

指紋照合とDNA型照合

法数学勉強会

2016年4月会

京都大学(医)統計遺伝学分野

山田 亮

[製品](#)

[ソリューション・サービス](#)

[導入事例](#)

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[ニュース](#)

[企業情報](#)

[ホーム](#) > [プレスリリース](#) > NEC、NISTの指紋認証技術 ベンチマークテストにおいて第1位の評価を獲得

NEC、米国国立標準技術研究所(NIST)の指紋認証技術 ベンチマークテストで第1位の評価を獲得

～ 国民IDなど、大規模データベースでの実運用を想定した高速・高精度な認証を実現 ～

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2015年3月6日
日本電気株式会社

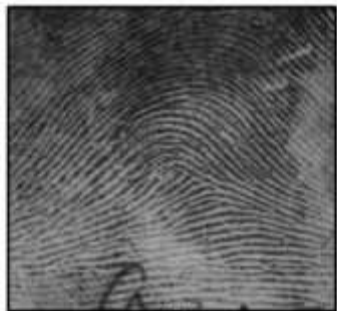
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指紋認証システムの利用イメージ



Input Image

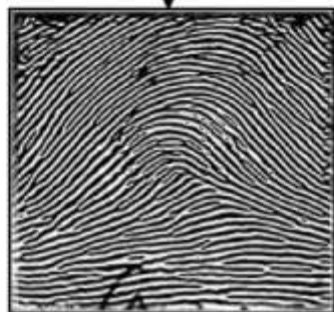


Local Contrast Enhancement

Local Orientation Estimation

Local Frequency Estimation

Contextual Filtering



Enhanced Image

CHAPTER

6

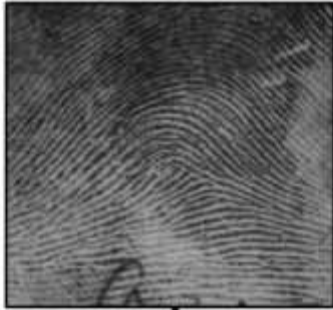
**AUTOMATED FINGERPRINT
IDENTIFICATION SYSTEM (AFIS)**

KENNETH R. MOSES

CONTRIBUTING AUTHORS
PETER HIGGINS, MICHAEL MCCABE,
SALIL PRABHAKAR, SCOTT SWANN

CONTENTS

Input Image

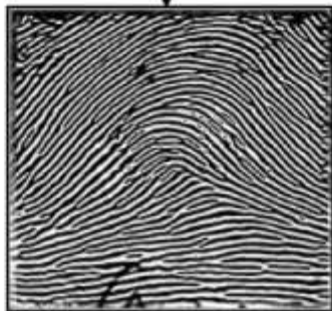


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Enhanced Image

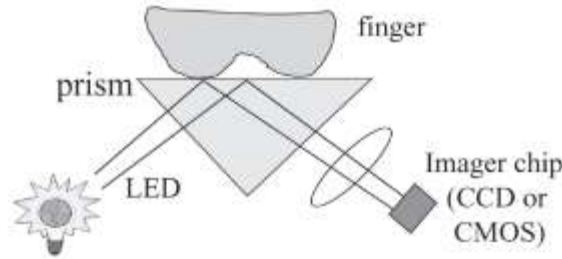


Fig. 2 Optical fingerprint sensor using a prism.

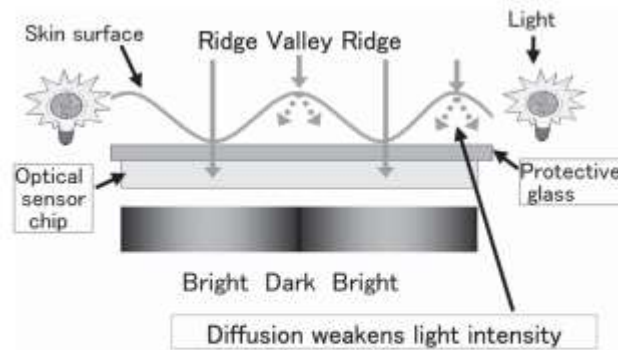


Fig. 3 Optical sensor using in-finger light dispersion.

