EURASIP Journal on Applied Signal Processing 2004:4, 480–494

Segmentation of Fingerprint Images Using Linear Classifier

Xinjian Chen
Intelligent Bioinformatics Systems Division, Institute of Automation, The Chinese Academy of Sciences, Beijing 100080, China
Email: xjchen@fingerpass.net.cn

Jie Tian
Intelligent Bioinformatics Systems Division, Institute of Automation, The Chinese Academy of Sciences, Beijing 100080, China
Email: tian@doctor.com

Jiangang Cheng
Intelligent Bioinformatics Systems Division, Institute of Automation, The Chinese Academy of Sciences, Beijing 100080, China
Email: chengjg@fingerpass.net.cn

Xin Yang
Intelligent Bioinformatics Systems Division, Institute of Automation, The Chinese Academy of Sciences, Beijing 100080, China
Email: yx@fingerpass.net.cn

Received 28 October 2002; Revised 11 September 2003

An algorithm for the segmentation of fingerprints and a criterion for evaluating the block feature are presented. The segmentation uses three block features: the block clusters degree, the block mean information, and the block variance. An optimal linear classifier has been trained for the classification per block and the criteria of minimal number of misclassified samples are used. Morphology has been applied as postprocessing to reduce the number of classification errors. The algorithm is tested on FVC2002 database, only 2.45% of the blocks are misclassified, while the postprocessing further reduces this ratio. Experiments have shown that the proposed segmentation method performs very well in rejecting false fingerprint features from the noisy background.

Keywords and phrases: fingerprint image segmentation, block features, linear classification, image processing.

1. INTRODUCTION

The segmentation of fingerprint images is an important step in an automatic fingerprint recognition system. A captured fingerprint image usually consists of two components which are called the foreground and the background. The foreground is the component that originated from the contact of a fingertip with the sensor [1]. The noisy area at the borders of the image is called the background. The aim of segmentation of fingerprint images is to separate the fingerprint foreground area from the background area. Most feature-extraction algorithms extract a lot of false features when applied to the noisy background area. So accurate segmentation is especially important for the reliable extraction of features like minutiae and singular points. And after segmentation, the images needed to be enhanced are smaller, so the time needed to enhance is less.

Several approaches to fingerprint image segmentation are known from literature. In [1], Bazen and Gerez proposed a segmentation algorithm based on pixels features, using the criterion of Rosenblatt's perceptron to classify the pixels. The disadvantage of this algorithm is its low speed as it is based on pixels features and moderate performance. The error rate of this algorithm is 6.8%. In [2], the fingerprint is partitioned in blocks of 16×16 pixels. Then, each block is classified according to the distribution of the gradients in that block. In [3], the previous method is extended by excluding blocks in which gray-scale variance is lower than some threshold. The shortcoming of the above two methods is its moderate segmentation performance. In [4], an adaptive algorithm for uneven background removing at image segmentation base on morphological transformation is presented, but the authors did not give out the detailed experimental results and performance analysis.

In this paper, an algorithm for the segmentation of fingerprints is presented. The algorithm is based on block features so the speed is faster than [1]. The segmentation uses

Figure 1: Framework of the segmentation algorithm.

three block features, being the block clusters degree, the block mean information, and the block variance. An optimal linear classifier has been trained for the classification per block and the criteria of minimal number of misclassified samples are used. The proposed algorithm has excellent segmentation performance, only 2.45% of the blocks are misclassified on FVC2002 database (DB), while the postprocessing further reduces this ratio.

This paper is organized as follows. First, Section 2 discusses the block features extraction and linear classification, then Section 3 presents our detailed experimental results; finally, we conclude in Section 4.

2. BLOCK FEATURES EXTRACTION AND LINEAR CLASSIFICATION

Steps of our fingerprint segmentation algorithm are shown in Figure 1. The fingerprint is partitioned into blocks of $w \times w$ pixels ($w = 12$ in our algorithm). We select three features that contain useful information for segmentation. These three features are the block clusters degree, the block mean information, and the block variance. An optimal linear classification is used for our segmentation algorithm. Morphological postprocessing is applied to reduce classification errors.

Figure 2: One fingerprint image from each database.

2.1. Feature extraction

The aim of feature extraction is to acquire a group of most optimal features for classification. Here we give a criterion for evaluating a feature which is the classification error rate of the feature. The classification error rate Err is computed as follows:

$$\mathrm{Err} = \frac{N_{\mathrm{err}}}{N_{\mathrm{total}}} = p(\omega_0|\omega_1) + p(\omega_1|\omega_0), \tag{1}$$

where ω_0 represent background class, while ω_1 represent foreground class.

We select three block features: the block clusters degree, the block mean information, and the block variance. In order to evaluate these features, we randomly select fingerprints as samples in FVC2002 [5] DB3, and these fingerprints had been segmented manually. On the other hand, in order to verify whether these block features can be generalized to segment the fingerprints captured from other sensors, we also select samples from FVC2002 DB1, DB2, and DB4. According to the quality of fingerprints, we select 30 fingerprints in DB3 as samples because of its lower quality, 5 fingerprints in DB1 as samples because of its higher quality, and 10 fingerprints in DB2 and DB4 as samples because of their moderate quality. All of these samples had been segmented manually. In FVC2002, three different scanners and the synthetic fingerprint generator (SFinGe) were used to collect fingerprints (see Table 1). Figure 2 shows an image for each database at the same scale factor. Two examples of fingerprints segmented manually of DB3 are shown in Figure 3.

2.1.1. The block clusters degree CluD

The block clusters degree CluD measures how well the ridge pixels are clustering. It is mainly used for this case as in Figure 4.

Using I as the intensity of image, the block clusters degree is defined as follows:

$$\mathrm{CluD} = \sum_{i,j \in \mathrm{Block}} \mathrm{sign}\left(I_{ij}, \mathrm{Im}\, g_{\mathrm{mean}}\right) \cdot \mathrm{sign}\left(D_{ij}, \mathrm{Thre}_{\mathrm{CluD}}\right), \tag{2}$$

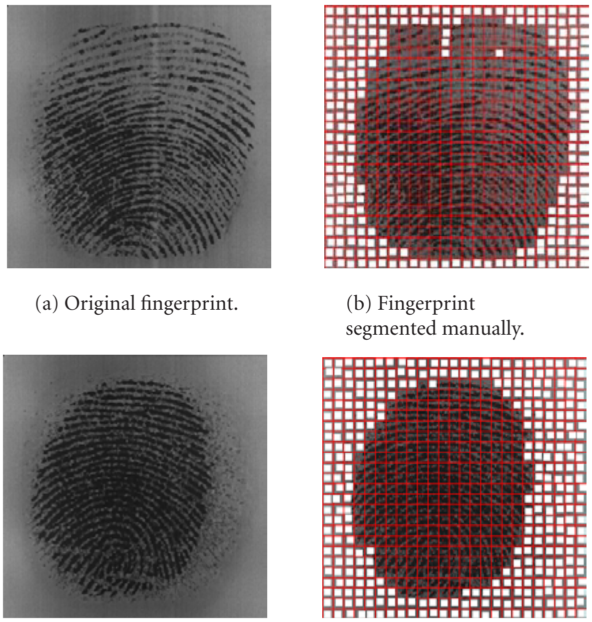
where

$$D_{ij} = \sum_{m=i-2}^{i+2} \sum_{n=j-2}^{j+2} \mathrm{sign}\left(I_{mn}, \mathrm{Im}\, g_{\mathrm{mean}}\right),$$
$$\mathrm{sign}(\alpha, \beta) = \begin{cases} 1 & \text{if } (\alpha < \beta), \\ 0 & \text{otherwise}, \end{cases} \tag{3}$$

$\mathrm{Im}\, g_{\mathrm{mean}}$ is the intensity mean of the whole image. The meaning of D_{ij} can be seen in Table 2. $\mathrm{Thre}_{\mathrm{CluD}}$ is an empirical parameter, $\mathrm{Thre}_{\mathrm{CluD}} = 15$ in our algorithm.

Table 1: Scanners/technologies used for the collection of FVC2002 databases.

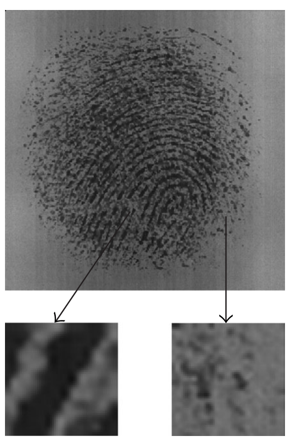
DB	Technology	Scanner	Image size resolution
DB1	Optical	Identix TouchView II	388 × 374, 500 dpi
DB2	Optical	Biometrika FX2000	296 × 560, 569 dpi
DB3	Capacitive	Precise Biometrics 100SC	300 × 300, 500 dpi
DB4	Synthetic	SFinGe v2.51	288 × 384, 500 dpi



(a) Original fingerprint. (b) Fingerprint segmented manually.

(c) Original fingerprint. (d) Fingerprint segmented manually.

Figure 3: Two examples of fingerprints and segmented fingerprints of DB3.



(a) (b)

Figure 4: The illustration of block clusters degree: (a) CluD is bigger and (b) CluD is smaller.

As we select 30 samples in DB3, the size of DB3 fingerprint images is 300 × 300, hence the total number of the samples' blocks is (300/12) × (300/12) × 30 = 625 × 30 = 18750. From Figure 5, we can find that the feature of block clusters degree has excellent classification performance for DB3. When threshold = 2, we can get the minimal error rate Err of this feature as Err = 1218/18750 = 0.06496.

Table 2: 25 pixels centered p_{ij} for computing D_{ij}.

P_{i-2j-2}	P_{i-2j-1}	P_{i-2j}	P_{i-2j+1}	P_{i-2j+2}
P_{i-1j-2}	P_{i-1j-1}	P_{i-1j}	P_{i+1j+1}	P_{i-1j+2}
P_{ij-2}	P_{ij-1}	P_{ij}	P_{ij+1}	P_{ij+2}
P_{i+1j-2}	P_{i+1j-1}	P_{i+1j}	P_{i+1j+1}	P_{i+1j+2}
P_{i+2j-2}	P_{i+2j-1}	P_{i+2j}	P_{i+2j+1}	P_{i+2j+2}

This block feature is also used for segmenting the fingerprint images captured from other sensors.

(1) As we select 5 samples in DB1, the size of DB1 fingerprint images is 388 × 374, hence the total number of the samples' blocks is (388/12) × (374/12) × 5 = 1056 × 5 = 5280. Figure 6 show the feature of block clusters degree of DB1 samples. When threshold = 1, we can get the minimal error rate Err of this feature as Err = 577/5280 = 0.10928.

(2) As we select 10 samples in DB2, the size of DB2 fingerprint images is 296 × 560, hence the total number of the samples' blocks is (296/12) × (560/12) × 10 = 1175 × 10 = 11750. Figure 7 show the feature of block clusters degree of DB2 samples. When threshold = 1, we can get the minimal error rate Err of this feature as Err = 568/11750 = 0.04834.

(3) As we select 10 samples in DB4, the size of DB4 fingerprint images is 288 × 384, hence the total number of the samples' blocks is (288/12) × (384/12) × 10 = 768 × 10 = 7680. Figure 8 show the feature of block clusters degree of DB4 samples. When threshold = 1, we can get the minimal error rate Err of this feature as Err = 781/7680 = 0.10169.

2.1.2. The block mean information MeanI

For most fingerprint sensors, the ridge-valley structures can be approximated by black and white lines, while the background, where the finger does not touch the sensor, is rather white. This means that the mean gray value in the foreground is in general lower, that is, darker gray, than it is in the background. But in fact there are always some fingerprints that are too wet or too dry. Examples are shown in Figure 9. So we cannot only use the block mean, we should take into account the mean intensity of the whole image. We use the difference of local block mean and global image mean as the second feature for fingerprints segmentation.

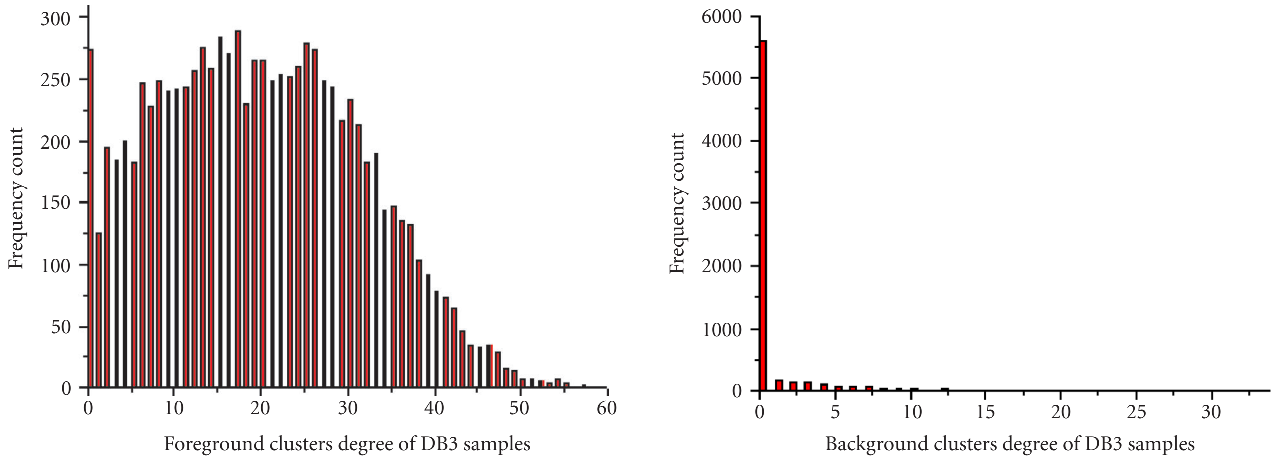


Figure 5: The block clusters degree CluD of the samples. The horizontal coordinate represents the value of the block clusters degree, while the vertical coordinate represents the frequency count of the value.

