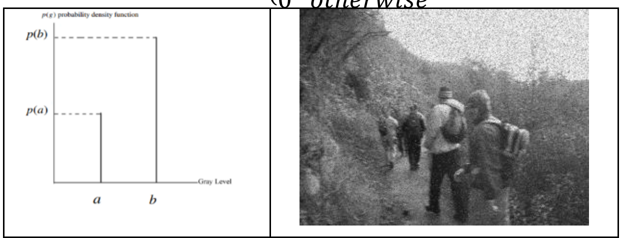


(a) PDF of Electronic noise	(b) Image with Electronic noise

Fig 1: Electronic Noise model

Salt & pepper noise is also termed as spike noise or impulse noise. The Probability density function (Pdf) of this noise has only two values either a salt value (255-pixel value) or a pepper value (0-pixel value) indicating, "an image containing this type of noise will have dark pixels in brighter regions and bright pixels in darker regions" [19]. Probability density function (Pdf) for the noise can be mathematically represented as below:

$$P(g) = \begin{cases} Pa & \forall\, g = a \\ Pb & \forall\, g = b \\ 0 & otherwise \end{cases}$$



(a) PDF of Salt & Pepper noise	(b) Image with Salt & Pepper noise

Fig 2: Salt & pepper Noise model

III. NEURAL NETWORK TRAINING AND CLASSIFICATION

For our application we have considered the network architecture as multilayer feed forward network. Based on this architecture the number of hidden layers and the number of neurons in each layer are decided. Until the desired output is achieved the process is continued by trial-and-error method based on the performance function. "Statistical moments kurtosis and skewness are the input variables to the input layer, having one hidden layer with nodes one greater than the nodes in input layer. The weights between the layers are initialized randomly and the weights are adjusted by means of back propagation on training the neural network" [19].

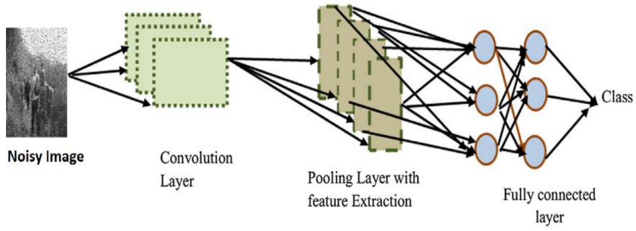


Fig 3: Convolution neural network model

The input size of the network must match with our images in order to train a network and make proper predictions on any new data. In case if the images don't match with the network then we can perform some processing technique like rescale or crop or resize the data so as to achieve the required size. The volume of training data can be improved by applying randomized *augmentation* to our data.

Augmentation helps us to get images with different invariant features of an image which can be used to train the network. This also helps to build a larger volume of dataset from a smaller number of images being considered like by using the rotating, translating or flipping of an image. For example, we can translate the input images so that a network is invariant to the presence of the object in an image. An augmented Image Datastore provides a beneficial means to apply a limited set of augmentations to two dimensional images for classification of images.

In order to identify the noise in an image we used the concept of Transfer learning which basically is a learning method to train a machine and develop a model for a task. This model is reprocessed as the introductory idea for a model on a second task.

IV. METHODOLOGY

Our methodology invokes to classify noise utilizing a pretrained neural network using transfer learning. Here we have considered two types of noise; Electronic noise and Impulse noise. For transfer learning googlenet is been used. Firstly, the images in the datatset are renamed and a dataset for each of the noise model is being created. The data which are stored in multiple files like disk, or a database as a single entity or say in a remote location can be read and processed with the help of this datastore. If the data is too big to fit in a memory then the datastore function generates a datastore, which acts as a storehouse for gathering of all the data. Later, all the images in the datastore are considered into two sets one for training and the other for testing the images. Based on the training provided to the network model, it can classify the test images accordingly as either Gaussian noise or say the impulse noise.

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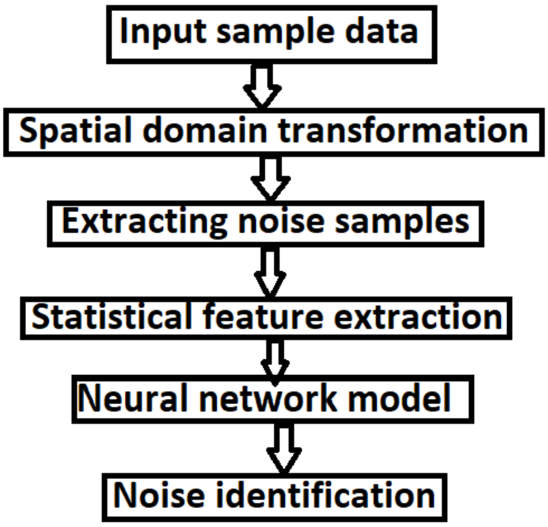

Fig 4 : Flowchart of the proposed model

V. RESULTS & DISCUSSION

In our paper, we have considered 400 different images among which 200 images are for each noise namely Electronic noise and Impulse noise present in an image. Among these, 200 images are of a Gaussian noise, which are spilt up into 60% for training and 40% for testing that is 120 images which are used for training the neural network and 80 images are used for testing purpose. Similarly, for salt & pepper noise among 200 images being considered, 120 images are used for training and 80 are used for testing. The image used for our purpose are considered from Kaggle database to train and test the neural network.

There are four possible test results which are as follows:

1. The Electronic noise present is identified correctly
2. The Electronic noise present is falsely detected as salt & pepper noise.
3. The salt & pepper noise is identified correctly.
4. The salt & pepper noise is falsely detected as Electronic noise.

Below table-1 and the fig-5 shows the evaluation measure values obtained for Electronic noise and Impulse noise present in an image.

