

Image Processing Toolbox 8.0

Perform image processing, analysis, and algorithm development

Image Processing Toolbox™ provides a comprehensive set of reference-standard algorithms and graphical tools for image processing, analysis, visualization, and algorithm development. You can perform image enhancement, image deblurring, feature detection, noise reduction, image segmentation, geometric transformations, and image registration. Many toolbox functions are multithreaded to take advantage of multicore and multiprocessor computers.

Image Processing Toolbox supports a diverse set of image types, including high dynamic range, gigapixel resolution, embedded ICC profile, and tomographic. Graphical tools let you explore an image, examine a region of pixels, adjust the contrast, create contours or histograms, and manipulate regions of interest (ROIs). With toolbox algorithms you can restore degraded images, detect and measure features, analyze shapes and textures, and adjust color balance.



[Getting Started with Image Processing Toolbox](#) 4:44

An introduction to image processing using a lane-marking detection example.

Key Features

- Image enhancement, filtering, and deblurring
- Image analysis, including segmentation, morphology, feature extraction, and measurement
- Geometric transformations and intensity-based image registration methods
- Image transforms, including FFT, DCT, Radon, and fan-beam projection
- Workflows for processing, displaying, and navigating arbitrarily large images
- Interactive tools, including ROI selections, histograms, and distance measurements
- DICOM file import and export

Importing and Exporting Images

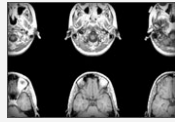
Image Processing Toolbox supports images generated by a wide range of devices, including digital cameras, satellite and airborne sensors, medical imaging devices, microscopes, telescopes, and other scientific instruments. You can visualize, analyze, and process these images in many data types, including single-precision and double-precision floating-point and signed and unsigned 8-bit, 16-bit, and 32-bit integers.

There are several ways to import and export images into and out of the [MATLAB](#)® environment for processing. You can use [Image Acquisition Toolbox](#)™ to acquire live images from Web cameras, frame grabbers, DCAM cameras, GigE Vision cameras, and other devices. Using [Database Toolbox](#)™, you can access images stored in ODBC-compliant or JDBC-compliant databases.

Standard and Specialized Formats Supported

MATLAB supports standard data and image formats, including JPEG, JPEG-2000, TIFF, PNG, HDF, HDF-EOS, FITS, Microsoft® Excel®, ASCII, and binary files. It also supports the multiband image formats BIP and BIL, as used by LANDSAT. Low-level I/O and memory mapping functions enable you to develop custom routines for working with any data format.

Image Processing Toolbox supports a number of specialized image file formats. For medical images, it supports DICOM files, including associated metadata, as well as the Analyze 7.5 and Interfile formats. The toolbox can also read geospatial images in NITF files and high dynamic range images in HDR files.



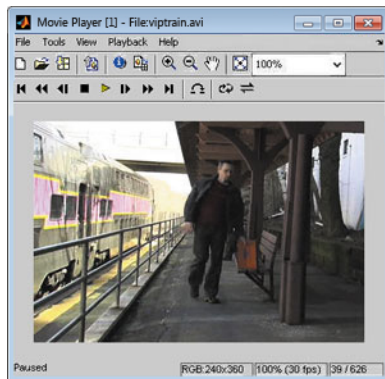
[Exploring Slices from a 3-Dimensional MRI Data Set](#)
Interpolating and reslicing a 3D MRI data set.

Displaying and Exploring Images

Displaying Images

Image Processing Toolbox provides image display capabilities that are highly customizable. You can create displays with multiple images in a single window, annotate displays with text and graphics, and create specialized displays such as histograms, profiles, and contour plots.

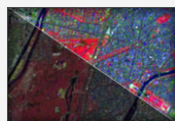
The toolbox includes tools for displaying video and sequences in either a time-lapsed video viewer or an image montage. Volume visualization tools in [MATLAB](#) let you create isosurface displays of multidimensional image data sets.



Video viewer paused on an individual frame of a video sequence.

Exploring Images

In addition to display functions, the toolbox provides a suite of interactive tools for exploring images. You can view image information, zoom and pan around the image, and closely examine a region of pixels. You can interactively place and manipulate ROIs, including points, lines, rectangles, polygons, ellipses, and freehand shapes. You can also interactively crop, adjust the contrast, and measure distances. The suite of tools is available within Image Tool or from individual functions that you can use to create custom interfaces.



