THERMAL FACE RECOGNITION BASED ON PHYSIOLOGICAL INFORMATION

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Shinfeng D. Lin, Kuanyuan Chen and Wensheng Chen

Dept. of Computer Science and Information Engineering, National Dong Hwa University, Hualien, Taiwan

ABSTRACT

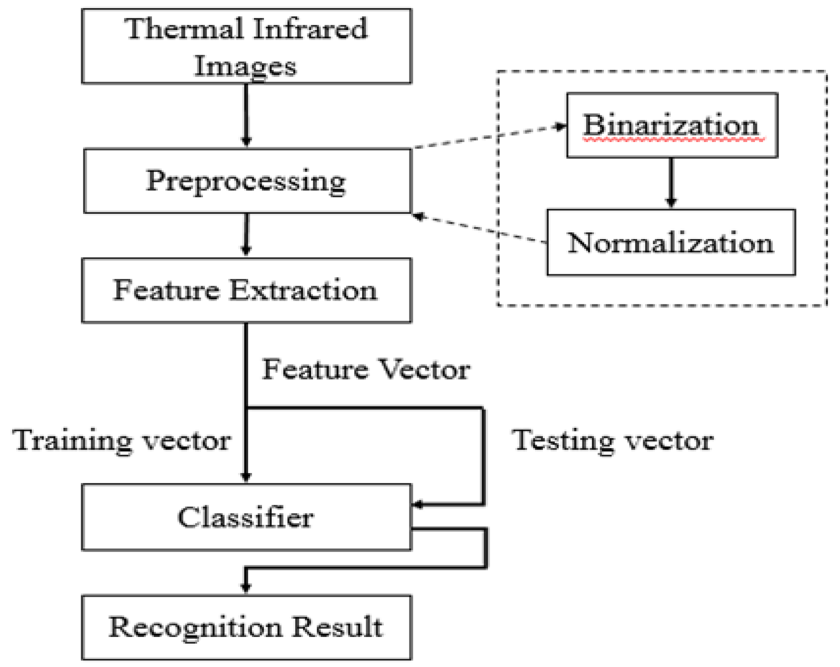
We propose a novel thermal face recognition based on physiological information. The training phase includes preprocessing, feature extraction and classification. In the beginning, the human face can be depicted from the background of thermal image using the Bayesian framework and normalized to uniform size. A grid of 22 thermal points is extracted as a feature vector. These 22 extracted points are used to train Linear Support Vector Machine Classifier (linear SVC). The classifier calculates the support vectors and uses them to find the hyperplane for classification. A feature vector of testing image is inputted to the classifier for face recognition. **Our contribution is that the proposed method firstly applies temperature information in face recognition.** Experimental results prove the effectiveness of the proposed method.

INTRODUCTION

Face recognition is generally important for many applications such as video surveillance, homeland security and identity management. The main spectrum of infrared for captured image is divided into near infrared (NIR) and thermal infrared (TIR). The physiological information of face thermal imaging is a dynamic temperature distribution from the heat transferred by the blood in the surface blood vessels, whose temperature gradually decreases toward the surrounding tissue.

Thermal face imaging may be affected by many factors such as physiological, environmental, and imaging conditions [1]. Buddharaju *et al*. [2] presented the vascular feature extraction algorithm for facial recognition. A network of blood vessel contour was extracted from the surface of the skin by using white top hat segmentation. It performed recognition by matching Thermal Minuta Points (TMP)-based feature vectors. Hermosilla *et al*. [3] proposed a classification system based on the "DrunkSpace". This system identified whether an individual is drunk, using pattern recognition and computer vision approaches. Vigneau *et al*. [4] analyzed the problems produced by temporal variations of infrared face images.

