COLOUR IMAGE RESTORATION BY NEAREST GOOD NEIGHBOUR METHOD

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ABSTRACT
This paper covers restoration of colour images corrupted by impulse noise using a new method known as the nearest good neighbour(NGN) filter, [I] first used on grey scale images using a single pass technique. A RGB format for the colour image was used. Restoration was then completed using NGN methods by searching the pixel block for the nearest good pixel and replicating it to the output. Colour images with 50-90% noise corruption were generated using a random number generator to replace image pixels with null impulse values.

1. GENERAL

There are two strategies that may be used to restore colour images corrupted with impulse noise. The first strategy, called the nearest good neighbour method is to replace noise impulse pixels with the spatially closest uncorrupted pixel. The second method is to treat good pixels as seed points for region growing. This second method is described elsewhere in the paper entitled sparse image restoration using a morphological filter.

2. NEAREST GOOD NEIGHBOUR METHOD

This paper covers the first application to colour images of a newly developed method of image restoration [1] using a non-linear filter called the NGN Filter. Our study covers the restoration of 8-bit colour images subjected to 50% and to 90% impulse noise. An alternate viewpoint is to regard the problem as the restoration of colour images with 50% and 10% of the original data. The principle of the NGN filter is to classify each pixel as either "good" or "bad" and then replace each "bad" pixel by the nearest "good" pixel. A bad pixel is a noise impulse while a good pixel is uncorrupted image data. A bad pixel may be either zero intensity, a full white impulse or one from a known range of colour values. The distance measure used to determine the nearest good neighbour would be Euclidean or pseudo-Euclidean, but for computational efficiency we use algorithms that employ the Manhattan or City block metric. [7] It is a requirement of this method that the corruption colour value or range is known. For non-iterative methods, the search window must be sized in accordance with the sparseness of the image. For example a 5x5 window may be used for an image with 90^{o}/ data loss whereas a 2x2 window may be used for a 50% loss image. Restoration methods may use separate buffers or a single buffer for input and output. With iterative methods and a single buffer, care must be taken to avoid excessive streaking of the output. The dual buffer block search strategy is better but the difference in results is slight with iterated restoration and a small search block. An iterated 2x2 block was used in this study. Search window strategy varied from a simple raster scan used earlier to a square of increasing size centred on the middle of the search block.

2.1 **Formal Definition of NGN Filter**

A formal definition using set theory nomenclature for the NGN filter is as follows:

Sij(d) = I(rs)p(ij);(rs) = d; I(rs)(C

Sij(d) is the set of good colour pixels at distance d from ij.
Sij(0) is the one element set containing Iii if Iij is 'good' otherwise it is null.
D is the integer distance measure function. Distance refers to the distance from the pixel output location to the nearest "good" pixel ie the distance from ij to rs. C is the set of noise impulses.

3. SUN RASTER DETAILS

The Sun raster is a 256 value colour palette chosen out of a possible 24 bit RGB colour palette. It is a Red Green Blue combination of colours with three bytes required for each colour in the image. The 8 bit image data value is an index to the three values in the red, green and blue look-up tables for the image. The lookup table requires three 256 entry tables ie a total of 756 bytes for the colour palette applicable to the image.

4. **COLOUR** ERRORS

Psychophysical features of human vision indicate that the eye has lower sensitivity to chrominance (colour) errors compared with luminance errors and appear to be routed to independent neural channels.[6] Since straight NGN restoration without post-processing will always replicate the data in the original image, there will be no new colours in the replicated data. Restored image points will replicate values in the sparse data. This will not always be appropriate where rapid changes in colour occur at different image neighbourhood boundaries for example. As data values become sparser, colour errors will occur more frequently and the requirement for further processing increases. Post-processing using median filtering of colour indexes will reduce splatter due to inter-mingling of colours at image regions of different colours. Post-processing of the restored data will increase SNR by up to ldB using grey scale fidelity measures and is particularly necessary for the larger regions produced by the NGN filter when data is sparse. Averaging filters can be used for post-processing filters for grey scale images but not for colour pictures. Median filters will reduce splatter due to colour intermingling at image region boundaries. The median filter reduces splatter by rejecting outliers caused by replication of pixels from a different colour region.

4. RESULTS

Figures **1** and 2 show the 90% data loss RGB picture before and after restoration using an iterative single buffer method using a two-connected neighbour search block. The restored image has a large amount of fine detail missing but the image structure is essentially the same as figure 3, the original image. The NGN method gives a recognisable image but with significant artefacts of black dots and intermingling of adjacent colours. It should be noted that results are image dependent. Images with large regions of constant colour will give better restorations compared with complex images and rapid spatial colour variations.

5. CONCLUSION

A new method of restoration of impulse noise colour images has been described, the nearest good neighbour method which gives good results for impulse noise removal of known colour range. The method searches a small window for a good data pixel and copies it to the output image. Superior results to rank filtering of colour indexes is obtained especially at higher corruption levels. Impulse noise corruption in the range 50 to 90% of image pixels was investigated.