Detection and Recognition Technologies

Fingerprint Identification

By Kaoru UCHIDA*

CHAPTER

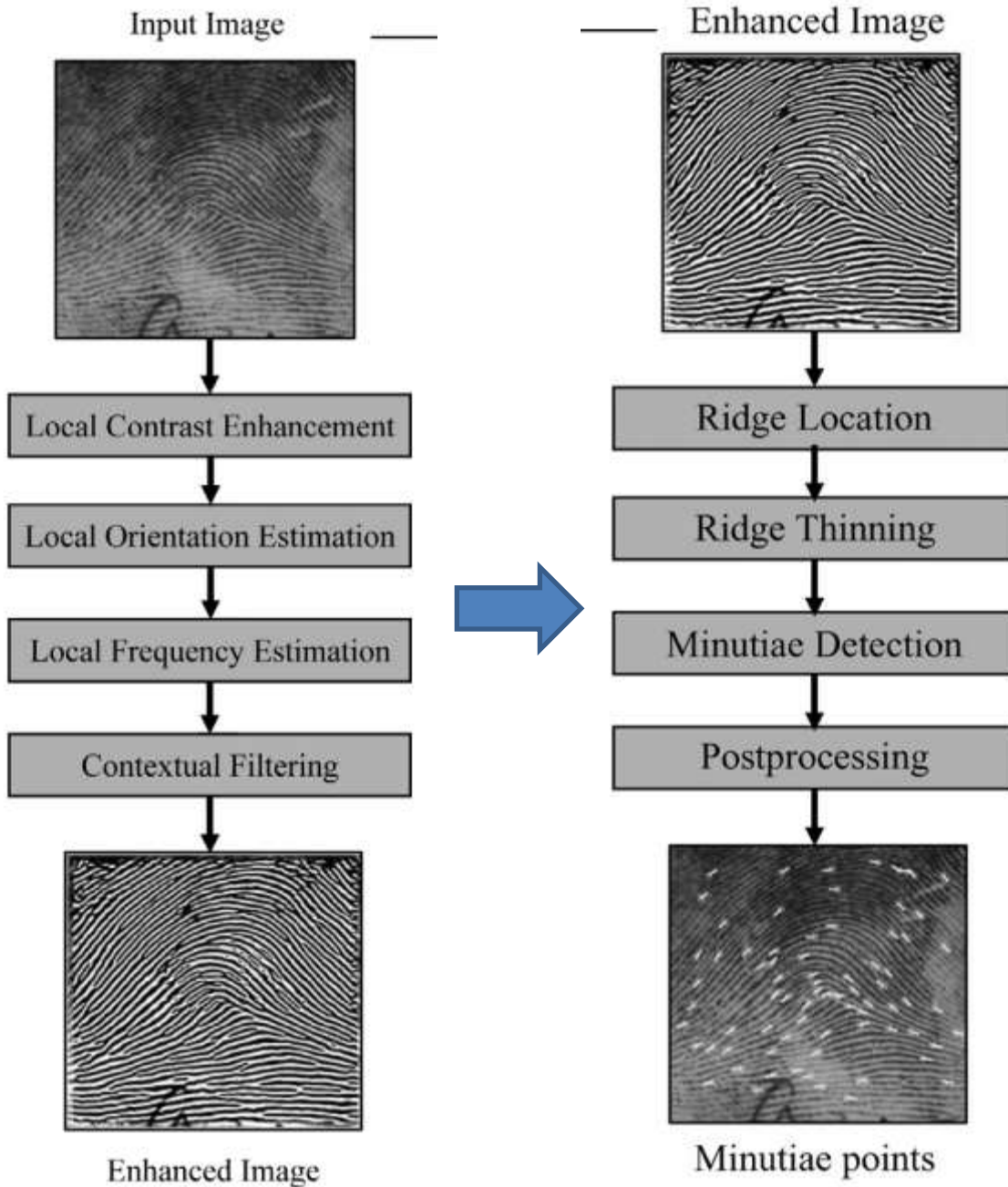