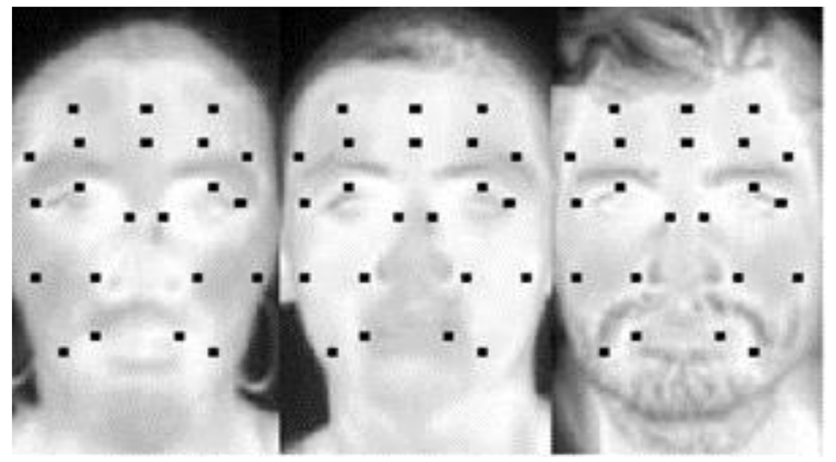
THE PROPOSED METHOD



Thermal Infrared Image

The images taken by a FLIR One Pro camera, include visible light and thermal.

Feature Extraction



22 points are selected at positions where there are veins and capillaries that cross the face[3]. The black block is a neighborhood of 3 × 3 pixels centered at every point of the grid.

Classification

In training phase, multi-class classification based on linear SVC. The 22 extracted points are used to train linear SVC, and classifier calculates the support vectors and uses them to find a hyperplane for classification. In testing phase, the support vector of testing image is calculated by the linear SVC. A probability value of the new feature vector calculated by each linear SVC for the corresponding category is exploited to identify which category it belongs to.

EXPERIMENT DATASET

The PUCV-TTF database consists of thermal images taken over time. The database includes 46 people with five subsets. Each subset has 50 images and a total of 250 images per subject.

The UCH-TTF database has 7 people, each of them has 50 face images. The images are cropped and aligned to 150*81 pixels and 125*225 pixels, respectively. Each of them has 350 thermal images of frontal faces.

(a) Normal (b) Occlusion (c) Noise2.5% (d) Noise5% (e) Noise10%

Each image was divided into 10 regions (5 rows, 2 columns) of equal size in Fig. b. Images with three different levels of noise: 2.5%, 5% and 10% (see Fig. c, d, e)

EXPERIMENTAL RESULTS

Performance with different feature size and normal face images (PUCV-TTF database)

	N=5	N=10	N=15	N=20	N=25	N=30
F=1	11.74	12.83	13.77	13.39	14.23	15.25
F=3	53.48	58.26	51.88	54.89	54.61	55.67
F=6	75.22	85.22	88.43	89.57	89.61	89.71
F=9	75.61	89.39	90.52	92.37	92.73	92.49
F=12	75.83	91.74	95.39	97.15	97.39	96.71
F=15	78.7	91.57	97.55	99.24	99.08	97.93
F=18	80.48	93.7	97.83	99.57	99.5	97.86
F=22	83.84	95.87	98.41	**99.77**	99.73	98.76

Performance with different training inputs for face recognition (PUCV-TTF database)

		Recognition rate				
		Normal	Occlusion	Noise 2.5%	Noise 5%	Noise 10%
Linear SVC	Normal	99.71	48.91	98.2	96.23	95.47
	5 datasets	99.47	97.91	99.14	98.74	98.54

Performance with each image dataset for face recognition (PUCV-TTF and UCH-TTF databases)

		Recognition rate				
		Normal	Occlusion	Noise 2.5%	Noise 5%	Noise 10%
Linear SVC	PUCV-TTF	99.71	90.91	99.14	98.74	98.54
	UCH-TTF	97.88	88.69	98.74	96.43	95.47

CONCLUSION

An effective thermal face recognition based on physiological information has been proposed. **The novelty of our method is that we propose the first research article that applies temperature information in face recognition.** Experimental results demonstrate the impressive results of the proposed method.

REFERENCES

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