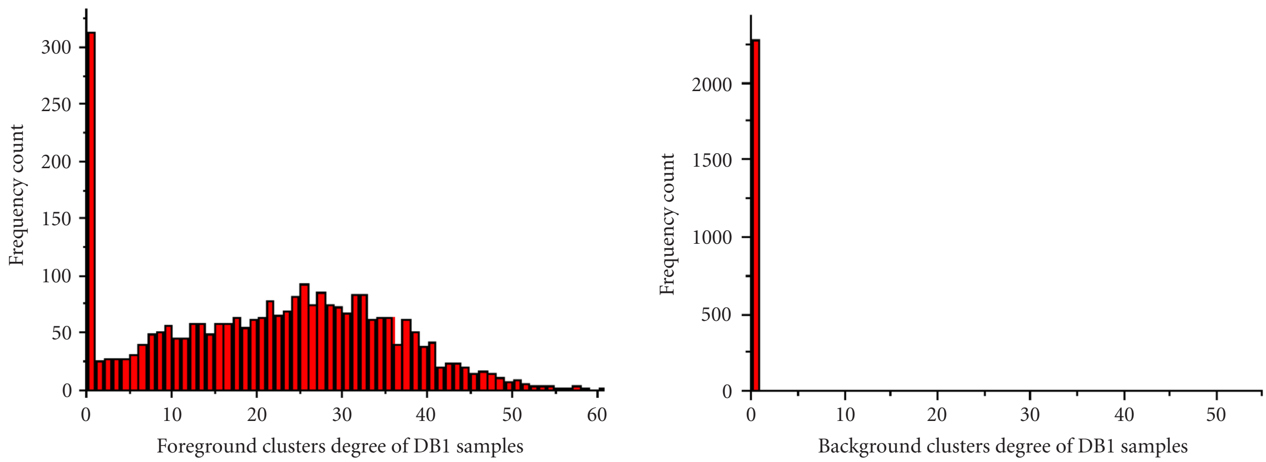


Figure 6: The block clusters degree CluD of the samples. The horizontal coordinate represents the value of the block clusters degree while the vertical coordinate represents the frequency count of the value.

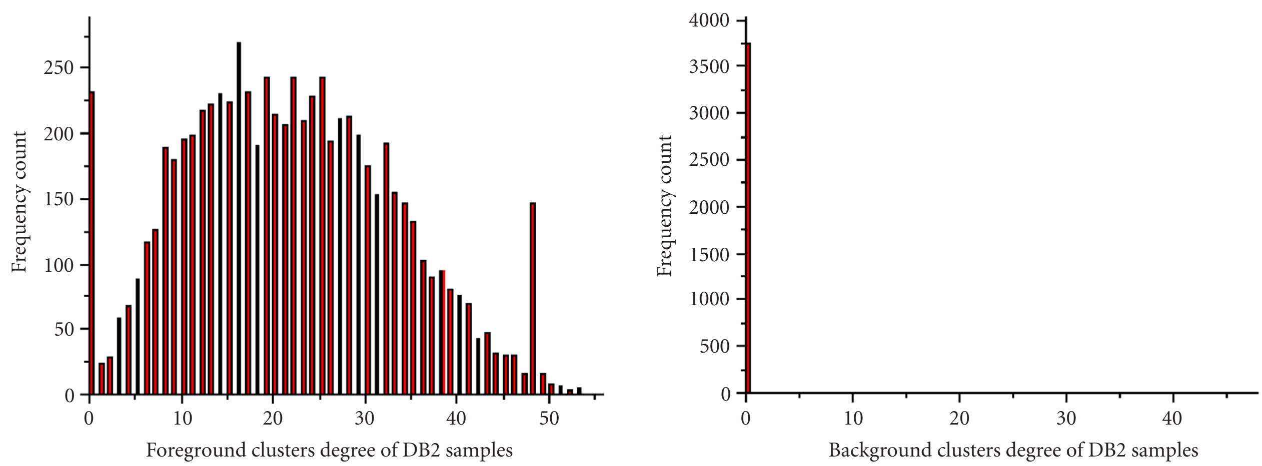


Figure 7: The block clusters degree CluD of the samples. The horizontal coordinate represents the value of the block clusters degree while the vertical coordinate represents the frequency count of the value.

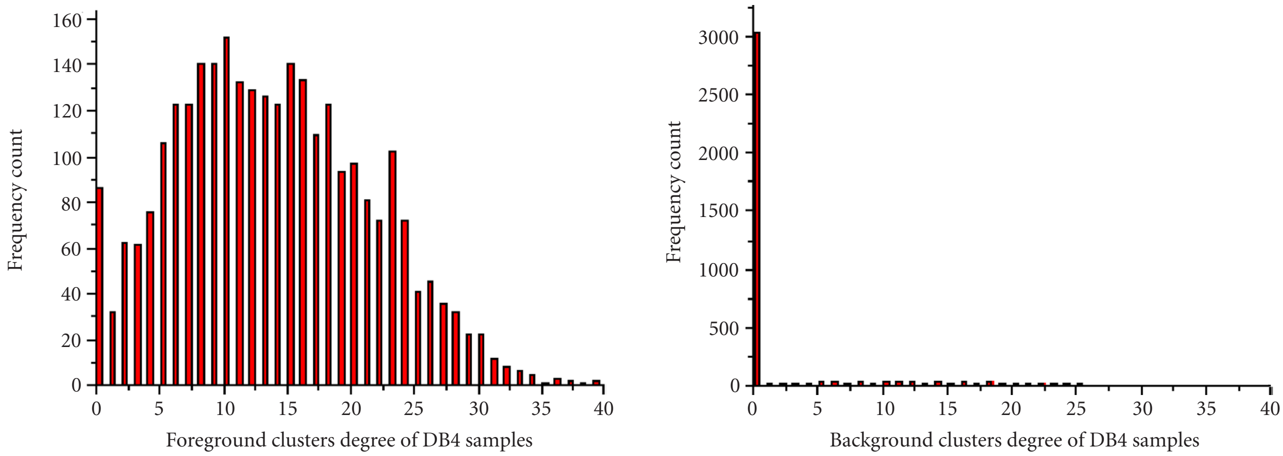


FIGURE 8: The block clusters degree CluD of the samples. The horizontal coordinate represents the value of the block clusters degree while the vertical coordinate represents the frequency count of the value.

(a) (b)

FIGURE 9: Examples of fingerprint: (a) too wet and (b) too dry.

The mean information MeanI for each block is given by

$$\text{MeanI} = \left(\frac{1}{w \cdot w} \sum_{\text{Block}} I\right) - \text{Im}\, g_{\text{mean}}. \quad (4)$$

From Figure 10, we also can find that the feature of block mean information have good classification performance for DB3. When threshold = 14.5, we can get the minimal error rate Err of this feature as Err = 2294/18750 = 0.12230.

On the other hand, we also use block mean to segment the fingerprints. In Figure 11, the feature of block mean of DB3 samples are shown. When threshold = 101, we can get the minimal error rate Err of this feature as Err = 2662/18750 = 0.14197. From Figures 10 and 11, we can find that block mean information MeanI has better classifier performance than block mean.

This block feature is also used for segmenting the fingerprint images captured from other sensors.

(1) Figure 12 shows the feature of block mean information of DB1 samples. When threshold = 16.5, we can get the minimal error rate Err of this feature as Err = 858/5280 = 0.16250.

(2) Figure 13 shows the feature of block mean information of DB2 samples. When threshold = 15.5, we can get the minimal error rate Err of this feature as Err = 1826/11750 = 0.15540.

(3) Figure 14 shows the feature of block mean information of DB4 samples. When threshold = 18.5, we can get the minimal error rate Err of this feature as Err = 1035/7680 = 0.13476.

2.1.3. The block variance Var

The block variance Var is the third feature that is used. In general, the variance of the ridge-valley structures in the foreground is higher than the variance of the noise in the background. The block variance Var for each block is given by

$$\text{Var} = \frac{1}{w \cdot w} \sum_{\text{Block}} (I - \text{mean})^2. \quad (5)$$

From Figure 15, we can also find that the feature of block variance have excellent classification performance for DB3. When threshold = 323, we can get the minimal error rate Err of this feature as Err = 1396/18750 = 0.07445.

This block feature is also used for segmenting the fingerprint images from other kinds of sensors.

(1) Figure 16 shows the feature of block variance of DB1 samples. When threshold = 486, we can get the minimal error rate Err of this feature: Err = 536/5280 = 0.10151.

(2) Figure 17 shows the feature of block variance of DB2 samples. When threshold = 165, we can get the minimal error rate Err of this feature: Err = 1159/11750 = 0.09863.

(3) Figure 18 shows the feature of block variance of DB4 samples. When threshold = 190, we can get the minimal error rate Err of this feature as Err = 608/7680 = 0.07916.

2.1.4. Summary of block features

Usually, fingerprints captured from different kinds of sensors have different characters. From Table 3, we can find that CluD has better classification performance for DB2, but Var has better classification performance for DB4; and CluD and Var play an equivalently important role in segmention for DB1 and DB3.

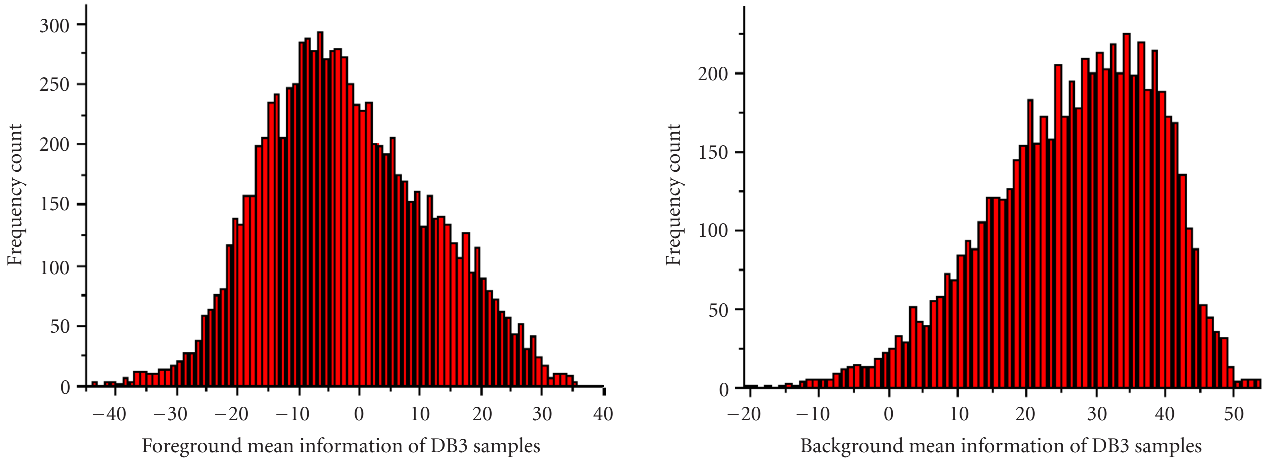


FIGURE 10: The block mean information MeanI of the samples. The horizontal coordinate represents the value of the block mean information while the vertical coordinate represents the frequency count of the value.

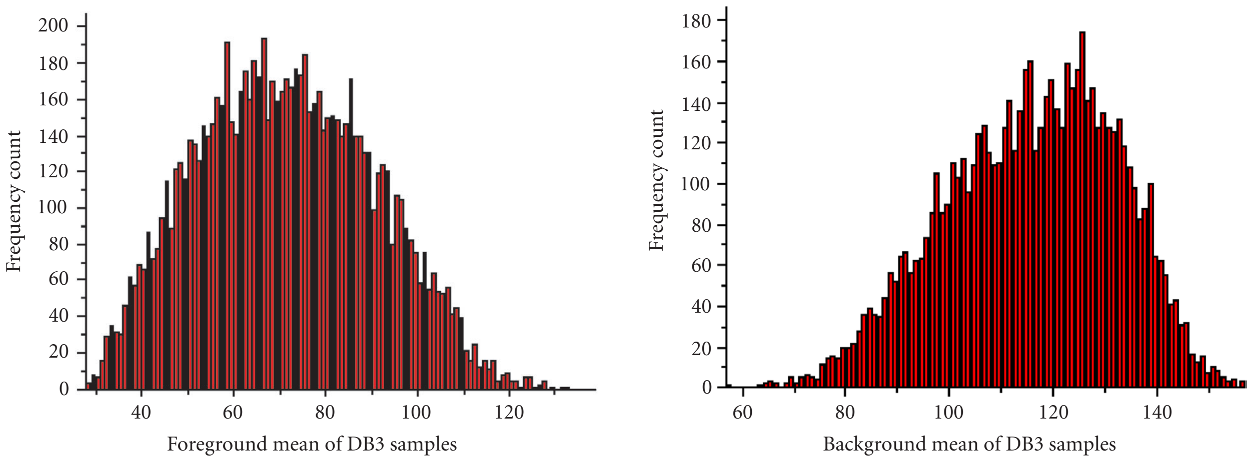


FIGURE 11: The block mean of the samples. The horizontal coordinate represents the value of the block mean while the vertical coordinate represents the frequency count of the value.

