# Kriging Interpolation Technique Basis Image Inpainting

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**Abstract— Image inpainting is the fine art of predicting damaged or scratched regions of an image. The physical technique of image inpainting is a time consuming. Therefore there must be an automatic digital method of image inpainting that recovers the image from the damaged or scratched regions. In this project, a novel statistical image inpainting algorithm based on Kriging interpolation technique was proposed. Kriging technique without human intervention means automatically fills the damaged or scratched region in an image using the information accessible from its surrounding regions in such a way that it uses the spatial correlation structure of points inside the kxk block. Kriging has the ability to face the challenge of keeping the structure and texture information as the size of damaged region heighten. Results shows that Kriging has a high PSNR value when recovering a variety of test images from scratches and text as damaged regions.image inpainting method based on Kriging interpolation technique is proposed.**

**Index Terms— image inpainting; image masking; Kriging; text removal; scratch removal.**

## I. INTRODUCTION

The filling-in of missing or not needed information is an extremely significant topic in image processing. For the most part important applications of image inpainting are items removal, scratch removal, restoring missing areas, image repairing, etc. An image or photograph is sometimes damaged because of aging. Therefore the correct definition of inpainting is that the restoration of damaged images in such a way that is not noticeable by the human eye. The manual work of inpainting is a very time consuming process. Due to digitalization of this technique it is automatic and more faster. The very essential inpainting technique is the diffusion-based technique [8]. In these techniques the missing blocks are filled by diffusing the image pixels from the observed blocks into the missing blocks. These techniques are based on the theory of partial differential equation. According to [9], the holes are filled by procreating the isophote into the absent blocks. The isophote are lines of equal grey value.

A Navier-Stokes equation in fluid dynamics have been utilized into the field of image inpainting [8]. Which uses an Euler-Lagrange equation recovers the misplaced information. In the Total Variational and inside the inpainting domain the model simply just employs an isotropic diffusion based on the contrast of the isophotes to incorporate the principle of continuity. It must be mentioned that, there is a pert for the statistics in the field of image inpainting.

In this paper, a novel technique based on Kriging interpolation method for spatial data was proposed. The organization of this paper is as follows: In section II that is in Kriging Techniques an unpretentious background concerning Kriging interpolation was presented. The proposed technique was discussed in section III that is in Proposed Techniques with an illustrative example. In section IV that is in Project Results, Results have been presented. These results contain ocular and numerical results to support the proposed technique.

## II. KRIGING TECHNIQUES

Kriging is a interpolation method it takes into both the distance and the amount of variation between known points when predicting values in unidentified or unknown locations. Kriging is used to estimate unidentified or unknown values at specific points in space by using data values from its surrounding regions. Kriging yield compared with the traditional interpolation methods [5]. It must be mentioned that Kriging is a interpolator technique because it ensures that the original observed values will keep on as it, i.e. the old values will not affect by the interpolation technique. Kriging predictions are treat as weighted linear combinations of the known locations. According to Kriging technique the closer the input the more positively correlated predictions [9]. Now bring the previously mentioned thoughts into digital image processing.

According to [9], the pixels within the same kxk block are highly correlated, therefore the application of Kriging inside the kxk block will yields high positively correlated predictions. Kriging gives weights for each point inside kxk block in accordance to its distance from the unknown value. Actually these predictions treated as weighted linear combinations of the known values. The weights should provide a Best Linear Unbiased Estimator of the predicted point [9]. The essential characteristic of Kriging over other interpolation methods is that it uses the spatial correlation structure of points in kxk block being interpolated in order to compute the unknown point [9]. There is a robust connection between image denoising and image inpainting especially scratch removal. Both fields are sharing the same principles in finding and removing the unwanted areas [6].
The basic formula of Kriging technique may be represented as follows:

$$\hat{P}^* = \sum_{i=1}^{N} \lambda_i P_i$$

where ,
N = total number of the non-scratched pixels insides the kxk block.
$P^{\wedge *}$ = the predicted pixel .
Pi = the non-scratched pixels insides the kxk block.
$\lambda_i$ =The weights of the non-scratched pixels $\lambda_i$ .

$$\sum_{i=1}^{N} \lambda_i = 1$$

The Kriging estimate is obtained by choosing $\lambda_i$ that minimize variance of the estimator under the unbiasedness constraint:

$$\sigma^2 = E[(P - \hat{P}^*)^2]$$

There are several Kriging types, differ in their treatments for the weighted components (λ's). The most preferred Kriging type and it is considered to be the best one is ordinary Kriging because it minimizes the variance of the prediction error [9]. It is mention that, the variogram is one of the most supporting functions to indicate spatial correlation in observations measured at observed points. The variogram is a function of the distance and direction separating two locations that is used to quantify dependence. The variogram is defined as the variance of the difference between two variables at two locations [9]. The variogram generally increases with distance and is described by nugget, sill, and range parameters. If the data is stationary, then the variogram and the covariance are theoretically related to each other. It is commonly represented as a graph that demonstrates the variance with respect to the distance between all points of the observed locations [4]. The variogram describes the variance of the difference of samples within the data set and is calculated by the following equation:

$$2\gamma(h) = \frac{1}{n} \sum_{i=1}^{N} [P(x_i) + P(x_i + h_i)]^2$$

where P(xi) and P(xi+h) are the pixel values at locations x and xi+h, respectively. In this paper, Kriging was treated as a supporting scheme that helps to reach the goal which is image inpainting. Hence, there is no need to discuss the variogram in a detailed manner. An exhaustive discussion and analysis about variogram could be found through recommended readings [4].

