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A New Texture Analysis Approach for Iris Recognition

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Abstract

One of the most important authentication approaches is the iris recognition system (IRS), which is based on the iris of aperson for the authentication.In this paper, we propose a new iris recognition system using a novel feature extraction method. The proposed method, Neighborhood-based Binary Pattern, compares each neighbor of the central pixel withthe next neighbor to encode it by 1 if it is greater or 0 if it is lower than the central pixel. The obtained binary code is converted into a decimal number to construct the NBP image. In order to deal with the rotation problem, we propose an encoding process to obtain a rotation-invariant image. This image is subdivided into several blocks and the mean of each block is calculated. After, the variations of the means are encoded by a binary code. The obtained binary matrix is considered as feature descriptor of the iris. In the evaluation part, the CASIA iris database [10] has been used to evaluate the performance of the proposed IRS. The experiments demonstrate that the proposed method gives better recognition rate compared to the LBP method. Experimental results show also that the proposed system especially the feature extraction method gives promising results.

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Keywords : Iris Recognition System; Neighborhood-based Binary Pattern; Local Binary Pattern; Texture analysis; Mean variation.

1. Introduction

Computer vision is one of the most important areas of research, which provides efficient solutions to many problems. Patten recognition is mainlyused to recognize automatically different entities from an image. The

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security field has shown a real interest in computer vision particularly for the identification. Indeed, every human has particular properties from others such as shape, size etc…

Modern security sciences use these differences to control the access to restricted places, which is one of the fundamental problems in security field. The increasing need of the security field has given rise to the development of recent and efficient authentication systems.Old approaches of identification such as key or passwordare not satisfactory in many application areas. These conventional methods can be forgotten, stolen or cracked. For these weaknesses, the recent science is interested in automatic systems of identification which are based on biometrics technology [1].Biometric identification is subdivided into two main classes: physiological characteristics such as fingerprints, iris (Fig 1),and behavior characteristics such as voice. The need of reliable and secure systems has involved the emergence of the biometric systems. Fingerprint,face and speaker recognition have been widely studied. Among all the biometric recognition systems, Iris Recognition System (IRS) is the most efficient and reliable system [2] for authenticity check. Iris identification was proposed by Flom and Aran [12]. Recent surveys of iris recognition algorithms can be found in [13]. This is due to the stability of the human iris, its invariant over time and its uniqueness for each person. Even between brothers or twins [4].

The IRS is a high accuracy verification technology [5],and a valid biometrics approach for personal identification. The IRS has been wildly studied [4] and used especially in the security fields. Thus, many countries use IRS in order to improve their security such as in airports and government buildings.Although the iris identification theory was started earlier, most important recent works [6] have been inspired by the works of John Daugman [7].

A classical iris recognition system includes a series of steps: image acquisition, iris preprocessing (includes localization and normalization), feature extraction and matching steps [4]. These steps are illustrated in Fig 1.

The acquisition process is to get an iris image from a person using a specifically sensor [4]. The preprocessing process allowsto remove the useless information from the iris image and to extract only the region of interest (ROI), which is only the iris. This includes segmentation and normalization.The segmentation process consists to isolate the iris ring from the iris image. The normalization process is applied to produce an invariant iris area.It transforms the circular iris region into a rectangular region with fixed dimensional.In fact, the inner and outer boundary can approximately be taken as circles.But, the two circles are not co-centric. Daugman [7] proposed to apply the Integro-differential operator to detect the inner and the outer boundaries.

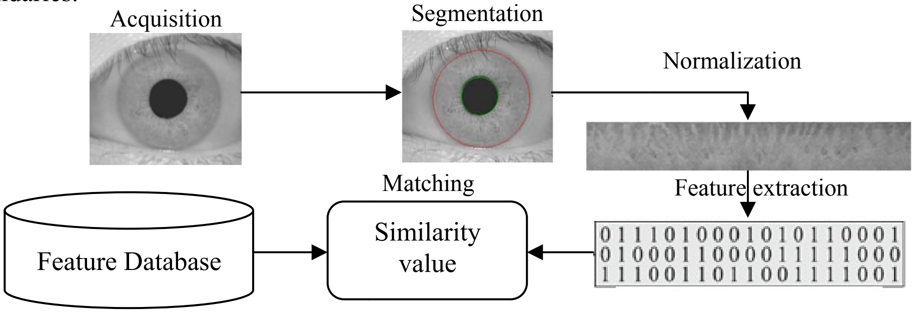

Fig.1. Typical iris recognition system.