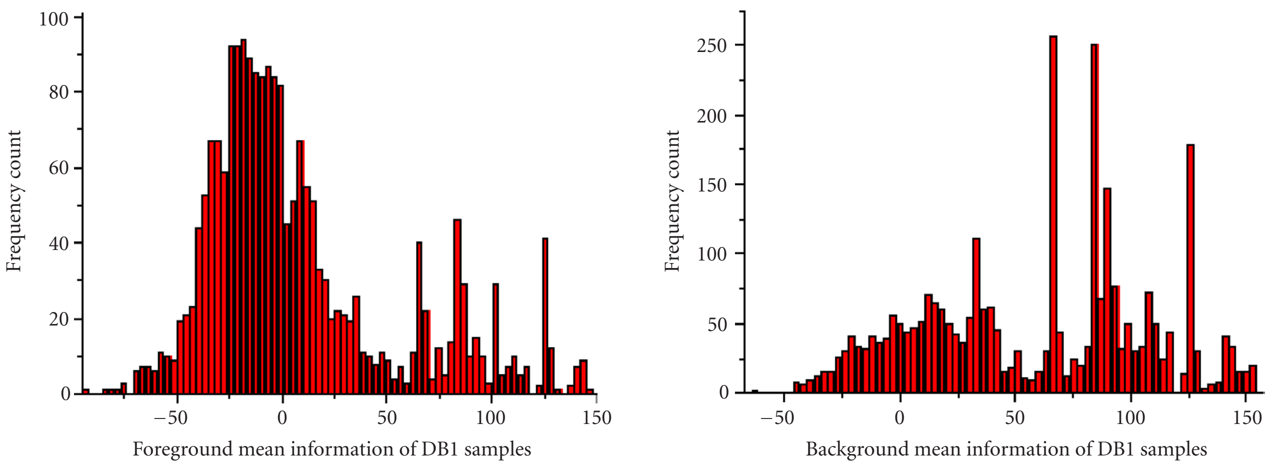


FIGURE 12: The block mean information MeanI of the samples. The horizontal coordinate represents the value of the block mean information while the vertical coordinate represents the frequency count of the value.

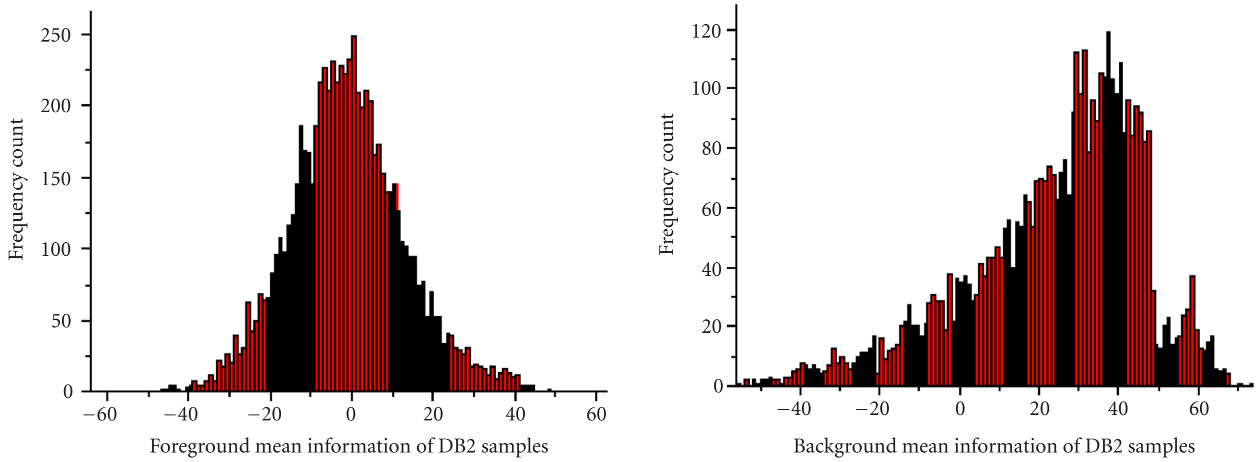


Figure 13: The block mean information MeanI of the samples. The horizontal coordinate represents the value of the block mean information while the vertical coordinate represents the frequency count of the value.

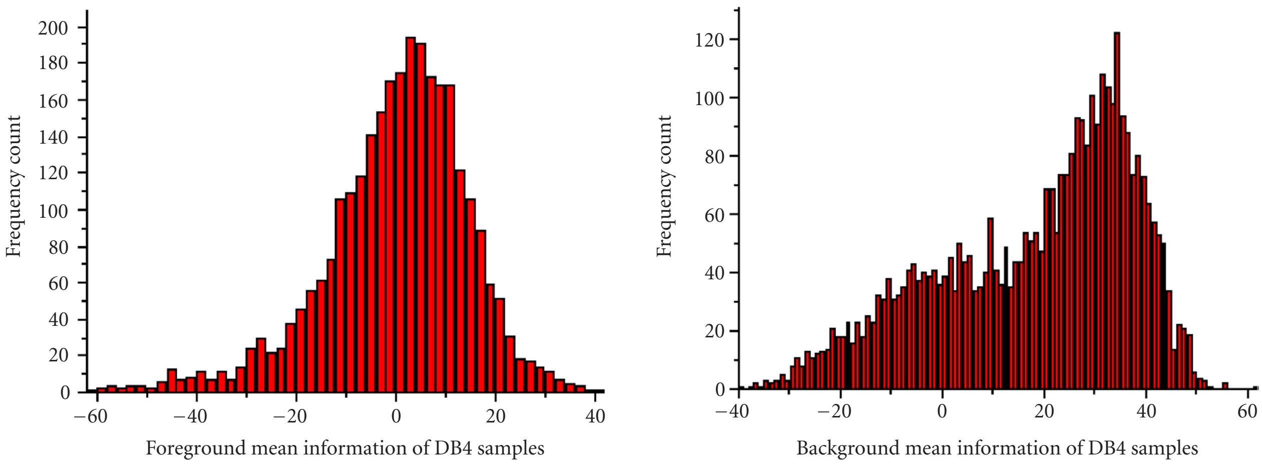


Figure 14: The block mean information MeanI of the samples. The horizontal coordinate represents the value of the block mean information while the vertical coordinate represents the frequency count of the value.

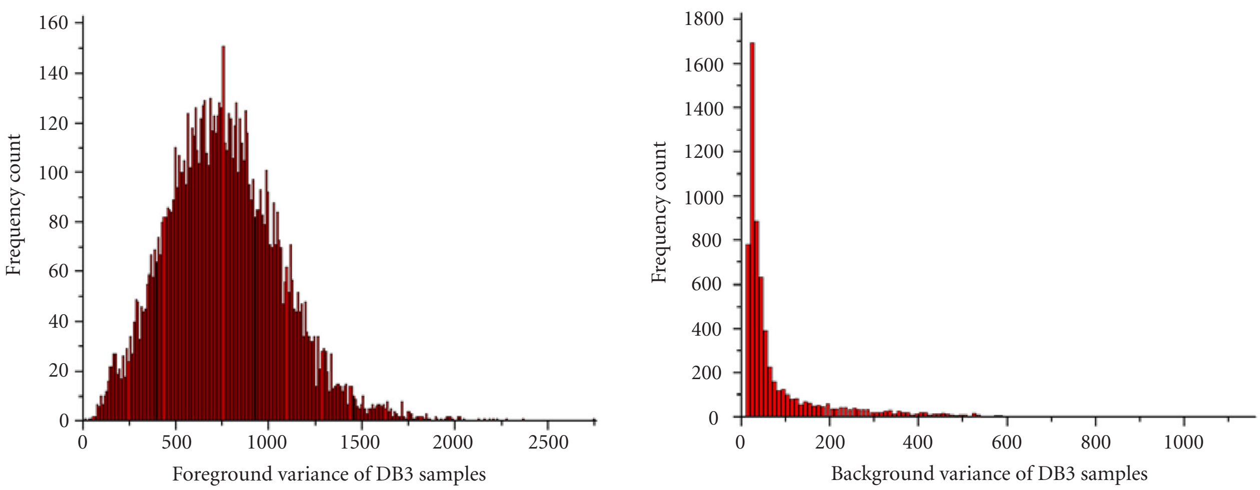


Figure 15: The block variance Var of the samples. The horizontal coordinate represents the value of the block variance while the vertical coordinate represents the frequency count of the value.

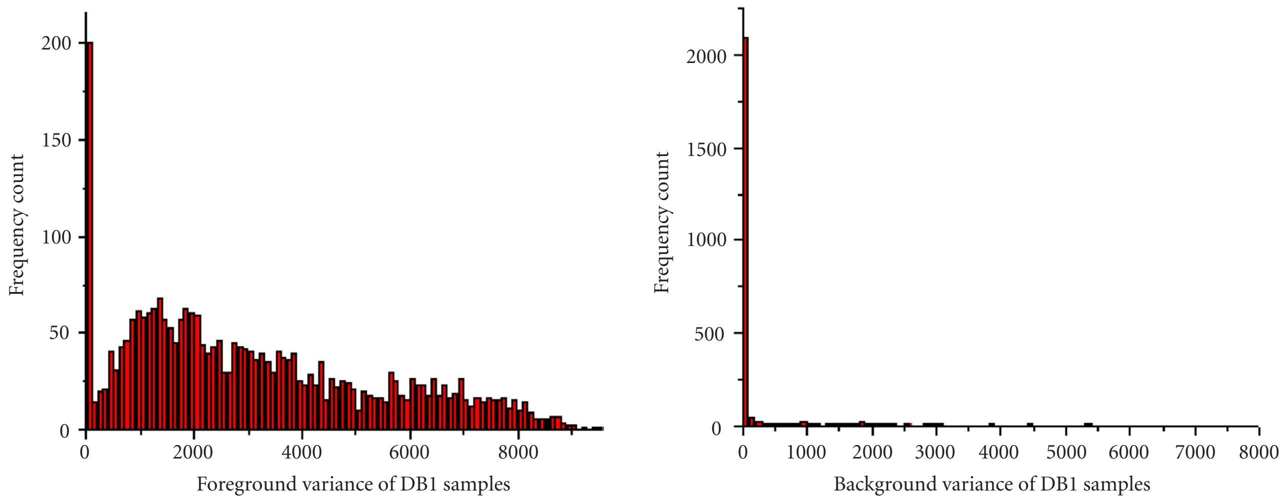


FIGURE 16: The block variance Var of the samples. The horizontal coordinate represents the value of the block variance while the vertical coordinate represents the frequency count of the value.

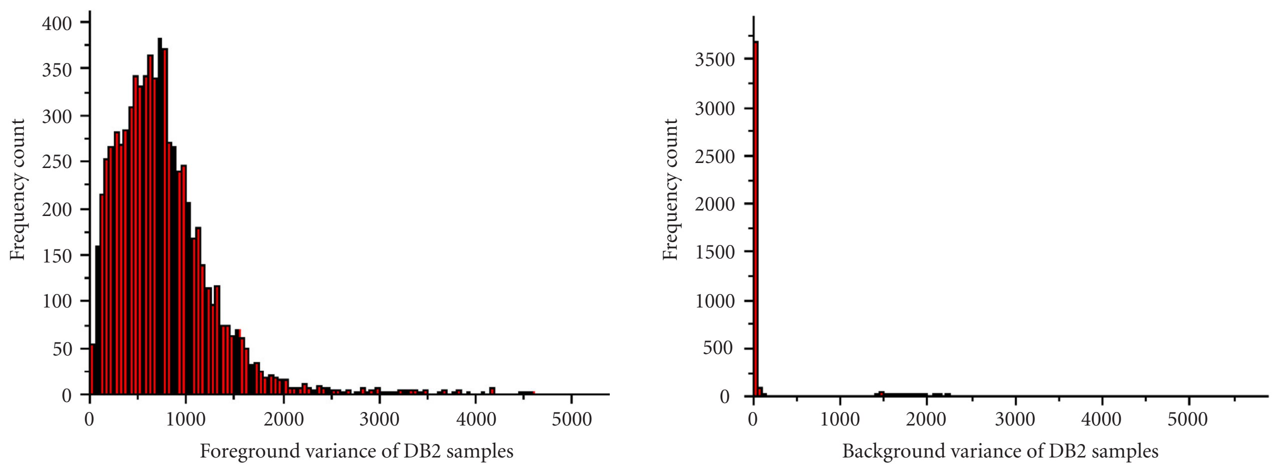


FIGURE 17: The block variance Var of the samples. The horizontal coordinate represents the value of the block variance while the vertical coordinate represents the frequency count of the value.