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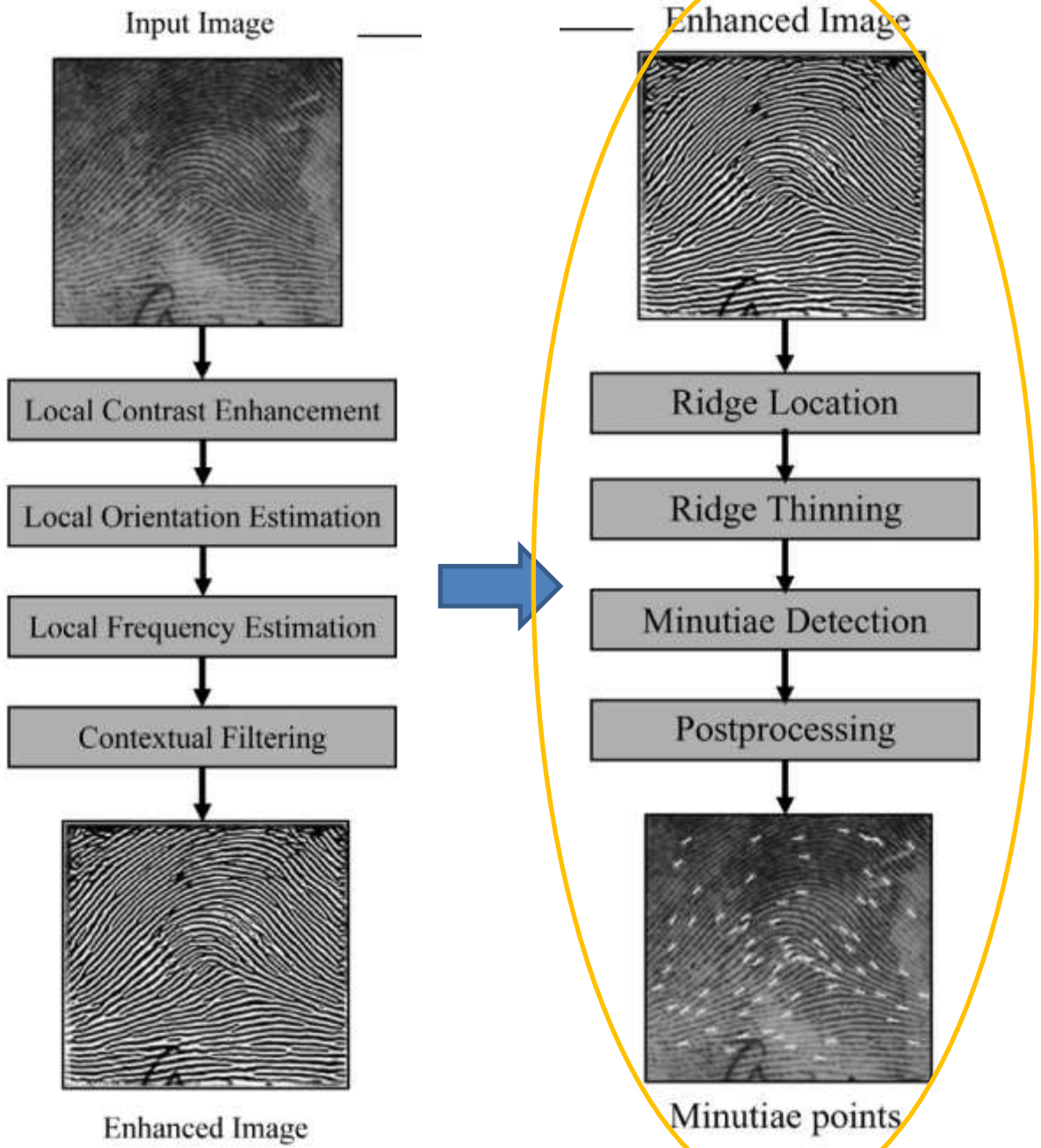
AUTOMATED FINGERPRINT
IDENTIFICATION SYSTEM (AFIS)

