Chapter 4
A Comparative Review for Color Image Denoising

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ABSTRACT

With the explosion in the number of color digital images taken every day, the demand for more accurate and visually pleasing images is increasing. Images that have only one component in each pixel are called scalar images. Correspondingly, when each pixel consists of three separate components from three different signal channels, these are called color images. Image denoising, which aims to reconstruct a high-quality image from its degraded observation, is a classical yet still very active topic in the area of low-level computer vision. Impulse noise is one of the most severe noises which usually affect the images during signal acquisition stage or due to the bit error in the transmission. The use of color images is increasing in many color image processing applications. Restoration of images corrupted by noises is a very common problem in color image processing. Therefore, work is required to reduce noise without losing the color image features.

1. INTRODUCTION

1.1 Overview

A person receives maximum information about an object or a living being through images. An image is an illustration or general imprint of an object. It can also be defined as a two variable function $o(i,j)$ where for each position (i,j) in the projection

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plane $o(i,j)$ defines the light intensity at that point. The most commonly used types of images are binary image, gray image and color image. Binary images contain only black and white colors, also known as one-bit images. Images which have only brightness information and grayscale intensity are called gray images. They contain 8-bit data which implies 256 brightness levels. A 0 is used to represent black while 255 is used for white. Color images are those that contain three band monochrome information. These bands contain the brightness level information. Color image is comprised of picture elements called as pixels and the pixel is represented by a vector $o(i,j)$ for a particular location, which has three intensity values $o^1(i,j)$, $o^2(i,j)$ and $o^3(i,j)$ each corresponding to red, green and blue colors, respectively (Plataniotis & Venetsanopoulos, 2000; Gonzalez & Woods, 2018; Petrou & Petrou, 2010). In the present day, visual information transferred in the form of digital images is becoming a primary medium of communication. The received image needs processing before it can be used in various applications like face recognition, surveillance, medical imaging, robot vision, underwater imaging, satellite imaging, remote sensing (Pal & Biswas, 2009; Dubey & Katarya, 2021; Ashok, 2021) etc. Frequently, the received image is of low quality due to problems such as noise, poor brightness, contrast, blur or artefacts. Image processing is a branch of engineering that investigates ways for restoring a damaged image to its original state. Image denoising (the reduction of noise from images) is primary pre-processing task for image analysis methods because noise is an unwanted and unavoidable component that is mixed with the original image in a variety of situations, such as during image acquisition, storage and transmission. Noise can highly dilute the image quality as it occurs due to multiple sources such as the transmission of image, dust on the camera lens, faulty photo sensors and faulty memory locations (Julliand et al., 2016). Generally, faulty photo sensors and faulty memory locations cannot be avoided as these occur due to the aging of electronic components. The possible types of noise that can affect images are: Gaussian noise, Shot noise, Impulse noise, Speckle noise, Thermal noise, etc. Gaussian noise originates from thermal vibration of atoms and discrete nature of radiation. Shot noise is a noise that occurs due to discrete nature of light. Impulse noise is the one type of noise which randomly modifies the pixel values and can be classified into fixed valued or SPN and RVIN. The pixel values get modified in case of SPN by only two values, either high or low value of the range whereas in case of RVIN the pixel values get modified independently as well as randomly. Speckle noise comes under the category of multiplicative noise which when introduces in any image then it is multiplied with the true pixel value of the noise free image. Thermal noise arises due to thermal energy of the chip. The effect of SPN on an image is shown in Figure 1a and noise reduction to get the denoised image is shown in Figure 1b.