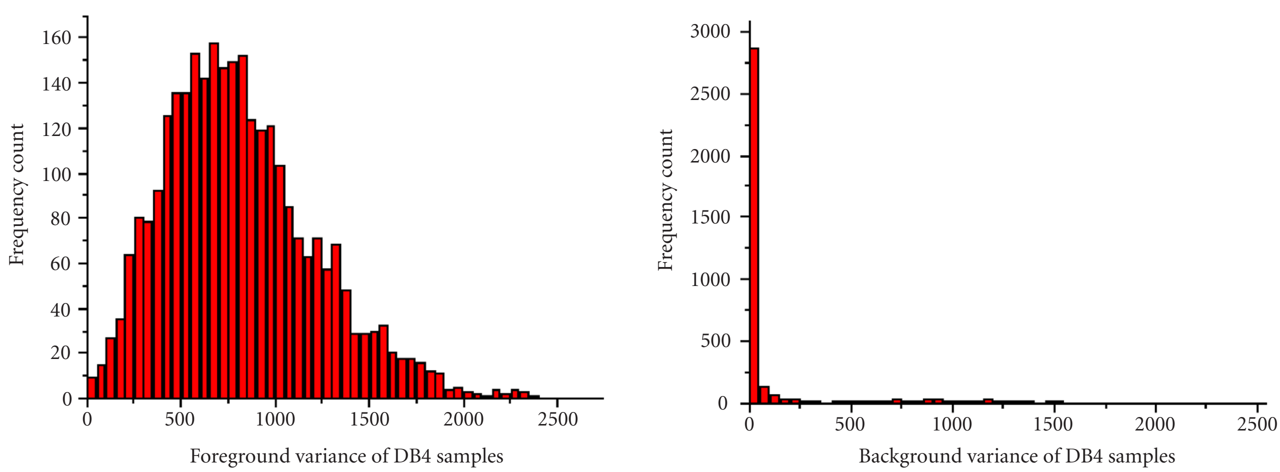


FIGURE 18: The block variance Var of the samples. The horizontal coordinate represents the value of the block variance while the vertical coordinate represents the frequency count of the value.

Table 3: Summary of block features Err for each DB.

DB	CluD	MeanI	Var
DB1	0.10928	0.16250	0.10151
DB2	0.04834	0.15540	0.09863
DB3	0.06496	0.12230	0.07445
DB4	0.10169	0.13476	0.07916

2.2. Linear classification design

In this paper, we will follow a supervised approach since the block features of samples in both areas are available. Using this method, a classification algorithm can be constructed that minimizes the probability of misclassifying. Many different classification algorithms exist that can be applied to this problem. One can for instance think of K-nearest neighbor, neural networks, and so forth to find the optimal decision boundaries [6]. However, it is very important to use a classification algorithm that has the lowest computational complexity possible. We have therefore chosen to use a linear classifier which tests a linear combination of the features given by

$$v = w^T x = w_0 \,\text{CluD} + w_1 \,\text{MeanI} + w_2 \,\text{Var} + w_3, \qquad (6)$$

where v is the value to be tested, $w = [w_0 \;\; w_1 \;\; w_2 \;\; w_3]^T$ is the weight vector, and $x = [\text{CluD} \;\; \text{MeanI} \;\; \text{Var}\; 1]^T$ is the feature vector. Then, using class ω_1 for the foreground, class ω_0 for the background, and $\hat{\omega}$ for the assigned class, the following decision function is applied:

$$\hat{\omega} = \begin{cases} \omega_1 & \text{if } w^T x > 0, \\ \omega_0 & \text{otherwise.} \end{cases} \qquad (7)$$

If the samples are two linearly separable classes, we know that there exists a vector w, satisfying

$$\begin{aligned} w^T x > 0 \quad \forall x \in \omega_1, \\ w^T x < 0 \quad \forall x \in \omega_0. \end{aligned} \qquad (8)$$

So we let

$$x'_n = \begin{cases} x_i & \forall x_i \in \omega_1, \\ -x_i & \forall x_i \in \omega_0, \end{cases} \qquad (9)$$

then our task is to find a weight vector w, where

$$w^T x'_n > 0, \quad n = 1, 2, \ldots, N; \qquad (10)$$

here N is the number of samples.

In [1], the criterion of Rosenblatt's perceptron is used to classify the pixels. But the criterion of Rosenblatt's perceptron is only suited for linearly separable classes, and generally, samples are not linearly separable, so the classification performance of [1] is moderate. In our algorithm, we use the criteria of minimal number of misclassified samples [7] to classify the blocks.

Using the form of matrix, (10) can be written as follows:

$$Xw > 0, \qquad (11)$$

where

$$X = \begin{bmatrix} x_1^T \\ x_2^T \\ \vdots \\ x_N^T \end{bmatrix} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{14} \\ x_{21} & x_{22} & \cdots & x_{24} \\ \vdots & \vdots & \vdots & \vdots \\ x_{N1} & x_{N2} & \cdots & x_{N4} \end{bmatrix}. \qquad (12)$$

In order to make the solution more credible, let

$$Xw \geq b > 0. \qquad (13)$$

In general, we let

$$b = \begin{bmatrix} 1 \\ 1 \\ \vdots \\ 1 \end{bmatrix}_{N\times 1}. \qquad (14)$$

Then the criteria function can be defined as follows:

$$J(w) = \left\| (Xw - b) - |xw - b| \right\|^2. \qquad (15)$$

If $Xw \geq b$, then $J(w) = 0$, otherwise $J(w) > 0$. So the more the number of samples unsatisfied are, the larger the value of $J(w)$ is. Then our aim is to find a vector w to make the value of $J(w)$ minimal. We use the conjugate gradient algorithm [8]; for the detailed steps of algorithm see [8].

2.3. Postprocessing

Unlike other images, fingerprint image has its own characteristics [9]. It is valuable to introduce human knowledge into the processing and postprocessing of the fingerprint images. More compact clusters can be obtained by a number of different postprocessing methods. It is possible to use either boundary-based methods like curve fitting and active contour models, or region-based methods like region growing and morphology [10]. We have chosen to apply morphology to the classification estimate. It reduces the number of false classifications. First, small clusters that are incorrectly assigned to the foreground are removed by means of an open operation [4]. Next, small clusters that are incorrectly assigned to the background are removed by a close operation. After the morphological processing, we connect the edges and corners using the lines.

Two examples of the postprocessing are shown in Figure 19. The segmented result is the fingerprint image bounded by blue line.

3. EXPERIMENTAL RESULTS

The segmentation algorithm was tested on 4 databases of FVC2002. All the experiments were done in Pentium 4 CPU

(a) Before postprocessing. (b) After postprocessing. (c) Before postprocessing. (d) After postprocessing.

FIGURE 19: Two examples of the postprocessing.

TABLE 4: Segmentation time in P4 2.4 GHz PC for each DB (seconds).

Segmentation time	DB1	DB2	DB3	DB4
Segmentation time of our algorithm (s)	0.018	0.019	0.015	0.016
Segmentation time used in the algorithm in [1] (s)	0.125	0.145	0.094	0.110

2.4 GHz PC. Table 4 gives the time needed to segment a fingerprint image for each DB of FVC2002. Meanwhile, in order to compare the proposed algorithm with [1], we have done some experiments that used the algorithm in [1]. From Table 4, we can conclude that our algorithm is enormously faster than [1].

3.1. The result of FVC2002 DB3

Firstly, the segmentation algorithm has been trained on these 30 fingerprint samples. The weight vector of the trained results is

$$w^T = (w_0, w_1, w_2, w_3) = (1.152, -0.433, 0.067, -24.0). \tag{16}$$

Then we use this weight vector for classification by expression (7), the computed results is shown in Figure 20. We can find that our classifier have excellent classification performance.

In Figure 21, segmentation results are shown for three fingerprints from FVC2002 DB3 using the proposed algorithm. Figure 21a is from the training data, while Figures 21b and 21c are from the test data. Human inspection shows that our algorithm provides satisfactory results. Meanwhile in Figure 22, we have given out segmentation results of the same three fingerprints using the algorithm in [1]. From Figure 22, we find that the segmentation results of our algorithm are better than the results of [1].

Apart from human inspection, we can quantitatively evaluate the results of a segmentation algorithm. The number of classification errors could be used as a performance measure. This is exactly the measure that was used during training:

$$\begin{aligned} p(\omega_0|\omega_1) &= \frac{\text{num}_{\text{error classification}}}{\text{num}_{\text{total foreground blocks}}} \\ &= \frac{335}{9309} = 0.0359, \\ p(\omega_1|\omega_0) &= \frac{\text{num}_{\text{error classification}}}{\text{num}_{\text{total background blocks}}} \\ &= \frac{328}{9441} = 0.0347, \\ \text{Err} &= \frac{\text{num}_{\text{error classification}}}{\text{num}_{\text{total blocks}}} = \frac{663}{18750} = 0.0353. \end{aligned} \tag{17}$$

Here Err is the value before morphological postprocessing; after postprocessing, the error rate will become smaller.

3.2. The result of FVC2002 DB1

Using the method above, the weight vector of trained results is

$$w^T = (w_0, w_1, w_2, w_3) = (3.723, -0.389, 0.071, -12.6). \tag{18}$$

The computed results are shown in Figure 23 and segmentation results are shown for three fingerprints from FVC2002 DB1 in Figure 24.

The error rate of DB1 is the following:

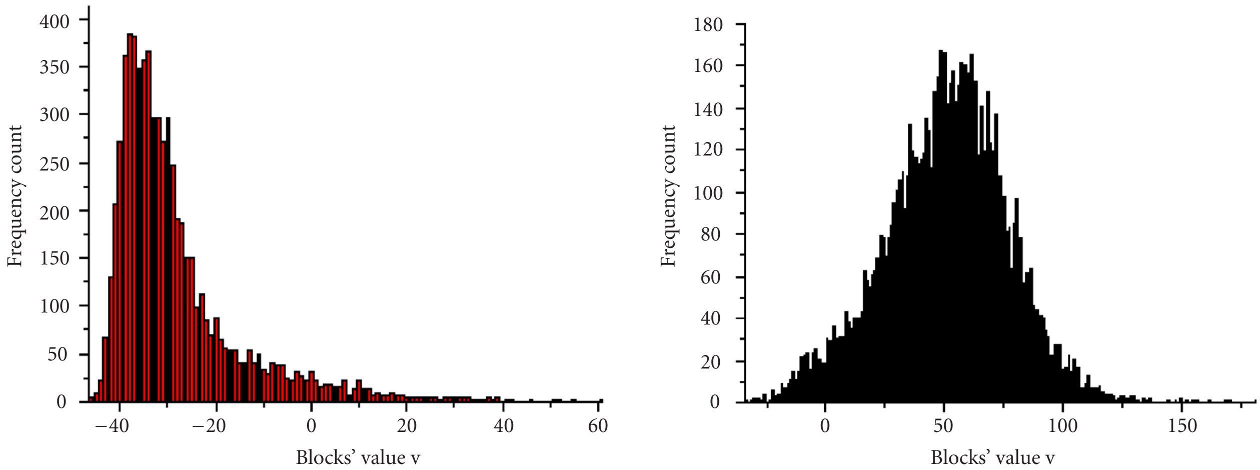
$$\begin{aligned} p(\omega_0|\omega_1) &= \frac{39}{2802} = 0.0139, \\ p(\omega_1|\omega_0) &= \frac{56}{2478} = 0.0225, \\ \text{Err} &= \frac{95}{5280} = 0.0180. \end{aligned} \tag{19}$$

3.3. The result of FVC2002 DB2

The weight vector of trained results is

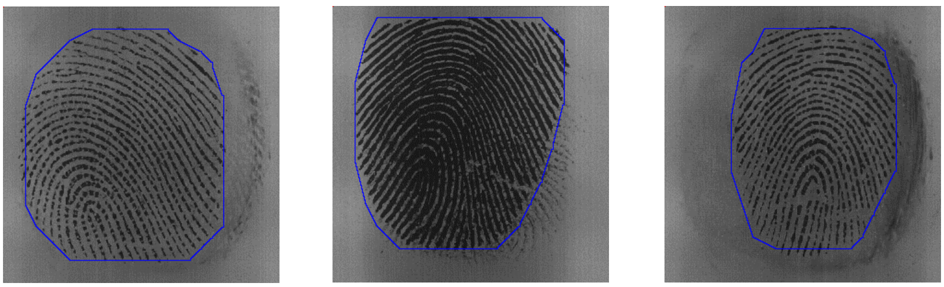
$$\begin{aligned} w^T &= (w_0, w_1, w_2, W_3) \\ &= (2.342, -0.793, 0.046, -11.9). \end{aligned} \tag{20}$$

The computed results are shown in Figure 25 and segmentation results are shown for three fingerprints from FVC2002 DB2 in Figure 26.



(a) (b)

FIGURE 20: The value of the (a) background and (b) foreground class in the linear classification in FVC2002 DB3.



