# Influence of Skin Diseases on Fingerprint Recognition

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# Talk Structure

- Damaged Fingerprint
- Fingerprint Skin Structure
- Influence of Skin Diseases on Fingerprints
- Diseased Fingerprint Database
- Classification of Skin Diseases
- Attributes of biometric characteristics
- Concept and Implementation of Algorithms
- Fingerprint Recognition
- Preprocessing
- Detectors
- CNN Algorithms
- CNN Performance

# Damaged Fingerprint

- Undamaged or perfect fingerprint is just a theoretical term
- An ideal fingerprint has nicely visible ridges (Papillary lines)

Figure: A nearly ideal fingerprint

Damages can be basically divided into three groups:

- Finger and user condition
  - Dirt on the finger: Thicker ridges, Broken ridges, Additional false minutiae points
  - Dry or moist finger
  - The physically damaged finger
- Sensor effects
  - Dirt on the surface of the sensor
  - Physical damage of the sensor
  - Sensor technology
- Influence of the environment
  - Vibration can create a blurred image
  - The surrounding light
  - The electromagnetic radiation

# Damaged Fingerprint-cont.

Figure: Additional minutiae points caused by hair (left), Broken ridges caused by fine sand(right).

Figure: The surrounding light impact on fingerprint image

The skin is composed of 3 main layers:

- The epidermis (outer) layer,
- The dermis (inner) layer and
- The fat layer found below the dermis.

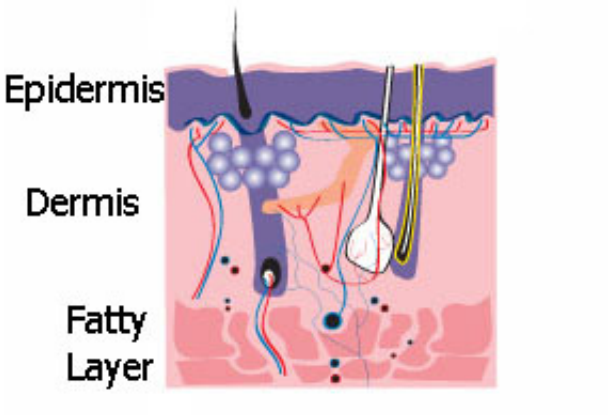



Figure: Skin structure

Skin diseases cause serious damages: in fingerprints

1. Diseases causing histopathologic changes of epidermis and dermis – can influence either the color or the internal structure of the skin
2. Diseases causing skin discoloration
3. Histopathologic changes of epidermis and dermis and skin discoloration – could cause structure changes underneath the skin at the junction between dermis and epidermis

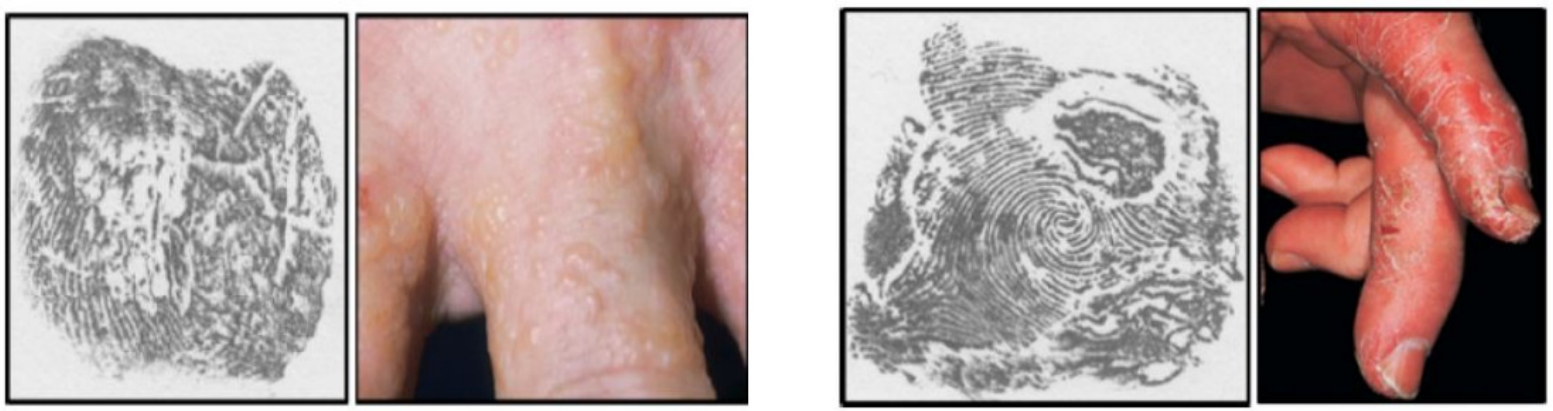


Figure: Dyshidrotic Eczema, belongs to the first group (left), Psoriasis, belongs to the third group (right)

Raynoud's phenomenon belongs to the second group (Skin discoloration)

- Have problem with optical scanner

# Diseased Fingerprint Database

Over 2,000 fingerprints images

- Database analysis
  - 12 common features
    - 7 of them are local features
    - The other 5 were global image patterns

Local features:

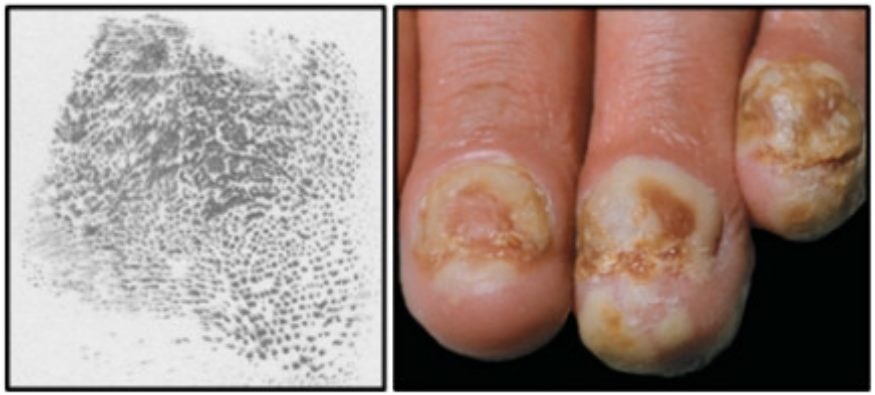
- Straight Lines (SL),
- A grid (G),
- Small papillary lines distruptions (PLD),
- Small cheetah spots (CS),
- Larger round/oblong spots (ROS),
- Large irregular spots (IS) and
- Dark places (DP),

Other five features:

- Blurring of (parts of) the image(B),
- A significantly high contrast of the image (HC),
- The entire fingerprint area affected (EA),
- Total deformation of the fingerprint image (TD),
- A significantly high quality and healthy fingerprint (HQ).