KENNETH R. MOSES

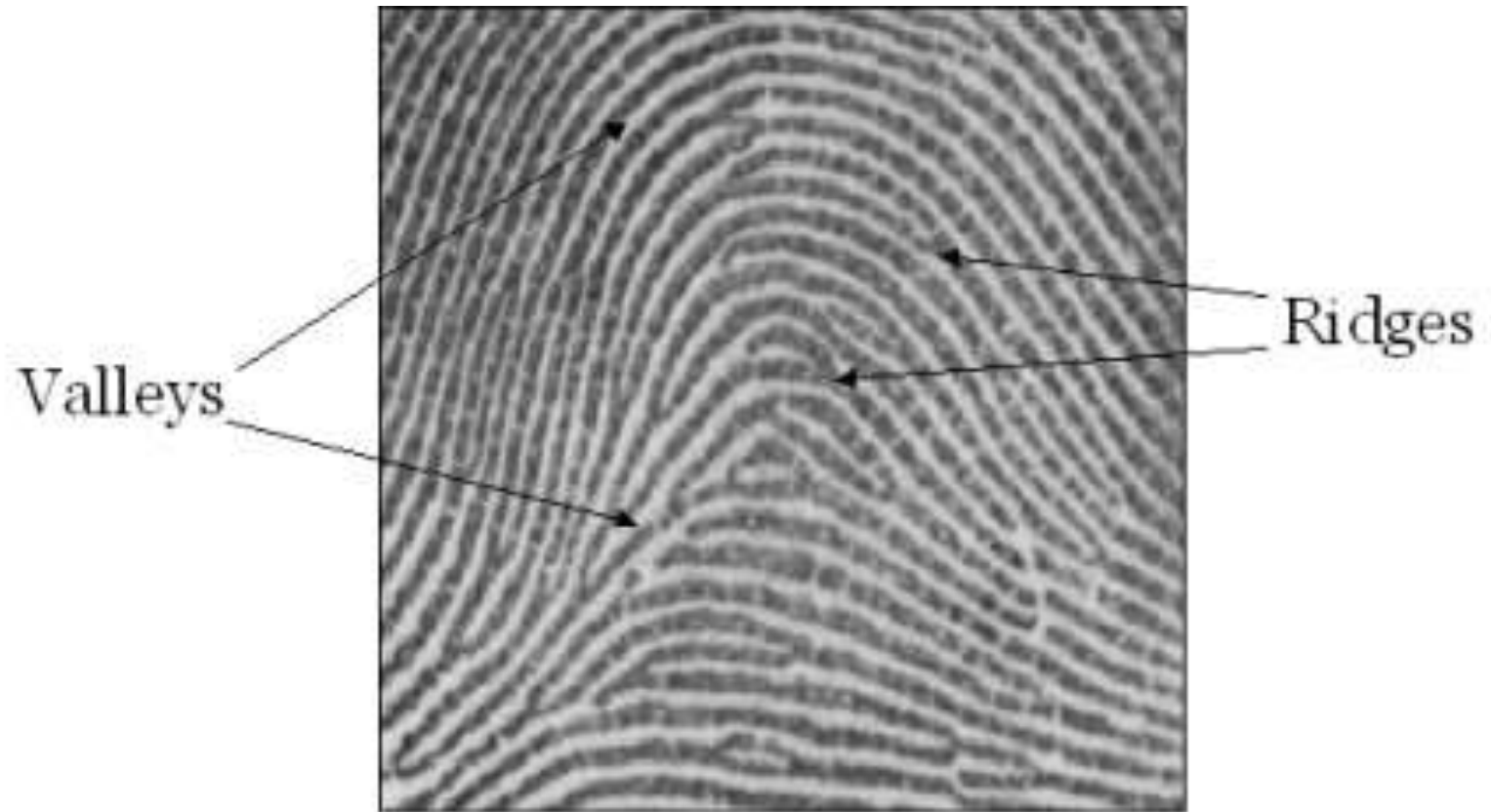
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SALIL PRABHAKAR, SCOTT SWANN

