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# Restoration of Images Using Radial Basis Function and Statistical Properties- A Case Study

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***Abstract:-*** **Today there has been much interest in developing statistical model for analyzing and organizing images. In this work a novel methodology is used to compare the two images and restoring the image according to the values of the images, for this ANOVA table is used as a statistical tool according to the set of values the images are compared . if the values are equal according to that then the images are to be restored. Very old images which are not properly maintained get diminished and it should be replaced. Our work makes a similar comparison of destroyed with original some novel methods are used to identify pattern matching.**

***Index Terms*—Gaussian Radial Basis Function (GRBF),Analysis of Variance(ANOVA), Un-Supervised, Supervised learning, pattern analysis, pattern recognition**

## I. INTRODUCTION

India was ruled by the various kings in the olden days. Peoples are very peaceful and workful on those days ruled by kings. Since kings had enormous faith in god, they lived happily along with people. They built different types of temples having their own pattern style of structure. Temples in india are more than 1000 years old due to poor maintenance and natural calamities sculptures inside the temple and outside got ruined. It is the time to restore damaged sculptures and give new shape for it.

A new process of methodology is used here is Gaussian based Radial basis function introduced into neural network literature by broomhead and lowe in 1988 which is used to identify the pattern matching of images using , radial basis function is a tool for the function approximation which is a central theme in pattern analysis and recognition. In our work three (or) four images having similar pattern are compared and evaluated with statistical properties. Data that are derived from images are calculated to find the changes in between them. Image manipulations which does not change semantic meaning is often acceptable such as histogram equalization and finding the errors using significance test using ANOVA tables etc, Image authentication is to be robust[1] to accept the manipulations and necessary to be sensitive by comparing and getting a original image. In order to be robust and acceptable manipulations non linear images with similar pattern having different structures are compared with damaged images. Using Gaussian basis radial function. RBF based input output relation has the form.

WHERE [X1….XD]

I=1 A*G*||X-TI|| ---- (1)
AI IS SAID TO BE WEIGHTS G(.) = R->R

is a nonlinear function. We focus on Gaussian RBF (GRBF) approximations where G is gauss function.
G(r) = {-exp(r2)/2}.

## II. OBJECTIVE OF THE STUDY

To Determine a solution for the damaged images
To Determine a correct image from compared image

## III. LITERATURE REVIEW

ACCORDING TO Shuiming Ye, Qibin Sun and Ee-Chien Chang[1] in their paper "Statistics- and Spatiality-based Feature Distance Measure for Error Resilient Image Authentication" Using Content-based image authentication assesses authenticity based on a distance measure between the image to be tested and its original. According to M´ario A.T.Figueiredo[2] in his work "On Gaussian Radial Basis Function Approximations: Interpretation, Extensions, and

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Learning Strategies " tells about using Gaussian Radial Based Function (GRBF) is a research tool for non linear approximation it is a central theme for pattern analysis and recognition. According to Shao-Hui Liu Hong-Xun Yao Wen Gao Yong-Liang Liu[3] in their work "An image fragile watermark scheme based on chaotic image pattern and pixel-pairs " worked in Fragile watermark, which . Are used to determine if a piece of watermarked digital content has been tampered, and distinguish tampered areas from non-tampered areas without referring to the original digital content. In the paper given by Friedhelm Schwenker*, Hans A. Kestler, GuÈnther Palm [4] "Three learning phases for radial-basis-function networks " tells about the RBF layer is trained, with the adaptation of centers and scaling parameters, and then the weights of the output layer are adapted. RBF centers may be trained by clustering, vector quantization and classification tree algorithms, and the output layer by supervised learning (through gradient descent or pseudo inverse solution).

## IV. METHODOLOGY

Damaged Images are taken it is compared with the original one. Image Sculptor had not given any information regarding old images and restoring techniques they had kept in secret form. First we have to train the images using the RBF layer is trained, including the adaptation of centers and scaling parameters, and then the weights of the output layer are adapted. RBF centers may be trained by clustering, vector quantization and classification tree algorithms, and the output layer by supervised learning (through gradient descent or pseudo inverse solution). In the classification scenario, the RBF has to perform a mapping from a continuous input space Rd into a finite set of classes Y .
{1,…,L}, where L is the number of classes. Here we are using one phase learning of RBF With this learning procedure, only the output layer weights w are adjusted through some kind of supervised optimization, e.g. minimizing the squared difference between the network's output and the desired output value. Here, the centers cj are sub-sampled from the set of input vectors xm (or all data points are used as centers) and, typically, all scaling parameters are set equal to a predefined real number s.