(a) (b) (c)

FIGURE 21: Segmentation results of three fingerprints from FVC2002 DB3 using our algorithm: (a) is from the training data, (b) and (c) are from the test data.

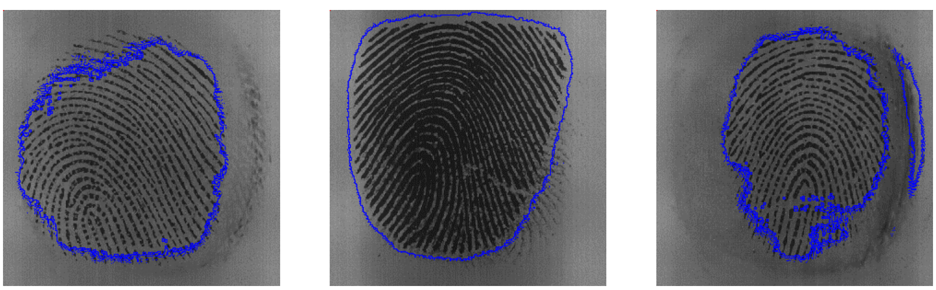


FIGURE 22: Segmentation results of three fingerprints from FVC2002 DB3 using the algorithm in [1].

The error rate of DB2 is the following:

$$p(\omega_0|\omega_1) = \frac{226}{7346} = 0.0307,$$
$$p(\omega_1|\omega_0) = \frac{118}{4404} = 0.0268, \qquad (21)$$
$$\text{Err} = \frac{344}{11750} = 0.0293.$$

3.4. The result of FVC2002 DB4

The weight vector of trained results is

$$w^T = (w_0, w_1, w_2, w_3) = (5.701, -0.263, 0.036, -10.5). \qquad (22)$$

The computed results are shown in Figure 27 and segmentation results are shown for three fingerprints from FVC2002 DB4 in Figure 28.

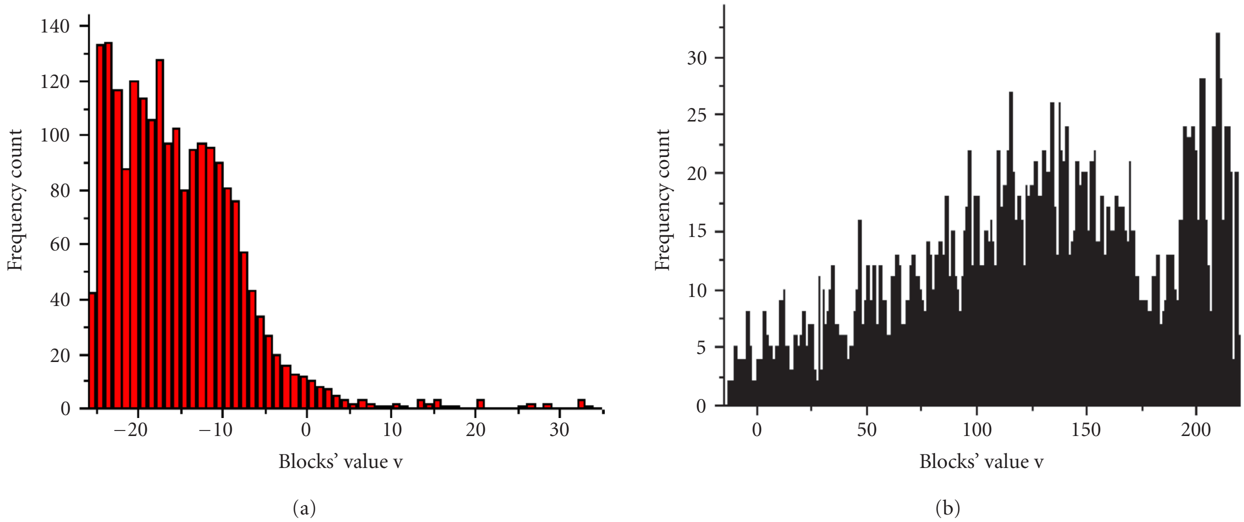


Figure 23: The value of the (a) background and (b) foreground class in linear classification in FVC2002 DB1.

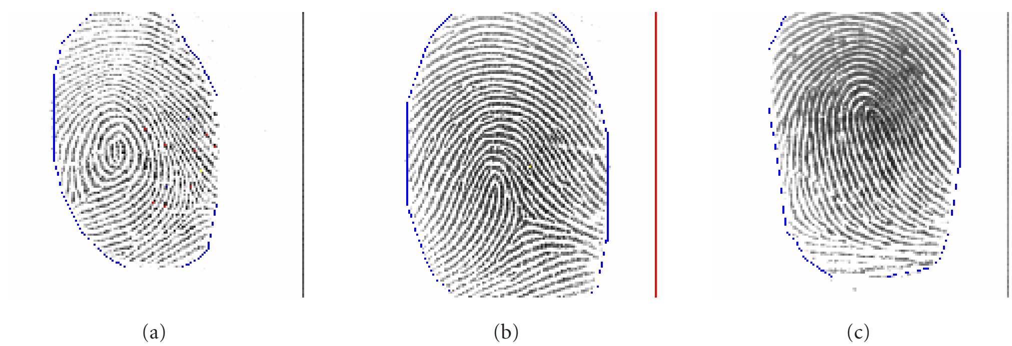


Figure 24: Segmentation results of three fingerprints from FVC2002 DB1: (a) is from the training data, (b) and (c) are from the test data.

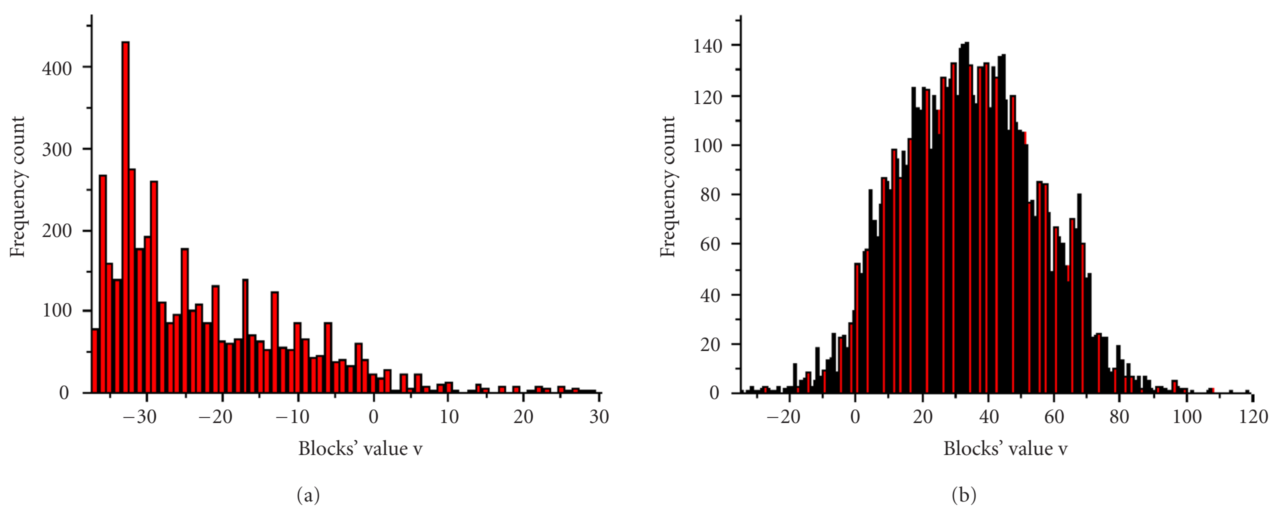


Figure 25: The value of the (a) background and (b) foreground class in linear classification in FVC2002 DB2.

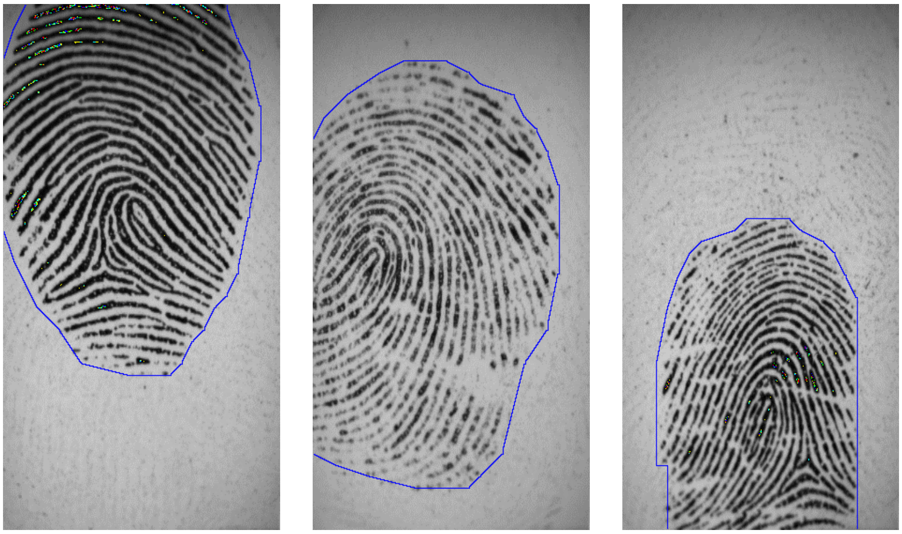


Figure 26: Segmentation results of three fingerprints from FVC2002 DB2: (a) is from the training data, (b) and (c) are from the test data.

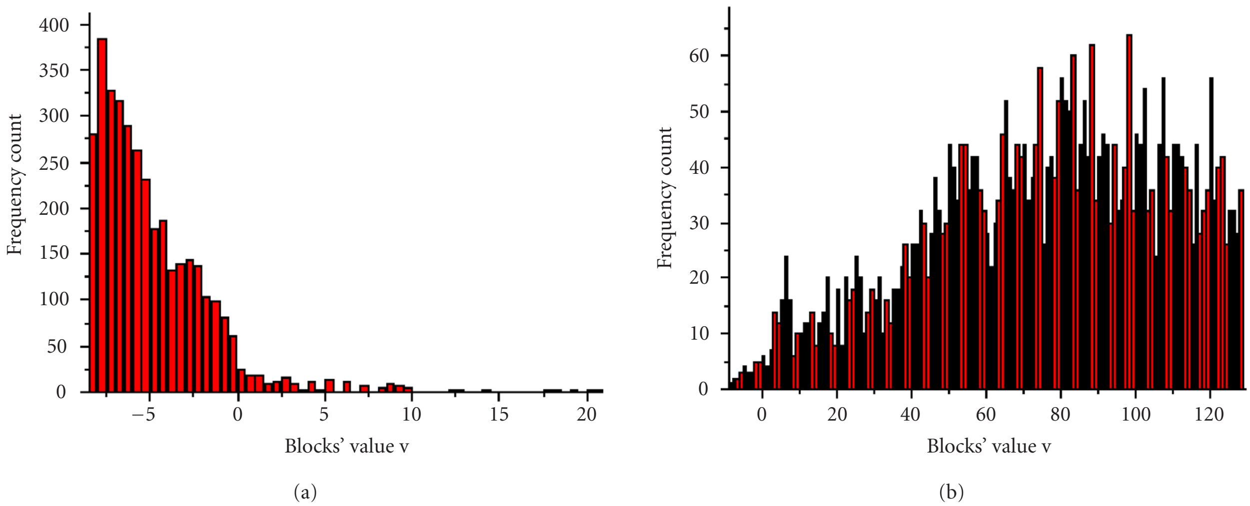


Figure 27: The value of the (a) background and (b) foreground class in linear classification in FVC2002 DB4.

The error rate of DB4 is the following:

$$p(\omega_0|\omega_1) = \frac{24}{4060} = 0.0059,$$
$$p(\omega_1|\omega_0) = \frac{95}{3620} = 0.0262, \quad (23)$$
$$\text{Err} = \frac{119}{7680} = 0.0155.$$

3.5. Summary on FVC2002

From Table 5, it can be seen that the four classifiers assign most importance to CluD. From this point, we can get that the feature of block clusters degree CluD play an important role in classification. From Table 6, we can conclude that our algorithm has excellent classification performance. In the database of FVC2002, only 2.45% of the blocks are misclassified, while the postprocessing further reduces this ratio. Compared with [1], experimental results show that our algorithm is better than [1]. Human inspection has shown that our algorithm provides accurate high-resolution segmentation results.

3.6. Segmentation of other fingerprints

The proposed algorithm is also used to segment the fingerprints of National Institute of Standards and Technology (www.nist.gov). Figure 29 shown two examples of segmented fingerprints of NIST 27. Human inspection shows that the algorithm provides satisfactory results.

Table 5: Results of the linear classifier on FVC2002.

FVC2002 DB	Weight vector (w_0, w_1, w_2, w_3)	$p(\omega_0 \vert \omega_1)$	$p(\omega_1 \vert \omega_0)$	p_{error}
DB1	$(3.723, -0.389, 0.071, -12.6)$	0.0139	0.0225	0.0180
DB2	$(2.342, -0.793, 0.046, -11.9)$	0.0307	0.0268	0.0293
DB3	$(1.152, -0.433, 0.067, -24.0)$	0.0359	0.0347	0.0353
DB4	$(5.701, -0.263, 0.036, -10.5)$	0.0059	0.0262	0.0155
Average error rate		0.0216	0.0275	0.0245

Table 6: The comparison of error rates of the proposed algorithm and the algorithm in [1] on FVC2002 DB.

