

Digital Image Processing

1. Introduction to image processing

Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. Nowadays, image processing is among rapidly growing technologies. It forms core research area within engineering and computer science disciplines too.

Image processing basically includes the following three steps:

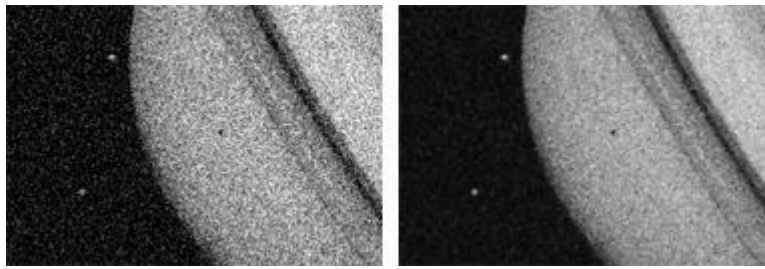
- Importing the image via image acquisition tools;
- Analysing and manipulating the image;
- Output in which result can be altered image or report that is based on image analysis.

There are two types of methods used for image processing namely, analogue and digital image processing. Analogue image processing can be used for the hard copies like printouts and photographs. Image analysts use various fundamentals of interpretation while using these visual techniques. Digital image processing techniques help in manipulation of the digital images by using computers. The three general phases that all types of data have to undergo while using digital technique are pre-processing, enhancement, and display, information extraction.

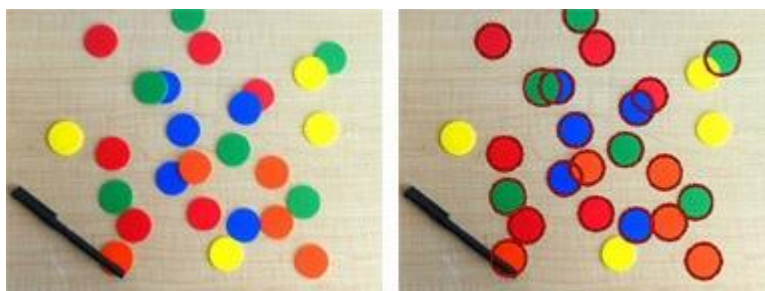
Digital image processing is the use of computer algorithms to create, process, communicate, and display digital images. Digital image processing algorithms can be used to:

- Convert signals from an image sensor into digital images
- Improve clarity, and remove noise and other artifacts
- Extract the size, scale, or number of objects in a scene
- Prepare images for display or printing
- Compress images for communication across a network

The following images illustrate a few of these examples:



Removing noise using a Wiener Filter.



Counting circular objects in an image.

Effective techniques for processing digital images include using algorithms and tools that provide a comprehensive environment for data analysis, visualization, and algorithm development.

Since images are defined over two dimensions (perhaps more) digital image processing may be modeled in the form of multidimensional systems.

History

Many of the techniques of digital image processing, or digital picture processing as it often was called, were developed in the 1960s at the Jet Propulsion Laboratory, Massachusetts Institute of Technology, Bell Laboratories, University of Maryland, and a few other research facilities, with application to satellite imagery, wire-photo standards conversion, medical imaging, videophone, character recognition, and photograph enhancement.^[1] The cost of processing was fairly high, however, with the computing equipment of that era. That changed in the 1970s, when digital image processing proliferated as cheaper computers and dedicated hardware became available. Images then could be processed in real time, for some dedicated problems such as television standards conversion. As general-purpose computers became faster, they started to take over the role of dedicated hardware for all but the most

specialized and computer-intensive operations. With the fast computers and signal processors available in the 2000s, digital image processing has become the most common form of image processing and generally, is used because it is not only the most versatile method, but also the cheapest.

Digital image processing technology for medical applications was inducted into the Space Foundation Space Technology Hall of Fame in 1994.

Tasks

Digital image processing allows the use of much more complex algorithms, and hence, can offer both more sophisticated performance at simple tasks, and the implementation of methods which would be impossible by analog means.

In particular, digital image processing is the only practical technology for:

- Classification
- Feature extraction
- Multi-scale signal analysis
- Pattern recognition
- Projection

Some techniques which are used in digital image processing include:

- Anisotropic diffusion
- Hidden Markov models
- Image editing
- Image restoration
- Independent component analysis
- Linear filtering
- Neural networks
- Partial differential equations
- Pixelation
- Principal components analysis
- Self-organizing maps
- Wavelets

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.

Applications

Digital camera images[\[edit\]](#)

Digital cameras generally include specialized digital image processing hardware – either dedicated chips or added circuitry on other chips – to convert the raw data from their image sensor into a color-corrected image in a standard image file format

Film

Westworld (1973) was the first feature film to use the digital image processing to pixellate photography to simulate an android's point of view.