[Enhancing Multispectral Color Composite Images](#)
Constructing color composites to highlight and segment vegetation in satellite imagery.



[Detecting Cars in a Video of Traffic](#)
Visualizing and analyzing videos and image sequences.

Preprocessing and Postprocessing Images

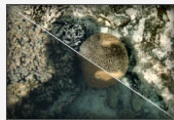
Image Processing Toolbox provides reference-standard algorithms for preprocessing and postprocessing tasks that solve frequent system problems, such as noise, low dynamic range, out-of-focus optics, and the difference in color representation between input and output devices.

Image Enhancement

Image enhancement techniques in Image Processing Toolbox enable you to increase the signal-to-noise ratio and accentuate image features by modifying the colors or intensities of an image. You can:

- Perform histogram equalization
- Perform decorrelation stretching
- Remap the dynamic range
- Adjust the gamma value
- Perform linear, median, or adaptive filtering

The toolbox includes specialized filtering routines and a generalized multidimensional filtering function that handles integer image types, offers multiple boundary-padding options, and performs convolution and correlation. Predefined filters and functions for designing and implementing your own linear filters are also provided.

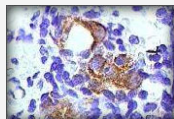


Contrast Enhancement Techniques

Enhancing grayscale and truecolor images with adaptive histogram equalization.

Image Deblurring

Image deblurring algorithms in Image Processing Toolbox include blind, Lucy-Richardson, Wiener, and regularized filter deconvolution, as well as conversions between point spread and optical transfer functions. These functions help correct blurring caused by out-of-focus optics, movement by the camera or the subject during image capture, atmospheric conditions, short exposure time, and other factors. All deblurring functions work with multidimensional images.



Deblurring Images Using a Regularized Filter

Restoring a blurred and noisy image using a constrained least square restoration algorithm.



Deblurring Images Using the Blind Deconvolution Algorithm

Restoring an image when no information about the distortion is available.

Device-Independent Color Management

Device-independent color management in Image Processing Toolbox enables you to accurately represent color independent of an input or output device. This helps you analyze the characteristics of a device, quantitatively measure color accuracy, or develop algorithms for several different devices. With specialized functions in the

toolbox, you can convert images between device-independent color spaces, such as sRGB, XYZ, xyY, L*a*b*, uvL, and L*ch.



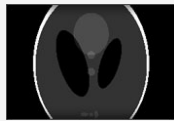
Color-Based Segmentation Using the L*a*b* Color Space

Identifying different colors by analyzing an image in an alternative color space.

For more flexibility and control, the toolbox supports profile-based color space conversions using a color management system based on ICC version 4. For example, you can import N-dimensional ICC color profiles, create new or modify existing ICC color profiles for specific input and output devices, specify the rendering intent, and find all compliant profiles on your machine.

Image Transform

Image transforms such as FFT and DCT play a critical role in many image processing tasks, including image enhancement, analysis, restoration, and compression. Image Processing Toolbox provides several image transforms, including Radon and fan-beam projections. You can reconstruct images from parallel-beam and fan-beam projection data (common in tomography applications). Image transforms are also available in [MATLAB](#) and [Wavelet Toolbox™](#).



Reconstructing an Image from Projection Data

Comparing the reconstruction of an image using parallel (Radon) and fan-beam geometries.

Image Conversion

Image conversions between data classes and image types are a common requirement for imaging applications. Image Processing Toolbox provides a variety of utilities for conversion between data classes, including single-precision and double-precision floating-point and signed or unsigned 8-bit, 16-bit, and 32-bit integers. The toolbox includes algorithms for conversion between image types, including binary, grayscale, indexed color, and truecolor. Specifically for color images, the toolbox supports a variety of color spaces such as YIQ, HSV, and YCrCb, as well as Bayer pattern encoded and high dynamic range images.

Analyzing Images

Image Processing Toolbox provides a comprehensive suite of reference-standard algorithms and graphical tools for image analysis tasks such as statistical analysis, feature extraction, and property measurement.

Statistical Functions

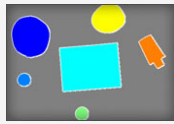
Statistical functions let you analyze the general characteristics of an image by:

- Computing the mean or standard deviation
- Determining the intensity values along a line segment
- Displaying an image histogram
- Plotting a profile of intensity values



Correcting Nonuniform Illumination

Enhancing an image and computing statistics of segmented objects using REGIONPROPS.