4.1 Behaviour of the RBF Classifier

A radial basis function (RBF) network with k hidden neurons has the form

$y(x) = wT\ f(x) + b$ ----(2)

where f are basis functions The weight coefficients w combine the basis functions into an output value. b is a bias

4.2 Un-Supervised Competitive Learning

A competitive neural network consists of a single layer of K neurons. Their synaptic weights vectors c1….ck£ Rd divide the input space into K disjoint regions R1….Rk c,Rn

$Rj = \{x \in Rd \mid\mid x - cj\mid\mid = mini{=}1..k\mid\mid x - cj\mid\mid$-----(3)

4.3 Unsupervised Competitive Learning Rule

$\Delta cj \,{*}{=}\, \eta t(X\mu - cj{*})$---------(4)

Where cj* is the closest prototype to the input Xµ

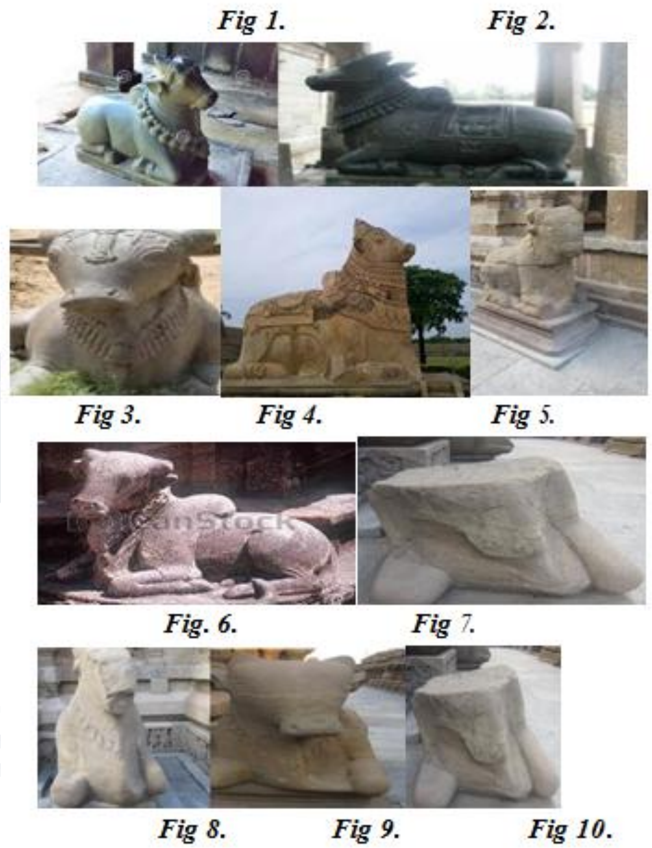


***Fig 1,2,3 ,4,6 ,9nandhi images***
***Fig 5,7,8,10 damaged nandhi images***

The above nandhi images are taken and the damaged parts compared with the other images. First we have trained the images using Radial Basis Function.

 

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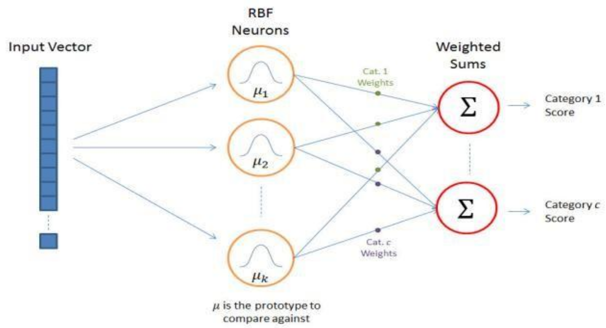



*Fig 11 RBF Architecture*

The above figure shows a set of input vector is given to the RBF neurons and the vectors are trained with the assigned weighted, output value will be trained vectors.

