Image processing Hw1

Omer Khan 391007603

Contents

1 Types of Transformation Techniques in Image Processing

Image processing includes various techniques for enhancing or modifying digital images. An important aspect is the use of transforms that allow images to be manipulated based on mathematical operations. Here are some transformation techniques commonly used in image processing.

1.1 Spatial transformation

These techniques affect individual pixels or small neighborhoods in the image. This includes operations such as scaling, rotation, translation and shearing. Spatial transformations preserve the overall structure of an image while changing its appearance.

1.2 Intensity conversion

These techniques adjust the pixel intensity within the image. Examples include contrast stretching, histogram equalization, and logarithmic transformation. Intensity transforms are often used to improve visibility or emphasize certain features in an image.

1.3 Geometric transformation

These techniques modify the geometric properties of the image. Common geometric transformations include perspective, affine, and projective transformations. Geometric transformations are useful for correcting distortions and aligning images.

1.4 Fourier transform

These techniques are based on the Fourier transform, which converts images from the spatial domain to the frequency domain. Fourier transforms are used for image filtering, compression, noise reduction, and other operations. These utilize the frequency content of an image to manipulate its properties.

2 Mathematical Definition and Representation of Transformation

2.1 Scaling Mathematical Definition

Let (x, y) represent the coordinates of a pixel in the original image, and let (x', y') denote the transformed coordinates of the corresponding pixel in the scaled image. The scaling factors along the x and y axes are denoted as S_x and S_y, respectively. The scaling transformation function T_{scales} maps the original coordinates (x, y) to the transformed coordinates (x', y'), and can be expressed as:
$(x', y') = T_s(x, y)$
$x' = S_x * x$
$y' = S_y * y$

2.2 Histogram equalization Mathematical Definition

$I(x, y)$ represent the intensity value of a pixel at coordinates (x, y) in the original image. The histogram equalization transformation function $T_{equalize}$ maps the original intensity values $I(x, y)$ to the transformed intensity values $I'(x, y)$, and can be expressed as:

$I'(x, y) = T_{equalize}(I(x, y))$

The transformation equation for histogram equalization can be defined as:

$I'(x, y) = \frac{L-1}{M*N} \sum_{i=0}^{I(x,y)} ni$

where L is the maximum intensity level of the image, M and N are the width and height of the image, respectively, and n_i represents the number of pixels with intensity i in the image histogram.
This equation indicates that the transformed intensity $I'(x, y)$ is computed as the cumulative distribution of pixel intensities up to the original intensity $I(x, y)$. The histogram equalization process redistributes the pixel intensities to achieve a more uniform histogram, enhancing the overall contrast and brightness of the image.

3 Different Transformations Used in Image Processing

3.1 Scaling

This conversion resizes the image. This can be done by multiplying the coordinates by scale factors along the x and y axes.

3.2 Rotation

Rotation transforms an image by a specific angle around a specific point. Calculating new pixel coordinates requires trigonometric operations.

3.3 Translation

Translation moves the image along the x and y axes. This is achieved by adding a constant value to the coordinates of every pixel in the image.

3.4 Shearing

Shear distorts the image along either axis. Modifies pixel positions based on shear modulus.

3.5 Contrast stretching

This intensity transform extends the range of pixel values, improves contrast, and brings out image detail.

3.6 Histogram equalization

Histogram equalization redistributes pixel intensities in an image to create a more uniform histogram. Improves contrast and brightness throughout the image.

3.7 The Fourier transform

converts an image from the spatial domain to the frequency domain. It decomposes an image into its frequency components, allowing various operations such as filtering and compression.