FVC2002 DB	DB1	DB2	DB3	DB4	Average error rate
Classification error rates of the proposed algorithm	0.0180	0.0293	0.0353	0.0155	0.0245
Classification error rates of the algorithm in [1]	0.0565	0.0659	0.0782	0.0532	0.0635

(a) (b) (c)

Figure 28: Segmentation results of three fingerprints from FVC2002 DB4: (a) is from the training data, (b) and (c) are from the test data.

Figure 29: Segmentation results of two fingerprints from NIST 27; the size of image is 800 × 768.

4. CONCLUSIONS AND FUTURE WORKS

In this paper, an algorithm for the segmentation of fingerprints and a criterion for evaluating the block feature are presented. The segmentation uses three block features, being the block clusters degree, the block mean information, and the block variance. An optimal linear classifier has been trained for the classification per block, the criterion of minimal number of misclassified samples is used. Morphology has been applied as postprocessing to obtain compact clusters and to reduce the number of classification errors.

Human inspection has shown that the proposed method provides accurate high-resolution segmentation results. In the database of FVC2002, only 2.45% of the blocks are misclassified while the postprocessing further reduces this ratio.

Other texture features of the fingerprint images and the third class representing low quality regions will be investigated in the near future.

ACKNOWLEDGMENT

This paper is supported by the National Natural Science Foundation of China under Grants 79990580, 69931010, 60172057, 60071002, and 60072007, and the National High Technology Development Program of China under Grant 2001AA144120.

REFERENCES

[1] A. M. Bazen and S. H. Gerez, "Segmentation of fingerprint images," in *ProRISC 2001 Workshop on Circuits, Systems and Signal Processing*, Veldhoven, The Netherlands, November 2001.
[2] B. M. Mehtre, N. N. Murthy, S. Kapoor, and B. Chatterjee, "Segmentation of fingerprint images using directional image," *Pattern Recognition*, vol. 20, no. 4, pp. 429–435, 1987.
[3] B. M. Mehtre and B. Chatterjee, "Segmentation of fingerprint images–A composite method," *Pattern Recognition*, vol. 22, no. 4, pp. 381–385, 1989.
[4] V. Mosorov, "Using tophat transformation for image fingerprint segmentation," in *International Conference on Signals and Electronic Systems*, Lodz, Poland, September 2001, pp. 241–246.
[5] D. Maio, D. Maltoni, R. Cappelli, J. L. Wayman, and A. K. Jain, "FVC2002: fingerprint verification competition," Biolab internal Tech. Rep., University of Bologna, Italy, 2002, http://bias.csr.unibo.it/fvc2002/.
[6] A. K. Jain, R. P. W. Duin, and J. Mao, "Statistical pattern recognition: A review," *IEEE Trans. on Pattern Analysis and Machine Intelligence*, vol. 22, no. 1, pp. 4–37, 2000.
[7] Z. Bian and X. Zhang, *Pattern Recognition*, Tsinghua University Press, Beijing, China, 2nd edition, 2000.
[8] G. Nagaraja and G. Krishna, "An algorithm for the solution of linear inequalities," *IEEE Trans. on Computers*, vol. 23, no. 4, pp. 421–427, 1974.
[9] X. P. Luo and J. Tian, "Knowledge based fingerprint image enhancement," in *Proc. IEEE International Conference on Pattern Recognition (ICPR '00)*, Barcelona, Spain, September 2000, vol. 4, pp. 783–786.
[10] A. K. Jain, *Fundamentals of Digital Image Processing*, Prentice-Hall, NJ, USA, 1989.

Xinjian Chen received his B.S. degree in geophysics from Central South University of Technology, China, in 2001. Now he is a candidate for Ph.D. degree at the Institute of Automation, Chinese Academy of Sciences. His research interests include pattern recognition, machine learning, and image processing and their applications in biometrics.

Jie Tian received his Ph.D. degree (with honor) in artificial intelligence from the Institute of Automation, Chinese Academy of Sciences in 1992. From 1994 to 1996, he was a postdoctoral fellow at the medical image processing group, University of Pennsylvania. Sine 1997, he has been a Professor in the Institute of Automation, Chinese Academy of Sciences. His research interests are bioinformatics, medical image process and analysis, pattern recognition, and so forth.

Jiangang Cheng received his B.S. and M.S. degrees in mathematics from Dalian University of Technology, China, in 1998 and 2001, respectively. Now he is a candidate for Ph.D. degree at the Institute of Automation, Chinese Academy of Sciences. His research interests include pattern recognition, machine learning, and image processing and their applications in biometrics.

Xin Yang received her Ph.D. degree in precision instrument from Tianjig University in 2000. Now she is a postdoctoral fellow in the Institute of Automation, Chinese Academy of Sciences. Her research interests are pattern recognition, medical image process and analysis, and so forth.

Special Issue on Spatial Sound and Virtual Acoustics

Call for Papers

Spatial sound reproduction has become widespread in the form of multichannel audio, particularly through home theater systems. Reproduction systems from binaural (by headphones) to hundreds of loudspeaker channels (such as wave field synthesis) are entering practical use. The application potential of spatial sound is much wider than multichannel sound, however, and research in the field is active. Spatial sound covers for example the capturing, analysis, coding, synthesis, reproduction, and perception of spatial aspects in audio and acoustics.

In addition to the topics mentioned above, research in virtual acoustics broadens the field. Virtual acoustics includes techniques and methods to create realistic percepts of sound sources and acoustic environments that do not exist naturally but are rendered by advanced reproduction systems using loudspeakers or headphones. Augmented acoustic and audio environments contain both real and virtual acoustic components.

Spatial sound and virtual acoustics are among the major research and application areas in audio signal processing. Topics of active study range from new basic research ideas to improvement of existing applications. Understanding of spatial sound perception by humans is also an important area, in fact a prerequisite to advanced forms of spatial sound and virtual acoustics technology.

This special issue will focus on recent developments in this key research area. Topics of interest include (but are not limited to):

- Multichannel reproduction
- Wave field synthesis
- Binaural reproduction
- Format conversion and enhancement of spatial sound
- Spatial sound recording
- Analysis, synthesis, and coding of spatial sound
- Spatial sound perception and auditory modeling
- Simulation and modeling of room acoustics
- Auralization techniques
- Beamforming and sound source localization
- Acoustic and auditory scene analysis
- Augmented reality audio
- Virtual acoustics (sound environments and sources)
- Intelligent audio environments
- Loudspeaker-room interaction and equalization
- Applications

Authors should follow the EURASIP JASP manuscript format described at http://www.hindawi.com/journals/asp/. Prospective authors should submit an electronic copy of their complete manuscript through the EURASIP JASP manuscript tracking system at http://www.mstracking.com/asp/, according to the following timetable:

Manuscript Due	May 1, 2006
Acceptance Notification	September 1, 2006
Final Manuscript Due	December 1, 2006
Publication Date	1st Quarter, 2007

GUEST EDITORS:

Ville Pulkki, Helsinki University of Technology, Espoo, Finland; ville@acoustics.hut.fi

Christof Faller, EPFL, Lausanne, Switzerland; christof.faller@epfl.ch

Aki Harma, Philips Research Labs, Eindhoven, The Netherlands; aki.harma@philips.com

Tapio Lokki, Helsinki University of Technology, Espoo, Finland; ktlokki@cc.hut.fi

Werner de Bruijn, Philips Research Labs, Eindhoven, The Netherlands; werner.de.bruijn@philips.com

EURASIP JOURNAL ON APPLIED SIGNAL PROCESSING

Special Issue on

Advances in Electrocardiogram Signal Processing and Analysis

Call for Papers

Since its invention in the 19th century when it was little more than a scientific curiosity, the electrocardiogram (ECG) has developed into one of the most important and widely used quantitative diagnostic tools in medicine. It is essential for the identification of disorders of the cardiac rhythm, extremely useful for the diagnosis and management of heart abnormalities such as myocardial infarction (heart attack), and offers helpful clues to the presence of generalised disorders that affect the rest of the body, such as electrolyte disturbances and drug intoxication.

Recording and analysis of the ECG now involves a considerable amount of signal processing for S/N enhancement, beat detection, automated classification, and compression. These involve a whole variety of innovative signal processing methods, including adaptive techniques, time-frequency and time-scale procedures, artificial neural networks and fuzzy logic, higher-order statistics and nonlinear schemes, fractals, hierarchical trees, Bayesian approaches, and parametric models, amongst others.

This special issue will review the current status of ECG signal processing and analysis, with particular regard to recent innovations. It will report major achievements of academic and commercial research institutions and individuals, and provide an insight into future developments within this exciting and challenging area.

This special issue will focus on recent developments in this key research area. Topics of interest include (but are not limited to):

- Beat (QRS complex) detection
- ECG compression
- Denoising of ECG signals
- Morphological studies and classification
- ECG modeling techniques
- Expert systems and automated diagnosis
- QT interval measurement and heart-rate variability
- Arrhythmia and ischemia detection and analysis
- Interaction between cardiovascular signals (ECG, blood pressure, respiration, etc.)
- Intracardiac ECG analysis (implantable cardiovascular devices, and pacemakers)
- ECGs and sleep apnoea
- Real-time processing and instrumentation
- ECG telemedicine and e-medicine
- Fetal ECG detection and analysis
- Computational tools and databases for ECG education and research

Authors should follow the EURASIP JASP manuscript format described at http://www.hindawi.com/journals/asp/. Prospective authors should submit an electronic copy of their complete manuscripts through the EURASIP JASP manuscript tracking system at http://www.mstracking.com/asp/, according to the following timetable:

Manuscript Due	May 1, 2006
Acceptance Notification	September 1, 2006
Final Manuscript Due	December 1, 2006
Publication Date	1st Quarter, 2007

GUEST EDITORS:

William Sandham, Scotsig, Glasgow G12 9pf, UK; w.sandham@scotsig.co.uk

David Hamilton, Department of Electronic and Electrical Engineering, University of Strathclyde, Glasgow G1 1XW, UK; d.hamilton@eee.strath.ac.uk

Pablo Laguna Lasaosa, Departmento de Ingeniería Electrónica y Communicaciones, Universidad de Zaragoza, 50015 Zaragoza, Spain; laguna@unizar.es

Maurice Cohen, University of California, San Francisco, USA; mcohen@fresno.ucsf.edu

Special Issue on

Emerging Signal Processing Techniques for Power Quality Applications

Call for Papers

Recently, end users and utility companies are increasingly concerned with perturbations originated from electrical power quality variations. Investigations are being carried out to completely characterize not only the old traditional type of problems, but also new ones that have arisen as a result of massive use of nonlinear loads and electronics-based equipment in residences, commercial centers, and industrial plants. These nonlinear load effects are aggravated by massive power system interconnections, increasing number of different power sources, and climatic changes.

In order to improve the capability of equipments applied to monitoring the power quality of transmission and distribution power lines, power systems have been facing new analysis and synthesis paradigms, mostly supported by signal processing techniques. The analysis and synthesis of emerging power quality and power system problems led to new research frontiers for the signal processing community, focused on the development and combination of computational intelligence, source coding, pattern recognition, multirate systems, statistical estimation, adaptive signal processing, and other digital processing techniques, implemented in either DSP-based, PC-based, or FPGA-based solutions.

The goal of this proposal is to introduce powerful and efficient real-time or almost-real-time signal processing tools for dealing with the emerging power quality problems. These techniques take into account power-line signals and complementary information, such as climatic changes.

This special issue will focus on recent developments in this key research area. Topics of interest include (but are not limited to):

- Detection of transients
- Classification of multiple events
- Identification of isolated and multiple disturbance sources
- Compression of voltage and current data signals
- Location of disturbance sources
- Prediction of transmission and distribution systems failures
- Demand forecasting
- Parameters estimation for fundamental, harmonics, and interharmonics

Digital signal processing techniques applied to power quality applications are a very attractive and stimulating area of research. Its results will provide, in the near future, new standards for the decentralized and real-time monitoring of transmission and distribution systems, allowing to closely follow and predict power system performance. As a result, the power systems will be more easily planned, expanded, controlled, managed, and supervised.