***4.4 Generalized Linear Models***

A special class of nonlinear models, called generalized linear models, uses linear methods. For generalized linear models, these characteristics are generalized as follows:

a. At each set of values for the predictors, the response has a distribution that can be normal, binomial, Poisson, gamma, or inverse Gaussian, with parameters including a mean μ.
b. A coefficient vector b defines a linear combination Xb of the predictors X.
c. A link function f defines the model as f(μ) = Xb. d. 4.5Gaussian Filtering
e. Gaussian smoothing operator is a 2-D convolution
operator that is used to `blur' images and remove detail and noise

***4.6 Statistical Study***

***4.6.A Standard Deviation, Variance and Covariance***

a. Random Experiment: A process leading to at least 2 possible outcomes with uncertainty as to which will occur.
b. Event: An event is a subset of all possible outcomes of an experiment
c. A random variable is a variable whose value is a numerical outcome of a random phenomenon.
d. The Variance of a random variable X with expected value EX = μX is defined as var(X) = E(X - μX)2.---(5) The covariance between two random variables Y and Z with expected values μy and μz is defined as
cov(Y,Z) = E(Y - μY)(Z- μZ) ---(6)

ALGORITHM.
1. Read the image
2. Smooth the image using a filter
3. Convert the image into double value
4. Calculate the Gaussian Radial basis function
5. Compare the results through ANOVA table if any image value coincides then compare value with the image
6. Restore the image

## V. RESULTS AND DISCUSSIONS

Using mathematics laboratory (matlab) 2013 software all the images are to be read, then convert images into double values.

| Image 1 | Image 2 | Image 3 | Image 4 | Image 5 |
|---|---|---|---|---|
| 0.3686 | 0.3412 | 0.3255 | 0.3216 | 0.3608 |
| 0.3961 | 0.3373 | 0.3137 | 0.3647 | 0.3333 |
| 0.4078 | 0.3255 | 0.2980 | 0.3882 | 0.3020 |
| 0.4000 | 0.3176 | 0.3020 | 0.3882 | 0.2824 |
| 0.3765 | 0.2784 | 0.3412 | 0.3216 | 0.3059 |
| 0.3412 | 0.2941 | 0.3333 | 0.3451 | 0.3137 |
| 0.3373 | 0.3608 | 0.3490 | 0.3569 | 0.2863 |
| 0.3608 | 0.4471 | 0.3686 | 0.3490 | 0.2510 |
| 0.3255 | 0.4196 | 0.3294 | 0.3373 | 0.2971 |
| 0.3675 | 0.3608 | 0.3294 | 0.3020 | 0.2863 |

*Tab1.1 Double values for five images*

| Image 6 | Image 7 | Image 8 | Image 9 | Image 10 |
|---|---|---|---|---|
| 0.4078 | 0.3137 | 0.3569 | 0.3000 | 0.8471 |
| 0.3412 | 0.2824 | 0.3569 | 0.3412 | 0.8431 |
| 0.3412 | 0.2510 | 0.2980 | 0.3213 | 0.8157 |
| 0.3216 | 0.2902 | 0.3529 | 0.3241 | 0.8331 |
| 0.3373 | 0.3176 | 0.2667 | 0.5451 | 0.8356 |
| 0.3137 | 0.2824 | 0.2745 | 0.2880 | 0.4980 |
| 0.2706 | 0.2824 | 0.3373 | 0.3478 | 0.4510 |
| 0.2902 | 0.3216 | 0.3451 | 0.3882 | 0.4123 |
| 0.2902 | 0.3333 | 0.3098 | 0.3843 | 0.4535 |
| 0.3176 | 0.3333 | 0.3725 | 0.3922 | 0.7861 |

*Tab1.2 Double values for next five images*

Ten types of similar images are taken and it is converted into double values. From the two tables a particular set of values are taken and analyzed. The values of each and every image are similar to one another. Consider the image fig 10 which is a damaged image and comparison of values are done . Fig 2 and Fig 9 have the similar types of values and then go for further process.

To find out the noisy in the image Gaussian Filter is used to smoothen the image

*Fig 12& Fig 13 are blurred and smoothened damaged images*

*Fig 14 & Fig 15 are blurred and smoothened image*

*Fig 16&17 are blurred and smoothened images*

These three set of blurred and smoothened image are taken white color image is blurred and red color is smoothened because of noisy level in the image. Third step is Gaussian radial function this is used to train the images and find out the pattern of similar images.
Taking a set of neurons and with a minimum set of weight is assigned consider the weight = 0.01. To compare the metrics and quality of two images mean square error(MSE) is calculated by giving a set of neurons weighted sum=0.01 is assigned to get good quality of image

Mean Square Error was calculated by
MSE = 1/ mn∑n-1i=0∑j=0n-1 [I(i,j) – K(I,j)]2 ----(7)

| NEURONS | MSE VALUE |
|---|---|
| neurons=0 | 0.0859942 |
| neurons=1 | 0.0272587 |
| neurons=2 | 0.0271467 |
| neurons=3 | 0.0271127 |