Table -1: Evaluative measures values

Noise / prediction	Correct detection	Wrong detection	Accuracy
Electronic Noise	75	5	93.75%
Impulse Noise	76	4	95%

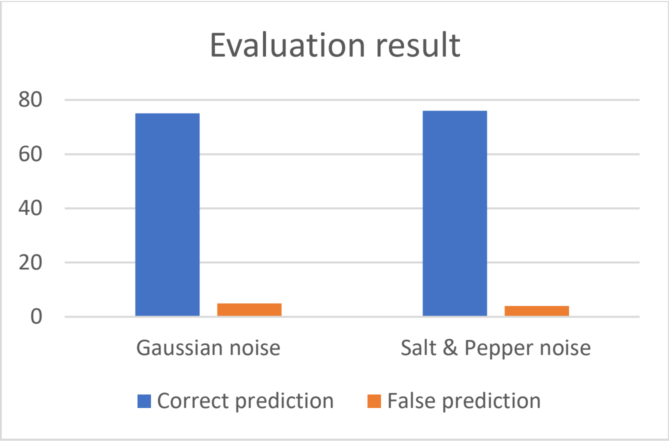

Fig 5: Graph of evaluation results

The below table-2 shows the performance parameters obtained for the proposed method:

Table -2: Performance parameters values of proposed method

Parameters	**Value**
Class category	2
Maximum epoch	6
Minimum batch size	10
Elapsed time	6 min 4 sec
Average Accuracy obtained	94.37%
Total Iteration	144
Iteration per epoch	24

Fig 6 shows the result of identification of salt & pepper noise and fig-7 shows the correct identification of the Electronic noise. Final fig-8 show the performance of training progress.

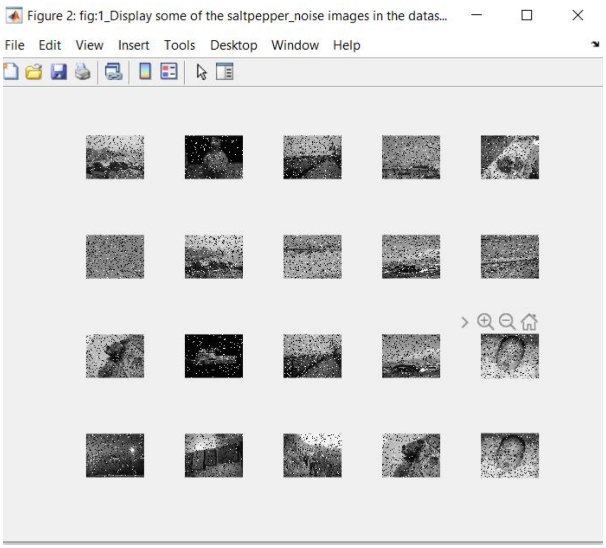

Fig 6: Sample images of salt & pepper noise identified

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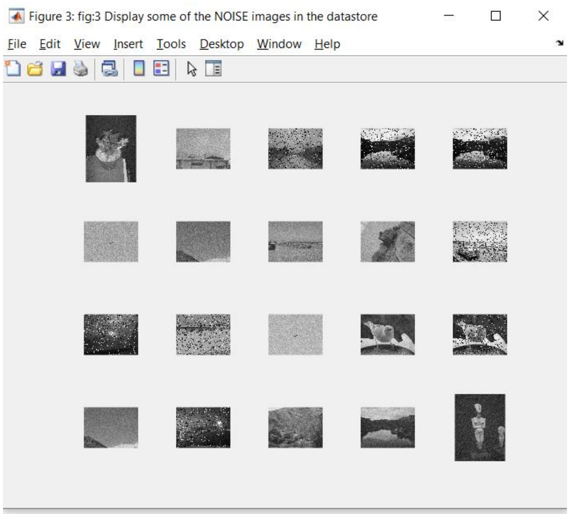

Fig 7: Sample images of Electronic noise identified

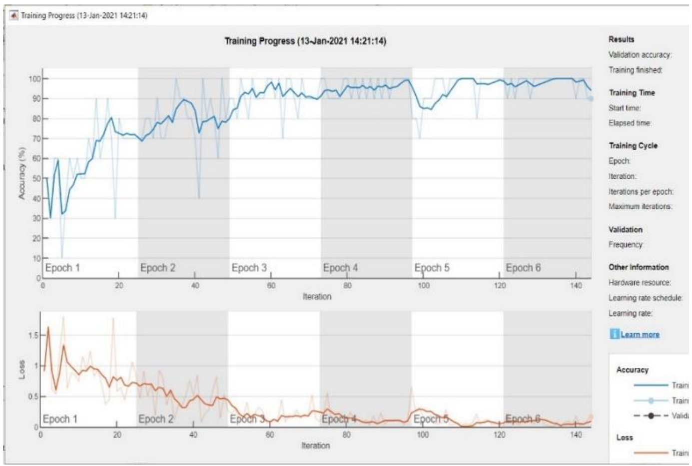

Fig 8: Graph showing performance of training progress

VI. CONCLUSION

We proposed an algorithm in direction to distinguish the noise present in an image using the neural network. Mainly we considered two types of noises such as impulse noise and Electronic noise. The measuring factors used in our work are accurateness rate (AR) and erroneous identification (EI) as shown in equation below

AR = (number of images accurately recognized/ total number of images verified) * 100

$$\mathbf{AR = (I_c / I_t) * 100}$$

$$\mathbf{EI = 100 - AR}$$

Where I_c indicates total number of images accurately recognized, I_t indicates total number of images verified. 95% accurateness of salt & pepper noise confirms the robustness of our proposed work. Accurateness of 93.75% for the Gaussian noise is being achieved. Extension of this work would be to firstly, use more images to train and test the network and secondly, to go for varied variety of noises in an image.

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