**Acrodermatitis continua.**

- Chronic inflammatory disease of the hands and feet
- Small round spots that look like a cheetah skin and cover usually the whole fingerprint
- Papillary lines cannot be recognized at all

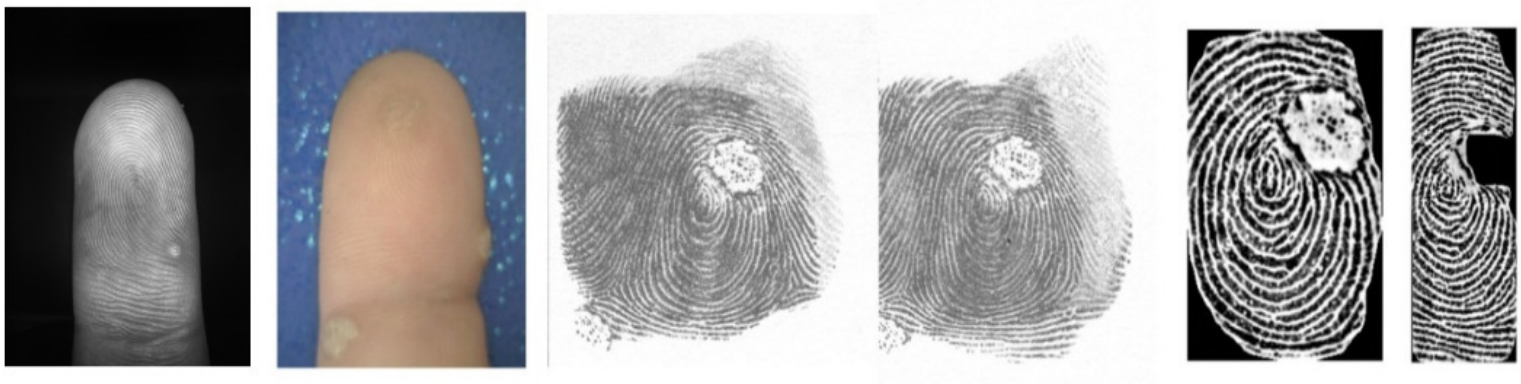


**Cut wound**

- Causes blurred white area
- The damage is minor
- It's not difficult to remove

## Verruca Vulgaris (Warts)

- Very common skin disease
- Influence on the fingerprint is minor and easily removable



**Advanced atopic eczema** Two groups of these fingerprints:

- Less (papillary lines partially unreadable.)
- More severely (This type of damage is by no mean recoverable)

Diseases were classified into three categories according to the seriousness of the damage:

- Minor damage: verruca vulgaris, cut wound, Scleroderma
- Medium damage: mild form of fingerprint eczema, hyperkeratotic eczema, colagenosis
- Major damage (unrecoverable): acrodermatitis, severe form of fingertip eczema, psoriasis

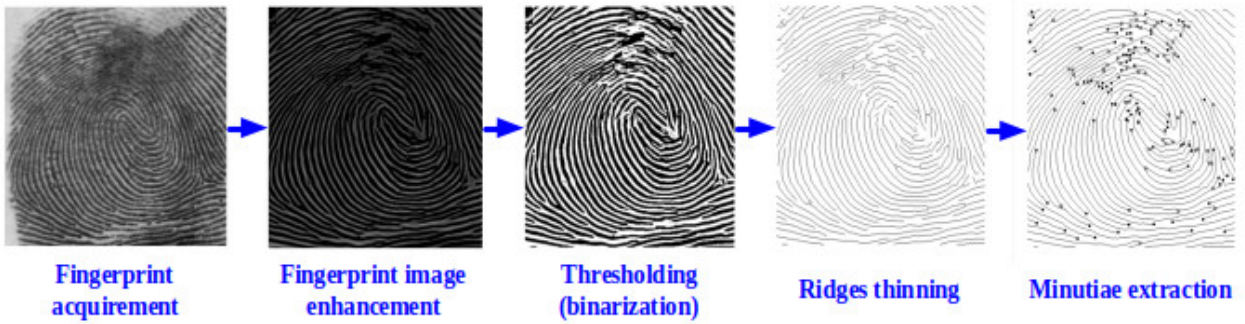
- Detection of various types of skin diseases
- Distinguish between healthy, partially damaged and unrecoverable fingerprints
- Fingerprint recognition uses slightly different features
  - Harris detector, Detection of interest points, etc.