*Tab 2.1 shows MSE value for damaged image*

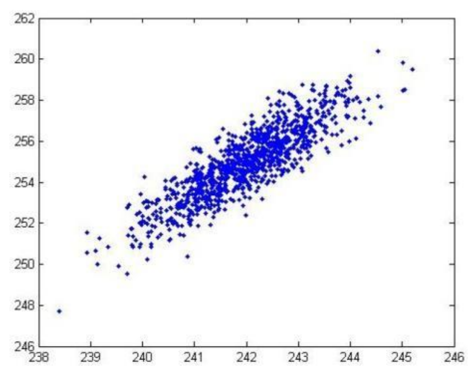
| NEURONS | MSE VALUE |
|---|---|
| neurons=5 | 0.0262077 |
| neurons=6 | 0.0203401 |
| neurons=7 | 0.0191405 |
| neurons=8 | 0.0191123 |

*Tab 2.2 shows MSE values for corrected image*

| NEURONS | MSE VALUE |
|---|---|
| neurons = 9 | 0.0188952 |
| neurons= 10 | 0.0153509 |
| neurons= 11 | 0.0102749 |
| neurons= 12 | 0.0046697 |

*Tab 2.3 shows MSE values for second corrected image*

By comparing the three sets of MSE values




*Graph1 shows the pixel cluster of an image(fig 14&15) using Gaussian filter*

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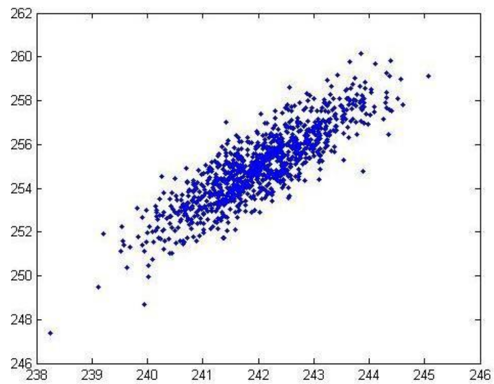
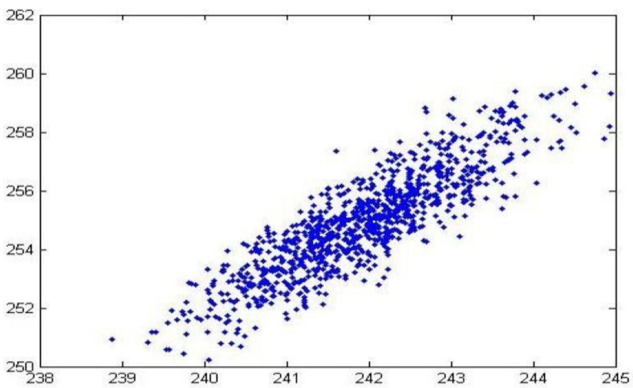
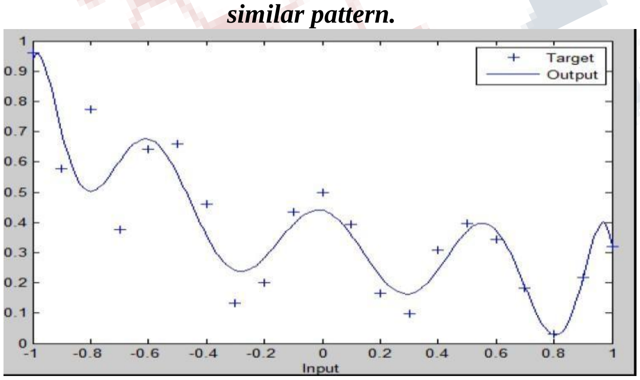


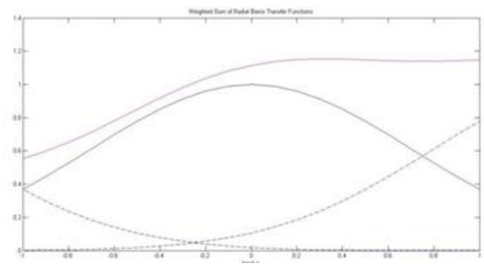

***Graph 2 shows the pixel cluster of an image(fig 16&17) using Gaussian filter***




***Graph 3 shows the pixel cluster of destructed image of similar pattern.***




***Graph 4 shows values given was trained and pixels of three sets of image having a similar pattern.***



***Graph 5 shows weighted value is to get a target vector a weight sum = 0.01 is assigned the bell shaped curve shows similarity of two image and a dotted curve indicates destructed image that has similar pattern.***

The above graph shows the training vector and target vector in the training vector a set of input is taken and it has trained. Using weights assigned to the each and every input image we are getting target vector. A Bell shaped curve shows that it is Gaussian curve. From this curve we infer that the image are trained.