CONTENTS





Ridge & valley



Galton details

F.M.R.	F.M.R.	Th. Th.	F.M.R.	F.M.R.	Th. L.	Th. L.	№
Aaa	aaa	1 2	.	d d	. dl	d	3516
	aal	5 2	.	.	2	ll	2301
		5 4	.	.	.	.	1995
Aal	aal	5 5	.	2a	2	v	3640
		5 5	.	.	2	v	2740
	all	5 5	.	l	yw	vw	3550
		5 5	.	l	v	.	3639
	rll	5 5	.	k	vy	.	3598
		5 5	.	t	ly	.	3647
	ual	5 4	.	.	*d	.	3570
	ull	5 5	.	ll	.	.	1892
		5 8	.	ry	2	v	3490
Aaw	aal	5 5	.	b	.	svq	y
	alw	5 5	.	.	.	v	3542
	aaa	4 4	.	u	3	.	3858
Ala	aaa	4 4	.	u	3	.	3548
All	aal	5 5	.	2a	.	.	2513
	all	5 2	.	r	.	3	1956

¹ 295 of these are pasted in two volumes; the remaining 5, which are numbered 6995 to 6999, are supplementary.

Basic and composite ridge characteristics (minutiae)

Minutiae	Example
ridge ending	
bifurcation	
dot	
island (short ridge)	
lake (enclosure)	
hook (spur)	

Minutiae	Example
bridge	
double bifurcation	
trifurcation	
opposed bifurcations	
ridge crossing	
opposed bifurcation/ridge ending	

1	2	3	4	5	6	7	8
All	aal	5 5	.	3	.	.	2991
		5 5	.	a	y	.	2754
		5 5	.	u	.	.	3525
	alw	5 5	.	.	†	v	3559
	ral	5 5	.	.	pl	b	2357
	rll	5 5	tr	.	v	.	2614
		5 5	3a	.	.	.	3504
		5 5	2u	.	.	.	3628
		5 5	lu	.	.	.	1743
		5 5	.	a	2a	a	2247
	ual	5 5	t	.	tr	.	2815
	ull	5 5	t	v	vy	.	8113
		5 2	t	.	.	.	3602
		5 5	u	.	.	rk	6998
		5 5	t	.	.	.	3499
		5 5	t	.	.	.	2375
		5 5	t	2	.	3a	741
		5 5	t	.	.	.	3569
		5 5	r	.	.	s	1353
		5 5	.	rt	.	.	3562
		5 5	.	a3	.	†	3132
		5 5	.	.	.	sb	293
Alw	alw	2 2	.	3	vyl	v	3614
	rll	9 5	kv	.	vy	†	vy
	rlw	5 5	.	.	.	v	3491
	ull	5 5	k	.	yl	v	3575
		9 5	kv	.	.	.	446
Ral	rll	5 5	.	.	.	.	3663
		5 5	.	3	†	sb	3632
Raw	aal	5 5	3a	.	.	.	3616
Rll	aal	5 5	2a	.	r	d	3517
	rll	5 2	3	.	r8	.	3595
		5 5	2at	.	.	.	2046
		5 5	2a	.	vy	.	at
		5 5	3	.	v	.	†
		5 5	4	.	.	y	.
		5 5	4	.	.	.	275
		5 5	4	.	2	.	v
		5 5	5	.	.	.	.
		5 5	5	r	.	.	.
		5 5	5	r	.	.	.
		5 5	5	y	.	.	.
		5 5	5	y	.	.	.
		5 5	5	kv	.	.	.
		5 5	5	v	.	.	.