Some examples of algorithms for dealing with damaged fingerprints:

- Object detection algorithms
- Block orientation field
- Histogram analysis
- Connected component labeling
- Local Binary patterns

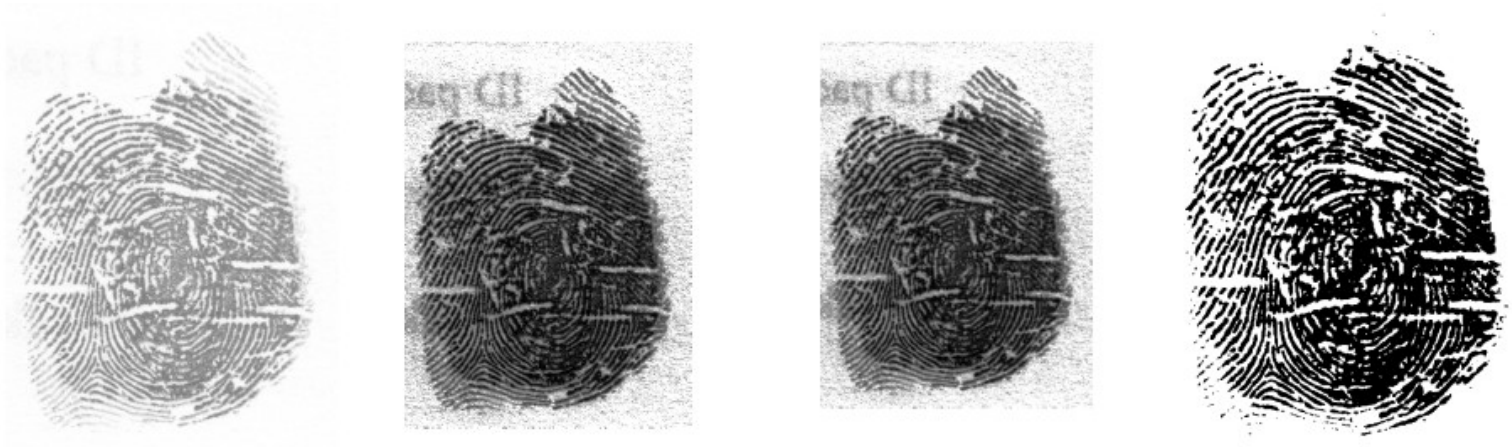
# Fingerprint Recognition

- Fingerprint acquisition
- Fingerprint enhancement
- Thresholding
- Ridges thinning
- Minutia extraction

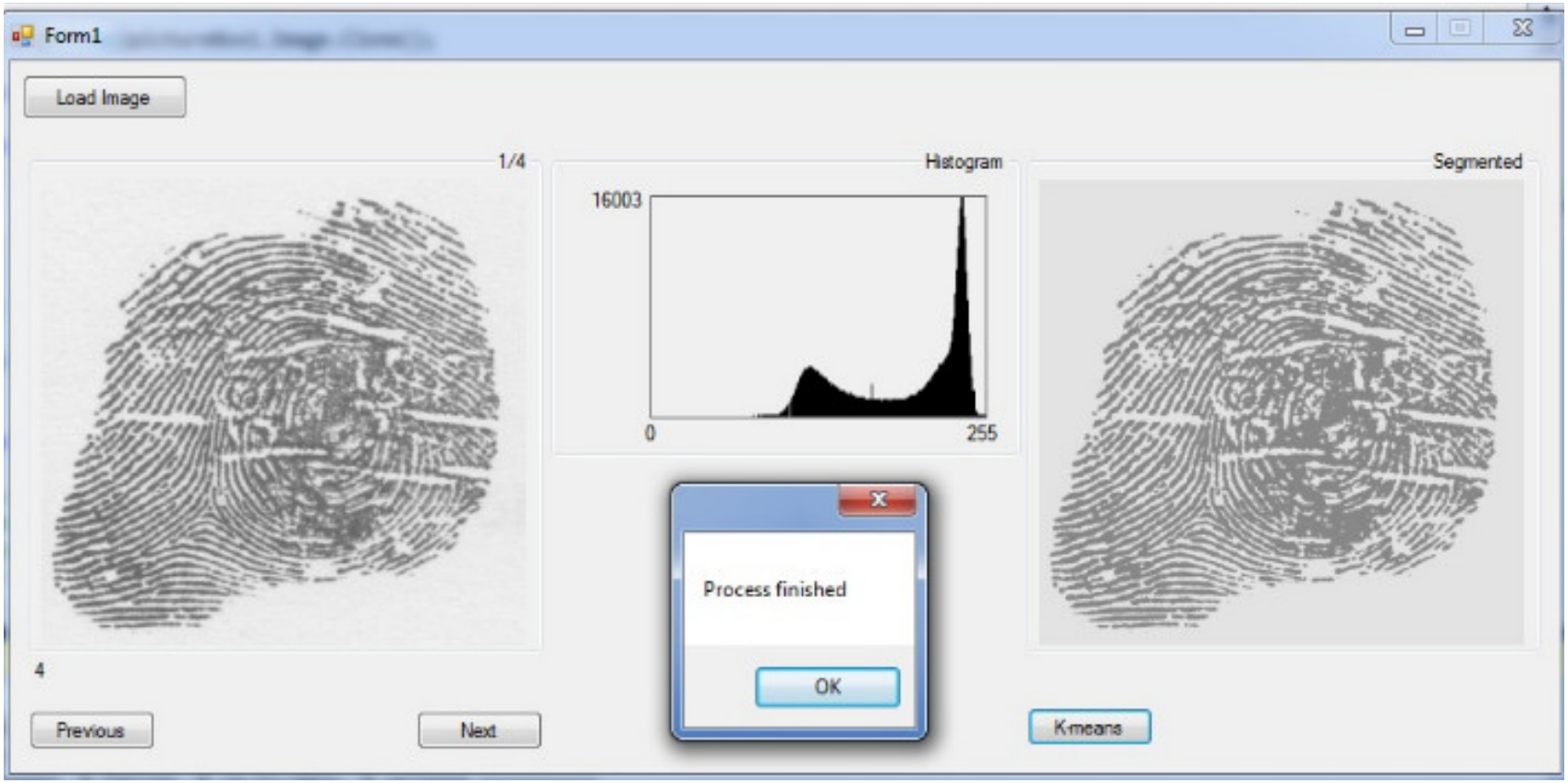


The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze.