This method (integro-differential) is used to transform the image from the Cartesian (x,y) to the polar coordinate(r, θ) space [4]. The center of the pupil is illustrated by a green point. The center of the iris is illustrated in red point in Fig 2.We can notice that the two boundaries are not co-centric.Fig 2 illustrates an iris image in the Cartesian coordinates and its rectangular transformation result.The third is the feature extraction step. The goal is to capture the relevant information from image. Daugman applied the Gabor filter on the rectangular iris. He used a multiscale quadrate method on the obtained image. This method encodes the signs of the real and the imaginary part of the Gabor coefficients. Each pixel is encoded by two binary codes. The generated binary code is called ‘Iris Code’ (Fig 2).

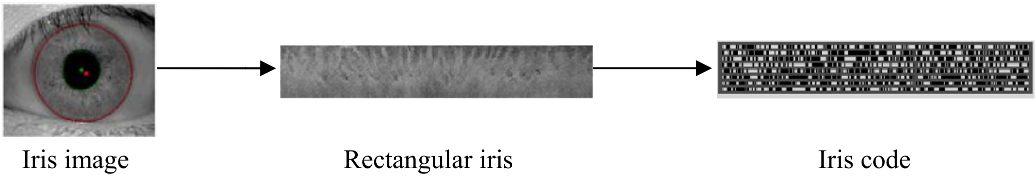

Fig.2. Normalization using Daugman’s rubber sheet model and extraction of the Iris code.

Fig. 2 illustrates an example of an iris image and its iris code. The positive coefficients are represented by a white line and the negatives by a black line. For the Matching step, a distance measure between a generated iris code and stored iris code is calculated. The query iris is considered authentic if the distance measure is below a threshold. Daugman has considered the quality of the iris image, and extracted a matching mask from the iris image. He used the Hamming distance (HD) to calculate the distance between two irises. For the identification, Daugman fixed the threshold of the matching around 0.34 [8]. The iris recognition system proposed by Daugman is often used and is a basis of all current iris recognition systems.

In order to extract the relevant information from an iris image, we propose a novel feature extraction method. The proposed method is inspired by the Local Binary Pattern (LBP) method. Some improvements are made to capture the local information and describe better the iris texture. This paper has been organized as follows: In section 2, our proposed method for iris texture analyses is explained. Section 3illustratessome experimental results.The conclusion of this paper is given in section 4.

2. Proposed method

In this section, we will details the proposed texture analysis method. This method is inspired from LBP method. So, the LBP method is briefly explained. After that, the proposed method is detailed on two parts.Part 1 explains our NBP method,Part 2 illustrates the invariance to rotation of NBP. Anillustration which summarizes the proposed architecture of the IRS will be also given.The Local Binary Pattern (LBP) operator was proposed by Ojala and Pietikainen in 1996 [9].And used in recent works [3][11].This method uses a 3x3 analysis window. The neighborhood of the central pixel is thresholded by the value of the central pixel. Each neighbor is coded by 1 if its value is above or equal than the central pixel value, and encoded by 0 otherwise. Binary code is obtained from the analysis window and converted into a decimal number LBP number.

By studying the iris recognition system detailed earlier, we can notice that the main step of recognition is the feature extraction. A novel transformation, called Neighborhood-based Binary Pattern (NBP), is proposed to extract the local features from the texture.