Identifying Round Objects

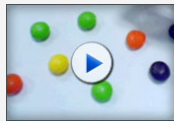
Thresholding an image and calculating measurements of objects.

Edge-Detection Algorithms

Edge-detection algorithms let you identify object boundaries in an image. These algorithms include the Sobel, Prewitt, Roberts, Canny, and Laplacian of Gaussian methods. The powerful Canny method can detect true weak edges without being fooled by noise.

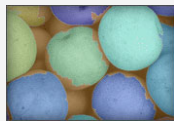
Image Segmentation Algorithms

Image segmentation algorithms determine region boundaries in an image. You can explore many different approaches to image segmentation, including automatic thresholding, edge-based methods, and morphology-based methods such as the watershed transform, often used to segment connected objects.



Color-Based Segmentation with Live Image Acquisition 4:44

Acquiring and processing images from a camera to count objects of similar color.



Marker-Controlled Watershed Segmentation

Separating overlapping objects into catchment basins and watershed ridge lines.



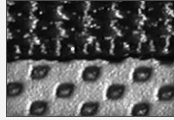
Detecting a Cell Using Image Segmentation

Segmenting a cell using edge detection and morphology.

Morphological Operators

Morphological operators enable you to detect edges, enhance contrast, remove noise, segment an image into regions, thin regions, or perform skeletonization on regions. Morphological functions in Image Processing Toolbox include:

- Erosion and dilation
- Opening and closing
- Labeling of connected components
- Watershed segmentation
- Reconstruction
- Distance transform



Texture Segmentation Using Texture Filters

Identifying regions of different textures using entropy measurements and morphological operations.

Advanced Image Analysis

Image Processing Toolbox also contains advanced image analysis functions that let you:

- Measure the properties of a specified image region, such as the area, center of mass, or bounding box
- Detect lines and extract line segments from an image using the Hough transform
- Measure properties, such as surface roughness or color variation, using texture analysis functions

Geometric Transformations and Image Registration

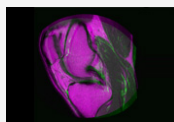
Geometric transformations are useful for tasks such as rotating an image, reducing its resolution, correcting geometric distortions, and performing image registration. Image Processing Toolbox supports simple operations, such as resizing, rotating, and cropping, as well as more complex 2D geometric transformations, such as affine and projective. The toolbox also provides a flexible and comprehensive framework for creating and applying customized geometric transformations and interpolation methods for N-dimensional arrays.

Image registration is important in remote sensing, medical imaging, and other applications where images must be aligned to enable quantitative analysis or qualitative comparison. Image Processing Toolbox supports intensity-based image registration, which automatically aligns images using relative intensity patterns. The toolbox also supports control-point image registration, which requires the manual selection of control points in each image to align two images. Additionally, [Computer Vision System Toolbox™](#) supports feature-based image registration, which automatically aligns images using feature detection, extraction, and matching followed by geometric transformation estimation.



Registering an Aerial Photo to an Orthophoto

Aligning two images using control-point selection.



Registering Multimodal MRI Images

Aligning two MRI images using intensity-based image registration.

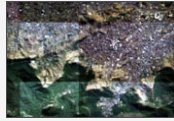
Working with Large Images

Some images are so large that they are difficult to process and display with standard methods. Image Processing Toolbox provides workflows specifically for working with larger images. Without loading a large image entirely into memory, you can create a reduced-resolution data set (R-Set) that divides an image into spatial tiles and resamples the image at different resolution levels. Using this workflow improves image display and navigation performance. You can use a block processing workflow to apply a function to each distinct block of a large image, significantly reducing memory use. In this workflow, you can use [Parallel Computing Toolbox™](#) to further improve performance.



Block Processing Large Images

Reducing memory use for processing large images by incrementally reading, processing, and writing results back to disk.



Computing Statistics for Large Images

Calculating and applying global statistics when processing large images with BLOCKPROC.

Resources

Product Details, Examples, and System Requirements

www.mathworks.com/products/image

Trial Software

www.mathworks.com/trialrequest

Sales

www.mathworks.com/contactsales

Technical Support

www.mathworks.com/support

Online User Community

www.mathworks.com/matlabcentral

Training Services

www.mathworks.com/training

Third-Party Products and Services

www.mathworks.com/connections

Worldwide Contacts

www.mathworks.com/contact