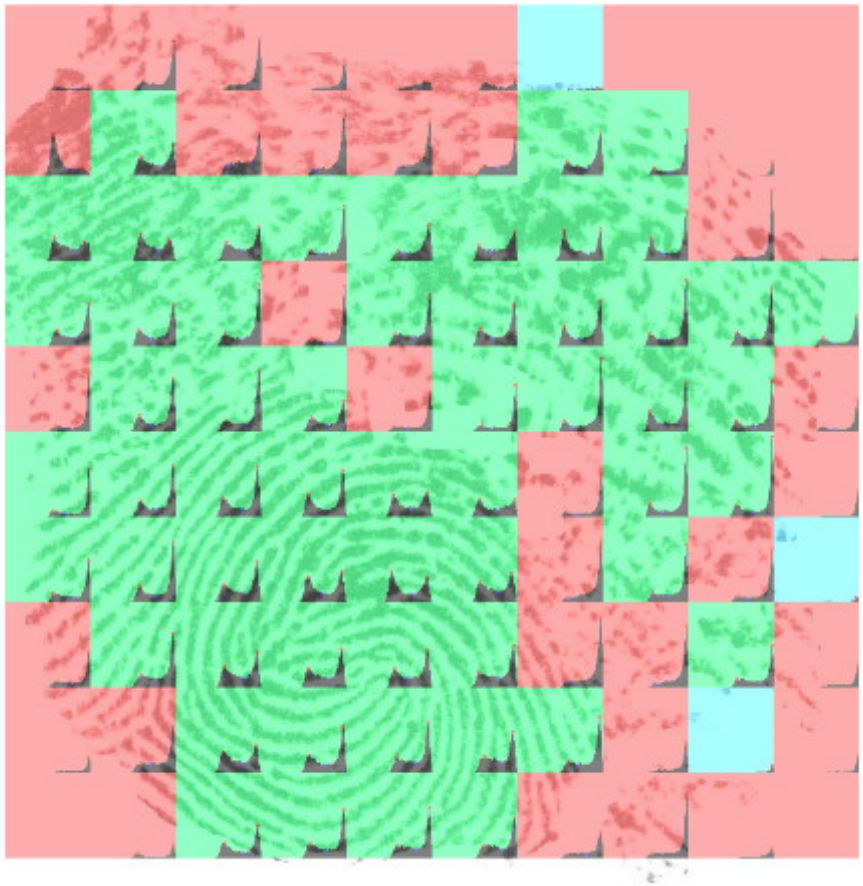
Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images.



**Histogram equalization** A histogram of an ideal fingerprint has only two peaks visible one representing ridges and one representing background and valleys.



**Histogram equalization** of a fingerprint image



**Thinning**
is a morphological operation that is used to remove selected foreground pixels from binary images.

Reducing all lines to single pixel thickness.

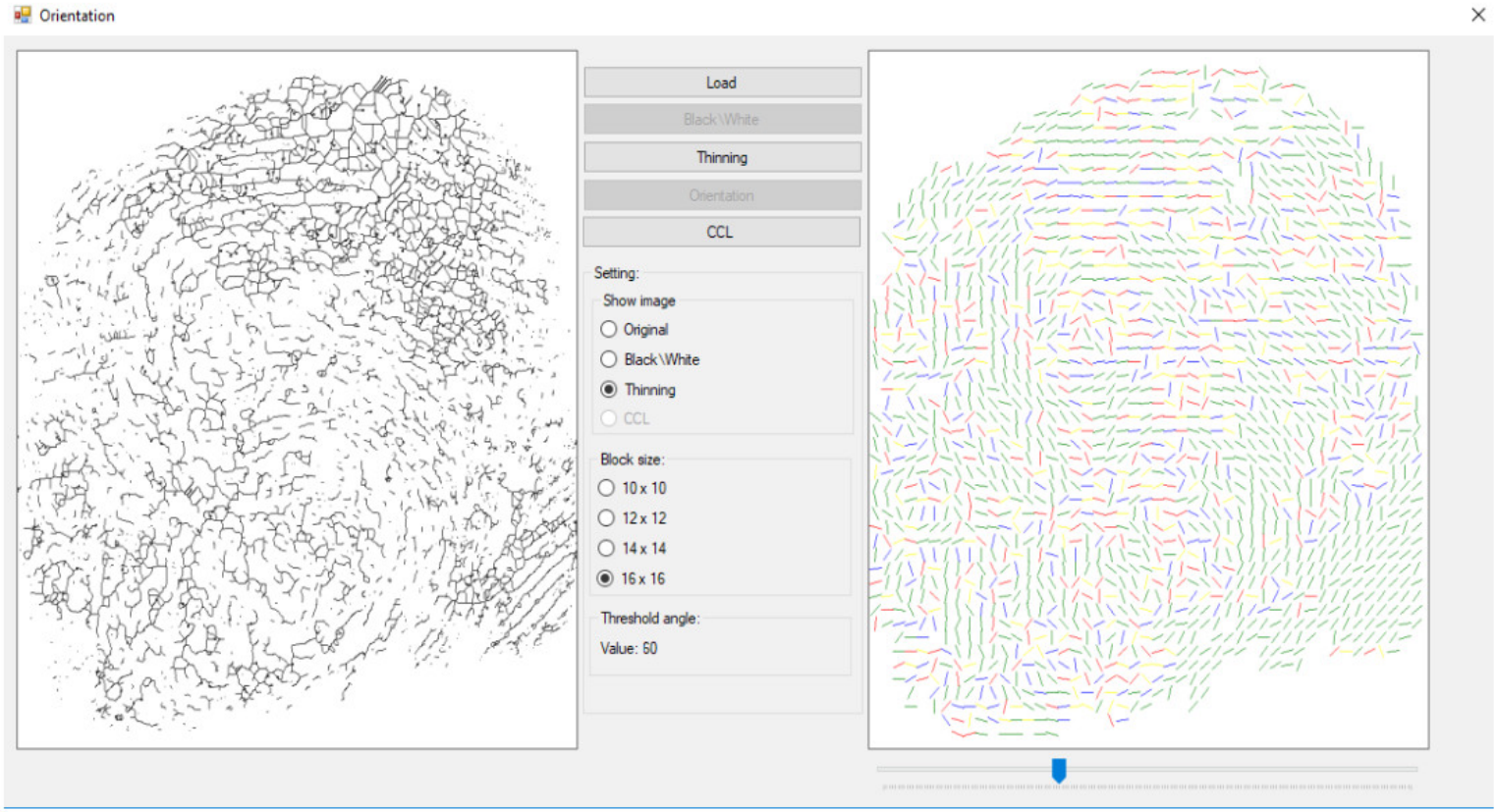



Figure: Thinning of a fingerprint image affected by skin disease

Gradients are the small changes in the x and y directions. There are two important attributes of an image gradient:

- Magnitude: is the L2-form of the vector, $g = \sqrt{g_x^2 + g_y^2}$
- Direction $\Theta$ = arctan $(g_y/g_x)$

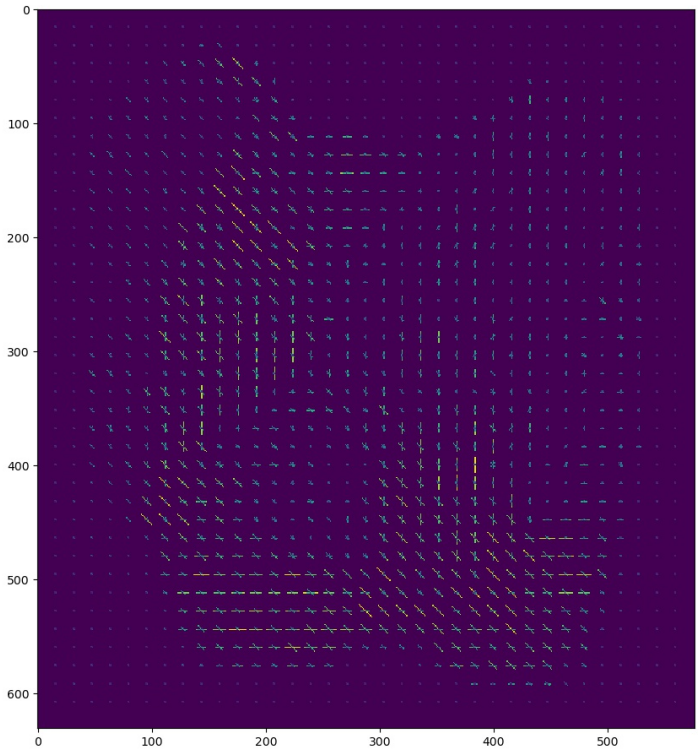



Figure: Histogram of gradient

Blob detection algorithm as a detector:

- Aim at detecting regions in an image
- Blob: a region of an image in which some properties are approximately constant

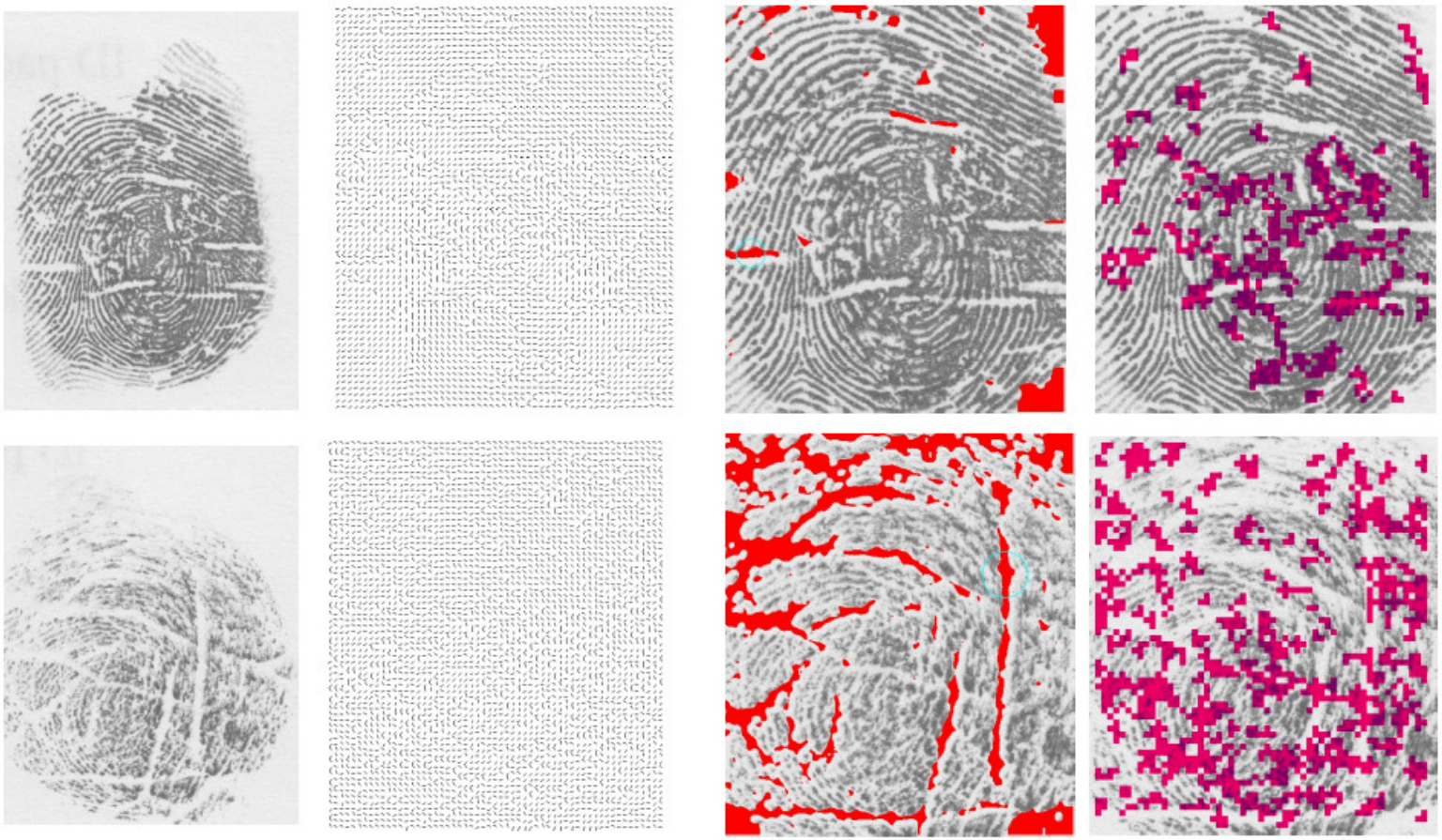


Figure: Blob detection algorithm results

**Flood fill** is an algorithm mainly used to determine a bounded area connected to a given node in a multi-dimensional array.