6.REFERENCES

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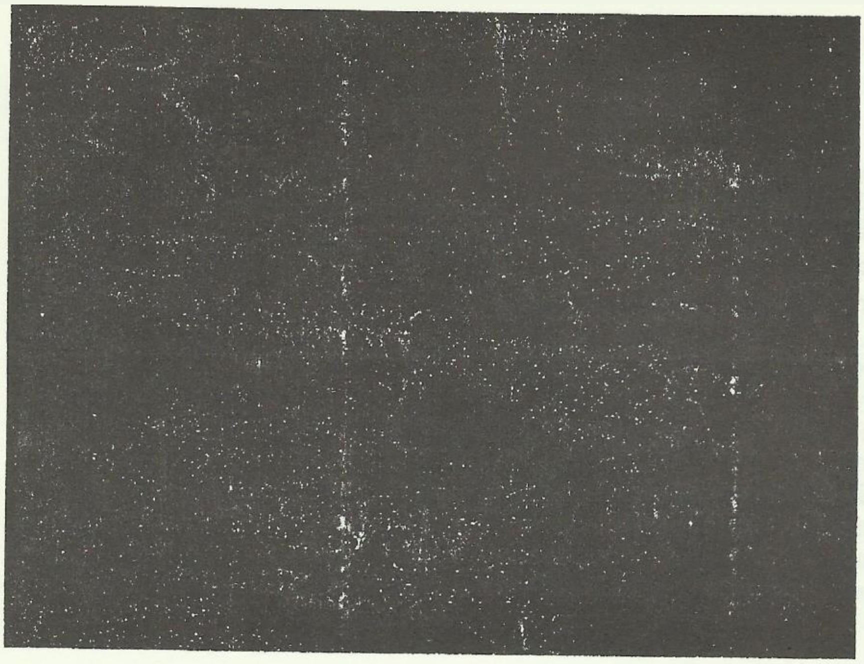

Figure 1. Coastal Scene 90% data loss.

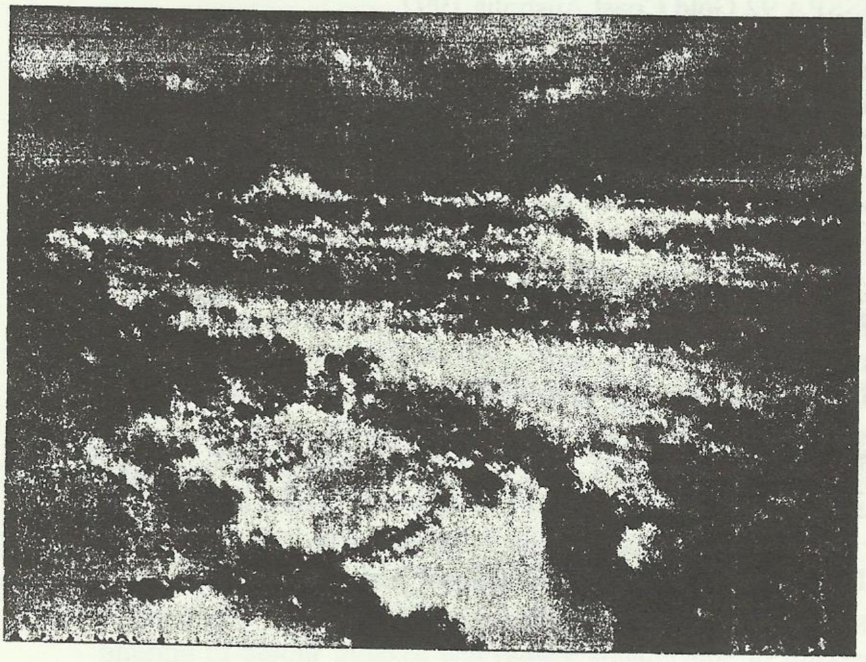

Figure 2. 90% loss Restoration

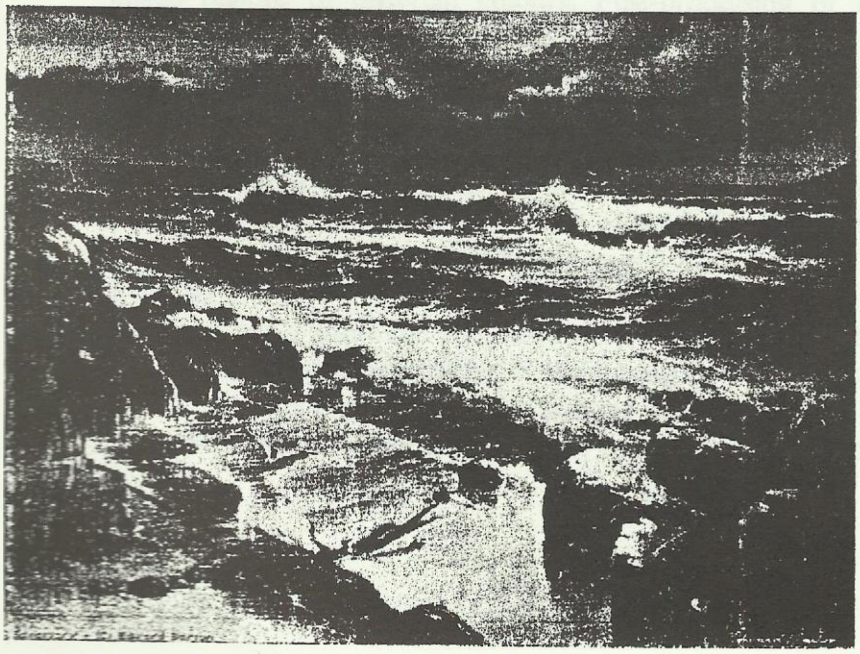

Figure 3. Original Coastal Scene