CHAPTER 9

ENHANCEMENT OF SCARRED FINGERPRINT IMAGES

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9.1 INTRODUCTION

In biometric applications, fingerprints are widely used. To improve fingerprint images, numerous studies have been conducted on image enhancement techniques (Verma at el., 2013). Although scars remain a challenge in biometrics, they degrade the quality of images. In addition to lowering the accuracy of identification, scars compromise fingerprint minutiae information due to broken ridges. Using an image enhancement method, the researchers were able to increase the quality of scarred fingerprint images to generate accurate minutiae extractions. A new filter, median Sigmoid (MS), was used to reduce noise in the scarred image, and ridge structure enhancement was applied to reconstruct the corrected ridges. The purpose of this was to improve the structure of the broken ridge. By combining a median filter with a modified sigmoid filter, the MS filter improves image contrast and removes noise from fingerprint images at the same time. Afterwards, the filtered image was used for ridge structure enhancement.

9.2 UNDERSTAND THE BASICS

Noise in images refers to random variations in intensity that appear as grainy or speckled patterns often obscuring true pixel values. It manifests as pixels with differing intensity levels from their actual values, leading to visual distortion. Noise removal, or denoising, is the process of reducing or eliminating this unwanted variation to improve image quality. This typically involves smoothing the image while preserving important features such as edges and contrast boundaries. Common types of image noise include impulse noise (salt-and-pepper noise), Gaussian noise (amplifier noise), shot noise, quantisation noise (uniform noise), film grain, anisotropic noise, multiplicative noise (speckle noise), and periodic noise.

9.2.1 Average Filter

The average filter is a type of linear filter commonly used in image processing to reduce certain types of noise, such as grain noise. Linear filters like the averaging and Gaussian filters work by smoothing the image, which helps suppress local intensity variations. In the case of the average filter, each pixel is replaced by the average intensity of its neighbouring pixels (see Figure 9.1). This process reduces noise by smoothing out abrupt changes in pixel values; however, it also tends to blur edges in the image. Specifically, the filter computes the mean intensity within a predefined neighbourhood and replaces the centre pixel with this average value.

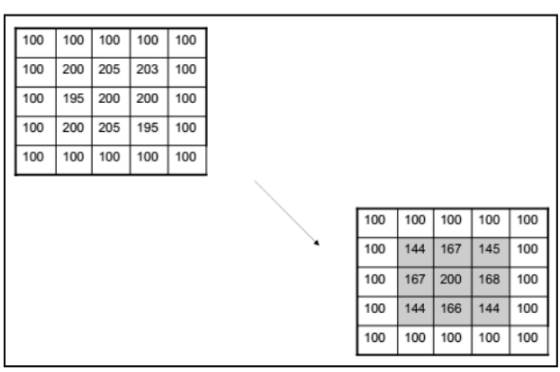

Figure 9.1 Example of a 3×3 average filter

9.2.2 Median Filter

Unlike the average filter, the median filter is particularly effective at removing impulse noise, such as salt-and-pepper noise. It is one of the most widely used filters for smoothing in both image and signal processing. A key advantage of the median filter is its ability to eliminate noise values with extremely large magnitudes while preserving edges better than the average filter. The basic principle involves replacing each pixel value with the median of the intensity values in its surrounding neighbourhood. Although similar in concept to the averaging filter, where the output pixel is based on the surrounding pixel values, the median filter uses the median value rather than the mean. This allows it to reduce noise without significantly blurring image details and edges. Figure 9.2 illustrates an example of a 3×3 median filter. Median filtering is highly effective at removing noise, particularly salt-and-pepper noise, and remains computationally efficient. However, it may introduce slight blurring around edges.

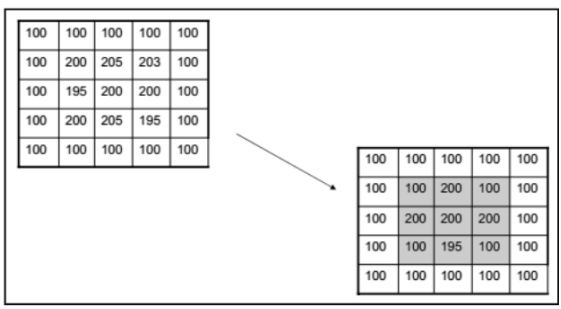

Figure 9.2 Example of a 3×3 median filter

9.2.3 Adaptive Weiner Filter

The adaptive filter is a type of spatial filter whose response varies based on the statistical properties of the image within a local neighbourhood. Unlike fixed filters, its behaviour adapts according to the local image characteristics, particularly through a ranking or statistical estimation process. The filter operates by analysing a window of surrounding pixels