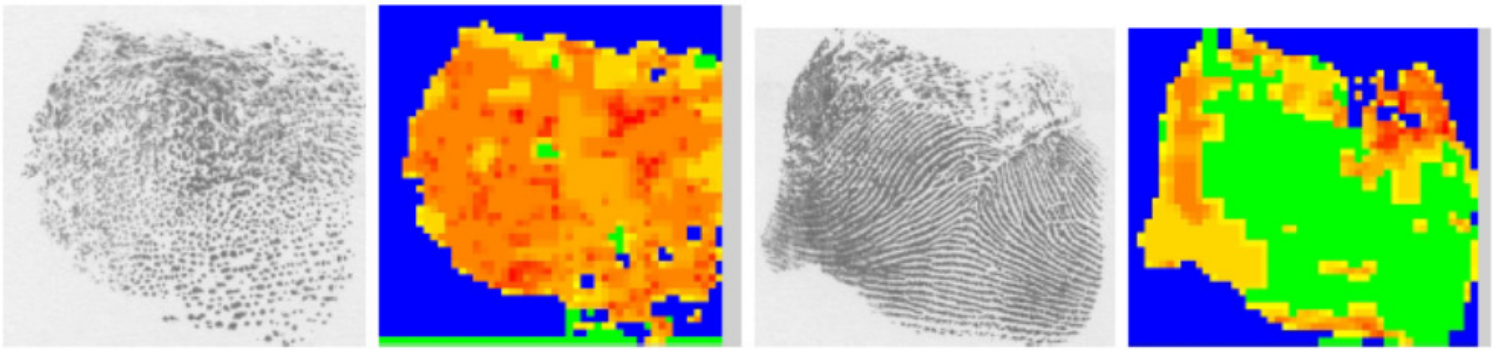
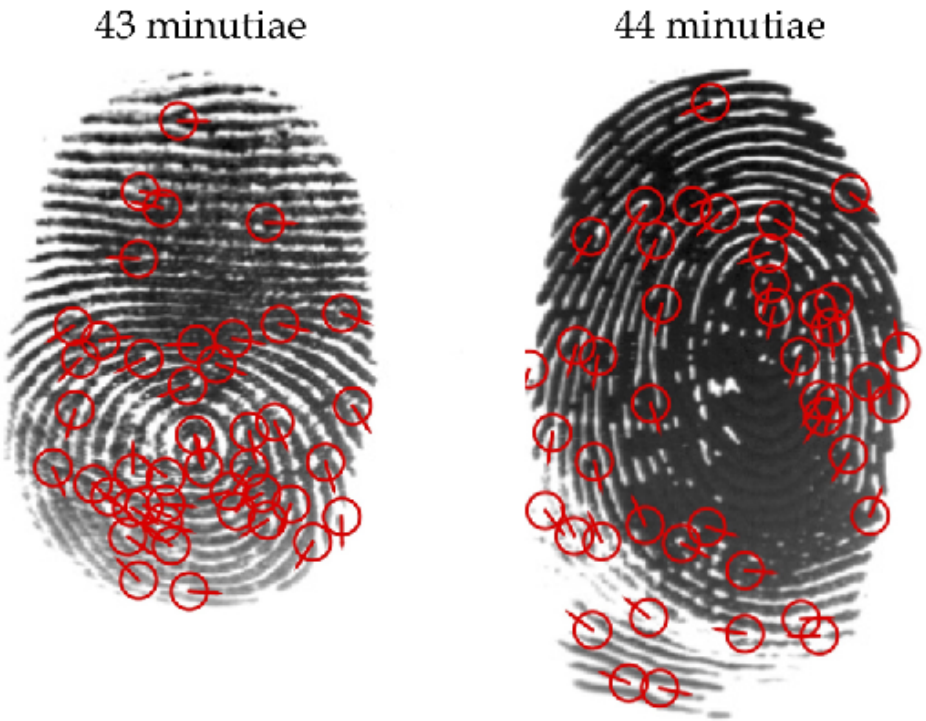
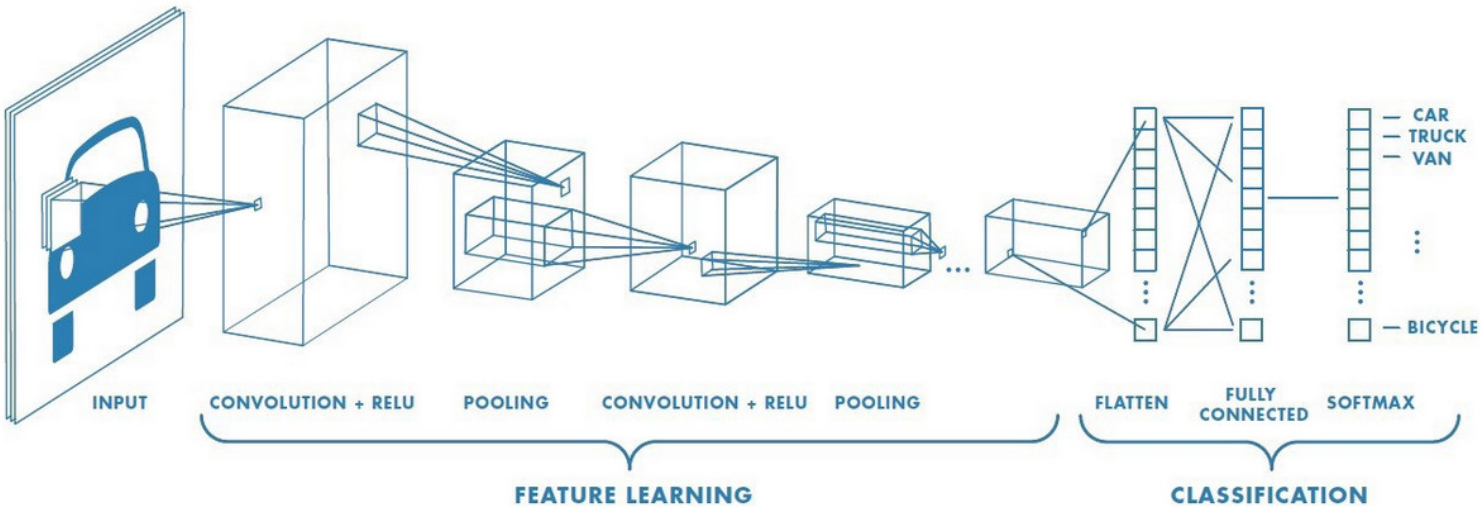


