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GENERALIZED NET MODEL OF IRIS RECOGNITION USING NEURAL NETWORKS

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Abstract: The present paper describes the process of scanning, preprocessing, learning and recognition of the iris. For the purpose we use generalized nets. The model describes an algorithm for the entire process, beginning with scanning, preprocessing of the pictures, and preparing the neural network. In the final stage, the neural network recognizes the different irises.

Keywords: Generalized nets, Iris scanning, Neural network, Modelling.

1. Introduction

Iris recognition is a form of biometric identification, like fingerprinting. Like the fingerprint, the pattern in the iris is randomly formed during gestation, so no two individuals have identical iris patterns [4-13].

Iris recognition has many advantages over other potential biometric technologies. One is that it can be used to identify a larger portion of the population than other biometric technologies, including fingerprinting. Another advantage is that the iris remains more stable than other biometric measures, meaning that once an iris map is registered, a person may not need to be re-registered for 30 years or more. Iris recognition is also relatively fast, so it has the potential for immediate commercial application.

Iris recognition is, however, probably many years away from widespread application due to a number of factors. First, building up an appropriate database of iris maps will take a long time, whereas the database for fingerprints and the technology for taking and checking fingerprints is already in place. Also, it is very difficult to use iris identification on an unwilling subject. The position of the eyelid and eyelashes can also lead to false rejects.

In addition, current iris recognition technology is susceptible to many types of frauds, including the use of a dead eye, or even a high-quality photo of a face. However, there are several recommendations for overcoming this weakness, including the use of changing light conditions to measure the iris at several points as it expands or contracts in response to the light.

Although prototype systems had been proposed earlier, it was not until the early nineties that Cambridge researcher, John Daugman, implemented a working automated iris recognition system [15, 18]. Even though the Daugman system is the most successful and most well known, many other systems have been developed. The most notable include the systems of Wildes et al. [17] and Lim et al. [14].

2. Generalized net model

All definitions related to the concept of generalized nets are taken from [1-3]. In [10], the GN models of image processing, pattern and face recognition were constructed.

The model describes an algorithm using a phase-based image: an image matching technique using only the phase components.

The generalized net, as illustrated in Figure 1, consists of the set of transitions:

$$A = \{Z_1, Z_2, Z_3, Z_4, Z_5, Z_6\},$$

where the transitions describe the following processes:

- Z_1 – Eye acquisition;
- Z_2 – Preprocessing;
- Z_3 – Eye extraction;
- Z_4 – Choosing of the structure of the neural network;
- Z_5 – Forming the initial weight coefficients;
- Z_6 – Learning and recognition process of the neural network.

Initially in place L_1 one token stays with the characteristic "Person for recognition"; and one token stays in place L_{11} with the characteristic "Database with neural networks structures". These tokens will remain in these places during the whole time-span of GN functioning.

The forms of the transitions are the following.

$$Z_1 = \langle \{L_1, L_3\}, \{L_2, L_3\}, R_1, \vee(L_1, L_3) \rangle$$

where:

$$R_1 = \begin{array}{c|cc} & L_2 & L_3 \\ \hline L_1 & True & False \\ L_3 & W_{2,2} & W_{2,3} \end{array},$$

- $W_{2,2}$ = "The eye is scanned successfully",
- $W_{2,3} = \neg W_{2,2}$.

The tokens entering place L_2 obtain characteristics: "Image of the scanned eye".

Here have to use a CCD camera without any contact between the camera and eyes.

The next step is to prepare the image for the next process. Here, the pupil has to be placed in the center of the image. If the image is small, it has to be enlarged to a reasonable radius. The outer boundary of the pupil has to be placed in the right place in order to be properly recognized.

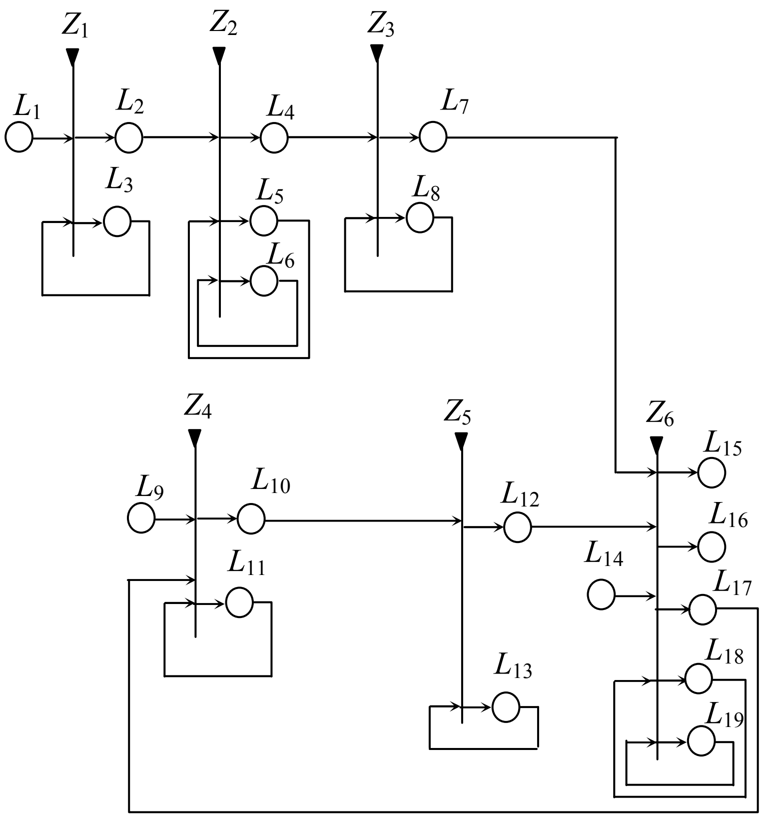

Figure 1. Generalized net model of iris recognition using neural networks

The second transition has the form:

$$Z_2 = \langle \{L_2, L_5, L_6\}, \{L_4, L_5, L_6\}, R_2, \vee(L_4, L_5, L_6)\rangle,$$

where:

$$R_2 = \begin{array}{c|ccc} & L_4 & L_5 & L_6 \\ \hline L_2 & False & True & False \\ L_5 & False & W_{5,5} & W_{5,6} \\ L_6 & W_{6,4} & False & W_{6,6} \end{array},$$

- $W_{5,5}$ = “The pupil of the eye is not in the center and has to be moved”;
- $W_{5,6} = \neg W_{5,5}$;
- $W_{6,6}$ = “The iris of the eye does not fill up the image and has to be zoomed”;
- $W_{6,4} = \neg W_{6,6}$.

The token that enters place L_4 obtains the characteristics “Image with a centered pupil and filled iris”.

The third transition has the form:

$$Z_3 = \langle \{L_4, L_8\}, \{L_7, L_8\}, R_3, \vee(L_4, L_8)\rangle$$

where:

$$R_3 = \begin{array}{c|cc} & L_7 & L_8 \\ \hline L_4 & False & True \\ L_8 & W_{8,7} & W_{8,8} \end{array}.$$

- $W_{8,7}$ = "Iris feature points are extracted";
- $W_{8,8} = \neg W_{8,7}$.

The token that enters place L_7 obtains characteristic "Extracted iris feature points".

According to [14, 18], Gabor transform and wavelet transform are typically used for analyzing the human iris patterns and extracting feature points from them [4–16]. Here, a wavelet transform is used to extract features from iris images.

The fourth transition has the form:

$$Z_4 = \langle \{L_9, L_{17}, L_{11}\}, \{L_{10}, L_{11}\}, R_4, \vee(L_9, L_{17}, L_{11})\rangle,$$

where:

$$R_4 = \begin{array}{c|cc} & L_{10} & L_{11} \\ \hline L_9 & False & True \\ L_{17} & False & True \\ L_{11} & W_{11,10} & W_{11,11} \end{array},$$

- $W_{11,10}$ = "The SOM structure are chosen",
- $W_{11,11} = \neg W_{11,10}$

The token that enters place L_{10} obtains the characteristic "SOM structure".

The fifth transition has the form:

$$Z_5 = \langle \{L_{10}, L_{13}\}, \{L_{12}, L_{13}\}, R_5, \vee (L_{10}, L_{13})\rangle,$$

where:

$$R_5 = \begin{array}{c|cc} & L_{12} & L_{13} \\ \hline L_{10} & False & True \\ L_{13} & W_{13,12} & W_{13,13} \end{array}$$

- $W_{13,12}$ = "The initial weight coefficients are forming",
- $W_{13,13} = \neg W_{13,12}$,

The token that enters place L_{13} obtains characteristic "Initial weight coefficients".

The sixth transition has the form:

$$Z_6 = \langle \{L_7, L_{12}, L_{14}, L_{18}, L_{19}\}, \{L_{15}, L_{16}, L_{17}, L_{18}, L_{19}\}, R_6, \vee(\wedge(L_7, L_{12}, L_{14}), L_{18}, L_{19})\rangle,$$

where:

$$R_6 = \begin{array}{c|ccccc} & L_{15} & L_{16} & L_{17} & L_{18} & L_{19} \\ \hline L_7 & False & False & False & True & False \\ L_{12} & False & False & False & True & False \\ L_{14} & False & False & False & True & False \\ L_{18} & W_{18,15} & W_{18,16} & W_{18,17} & False & W_{18,19} \\ L_{19} & False & False & False & W_{19,18} & True \end{array}$$

- $W_{18,17}$ = "The current structure of the SOM is not enough for the recognition" & "The current structure not satisfied threshold value";
- $W_{18,19} = \neg W_{18,17}$,
- $W_{18,15}$ = "The current structure is classified from the SOM" & "The result cluster already exist";
- $W_{18,16}$ = "The current structure is classified from the SOM" & "The result cluster not exist".

The tokens entering places L_{15} and L_{16} obtain characteristics, respectively "The iris fits to the existing clusters" and "The iris is classified as a new iris".

The token that enters place L_{19} obtains the characteristics: "Weight coefficients for SOM";

3. Conclusions

Here we design a generalized net model, that represent Iris recognition as a one on the most powerful biometric technologies for biometric identification existing.

The GN model can help the developers to make analysis and use them for the future.

The model is a part of the bigger generalized net model for the identification. Of course, the same of the transition can be detailized.

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