Authors should follow the EURASIP JASP manuscript format described at http://www.hindawi.com/journals/asp/. Prospective authors should submit an electronic copy of their complete manuscripts through the EURASIP JASP manuscript tracking system at http://www.mstracking.com/asp/, according to the following timetable:

Manuscript Due	May 1, 2006
Acceptance Notification	September 1, 2006
Final Manuscript Due	December 1, 2006
Publication Date	2nd Quarter, 2007

GUEST EDITORS:

Moisés Vidal Ribeiro, Department of Electrical Circuit, Federal University of Juiz de Fora, CEP 36036-330, Juiz de Fora, Brazil; mribeiro@ieee.org

Jacques Szczupack, Department of Electrical Engineering, Pontifical Catholic University of Rio de Janeiro, CEP 22453-900, Rio de Janeiro, Brazil; jacques@ele.puc-rio.br

M. Reza Iravani, The Edward S. Rogers SR., Department of Electrical and Computer Engineering, University of Toronto, Toronto, ON, Canada M5S 3G4; iravani@ecf.utoronto.ca

Irene Yu-Hua Gu, Department of Signals and Systems, Chalmers University of Technology, SE-412 96, Gothenburg, Sweden; irenegu@s2.chalmers.se

Pradipta Kishore Dash, C. V. Raman, College of Engineering Bhubaneswar, Khurda-752054, Orissa, India; pkdash_india@yahoo.com

Alexander Mamishev, Department of Electrical Engineering, University of Washington, WA 98195-2500, Seattle, USA; mamishev@ee.washington.edu

EURASIP JOURNAL ON APPLIED SIGNAL PROCESSING

Special Issue on
Super-resolution Enhancement of Digital Video

Call for Papers

When designing a system for image acquisition, there is generally a desire for high spatial resolution and a wide field-of-view. To achieve this, a camera system must typically employ small f-number optics. This produces an image with very high spatial-frequency bandwidth at the focal plane. To avoid aliasing caused by undersampling, the corresponding focal plane array (FPA) must be sufficiently dense. However, cost and fabrication complexities may make this impractical. More fundamentally, smaller detectors capture fewer photons, which can lead to potentially severe noise levels in the acquired imagery. Considering these factors, one may choose to accept a certain level of undersampling or to sacrifice some optical resolution and/or field-of-view.

In image super-resolution (SR), postprocessing is used to obtain images with resolutions that go beyond the conventional limits of the uncompensated imaging system. In some systems, the primary limiting factor is the optical resolution of the image in the focal plane as defined by the cut-off frequency of the optics. We use the term "optical SR" to refer to SR methods that aim to create an image with valid spatial-frequency content that goes beyond the cut-off frequency of the optics. Such techniques typically must rely on extensive a priori information. In other image acquisition systems, the limiting factor may be the density of the FPA, subsequent postprocessing requirements, or transmission bitrate constraints that require data compression. We refer to the process of overcoming the limitations of the FPA in order to obtain the full resolution afforded by the selected optics as "detector SR." Note that some methods may seek to perform both optical and detector SR.

Detector SR algorithms generally process a set of low-resolution aliased frames from a video sequence to produce a high-resolution frame. When subpixel relative motion is present between the objects in the scene and the detector array, a unique set of scene samples are acquired for each frame. This provides the mechanism for effectively increasing the spatial sampling rate of the imaging system without reducing the physical size of the detectors.

With increasing interest in surveillance and the proliferation of digital imaging and video, SR has become a rapidly growing field. Recent advances in SR include innovative algorithms, generalized methods, real-time implementations, and novel applications. The purpose of this special issue is to present leading research and development in the area of super-resolution for digital video. Topics of interest for this special issue include but are not limited to:

- Detector and optical SR algorithms for video
- Real-time or near-real-time SR implementations
- Innovative color SR processing
- Novel SR applications such as improved object detection, recognition, and tracking
- Super-resolution from compressed video
- Subpixel image registration and optical flow

Authors should follow the EURASIP JASP manuscript format described at http://www.hindawi.com/journals/asp/. Prospective authors should submit an electronic copy of their complete manuscript through the EURASIP JASP manuscript tracking system at http://www.mstracking.com/asp/, according to the following timetable:

Manuscript Due	September 1, 2006
Acceptance Notification	February 1, 2007
Final Manuscript Due	April 15, 2007
Publication Date	3rd Quarter, 2007

GUEST EDITORS:

Russell C. Hardie, Department of Electrical and Computer Engineering, University of Dayton, 300 College Park, Dayton, OH 45469-0026, USA; rhardie@udayton.edu

Richard R. Schultz, Department of Electrical Engineering, University of North Dakota, Upson II Room 160, P.O. Box 7165, Grand Forks, ND 58202-7165, USA; RichardSchultz@mail.und.nodak.edu

Kenneth E. Barner, Department of Electrical and Computer Engineering, University of Delaware, 140 Evans Hall, Newark, DE 19716-3130, USA; barner@ee.udel.edu

EURASIP JOURNAL ON APPLIED SIGNAL PROCESSING

Special Issue on

Advanced Signal Processing and Computational Intelligence Techniques for Power Line Communications

Call for Papers

In recent years, increased demand for fast Internet access and new multimedia services, the development of new and feasible signal processing techniques associated with faster and low-cost digital signal processors, as well as the deregulation of the telecommunications market have placed major emphasis on the value of investigating hostile media, such as powerline (PL) channels for high-rate data transmissions.

Nowadays, some companies are offering powerline communications (PLC) modems with mean and peak bit-rates around 100 Mbps and 200 Mbps, respectively. However, advanced broadband powerline communications (BPLC) modems will surpass this performance. For accomplishing it, some special schemes or solutions for coping with the following issues should be addressed: (i) considerable differences between powerline network topologies; (ii) hostile properties of PL channels, such as attenuation proportional to high frequencies and long distances, high-power impulse noise occurrences, time-varying behavior, and strong inter-symbol interference (ISI) effects; (iv) electromagnetic compatibility with other well-established communication systems working in the same spectrum, (v) climatic conditions in different parts of the world; (vii) reliability and QoS guarantee for video and voice transmissions; and (vi) different demands and needs from developed, developing, and poor countries.

These issues can lead to exciting research frontiers with very promising results if signal processing, digital communication, and computational intelligence techniques are effectively and efficiently combined.

The goal of this special issue is to introduce signal processing, digital communication, and computational intelligence tools either individually or in combined form for advancing reliable and powerful future generations of powerline communication solutions that can be suited with for applications in developed, developing, and poor countries.

Topics of interest include (but are not limited to)

- Multicarrier, spread spectrum, and single carrier techniques
- Channel modeling
- Channel coding and equalization techniques
- Multiuser detection and multiple access techniques
- Synchronization techniques
- Impulse noise cancellation techniques
- FPGA, ASIC, and DSP implementation issues of PLC modems
- Error resilience, error concealment, and Joint source-channel design methods for video transmission through PL channels

Authors should follow the EURASIP JASP manuscript format described at the journal site http://asp.hindawi.com/. Prospective authors should submit an electronic copy of their complete manuscripts through the EURASIP JASP manuscript tracking system at http://www.mstracking.com/asp/, according to the following timetable:

Manuscript Due	October 1, 2006
Acceptance Notification	January 1, 2007
Final Manuscript Due	April 1, 2007
Publication Date	3rd Quarter, 2007

GUEST EDITORS:

Moisés Vidal Ribeiro, Federal University of Juiz de Fora, Brazil; mribeiro@ieee.org

Lutz Lampe, University of British Columbia, Canada; lampe@ece.ubc.ca

Sanjit K. Mitra, University of California, Santa Barbara, USA; mitra@ece.ucsb.edu

Klaus Dostert, University of Karlsruhe, Germany; klaus.dostert@etec.uni-karlsruhe.de

Halid Hrasnica, Dresden University of Technology, Germany hrasnica@ifn.et.tu-dresden.de

Special Issue on

Video Adaptation for Heterogeneous Environments

Call for Papers

The explosive growth of compressed video streams and repositories accessible worldwide, the recent addition of new video-related standards such as H.264/AVC, MPEG-7, and MPEG-21, and the ever-increasing prevalence of heterogeneous, video-enabled terminals such as computer, TV, mobile phones, and personal digital assistants have escalated the need for efficient and effective techniques for adapting compressed videos to better suit the different capabilities, constraints, and requirements of various transmission networks, applications, and end users. For instance, Universal Multimedia Access (UMA) advocates the provision and adaptation of the same multimedia content for different networks, terminals, and user preferences.

Video adaptation is an emerging field that offers a rich body of knowledge and techniques for handling the huge variation of resource constraints (e.g., bandwidth, display capability, processing speed, and power consumption) and the large diversity of user tasks in pervasive media applications. Considerable amounts of research and development activities in industry and academia have been devoted to answering the many challenges in making better use of video content across systems and applications of various kinds.

Video adaptation may apply to individual or multiple video streams and may call for different means depending on the objectives and requirements of adaptation. Transcoding, transmoding (cross-modality transcoding), scalable content representation, content abstraction and summarization are popular means for video adaptation. In addition, video content analysis and understanding, including low-level feature analysis and high-level semantics understanding, play an important role in video adaptation as essential video content can be better preserved.

The aim of this special issue is to present state-of-the-art developments in this flourishing and important research field. Contributions in theoretical study, architecture design, performance analysis, complexity reduction, and real-world applications are all welcome.

Topics of interest include (but are not limited to):

- Heterogeneous video transcoding
- Scalable video coding
- Dynamic bitstream switching for video adaptation
- Signal, structural, and semantic-level video adaptation
- Content analysis and understanding for video adaptation
- Video summarization and abstraction
- Copyright protection for video adaptation
- Crossmedia techniques for video adaptation
- Testing, field trials, and applications of video adaptation services
- International standard activities for video adaptation

Authors should follow the EURASIP JASP manuscript format described at http://www.hindawi.com/journals/asp/. Prospective authors should submit an electronic copy of their complete manuscript through the EURASIP JASP manuscript tracking system at http://www.mstracking.com/asp/, according to the following timetable:

Manuscript Due	September 1, 2006
Acceptance Notification	January 1, 2007
Final Manuscript Due	April 1, 2007
Publication Date	3rd Quarter 2007

GUEST EDITORS:

Chia-Wen Lin, Department of Computer Science and Information Engineering, National Chung Cheng University, Chiayi 621, Taiwan; cwlin@cs.ccu.edu.tw

Yap-Peng Tan, School of Electrical and Electronic Engineering, Nanyang Technological University, Nanyang Avenue, Singapore 639798, Singapore; eyptan@ntu.edu.sg

Ming-Ting Sun, Department of Electrical Engineering, University of Washington, Seattle, WA 98195, USA ; sun@ee.washington.edu

Alex Kot, School of Electrical and Electronic Engineering, Nanyang Technological University, Nanyang Avenue, Singapore 639798, Singapore; eackot@ntu.edu.sg

Anthony Vetro, Mitsubishi Electric Research Laboratories,
201 Broadway, 8th Floor, Cambridge, MA 02138, USA;
avetro@merl.com

Hindawi Publishing Corporation
http://www.hindawi.com

EURASIP JOURNAL ON APPLIED SIGNAL PROCESSING

Special Issue on

Transforming Signal Processing Applications into Parallel Implementations

Call for Papers

There is an increasing need to develop efficient "system-level" models, methods, and tools to support designers to quickly transform signal processing application specification to heterogeneous hardware and software architectures such as arrays of DSPs, heterogeneous platforms involving microprocessors, DSPs and FPGAs, and other evolving multiprocessor SoC architectures. Typically, the design process involves aspects of application and architecture modeling as well as transformations to translate the application models to architecture models for subsequent performance analysis and design space exploration. Accurate predictions are indispensable because next generation signal processing applications, for example, audio, video, and array signal processing impose high throughput, real-time and energy constraints that can no longer be served by a single DSP.

There are a number of key issues in transforming application models into parallel implementations that are not addressed in current approaches. These are engineering the application specification, transforming application specification, or representation of the architecture specification as well as communication models such as data transfer and synchronization primitives in both models.

The purpose of this call for papers is to address approaches that include application transformations in the performance, analysis, and design space exploration efforts when taking signal processing applications to concurrent and parallel implementations. The Guest Editors are soliciting contributions in joint application and architecture space exploration that outperform the current architecture-only design space exploration methods and tools.

Topics of interest for this special issue include but are not limited to:

- modeling applications in terms of (abstract) control-dataflow graph, dataflow graph, and process network models of computation (MoC)
- transforming application models or algorithmic engineering
- transforming application MoCs to architecture MoCs
- joint application and architecture space exploration
- joint application and architecture performance analysis
- extending the concept of algorithmic engineering to architecture engineering
- design cases and applications mapped on multiprocessor, homogeneous, or heterogeneous SOCs, showing joint optimization of application and architecture

Authors should follow the EURASIP JASP manuscript format described at http://www.hindawi.com/journals/asp/. Prospective authors should submit an electronic copy of their complete manuscript through the EURASIP JASP manuscript tracking system at http://www.mstracking.com/asp/, according to the following timetable:

Manuscript Due	September 1, 2006
Acceptance Notification	January 1, 2007
Final Manuscript Due	April 1, 2007
Publication Date	3rd Quarter 2007

GUEST EDITORS:

F. Deprettre, Leiden Embedded Research Center, Leiden University, Niels Bohrweg 1, 2333 CA Leiden, The Netherlands; edd@liacs.nl

Roger Woods, School of Electrical and Electronic Engineering, Queens University of Belfast, Ashby Building, Stranmillis Road, Belfast, BT9 5AH, UK; r.woods@qub.ac.uk

Ingrid Verbauwhede, Katholieke Universiteit Leuven, ESAT-COSIC, Kasteelpark Arenberg 10, 3001 Leuven, Belgium; Ingrid.verbauwhede@esat.kuleuven.be

Erwin de Kock, Philips Research, High Tech Campus 31, 5656 AE Eindhoven, The Netherlands; erwin.de.kock@philips.com

Special Issue on Facial Image Processing

Call for Papers

Facial image processing is an area of research dedicated to the extraction and analysis of information about human faces; information which is known to play a central role in social interactions including recognition, emotion, and intention. Over the last decade, it has become a very active research field that deals with face detection and tracking, facial feature detection, face recognition, facial expression and emotion recognition, face coding, and virtual face synthesis.