2.1. Neighborhood-based Binary Pattern

The NBP extracts the binary pattern by thresholding each neighbor of the central pixel by the next neighbor (starting from the top-left neighbor and going clockwise). The binary value of one neighbor is equal to 1 if its gray value is greater than the next neighbor, 0 otherwise.Fig 3 illustrates an example of the NBP method. The first neighbor (4) has a gray level value less than its next neighbor (6). Thus, its binary code is equal to 0. After that, the obtained binary code (11010) is converted into a decimal number (26) and considered as the value of the central pixel. Finally, the central pixel in the original image (5) will have the value 26 in the NBP image. NBP gets the relative connection between each neighbor of the central pixels Fig 3.

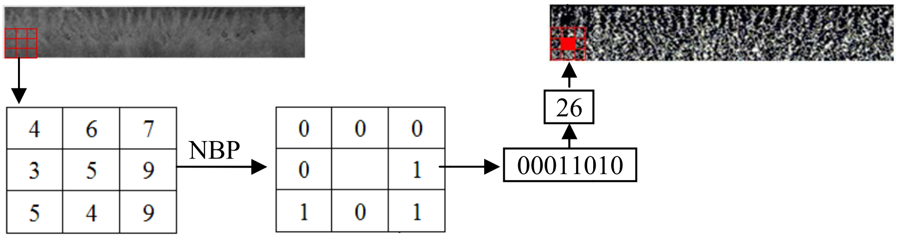

Fig.3. Extraction of the NBP pattern.

2.2. Rotation invariant Neighborhood-based Binary Pattern

Indeed, a small rotation of the same analysis window generates a different NBP code. In order to deal with the rotation problem of the NBP method, we proposed an encoding process. This encoding process starts relatively from the higher neighbor of the analysis window.Thus, even if the pattern is rotated, the encoding process gives the same code. This encoding process is illustrated in Fig4.

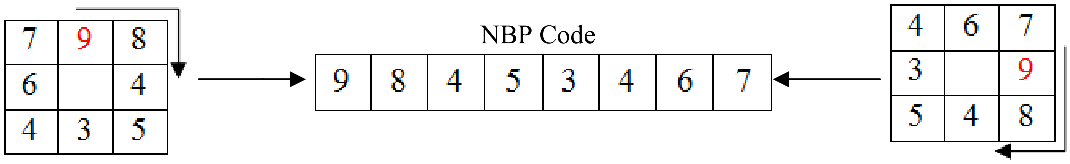

Fig.4. Rotation-invariant NBP method.

In order to describe the NBP image, we proposed to use a decomposing architecture.First, the NBP image is decomposed into several blocks. The mean of each block is calculated. After that, the variations of the means are encoded. One block is encoded by 1 if its mean are greater than its rightneighbor's mean, 0 otherwise. A binary matrix of the variation means are extracted and used as template of the iris(Fig5).

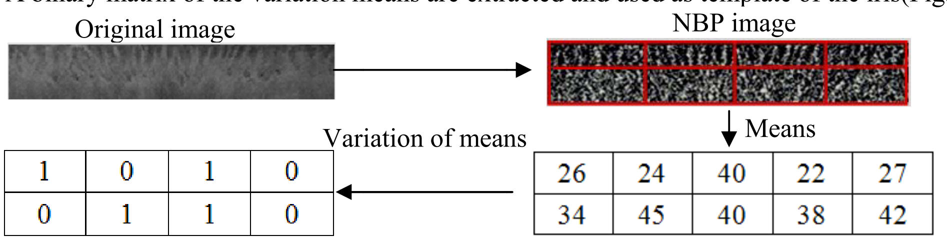

Fig.5. Mean variations encoding process.

Fig. 5 illustrates the variation encoding process. First, the NBP method is applied on the iris image. The obtained NBP image is decomposed into 2*4 blocks in red. The mean of each block is calculated. After that, the variation of the mean of each block is encoded. For example, the mean of the first block is equal to 26, which is greater than its right neighbor 24. Therefore, the first variation is coded by 1.

For the matching step, the intersection similarity measure is used. In order to compare two iris images, the similarity distance between the two features matrixes extracted are calculated following (1).

$$Dis(M1, M2) = \sum_{i=1}^{nb} S(i) \text{ where } \begin{cases} S(i) = 1 \text{ if } M1(i) = M2(i) \\ S(i) = 0 \text{ if } M1(i) \neq M2(i) \end{cases} \quad (1)$$

Where M1, M2 are the variation binary codes of the two iris images. S is equal to 1 if the i[th] blocks from M1 and M2 are the same, 0 otherwise. Nb is the number of blocks which depends on the decomposition of the iris image. If the distance Dis is above a threshold, the two irises are considered of the same person.

