Fingerprint Recognition System Using Cellular Neural Networks

- The main purpose is to implement a Finger print recognition system based on Cellular Neural Network (CNN) algorithm, which is divided into three parts:

  - Fingerprint Enhancement.

  - Ridgeline Thinning.

  - Matching & Recognition.

What is Fingerprint

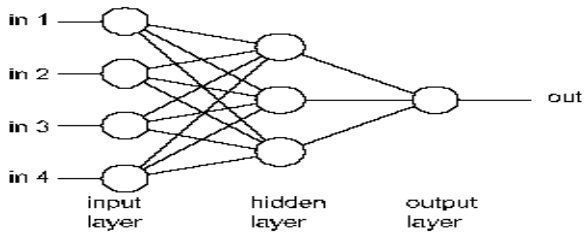
A fingerprint in its narrow sense is an impression left by the friction ridges of a human finger. The recovery of fingerprints from a crime scene is an important method of forensic science. Fingerprints are easily deposited on suitable surfaces (such as glass or metal or polished stone) by the natural secretions of sweat from the Eccrine glands that are present in epidermal ridges.

In a wider use of the term, fingerprints are the traces of an impression from the friction ridges of any part of a human or other primate hand. A print from the sole of the foot can also leave an impression of friction ridges.

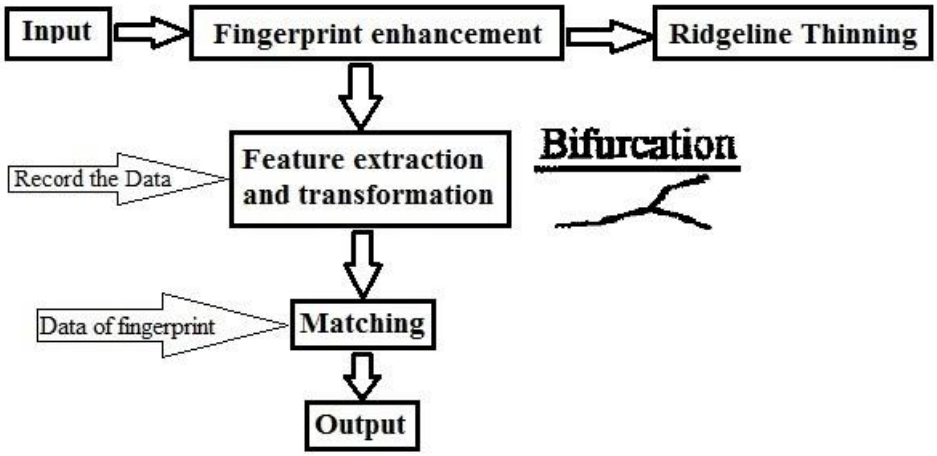
Deliberate impressions of fingerprints may be formed by ink or other substances transferred from the peaks of friction ridges on the skin to a relatively smooth surface such as a fingerprint card.[2] Fingerprint records normally contain impressions from the pad on the last joint of fingers and thumbs, although fingerprint cards also typically record portions of lower joint areas of the fingers.

What is Cellular Neural Network (CNN)

It is difficult to give a precise definition for a CNN processor their number and variety of architectures. From an architecture standpoint, CNN processors are a system of a finite, fixed-number, fixed-location, fixed-topology, locally interconnected, multiple-input, single-output, nonlinear processing units. The nonlinear processing units are often referred to as neurons or cells. Mathematically, each cell can be modeled as a dissipative, nonlinear dynamical system where information is encoded via its initial state, inputs and variables used to define its behavior. Dynamics are usually continuous, Continuous-Time CNN (CT-CNN) processors, but can be discrete, Discrete-Time CNN (DT-CNN) processors. Each cell has one output, by which it communicates its state with both other cells and external devices. Output is typically real-valued, but can be complex or even quaternion, i.e. Multi-Valued CNN (MV-CNN). In most CNN processors, processing units are identical, but there are applications that require, Non-Uniform Processor CNN (NUP-CNN) processor, consisting of different types of cells.



How it works



The system described here is depicted in above drawing.
Fingerprint enhancement and ridgeline thinning are employed before matching. Then feature extraction, recording the bifurcation, and transformation are completed. Finally the results are compared with database of fingerprint for identifying.

- ## Fingerprint enhancement

GABOR-TYPE FILTERS is described that fingerprint which is like sinusoidal wave is presented in form of level and smooth profile, and every point which is on the profile is fit the relative varied angle. After importing the image, the angle of every point is compared with the angle of relative else point. If the value is different and the smooth result is presented by the other points, it will be enhanced, and then the clear picture is presented.

- ## Ridgeline thinning

Because it is more difficult to search the bifurcation directly from fingerprint by Cellular Neural Networks, ridgeline must be thinned before extracting the feature point.
Ridgeline thinning, exactly as its meaning, let the object on the image which could be presented by its skeleton, and the width is just one pixel.

- ## Matching and Recognition

Feature extraction:

- **Feature Extraction using CNN**

The method of feature extraction could be described by the function:

$$\sum_{k=1}^{8}\left|P(k+1)-P(k)\right|=12$$

- **State Dynamic Route**

  State Dynamic Route is applied to analyze the path of varied state when the parameter is given. CNNFeatureExtract is presented below:

$$\dot{x}_{ij} = -x_{ij} + A \otimes Y_{ij} + B \otimes \left|U_{ij}\right| + z$$

$$\dot{x}_{ij} = \underbrace{-x_{ij} + a_{00} f(x_{ij})}_{g(x_{ij})} + \underbrace{\overline{A} \otimes Y_{ij} + B \otimes \left|U_{ij}\right| + z}_{w_{ij}(t)}$$

$$\dot{x}_{ij} = g(x_{ij}) + w_{ij}(x_{ij}, t)$$

Matching:

The idea is implemented according to the distribution of feature points. At first, the point at the center is the origin and then distance and the angle of the feature point are recorded. Then, the records are classified by the structure of disc. The Mean and standard deviation of angle and distance in sector are calculated and recorded. Finally, the process of matching is performed.