With the introduction of new powerful machine learning techniques, statistical classification methods, and complex deformable models, recent progresses have made possible a large number of applications in areas such as model-based video coding, image retrieval, surveillance and biometrics, visual speech understanding, virtual characters for e-learning, online marketing or entertainment, intelligent human-computer interaction, and others.

However, lots of progress is yet to be made to provide more robust systems, especially when dealing with pose and illumination changes in complex natural scenes. If most approaches focus naturally on processing from still images, emerging techniques may also consider different inputs. For instance, video is becoming ubiquitous and very affordable, and there is growing demand for vision-based human-oriented applications, ranging from security to human-computer interaction and video annotation.

Taking into account temporal information and the dynamics of faces may also ease applications like, for instance, facial expression and face recognition which are still very challenging tasks.

Capturing 3D data may as well become very affordable and processing such data can lead to enhanced systems, more robust to illumination effects and where discriminant information may be more easily retrieved.

The goal of this special issue is to provide original contributions in the field of facial image processing.

Topics of interest include (but are not limited to):

- Face Detection and Tracking
- Facial Feature Detection and Face Normalization
- Face Verification and Recognition
- Facial Emotion Recognition and Synthesis
- 3D Reconstruction and Modelling
- Video-Driven Facial Animation
- Face Synthesis and Mimicking
- Affective Facial Animation
- 3D Analysis and Synthesis

Authors should follow the IJIVP manuscript format described at http://www.hindawi.com/journals/ijivp/. Prospective authors should submit an electronic copy of their complete manuscript through the IJIVP manuscript tracking system at http://www.mstracking.com/mts, according to the following timetable:

Manuscript Due	May 1, 2006
Acceptance Notification	August 1, 2006
Final Manuscript Due	October 1, 2006
Publication Date	4th Quarter, 2006

GUEST EDITORS:

Christophe Garcia, Image, Rich Media and Hyperlanguages Laboratory, France Telecom Division R&D, Rennes, France; christophe.garcia@francetelecom.com

Jörn Ostermann, Institut für Informationsverarbeitung, Universität Hannover, 30167 Hannover, Germany ostermann@tnt.uni-hannover.de;

Tim Cootes, Division of Imaging Science and Biomedical Engineering, University of Manchester, Manchester M13 9PL, UK Tim.Cootes@manchester.ac.uk;

Special Issue on Genetic Regulatory Networks

Call for Papers

Genomic signal processing (GSP) has been defined as the analysis, processing, and use of genomic signals for gaining biological knowledge and the translation of that knowledge into systems-based applications. A major goal of GSP is to characterize genetic regulation and its effects on cellular behaviour and function, thereby leading to a functional understanding of diseases and the development of systems-based medical solutions. This involves the development of nonlinear dynamical network models for genomic regulation and of mathematically grounded diagnostic and therapeutic tools based on those models. This special issue is devoted to genetic regulatory networks. We desire high-quality papers on all network issues, including:

- Mathematical models
- Inference
- Steady-state analysis
- Optimal intervention
- Approximation and reduction
- Validation
- Computational complexity
- Applications

Authors should follow the EURASIP JBSB manuscript format described at http://www.hindawi.com/journals/bsb/. Prospective authors should submit an electronic copy of their complete manuscript through the EURASIP JBSB's manuscript tracking system at http://www.mstracking.com/mts, according to the following timetable.

Manuscript Due	July 1, 2006
Acceptance Notification	October 1, 2006
Final Manuscript Due	November 1, 2006
Publication Date	1st Quarter, 2007

GUEST EDITORS:

Edward R. Dougherty, Department of Electrical & Computer Engineering, College of Engineering, Texas A&M University, College Station, TX 77843-3128, USA; Translation Genomics Research Institute, Phoenix, AZ 85004, USA; edward@ece.tamu.edu

Tatsuya Akutsu, Bioinformatics Center, Institute for Chemical Research, Kyoto University, Gokasho, Uji, Kyoto 611-0011, Japan; takutsu@kuicr.kyoto-u.ac.jp

Paul Cristea, Digital Signal Processing Laboratory, Department of Electrical Engineering, "Politechnica" University Of Bucharest, 060032 Bucharest, Romania; pcristea@dsp.pub.ro

Ahmed Tewfik, Department of Electrical and Computer Engineering, Institute of Technology, University of Minnesota, Minneapolis, MN 55455, USA; tewfik@umn.edu

EURASIP JOURNAL ON AUDIO, SPEECH, AND MUSIC PROCESSING

Special Issue on

Adaptive Partial-Update and Sparse System Identification

Call for Papers

This special issue aims to draw together work on sparse system identification and partial-update adaptive filters. These research problems can be considered as exploiting sparseness in different "domains", namely, adaptive filter coefficient vector and update regressor vector. This special issue will further develop the positive outcomes of the EUSIPCO 2005 special session on sparse system identification and partial-update adaptive algorithms.

Identification of sparse and/or high-order FIR systems has always been a challenging research problem. In many applications, including acoustic/network echo cancellation and channel equalization, the system to be identified can be characterized as sparse and/or long. Partial-update adaptive filtering algorithms were proposed to address the large computational complexity associated with long adaptive filters. However, the initial partial-update algorithms had to incur performance losses, such as slow convergence, compared with full-update algorithms because of the absence of clever updating approaches. More recently, better partial-update techniques have been developed that are capable of minimizing the performance loss. In certain applications, these partial-update techniques have even been observed to produce improved convergence performance with respect to a full-update algorithm. The potential performance gain that can be achieved by partial-update algorithms is an important feature of these adaptive techniques that was not recognized earlier. The notion of partial-update adaptive filtering has been gaining momentum thanks to the recognition of its complexity and performance advantages.

Sparse system identification is a vital requirement for fast converging adaptive filters in, for example, certain specific deployments of echo cancellation. Recent advances, such as IPNLMS, have been used to good effect in network echo cancellation for VoIP gateways (to take account of unpredictable bulk delays in IP network propagation) and acoustic echo cancellation (to handle the unknown propagation delay of the direct acoustic path). It is known that several research labs are working on these problems with new solutions emerging.

This special issue will focus on recent developments in this key research area. Topics of interest include (but are not limited to):

- Adaptive filters employing partial-update methods,
- Time-domain and transform-domain implementations of partial-update adaptive filters,
- Convergence and complexity analysis of partial-update schemes,
- Single and multichannel algorithms employing partial updates,
- Adaptive algorithms for sparse system identification,
- Applications of partial-update adaptive filters and sparse system identification in echo/noise cancellation, acoustics, and telecommunications,
- Partial-update filters for sparse system identification.

Authors should follow the EURASIP JASP manuscript format described at http://www.hindawi.com/journals/asmp/. Prospective authors should submit an electronic copy of their complete manuscripts through the EURASIP JASP manuscript tracking system at http://www.mstracking.com/mts, according to the following timetable:

Manuscript Due	May 1, 2006
Acceptance Notification	September 1, 2006
Final Manuscript Due	December 1, 2006
Publication Date	1st Quarter, 2007

GUEST EDITORS:

Kutluyil Dogancay, School of Electrical and Information Engineering, University of South Australia, Mawson Lakes, South Australia 5095, Australia; kutluyil.dogancay@unisa.edu.au

Patrick A. Naylor, Department of Electrical & Electronic Engineering, Imperial College London, Exhibition Road, London SW7 2AZ, UK; p.naylor@imperial.ac.uk

Special Issue on Multimodality Imaging and Hybrid Scanners

Call for Papers

Over the past few decades, medical computed imaging has established its role as a major clinical tool. Technical advancements as well as advanced new algorithms have substantially improved spatial and temporal resolution and contrast. Nevertheless, despite these improvements single-modality scans cannot always provide the full clinical picture. Resolution and image quality are often compromised in order to obtain functional images. This is particularly true for NM imaging and has led to the development of hybrid scanners such as PET/CT and SPECT/CT. Also, the old problem of multimodality image fusion has and probably will continue to attract a lot of research. This has motivated us to edit a special issue which will provide a state-of-the-art picture of multimodality imaging.

The International Journal of Biomedical Imaging (IJBI) follows the Open Access model and publishes accepted papers on the web and in print. It targets rapid review, permanent archiving, high visibility, and lasting impact. In this special issue, the topics covered will include, but are not limited to, the following areas:

- New approaches and applications of PET/CT and SPECT/CT hybrid scanners
- Methods for image fusion of MRI and/or CT and/or Ultrasound
- Algorithms for data fusion and hybrid image reconstruction and display
- Methods for dual-modality scans alignment using fiducial markers, masks, and so forth
- Software-based multimodality image alignment
- Novel dual-modality scanning approaches
- Real-time navigation for image-guided intervention using multimodality systems

Authors should follow the IJBI manuscript format described at http://www.hindawi.com/journals/ijbi/. Prospective authors should submit an electronic copy of their complete manuscript through the IJBI manuscript tracking system at http://www.mstracking.com/mts, according to the following timetable:

Manuscript Due	May 1, 2006
Acceptance Notification	September 1, 2006
Final Manuscript Due	December 1, 2006
Publication Date	1st Quarter, 2007

GUEST EDITOR:

Haim Azhari, Department of Biomedical Engineering, Technion – Israel Institute of Technology, Haifa, 32000, Israel; haim@bm.technion.ac.il

Robert R. Edelman, Department of Radiology, Evanston Northwestern Healthcare, 2650 Ridge Ave., Evanston, IL 60201, USA; redelman@enh.org

David Townsend, Cancer Imaging and Tracer Development Program, University of Tennessee Medical Center, 1924, Alcoa Highway, Knoxville, TN 37920, USA; dtownsend@mc.utmck.edu

NEWS RELEASE

Nominations Invited for the Institute of Acoustics 2006 A B Wood Medal

The Institute of Acoustics, the UK's leading professional body for those working in acoustics, noise and vibration, is inviting nominations for its prestigious A B Wood Medal for the year 2006.

The A B Wood Medal and prize is presented to an individual, usually under the age of 35, for distinguished contributions to the application of underwater acoustics. The award is made annually, in even numbered years to a person from Europe and in odd numbered years to someone from the USA/Canada. The 2005 Medal was awarded to Dr A Thode from the USA for his innovative, interdisciplinary research in ocean and marine mammal acoustics.

Nominations should consist of the candidate's CV, clearly identifying peer reviewed publications, and a letter of endorsement from the nominator identifying the contribution the candidate has made to underwater acoustics. In addition, there should be a further reference from a person involved in underwater acoustics and not closely associated with the candidate. Nominees should be citizens of a European Union country for the 2006 Medal. Nominations should be marked confidential and addressed to the President of the Institute of Acoustics at 77A St Peter's Street, St. Albans, Herts, AL1 3BN. The deadline for receipt of nominations is **15 October 2005**.

Dr Tony Jones, President of the Institute of Acoustics, comments, "A B Wood was a modest man who took delight in helping his younger colleagues. It is therefore appropriate that this prestigious award should be designed to recognise the contributions of young acousticians."

Further information and an nomination form can be found on the Institute's website at www.ioa.org.uk.

A B Wood

Albert Beaumont Wood was born in Yorkshire in 1890 and graduated from Manchester University in 1912. He became one of the first two research scientists at the Admiralty to work on antisubmarine defence. He designed the first directional hydrophone and was well known for the many contributions he made to the science of underwater acoustics and for the help he gave to younger colleagues. The medal was instituted after his death by his many friends on both sides of the Atlantic and was administered by the Institute of Physics until the formation of the Institute of Acoustics in 1974.

PRESS CONTACT

Judy Edrich
Publicity & Information Manager, Institute of Acoustics
Tel: 01727 848195; E-mail: judy.edrich@ioa.org.uk

EDITORS NOTES

The Institute of Acoustics is the UK's professional body for those working in acoustics, noise and vibration. It was formed in 1974 from the amalgamation of the Acoustics Group of the Institute of Physics and the British Acoustical Society (a daughter society of the Institution of Mechanical Engineers). The Institute of Acoustics is a nominated body of the Engineering Council, offering registration at Chartered and Incorporated Engineer levels.

The Institute has some 2500 members from a rich diversity of backgrounds, with engineers, scientists, educators, lawyers, occupational hygienists, architects and environmental health officers among their number. This multidisciplinary culture provides a productive environment for cross-fertilisation of ideas and initiatives. The range of interests of members within the world of acoustics is equally wide, embracing such aspects as aerodynamics, architectural acoustics, building acoustics, electroacoustics, engineering dynamics, noise and vibration, hearing, speech, underwater acoustics, together with a variety of environmental aspects. The lively nature of the Institute is demonstrated by the breadth of its learned society programmes.

For more information please visit our site at www.ioa.org.uk.