Figure: Damage localizer using Flood-Fill algorithm

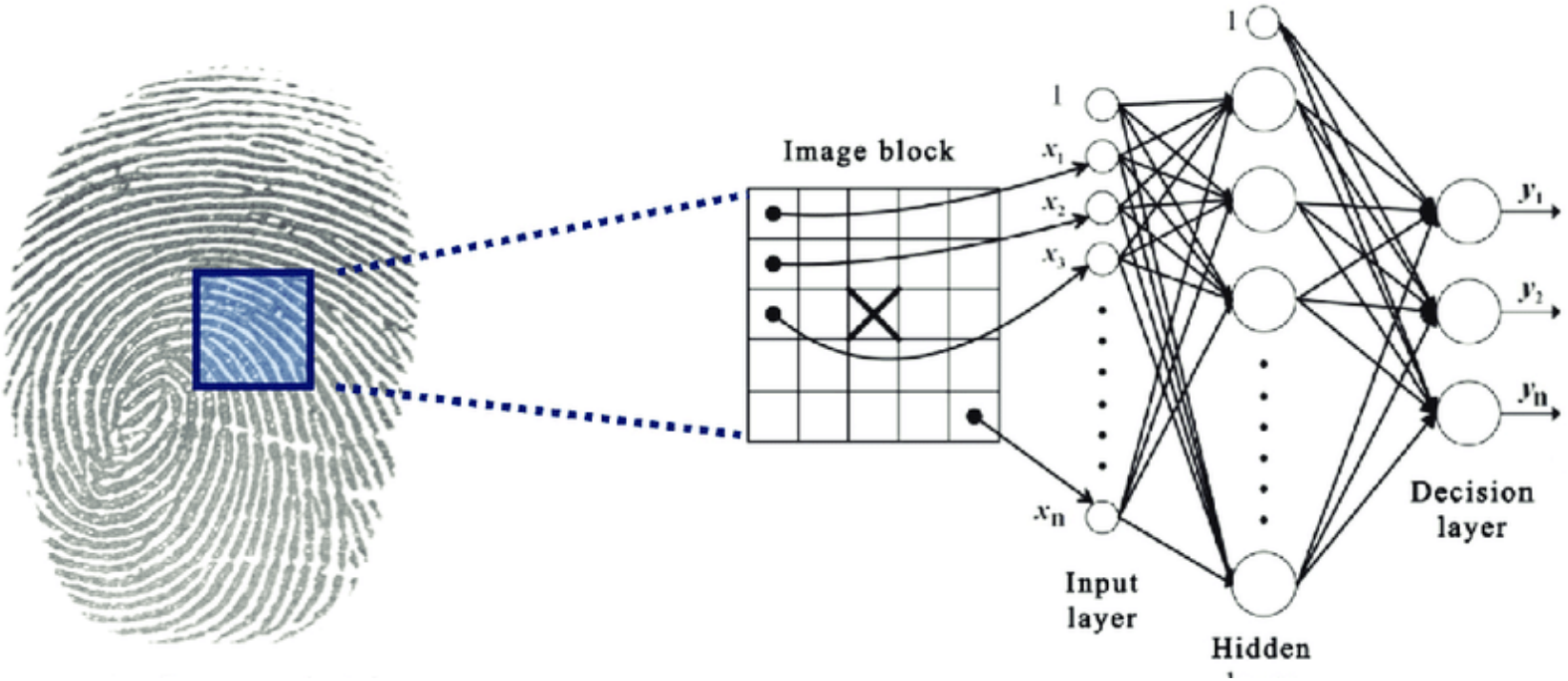
# Feature Matching



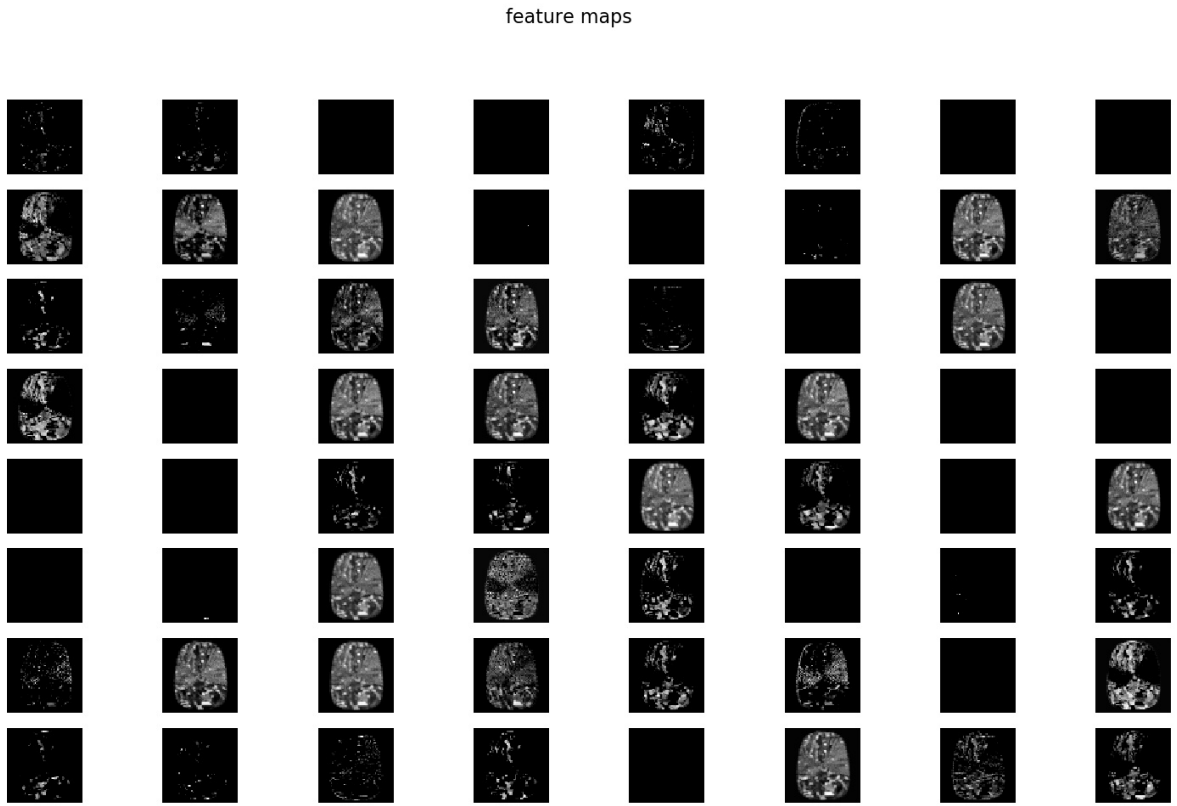
Data are distributed normally into two classes. The goal of using the CNNs is to classify the images and compute the accuracy of the network.



# CNN Algorithms-cont.

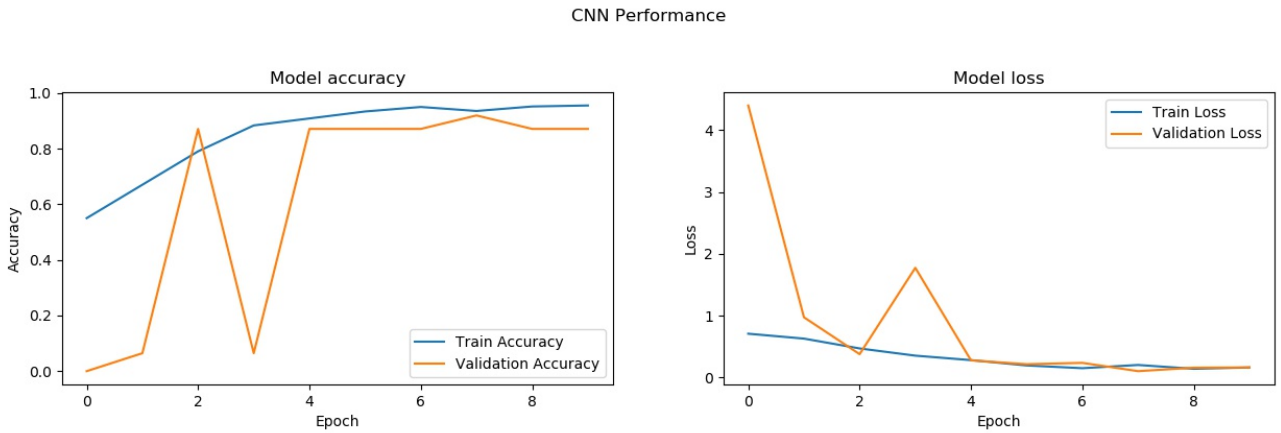


# Visualizing Convent Filters

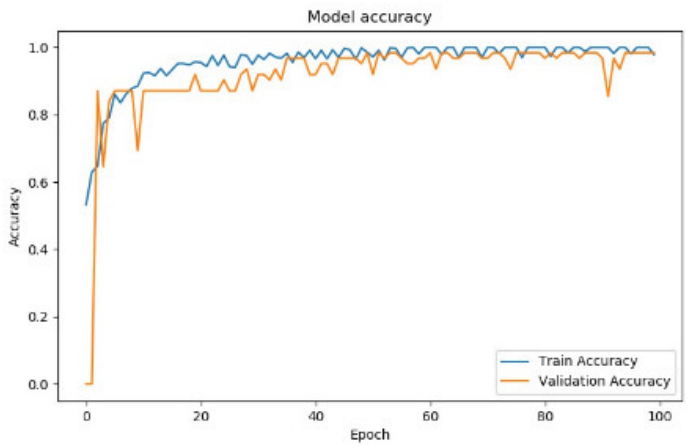


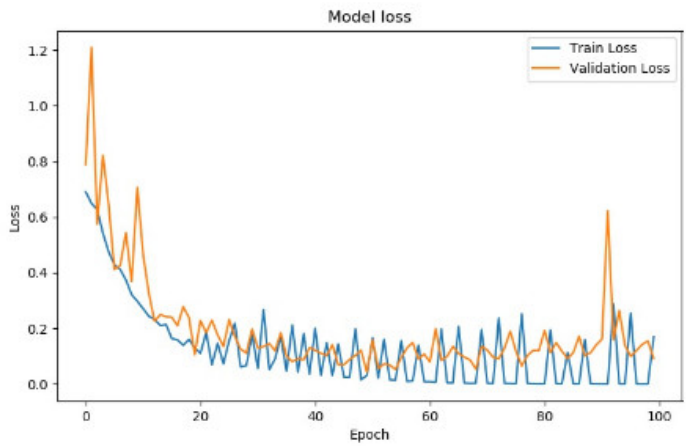

CNNs look for "features" such as straight lines. As such whenever those features get spotted-they will be reported to the feature map. Each feature map is looking for something else. One feature map could be looking for straight lines, the other for curves. The feature maps also look for their features in different locations.

The performance of the network with less amount of the data and only 10 epochs.



The accuracy of the network with more data and 100 epochs.
The amount of data-set improves the performance of a network.
More data more accuracy.



Thank You For Your Attention!