APPLICATIONS

Mail processing
ZIP code
Target tracking or detecting
Vehicle or traffic control
License plate
Range or distance measuring
Motion or velocity measuring
Surface texture or roughness measuring
Seismic or geological sample measuring
Animal, plant, or food inspection
Textiles or clothing
Document or print quality inspection
Reading maps, graphs, drawings, or schematics
Reading aids for the visually impaired
Personnel identification (e.g., biometrics)
Using a combination of features (e.g., signature and fingerprint)
Using a characteristic of the eye
Using a facial characteristic
Using a signature
Sensing pressure together with speed or acceleration
Sensing pressure only
Sensing speed or acceleration only
Sensing geometrical properties
Using a fingerprint
Extracting minutia such as ridge endings and bifurcations
With a guiding mechanism for positioning finger
With a prism
Biomedical applications
DNA or RNA pattern reading
Producing difference image (e.g., angiography)
Tomography (e.g., CAT scanner)
X-ray film analysis (e.g., radiography)
Cell analysis, classification, or counting

...Blood cells
Reading paper currency
Reading coins
Reading bank checks (e.g., documents bearing E-13B type characters)
Reading monetary amount
Reading MICR data
Including an optical imager or reader
Manufacturing or product inspection
Bottle inspection
Inspection of packaged consumer goods
Mask inspection (e.g., semiconductor photomask)
Inspection of semiconductor device or printed circuit board
Measuring external leads
Inspecting printed circuit boards
At plural magnifications or resolutions
Fault or defect detection
Faulty soldering
Alignment, registration, or position determination
Tool, workpiece, or mechanical component inspection
Robotics
3-D or stereo imaging analysis

LEARNING SYSTEMS
Neural networks
Network learning techniques (e.g., back propagation)
Network structures
Trainable classifiers or pattern recognizers (e.g., adaline, perceptron)
Generating a standard by statistical analysis
Alphanumerics

COLOR IMAGE PROCESSING
Drop-out color in image (i.e., color to be removed)
Image segmentation using color
Pattern recognition or classification using color
Compression of color images
Color correction

HISTOGRAM PROCESSING
With a gray-level transformation (e.g., uniform density transformation)
With pattern recognition or classification
For segmenting an image
For setting a threshold

**IMAGE SEGMENTATION**
- Using projections (i.e., shadow or profile of characters)
- Separating document regions using preprinted guides or markings
- Distinguishing text from other regions
- Segmenting individual characters or words
  - Separating touching or overlapping characters
  - Segmenting hand-printed characters
- Region labeling (e.g., page description language)

**PATTERN RECOGNITION**
- Limited to specially coded, human-readable characters
  - Characters formed entirely of parallel bars (e.g., CMC-7)
  - With separate timing or alignment marks
- Ideographic characters (e.g., Japanese or Chinese)
- Unconstrained handwriting (e.g., cursive)
- On-line recognition of handwritten characters
  - Writing on ordinary surface (i.e., electronics are in pen)
  - With a display
- Feature extraction
  - Multispectral features (e.g., frequency, phase)
  - Feature counting
    - Counting intersections of scanning lines with pattern
    - Counting individual pixels or pixel patterns
  - Local or regional features
    - Slice codes
    - Directional codes and vectors (e.g., Freeman chains, compasslike codes)
    - Extracted from alphanumeric characters

...Pattern boundary and edge measurements
...Measurements made on alphanumeric characters
...Point features (e.g., spatial coordinate descriptors)
...Linear stroke analysis (e.g., limited to straight lines)
...Shape and form analysis
...Topological properties (e.g., number of holes in a pattern, connectivity, etc.)
...Local neighborhood operations (e.g., 3x3 kernel, window, or matrix operator)
...Global features (e.g., measurements on image as a whole, such as area, projections, etc.)
...Waveform analysis
...With a tapped delay line
...Template matching (e.g., specific devices that determine the best match)
...Spatial filtering (e.g., holography)
...With electrically controlled light modulator or filter
...Nonholographic optical mask or transparency
...Using both positive and negative masks or transparencies
...With a display
...Using dynamic programming or elastic templates (e.g., warping)
...At multiple image orientations or positions
...Electronic template
...Comparator
...Determining both similarities and differences
...Calculating weighted similarity or difference (e.g., don't-care areas)
...Counting difference pixels
...Using an Exclusive-OR gate
...Resistor matrix
...Classification
...Cluster analysis
...Sequential decision process (e.g., decision tree structure)
With a multilevel classifier
Statistical decision process
Context analysis or word recognition (e.g., character string)
Trigrams or digrams
Checking spelling for recognition

IMAGE COMPRESSION OR CODING
Including details of decompression
Parallel coding architecture
Substantial processing of image in compressed form
Interframe coding (e.g., difference or motion detection)
Gray level to binary coding
Predictive coding
Adaptive coding (i.e., changes based upon history, activity, busyness, etc.)
Pyramid, hierarchy, or tree structure
Polygonal approximation
Contour or chain coding (e.g., Bezier)
Shape, icon, or feature-based compression
Lossless, icon, or feature-based compression
Huffman or variable-length coding
Arithmetic coding
Transform coding
Fractal
Discrete cosine or sine transform
Quantization
Error diffusion or dispersion
Vector quantization

IMAGE ENHANCEMENT OR RESTORATION
Focus measuring or adjusting (e.g., deblurring)
Object boundary expansion or contraction
Dilation or erosion (e.g., opening or closing)
Line thinning or thickening...Skeletonizing
Image filter
Adaptive filter
Median filter

Highpass filter (i.e., for sharpening or enhancing details)
Lowpass filter (i.e., for blurring or smoothing)
Recursive filter
Edge or contour enhancement
Minimize discontinuities in dot-matrix image data (i.e., connecting or merging the dots)
Minimize discontinuities at boundaries of image blocks (i.e., reducing blocking effects or effects of wrap-around)
Minimize jaggedness in edges (e.g., anti-aliasing)
Variable threshold, gain, or slice level
Based on the results of a count
Based on a local average, mean, or median
Based on peak levels
Intensity, brightness, contrast, or shading correction
Artifact removal or suppression (e.g., distortion correction)

IMAGE TRANSFORMATION OR PREPROCESSING
Transforming each dimension separately
Correlation
Convolution
Fourier transform
Walsh, Hough, or Hadamard transform
Selecting a portion of an image
Using a mask
Combining image portions (e.g., portions of oversized documents)
Mapping 2-D image onto a 3-D surface
Measuring image properties (e.g., length, width, or area)
Detecting alignment marks
Determining center of gravity or moment
Determining amount an image is rotated or skewed
Where the image is a character, word, or text
Determining the position of an object
Where the object is a character, word, or text

Changing the image coordinates

Registering or aligning multiple images to one another

To position or translate an image

To rotate an image

Rotation of image is limited to 90 degrees, 180 degrees, or 270 degrees

To change the scale or size of an image

Raising or lowering the image resolution (e.g., subpixel accuracy)

Interpolation

Where the image is an alphanumeric character

Multilayered image transformations

Pipeline processing

Parallel processing

Image storage or retrieval

Using identification indicia on document

General purpose image processor

Morphological operations (i.e., local neighborhood operations)

EDITING, ERROR CHECKING, OR CORRECTION (E.G., POSTRECOGNITION PROCESSING)

Correcting alphanumeric recognition errors

Including operator interaction

IMAGE SENSING

Hand-held

Sensing mechanism in stylus

Sensing mechanism in platen

Curve tracer

Sensor control (e.g., OCR sheet controls copier or fax)

Multiple scanning

Prescanning

Magnetic

Optical (e.g., OCR)

Single spot

Single line

Full retina

MISCELLANEOUS