## III. PROPOSED TECHNIQUE

In this Paper a novel image inpainting method based on Kriging interpolation technique was proposed. The proposed method starts with identifying the queer pixels within the kxk block from the infected image. The contamination or corruption may be thin scratch, thick scratch, text, bad areas generated by aging, or even unnecessary objects that may be removed from the original image. These contaminated or corrupted areas will be marked according to its corresponding mask. After that, the kxk block will be dispatched to Kriging interpolation technique to predict the contaminated areas using the accurate prediction feature of Kriging. As mentioned , Kriging method uses variogram to express the spatial variation and it minimizes the error of predicted values which are estimated by spatial distribution of the predicted values. The resulted predictions seem to be very close to the original pixels. Therefore Kriging is very suitable to estimate the mask's pixels accurately.In order to demonstrate the proposed inpainting technique, five bitmap test images were used as test images, Fig. (6). Additionally, four masks types were implemented to examine the proposed technique. The selection of masks was very adequate such that all kind of masks will be covered, Fig. (7). Starting from Thick scratch, thin scratch, low text, and heavy text, Kriging technique produces very sophisticated results according to the ocular reconstructed images. Furthermore, a standard measure that tests the quality of the reconstructed image is the Peak Signal to Noise Ratio (PSNR) [9]:

$$PSNR = 20log_{10}\frac{255}{\sqrt{MSE}}$$

where the MSE is shortened for mean square error that calculated as:.

$$MSE = \frac{1}{MN}\sum_{x=1}^{N}\sum_{y=1}^{M}[f(x,y) - g(x,y)]^2$$

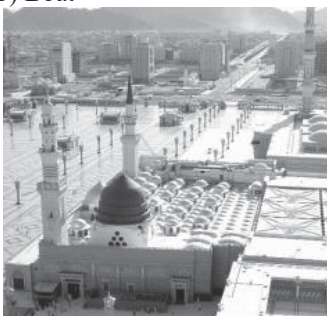
According to the calculated PSNR values for the five test images, table (I), it can be concluded that the results are excellent since it lie within the acceptable range which is 30 to 50 in conformity with.

(a) Lena

(b) Boat

(c) Bird

(a) peppers



(d)Mosque

Figure 1. five Test images

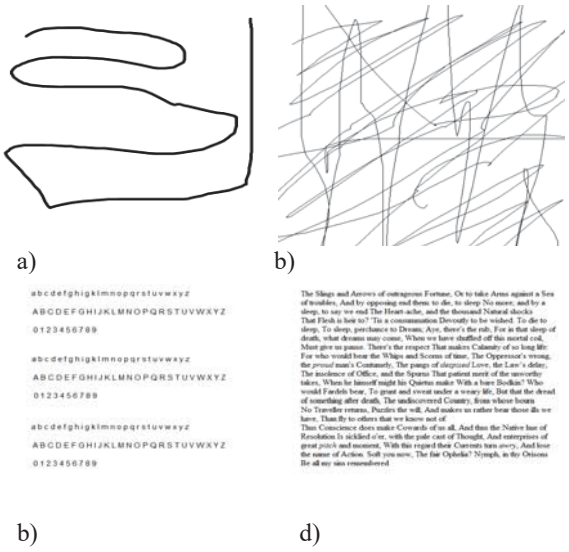



Figure 2. four mask images

## IV. RESULTS

| Image | Mask1 | Mask2 | Mask3 | Mask4 |
|---|---|---|---|---|
| Lena | 38.0277 | 45.4131 | 41.3416 | 34.3702 |
| Peppers | 39.2157 | 46.4947 | 43.9334 | 35.7265 |
| Mosque | 32.0316 | 36.6053 | 35.7167 | 35.7167 |
| Bird | 34.8415 | 42.7062 | 39.2466 | 31.9359 |
| Boat | 34.9864 | 41.1897 | 37.9275 | 29.9704 |

TABLE I: PSNR Values For The 10 Test Image

## V .CONCLUSION

This project is a new approach for removing scratches and text from contaminated images has been presented. The projected technique use Kriging in a way that removes unwanted regions from image which is known as image inpainting. in spite of Kriging being more computationally expensive, it has been shown that it gives very sophisticated output when repairing digital images that have scratches or unwanted text. Results make public that the projected Kriging technique having high PSNR value when implement on a selection of test images.

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