3. Experimental results

In order to evaluate our system performance, we have used the public iris database CASIA [10], which is a most used benchmark in the iris recognition research.In the evaluation process, three images from each person have been taken as a reference and four as test. In order to compare the LBP method and the proposed NBP method, twenty persons taken randomly from the database are used in the experimental process. Thus, 60 images are used as references and 80 as a test images. Each test image is considered as query. The LBP histogram is extracted and the mean variation of the NBP image is extracted. After that, the hammingdistance between the query's feature and the features extracted from all reference images of the database is calculated. The obtained hamming distances are sorted from the most similar to the dissimilar comparing to the query. A majority vote of the top three is considered and the query iris is classified following the majority. An experimental example is illustrated in Fig 6.

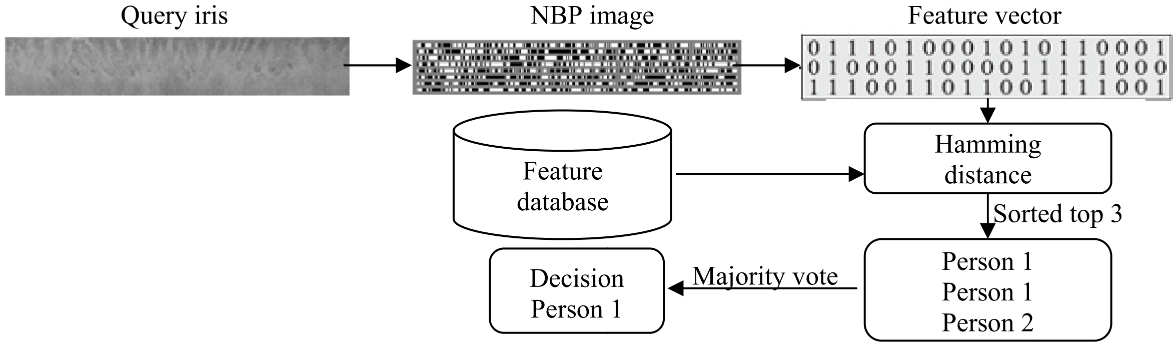

Fig.6. Example of the recognition process

The recognition rates (R.R) of the two methods are illustrated in Fig 7. The global rateof the LBP method is

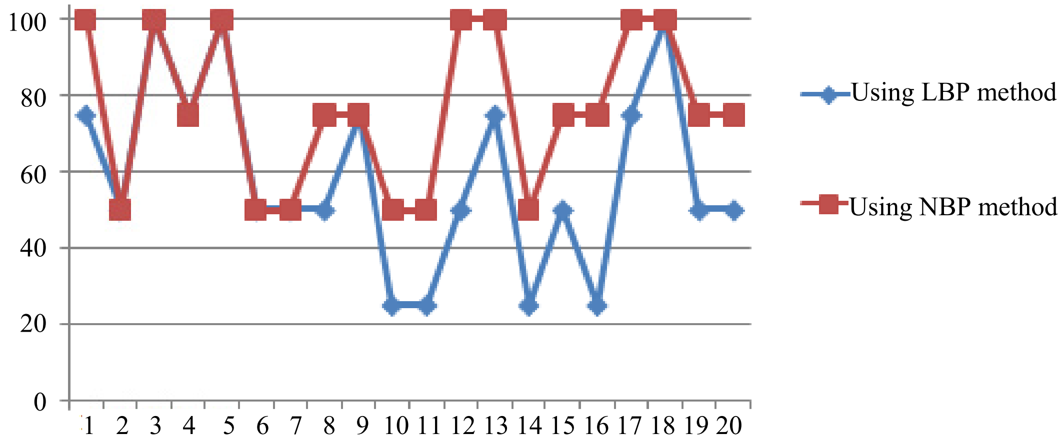

Fig.7. Recognition rate of each person using LBP and NBP

58.75% and the NBP method is 76.25%.We can notice, from the results, that the NBP method is better than the classical LBP method.Because in fact, the neighborhood of the central pixel is thresholded by its value using the LBP method.So, LBP get the relationship between each neighbor and the central pixel.However, the NBP method describes each pixel by the relationship of its neighborhoods.Experimental results demonstrate that it is more interesting to capture the relative pertinent information between the neighbors.Thus, the results have shown the robustness and the efficiency of the proposed NBP method.

