**ALGORITHMS:**

**DIGITAL IMAGE PROCESSING:**

Digital image processing is the use of computer [algorithms](https://en.wikipedia.org/wiki/Algorithm) to perform [image processing](https://en.wikipedia.org/wiki/Image_processing) on [digital images](https://en.wikipedia.org/wiki/Digital_image). As a subcategory or field of [digital signal processing](https://en.wikipedia.org/wiki/Digital_signal_processing), digital image processing has many advantages over [analog image processing](https://en.wikipedia.org/wiki/Analog_image_processing). It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and signal distortion during processing. Since images are defined over two dimensions (perhaps more) digital image processing may be modeled in the form of [multidimensional systems](https://en.wikipedia.org/wiki/Multidimensional_systems).

**Digital image transformations**

**Filtering**

Digital filters are used to blur and sharpen digital images. Filtering can be performed in the spatial domain by convolution with specifically designed kernels (filter array), or in the frequency (Fourier) domain by masking specific frequency regions. The following examples show both methods:

|  |  |  |
| --- | --- | --- |
| Filter type | Kernel or mask | Example |
| Original Image | {\displaystyle {\begin{bmatrix}0&0&0\\0&1&0\\0&0&0\end{bmatrix}}} | [Affine Transformation Original Checkerboard.jpg](https://en.wikipedia.org/wiki/File:Affine_Transformation_Original_Checkerboard.jpg) |
| [Spatial Lowpass](https://en.wikipedia.org/wiki/Lowpass) | {\displaystyle {\frac {1}{9}}\times {\begin{bmatrix}1&1&1\\1&1&1\\1&1&1\end{bmatrix}}} | [Spatial Mean Filter Checkerboard.png](https://en.wikipedia.org/wiki/File:Spatial_Mean_Filter_Checkerboard.png) |
| [Spatial Highpass](https://en.wikipedia.org/wiki/Edge_detection) | {\displaystyle {\begin{bmatrix}0&-1&0\\-1&4&-1\\0&-1&0\end{bmatrix}}} | [Spatial Laplacian Filter Checkerboard.png](https://en.wikipedia.org/wiki/File:Spatial_Laplacian_Filter_Checkerboard.png) |
| [Fourier Representation](https://en.wikipedia.org/wiki/Fast_Fourier_transform) | Pseudo-code:  image = checkerboard  F = Fourier Transform of image  Show Image: log(1+Absolute Value(F)) | [Fourier Space Checkerboard.png](https://en.wikipedia.org/wiki/File:Fourier_Space_Checkerboard.png) |
| Fourier Lowpass | [Lowpass Butterworth Checkerboard.png](https://en.wikipedia.org/wiki/File:Lowpass_Butterworth_Checkerboard.png) | [Lowpass FFT Filtered checkerboard.png](https://en.wikipedia.org/wiki/File:Lowpass_FFT_Filtered_checkerboard.png) |
| Fourier Highpass | [Highpass Butterworth Checkerboard.png](https://en.wikipedia.org/wiki/File:Highpass_Butterworth_Checkerboard.png) | [Highpass FFT Filtered checkerboard.png](https://en.wikipedia.org/wiki/File:Highpass_FFT_Filtered_checkerboard.png) |

**IMAGE PADDING IN FOURIER DOMAIN FILTERING**

Images are typically padded before being transformed to the Fourier space, the highpass filtered images below illustrate the consequences of different padding techniques:

|  |  |
| --- | --- |
| Zero padded | Repeated edge padded |
| [Highpass FFT Filtered checkerboard.png](https://en.wikipedia.org/wiki/File:Highpass_FFT_Filtered_checkerboard.png) | [Highpass FFT Replicate.png](https://en.wikipedia.org/wiki/File:Highpass_FFT_Replicate.png) |

Notice that the highpass filter shows extra edges when zero padded compared to the repeated edge padding.