ANOVA (Analysis of Variance) is a statistical technique which is used for comparing the products of homogeneity
Here we are taking a set of images for comparing with ANOVAs to check the images are equal or not. By analyzing the factor values along with the three images using one-way, two-way, three -way of ANOVAs we can predict a correct image for restoration.

***Table 2.4 Anova Table for Destructed Image. (fig 12 &fig 13)***

| SOURCE | SUM OF SQUARE(SS) | DEGREE OF FREEDOM | MEAN SQUARE | F DISTRIBUTION | PROBABILITY OF F DISTRI |
|---|---|---|---|---|---|
| COLUMNS | 0.036 | 8 | 0.00439 | 0.22 | 0.9882 |
| ERROR | 808.789 | 39816 | 0.02031 | | |
| TOTAL | 808.824 | 39824 | | | |

***Table 2.5 Anova table for Image(fig 14&fig 15)***

| SOURCE | SUM OF SQUARE(SS) | DEGREE OF FREEDOM | MEAN SQUARE | F DISTRIBUTION | PROBABILITY OF F DISTRI |
|---|---|---|---|---|---|
| COLUMNS | 291642.2 | 17 | 17155.4 | 23.16 | 8.82033 |
| ERROR | 8427881.8 | 11376 | 740.8 | | |
| TOTAL | 8719924 | 11393 | | | |

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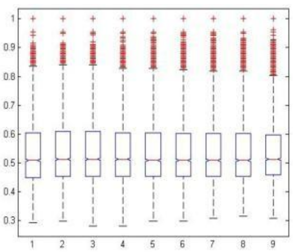
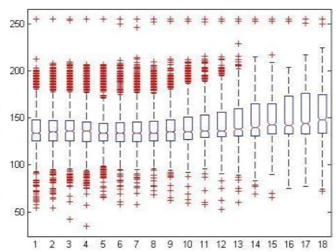
*Table 2.6 Anova table for Image(fig 16& fig 17)*

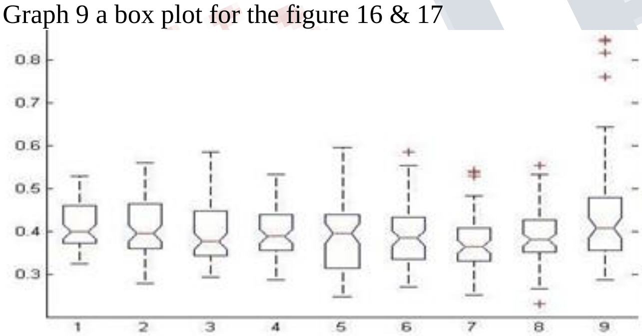
| SOURCE | SUM OF SQUARE(SS) | DEGREE OF FREEDOM | MEAN SQUARE | F DISTRIBUTION | PROBABILITY OF F DISTRI |
|---|---|---|---|---|---|
| COLUMNS | 0.02661 | 8 | 0.003178 | 0.19 | 0.7987 |
| ERROR | 799.890 | 40123 | 0.02371 | | |
| TOTAL | 800.871 | 39927 | | | |

From the above three tables we can infer that the destructed coincide with fig 16 and fig17. F-test is used to compare the data values. In order to identify the image that best fit. Data had been fit with least square .





Graph 7 a box plot for the destructed image
Graph 8 a box plot for the figure 14 & 15
Graph 9 a box plot for the figure 16 & 17



By comparing the three box plot graph we can find the similarity in between Graph 7 and Graph 9.

## VI. CONCLUSION

Nandi Image vehicle for lord Shiva is taken as a case study We have converted the images into double values taking three set of values of images. Using Gaussian Filter images has been smoothened. Using the Radial basis function we have found the similarity to go for accuracy we used ANOVA table for the comparison. Resultant value had got. This type of algorithm will be very useful for pattern recognition and image analysis.

## VII FUTURE WORK

This work can be adopted for the Archeological Survey of India. Many temples all over India is in ruin state to protect the images. This method will be very useful.

## VIII ACKNOWLEDGEMENTS

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