Noisy Image Restoration Based on Cellular Neural Network

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Abstract: - In this approach Image restoration methods provide a means for retrieval of damaged portions of an image. In communication networks, when any multimedia files send from principle to destination, noises will be take effects on them. Building a system for reconstructing images after noise take effected on noisy channel, is important way for computer in networks. In this paper, Cellular Neural Network (CNN) for reconstructing damaged file with high noise ratio are proposed and this means image restoration. Noises inside the pixel with different sizes are restored with different levels of surrounding information. So, the result showed that an almost noisy image or unrecognized pixel can be recovered with visually good effects. This method can be used for processing motion or static images with high ratio of noise. Evaluation using PSNR and logical MSE showed that this proposed method reduce recent methods.

Key-Words: - image restoration, cellular neural network, image processing, PSNR, logical MSE

1 Introduction

Reconstruction of missing or damaged portions of images is important way to restoration images in network channels that in two decades ago proposed, but until now there’s no appropriate methods to solving this problem. This activity, also known as restoration or retouching or retrieval, consists of filling in the missing areas or modifying the damaged ones in a manner non-detectable by an observer not familiar with the original images. The goal of restoration algorithm depending on the application, from making the retrieval parts look consistent with the rest of the image, to making them as close as possible to the original image, restoration of photographs, films and paintings, to removal of occlusions, such as text, subtitles, stamps and advertisements from images. In addition, restoration can also be used to produce special effects. While, traditionally skilled artists have performed image restoration manually, currently digital techniques are used, e.g. for automatic restoration of scratched films or images.

Some advantages of Cellular Neural Networks (CNN) is analog, continuous time, and nonlinear dynamic systems. This neural network Belongs to the class of recurrent Neural Networks. The Cellular Neural Network (CNN) is an artificial neural network of the nearest neighbour interaction type. It has been widely used for moving object detection, image processing, pattern recognition, target classification, signal processing, target trajectories, solving partial differential equations etc. numerical approximation algorithms. The dynamic equation of a cell C(i,j) in an M x N Cellular Neural Network is shown in formula (1) and (2):

\[
\frac{dx_{ij}(t)}{dt} = \frac{1}{R_x} x_{ij}(t) + \sum_{C(k,l) \in N_i(j)} A(i,j;k,l) y_{kl}(t) + \sum_{C(k,l) \in N_j(i)} B(i,j;k,l) u_{kl} + I
\]

\[
y_{ij}(t) = \frac{1}{2} \left( |x_{ij}(t) + 1| - |x_{ij}(t) - 1| \right), 1 \leq i \leq M, 1 \leq j \leq N
\]

Where \( x_{ij} \) and \( y_{ij} \) are the state voltage, output voltage and input voltage respectively and they are functions of time t. \( R_x \) is a linear resistance, \( C \) is a linear capacitor, and \( A(i,j;k,l) \) and \( B(i,j;k,l) \) are the transconductances of the output and input voltages of \( C(k,l) \) with respect to \( C(i,j) \) called the cloning templates of CNN. From equation (2) one can
discern that the output voltage is nonlinear. Now rewriting the cell equation (1) as follows (3), (4), (5):

\[ C \frac{dx_{ij}(t)}{dt} = -f[x_{ij}(t)] + g(t) \quad (3) \]
\[ f[x_{ij}(t)] = \frac{1}{R_x} x_{ij}(t), \quad (4) \]
\[ g(t) = \sum_{C(k,l) \in N_r(i,j)} A(i,j,k,l)y_{kl}(t) + \sum_{C(k,l) \in C(i,j)} B(i,j,k,l)u_{kl} + 1 \quad (5) \]

In this Paper, we describe the digital image restoration techniques based on reconstruction of damaged images using CNN methods, then testing and experimental results and finally conclusions are presented at last.

This method can process images and videos with high rate of noise and can be recovered between cells with different sizes in any surface of surrounded on data. This method can works on animated images like .GIF format with noise and other static formats like jpg and png. MATLAB can’t support CNN, but we can change the weights in codes and this is one of the best advantages of this neural network.

2 Methodology

Image or video frame with large ratio of noise and damaged named Damaged Image Block (DIB) is placed in the CNN. Each DIB cell can be further subdivided into different Image Blocks (IBs), each of which may or may not contain damaged pixels. Furthermore, each Image Block is subdivided into several Pixel Blocks (PBs) which are elementary objects to be retrieval. This project have been classified into 4 steps: 1) pre-processing that input image processed and C-means for segmentation take effect, 2) post-processing after segmentation that received some features and noise reduction by using Mean filter, 3) learning with neural network that trained with features, 4) last processing with result in images and evaluation.

3 Implementation

CNN can work parallel and this feature effects on noise reduction in images with more than 50% noise and this is an advantages of this neural network due to more speed than other methods. Operation and learning of CNN in this implementation is based on edge detection and segmentation with clustering. In fact, this neural network learned how to find edges and in training sets, the speed of this work will be increase with low time and error.

The data set used in this project, are images with index colour-map and size should be 256x256 pixel and divide images to 3 rows and 3 columns. This division method caused image transform to 9 cell that each cell have tiny parts named pixels. Averaging done for each row and column separately using convolution and then image segmentation effected and at the end, edge detection affect all parts. In image segmentation level, C-means method used and at first clustering with averaging that caused a little noise reduction by using Median filter, and then segmentation done. This segmentation due to clustering level in sub-space caused more accuracy compared with other methods. After averaging, normalization will be run. It’s important to notice about structure of CNN that process parallel and steps. It means each cell or pixel, linked with neighbor pixel. The method for finding neighbors and growing in all sides is Region Growing and KNN. After selecting neighbor pixel, recognized pixel for growing, used Region Growing again to find other neighbor pixel till it reach to no color. The purposes of using CNN for noise reduction is reducing time and square errors. MSE and PSNR for evaluation of images (a) used in Fig 1, 2 and 3.
It’s obvious that in our implementation, we found less errors. As example for image (b) we reached to PNSR=15.7429 that reduce 13 level of any article in this area. The MSE for (b) images that we reached is 1732.973 that we will improve it in future works.

4 Conclusion

In this method, we extended image restoration in noisy area like communication channels when sending multimedia files from starting point to destination in computer networks. By building restoration system at the end point, image retrieval take effect. The main methods used in this project is CNN (Cellular Neural Network) and some image processing effects like mean filter, C-means segmentation and then trained in CNN. The result showed that this approach have some advantages like less PSNR and logical MSE and noisy image determined better than other papers.
5- Future Works

At the future, this approach will be extended to reduce more PSNR by using Otsu thresholding and another neural network named RBF (Radial Basis Function) beside CNN. This will be more obvious image after denoising and retrieval and will be used better than always in computer terminals.

References:


