

IMAGE PROCESSING

APPLICATIONS

PHOTOGRAPHY

RECOGNITION

REGISTRATION

RETRIEVAL

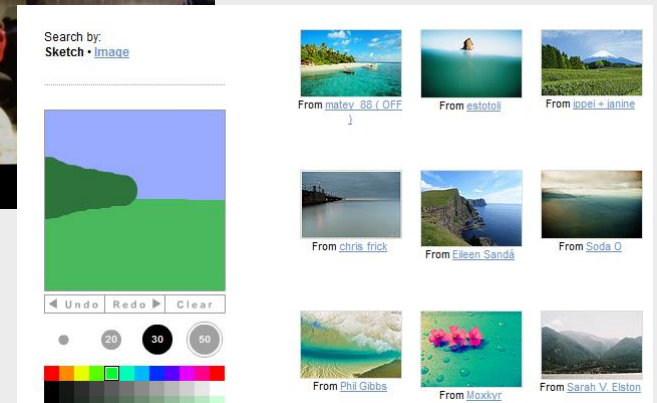


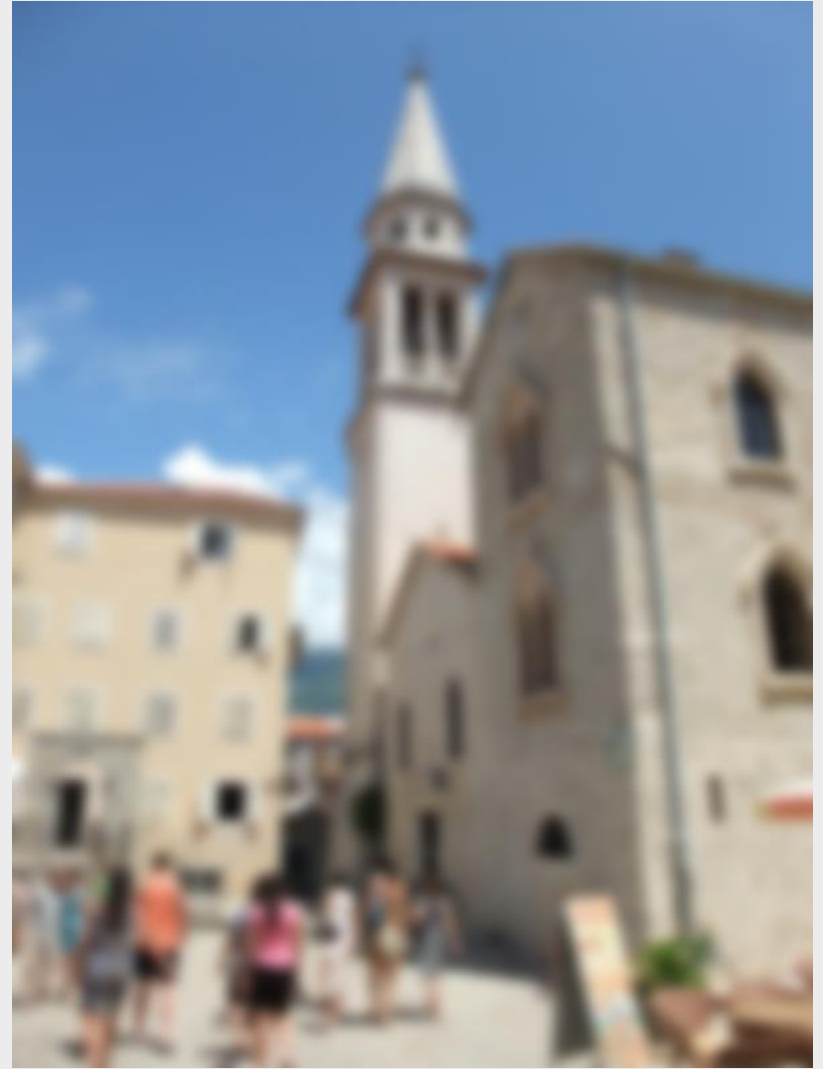
IMAGE PROCESSING – BASIC EXAMPLE



INPUT IS: IMAGE
OUTPUT IS: IMAGE

OTHER OUTPUT: E.G. RECOGNIZED LETTERS

EXAMPLE FUNCTION: BLUR



EXAMPLE FUNCTION: SHARPEN



EXAMPLE FUNCTION: EDGE DETECTION



CONVOLUTION

[FILTER] * [PIXEL NEIGHBORHOOD] = [NEW PIXEL VALUE]

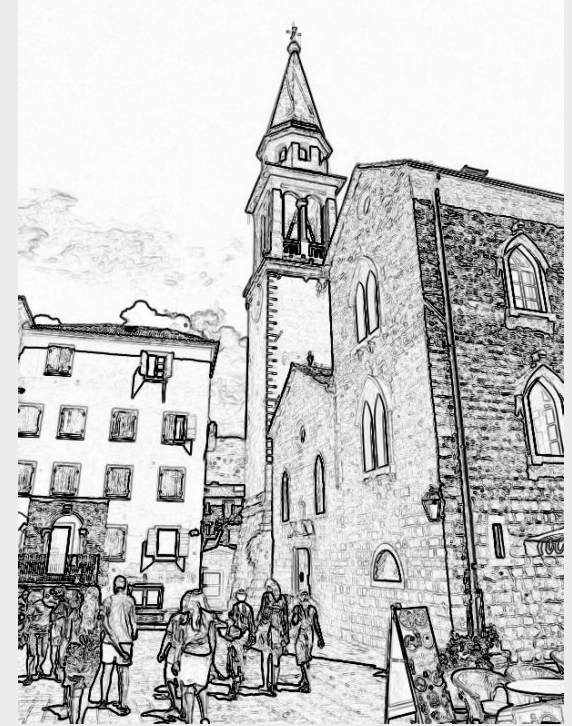
0 -1 0
-1 5 -1
0 -1 0

5	7	7	7	7	7
5	5	7	7	7	7
5	5	5	7	7	7
5	5	5	7	7	7
5	5	5	7	7	7
5	5	5	7	7	7

1	11	7	7	7	7
5	1	11	7	7	7
5	5	1	9	7	7
5	5	3	9	7	7
5	5	3	9	7	7
5	5	3	9	7	7

$$\begin{aligned} &0.5 + -1.7 + 0.7 + \\ &-1.5 + 5.5 + -1.7 + \\ &0.5 + -1.5 + 0.5 = 0 - 7 + 0 - 5 + 25 - 7 + 0 - 5 + 0 = 1 \end{aligned}$$

CONVOLUTION FILTER EXAMPLES



0	-1	0
-1	5	-1
0	-1	0

1	1	1
1	1	1
1	1	1

1	2	1
0	0	0
-1	-2	-1

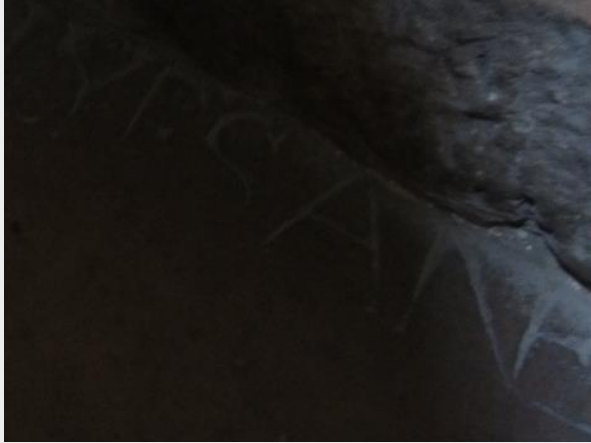
NOISE REDUCTION

REMOVE HIGH-FREQUENCY ERRORS

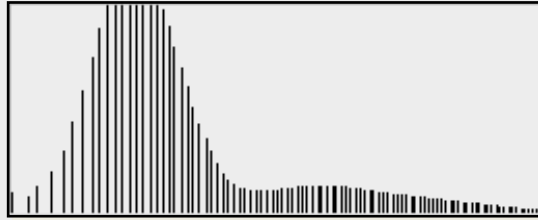
DOES SMOOTHING $\Rightarrow$ BLURS THE IMAGE



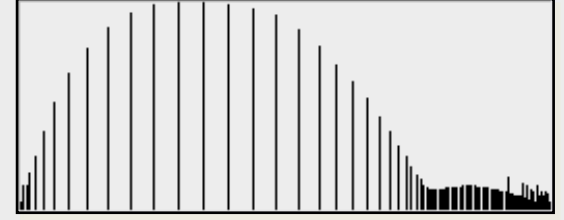
HISTOGRAM EQUALIZATION



Original image is too dark, there is no contrast



Histogram normalization adds brightness



Histogram equalization adds contrast to dark areas

WHITE BALANCE

LIGHT SOURCE AFFECTS IMAGE COLOR

Our brain compensates for that, camera not

AUTO BALANCE

MANUAL BALANCE

REFERENCE



HDR IMAGING

DYNAMIC RANGE = MIN INTENSITY : MAX INTENSITY

Human eye	~ 1:24 (1:12 with fixed pupil)
Digital cameras	~ 1:5 - 1:14

LIMITED DYNAMIC RANGE

Only a certain interval of intensities is captured
Intensities below limit result in black
Intensities above limit result in white

8BIT LIGHT INTENSITY (JPEG) NOT ENOUGH

HDR IMAGING

Bright areas are OK
Dark areas are black



Dark areas are OK
Bright areas are white



Selective combination
of first 2 images

SPECIAL PROCESSING

REMOVE BLUR CAUSED BY CAMERA MOTION



SPECIAL PROCESSING

CONTENT-AWARE RESIZING ("SEAM CARVING")



SPECIAL PROCESSING

CONTENT-AWARE FILL



COMPUTER VISION

WHAT IS COMPUTER VISION?

INFORMATION FROM IMAGES

Semantics, content

CLASSIFYING IMAGE INFORMATION

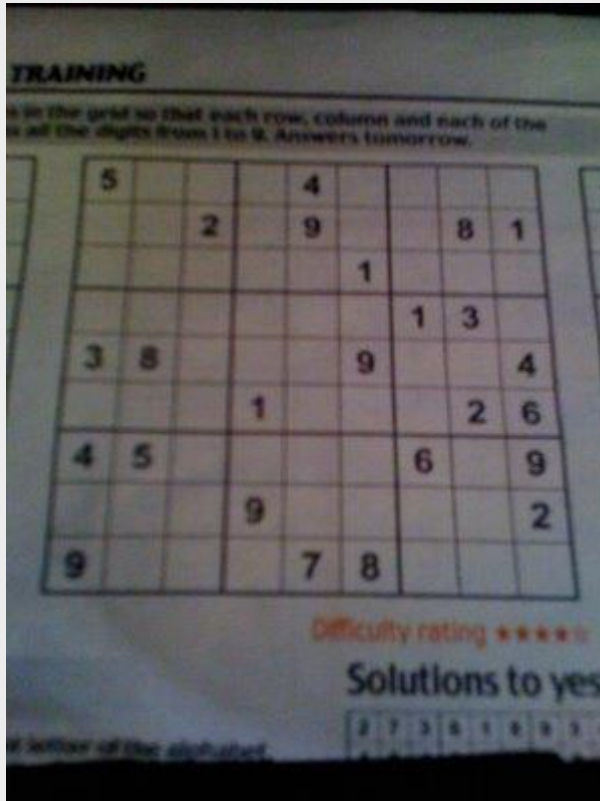
Pattern/object recognition

E.G.:

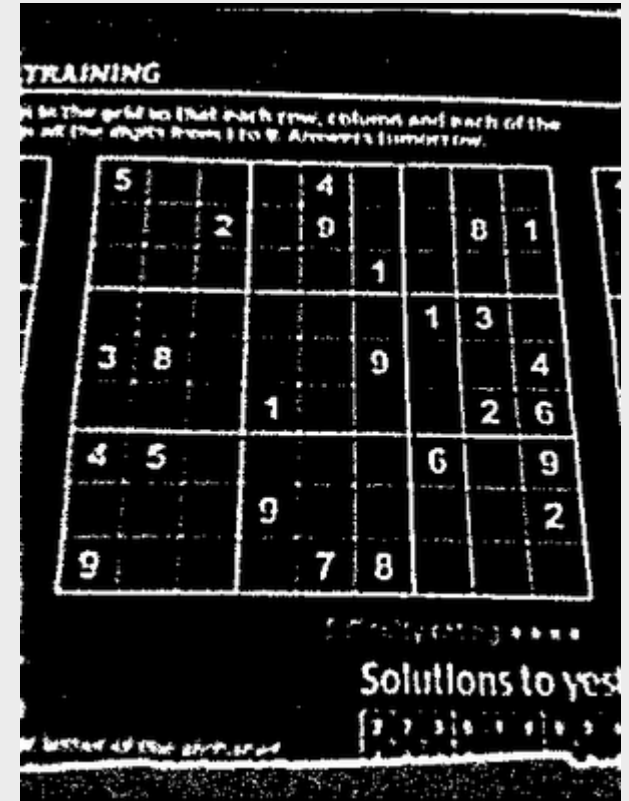


COMPUTER VISION EXAMPLE

IMAGE PROCESSING



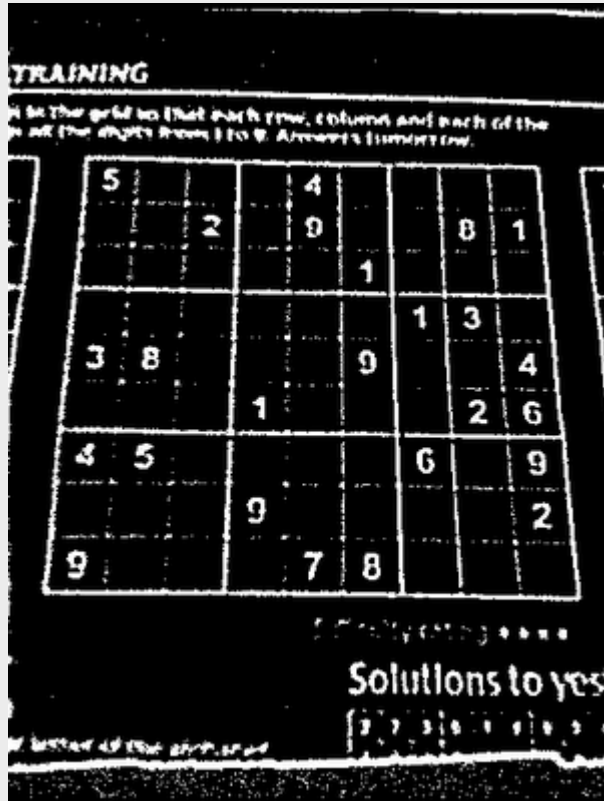
Adaptive
threshold



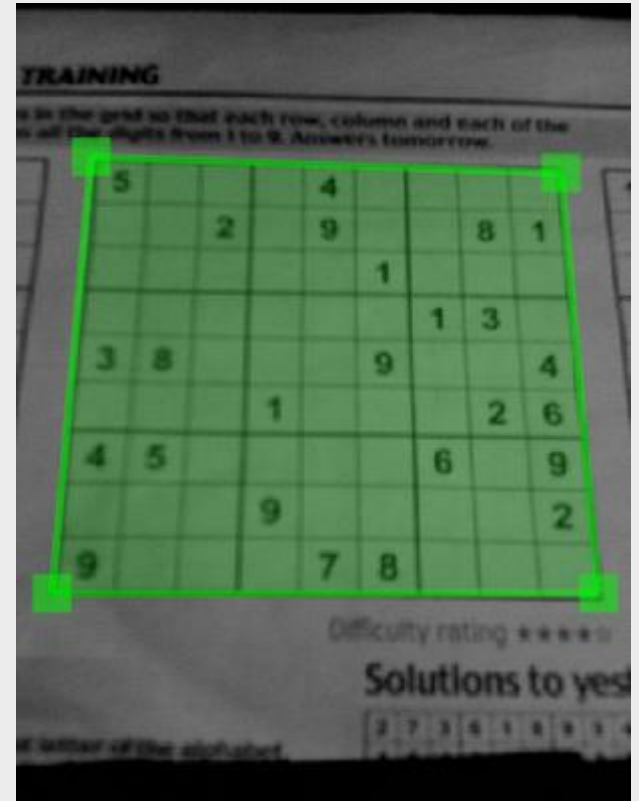
<http://sudokugrab.blogspot.com>

COMPUTER VISION EXAMPLE

PATTERN RECOGNITION



Hough transform



COMPUTER VISION EXAMPLE

CLASSIFICATION

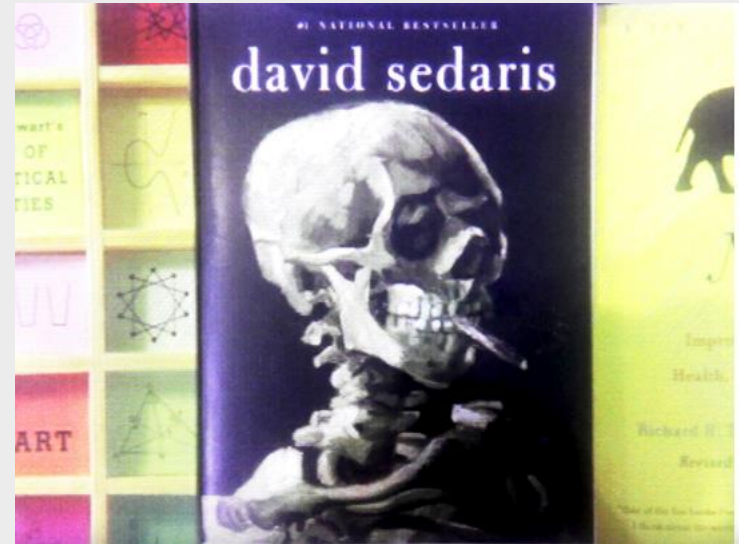


Neural network
OCR



HOW DOES IMAGE VISION WORK?

- A. COMPARE PIXELS TO TARGET IMAGE
- B. COMPARE FEATURES OR FEATURE VECTORS
- C. ARTIFICIAL INTELLIGENCE (NEURAL NETWORKS)
- D. COMBINATION OF ABOVE



COMPARE IMAGES

COMPUTE PIXEL-TO-PIXEL DIFFERENCES
IF (SUM OF DIFFERENCES < TOLERANCE)
THEN MATCH

PERCEPTUAL HASHES

E.G. PERCEPTUAL AVERAGE HASH

Downscale image (e.g. to 8x8 pixels)

Convert to 8bit gray scale

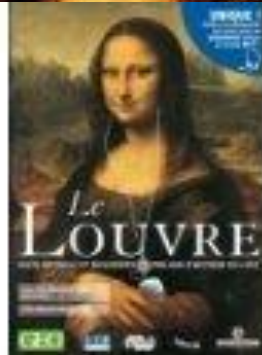
Threshold to average brightness => 1 bit color

8x8 pixels x 1 bit = 64bit code = hash

If two images have the same hash => match!

COMPARE IMAGES

EXAMPLE: TINEYE



CONTENT-BASED IMAGE RETRIEVAL

E.G. RETRIEVR - SEARCH FLICKR BY SKETCHES

Search by:
Sketch • [Image](#)

.....



◀ Undo Redo ▶ Clear

● 20 30 50



From [matey 88 \(OFF](#)

From [estotoli](#)

From [ippei + janine](#)

From [chris frick](#)

From [Eileen Sandá](#)

From [Soda O](#)

From [Phil Gibbs](#)

From [Moxkyr](#)

From [Sarah V. Elston](#)

CONTENT BASED IMAGE RETRIEVAL

PIXOLUTION VSEARCH - SEARCH BY COLORS

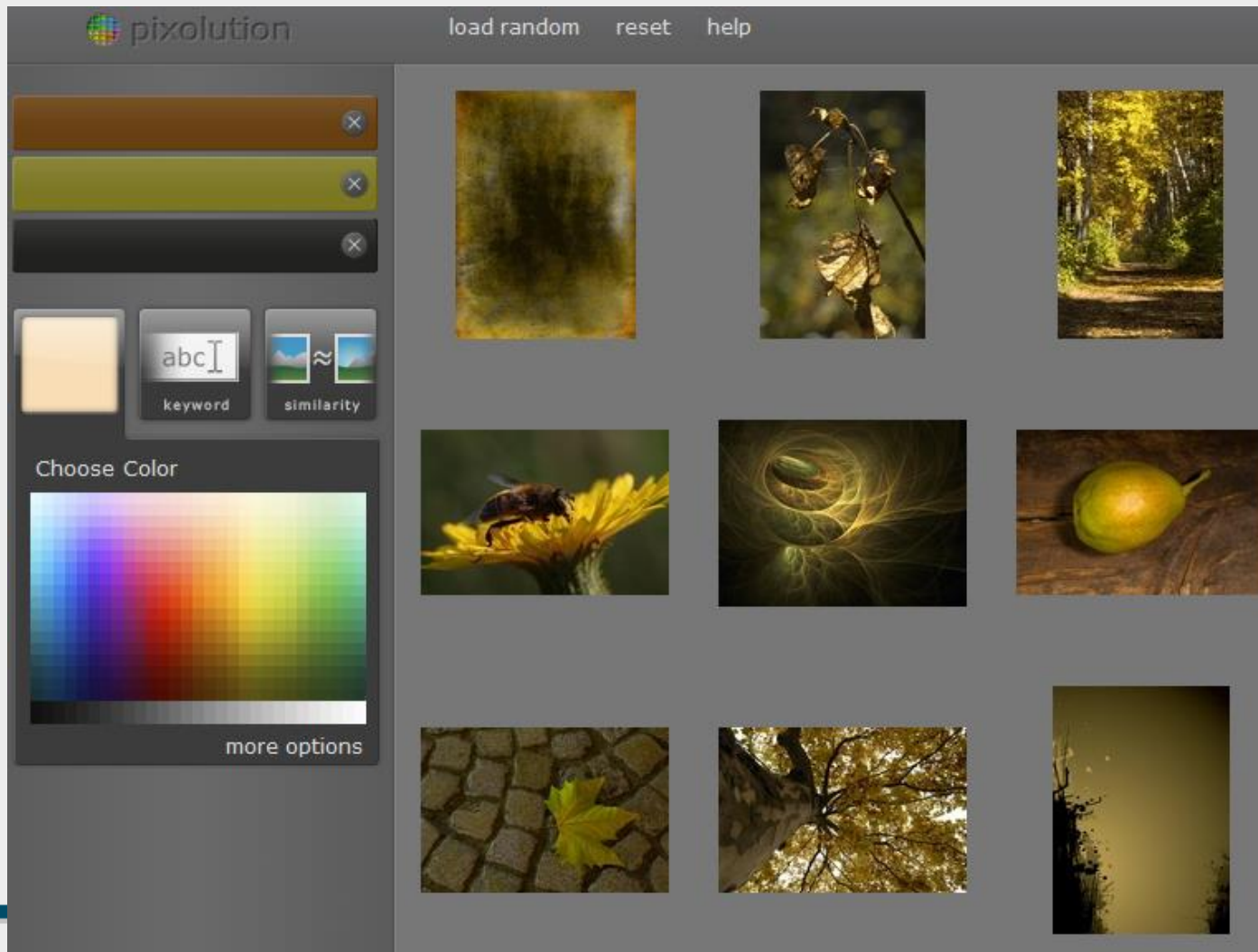


IMAGE STITCHING

FIND MATCHING IMAGE FEATURES

COMPUTE TRANSFORMATION BETWEEN
MATCHING PAIRS



PHOTOSYNTH



DETECTION & CLASSIFICATION

DETECTION

= IS THE OBJECT THERE?

CLASSIFICATION

= WHAT TYPE OF OBJECT
IS THERE?

FROM FEATURE POINTS TO FEATURE VECTORS

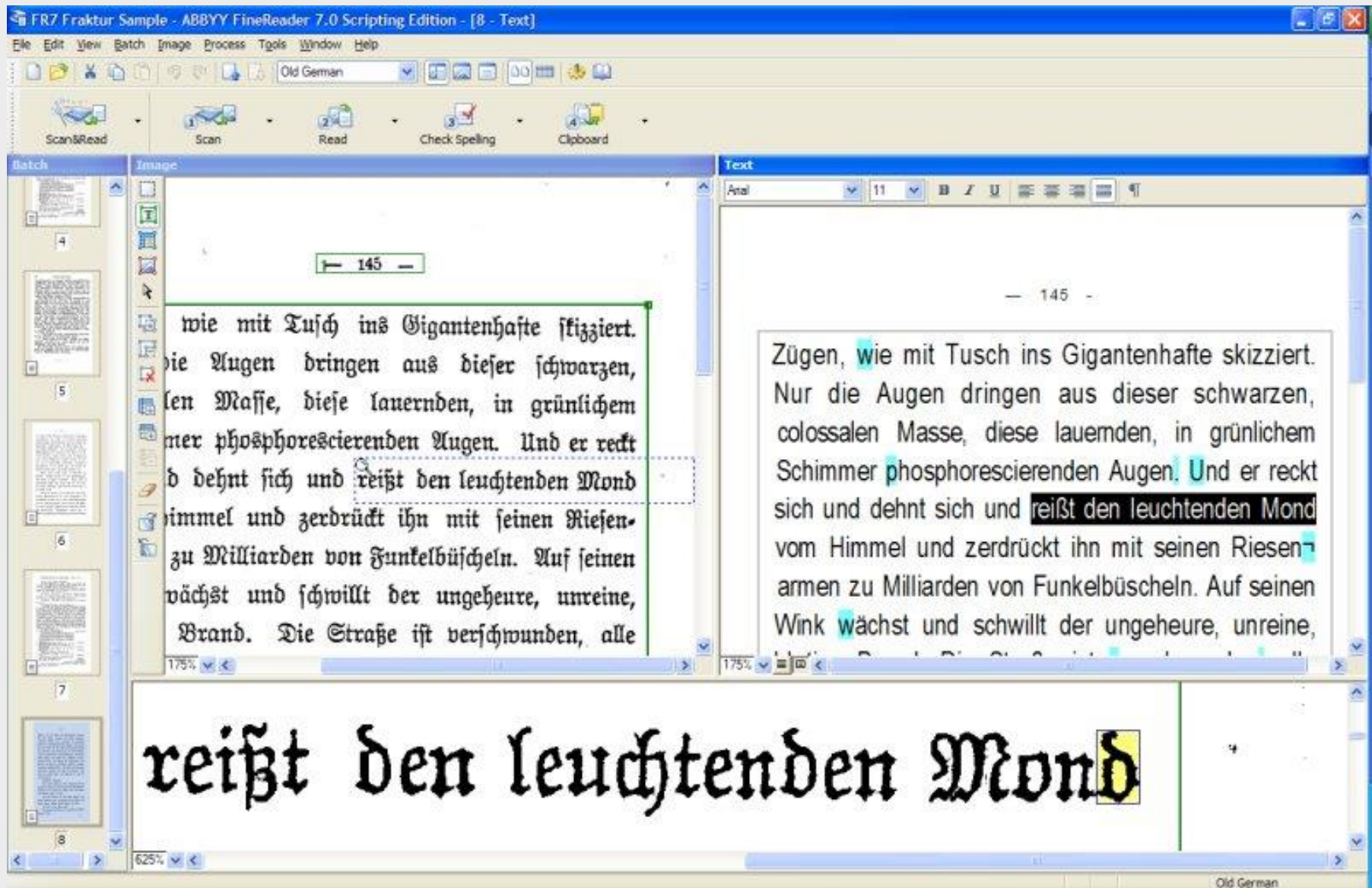
Set of characteristic values

TEXT RECOGNITION

FACE DETECTION

FACE RECOGNITION

OPTICAL CHARACTER RECOGNITION (OCR)



FACE DETECTION

COLOR TONE (WE LOOK FOR FLESH TONES)

SHAPE (WE LOOK FOR VERTICAL OVAL)

POSITION OF EYES AND MOUTH

IF IMAGE CONTAINS THE ABOVE: IT'S A FACE!

FURTHER:

DETECTION OF FACIAL FEATURE POINTS AND
FACE RECOGNITION

FACE RECOGNITION



FACE RECOGNITION



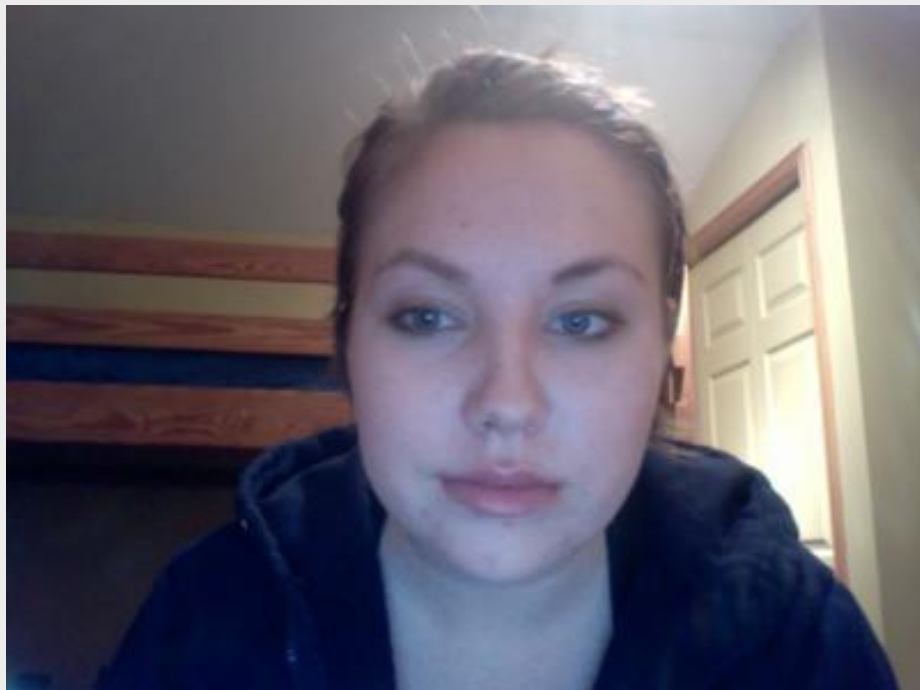
FACE RECOGNITION



WHAT WE HOPE IT IS:



WHAT IT REALLY IS:





FACE RECOGNITION APPLICATIONS

AUTHENTICATION

So far vulnerable

SECURITY

False positives, false negatives?

COMMERCIAL APPLICATIONS

Personalized advertisements

INTERNET

Person search