4. Conclusion

In this paper, we have proposed a new IRS system. This system used a new feature extraction method NBP. The NBP method extracts the relative connection between neighbors of pixels. Each neighbor of each pixel is thresholded by the next neighbor and encoded.After that, the NBP image is decomposed into several blocks. The mean of each block is calculated. Then, the variations of the meanare encoded. The resulted binary matrix is used as a feature descriptor of the iris. In the experimentation, the CASIA iris database is used. Good performance has been obtained for the proposed IRS. We can summarize that the proposed NBP method is interesting since it gets the relative relevant information between the neighbors of pixels.In future works, we will study the combination of the NBP method with other approaches like Gabor transform.

References

[1] B.Fang,Y.Y.Tang, “Elasticregistrationforretinal images based on reconstructedvascular trees”, IEEE Trans. on BiomedicalEngineering,vol. 53, no. 6, pp. 1183–1187, June 2006.
[2] R. Szewczyk, K. Grabowski,M. Napieralska, W. Sankowski, M. Zubert, A. Napieralski, “A reliable iris recognition algorithm based on reverse biorthogonal wavelet transform”, Pattern RecognitionLetters, Volume 33, Issue 8, Pages 1019–1026,2012.
[3] Shu-Ren Zhou, Jian-Ping Yin, Jian-Ming Zhang,“Local binary pattern (LBP) and local phase quantization (LBQ) based on Gabor filter for face representation”. Neurocomputing, Vol.116 ,pp. 260-264, 2013.
[4] J.G. Daugman, “High Confidence Visual Recognition of Persons by a Test of Statistical Independence”, IEEE Trans. on Pattern Analysis and Machine Intelligence, vol. 15, no. 11, pp.1148-1161,1993.
[5] J.Daugman,C.Downing, “Epigenetic randomness, complexity, and singularity of human iris patterns”, Proceedings of the Royal Society (London) Series B: Biological Sciences,vol. 268, pp.1737–1740. 2001.
[6] Abidin, Z.Z.; Manaf, M.; Shibghatullah, A.S.; Anawar, S.; Ahmad, R., "Feature extraction from epigenetic traits using edge detection in iris recognition system," IEEE International Conference on Signal and Image Processing Applications (ICSIPA), pp.145-149, 2013.
[7]J. Daugman, “How iris recognition works”, IEEE Trans. on Circuits and Systems for Video Technology, vol. 14, no.1, pp. 21-30,2004.
[8] J. Daugman, “New methods in iris recognition”, IEEE Trans. on System, Man, and Cybernetics, vol. 37, no. 5, pp. 1167-1175, 2007.
[9] J. Daugman “The importance of being random: statistical principles of iris recognition”, Pattern recognition, vol. 36, no.2, pp. 279-291.2003.
[10]CASIA iris image database (v1.0), The National Laboratory of Pattern Recognition (NLPR), Institute of Automation, Chinese Academy of Sciences (CAS), 2006.
[11] Hamouchene I. Aouat S, Lacheheb H. “New segmentation architecture for texture matching using the LBP method”. IEEE Technically Co-Sponsored SAI Conference, London UK, 2013.
[12] L. Flom and A. Safir, “Iris Recognition System”, U.S. Patent 4,641,349, 1987.
[13] Kevin W. Bowyer, Karen P. Hollingsworth, Patrick J. Flynn, “A Survey of Iris Biometrics Research: 2008–2010”, Handbook of Iris Recognition, pp. 15-54, 2013.