Galton details

F.M.R.	F.M.R.	Th. Th.	F.M.R.	F.M.R.	Th. L.	Th. L.	№
Aaa	aaa	1 2	. . .	. d d	. dl	. d	3516
	aal	5 2	. . .	. . 2	2	ll	2301
	aa1	5 4	. . .	. . . 2	. . .	. . .	1995
Aa1	aa1	5 5	. . .	. . . 2a	. . . 2	. . . v	3640
	all	5 5	. . .	. . . l	. . . yw	. . . vw	2740
	all	5 5	. . .	. . . l v	. . .	. . .	3550
	rll	5 5	. . .	. . . k	. . . vy	. . .	3639
	ual	5 4	. . .	. . . t ll y	. . . *d	. . .	3598
	ull	5 5	. . .	. . . ll	. . .	. . .	3647
	6 8	. . .	. . .	. . . ry	2	. . . v	3570
Aaw	aal	5 5	. . .	. . . b	. . .	. . . svq	1892
	alw	5 5	. . .	. . .	. . .	. . . y	3490
	aaa	4 4	. . .	. . . u 3	. . .	. . .	3542
Ala	aaa	4 4	. . .	. . . u 3	. . .	. . .	3548
All	aal	5 5	. . .	. . . 2a	. . .	. . .	2513
	all	5 2	. . .	. . . r	. . . 3	. . . a	1956

¹ 295 of these are pasted in two volumes; the remaining 5, which are numbered 6995 to 6999, are supplementary.

Basic and composite ridge characteristics (minutiae)

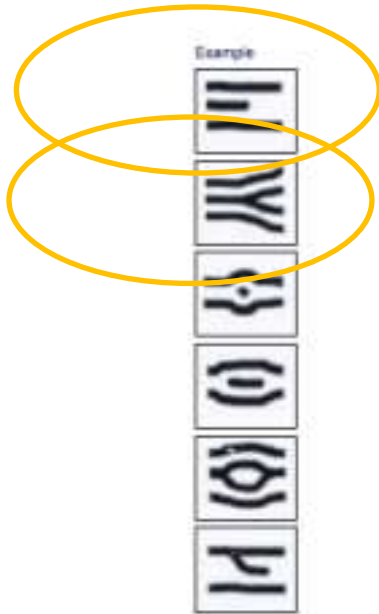
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FINGERPRINT DIRECTORIES

CHAP.

Minutiae

Example



ridge ending

bifurcation

dot

island (short ridge)

lake (enclosure)

hook (spur)

Minutiae

Example

bridge

double bifurcation

trifurcation

opposed bifurcations

ridge crossing

opposed bifurcation/ridge ending



1	2	3	4	5	6	7	8
All	aal	5 5	. . .	. 3	. . .	. . .	2991
		5 5	. . . a y	. . .	. . .	. . .	2754
		5 5	. . .	u	. . .	. . .	3525
	alw	5 5	. . .	. . . †	. . . v	. . . 2a	3559
	ral	5 5	. . .	. . . pl	. . . b	. . .	2357
	rll	5 5	. . . tr	. . .	. . . v	. . .	2614
		5 5	. . . 3a	. . .	. . .	. . .	3504
		5 5	. . . 2u	. . .	. . .	. . .	3628
		5 5	. . . lu	. . .	. . .	. . .	1743
	ual	5 5	. . . a	. . . 2a	. . . a	. . .	2247
	ull	5 5	. . . t v vy	. . .	. . . tr	. . . y	2815
		5 2	. . . t	. . .	. . . kv†	. . .	3113
		5 5	. . . u	. . .	. . . rk	. . .	3602
		5 5	. . . t	. . .	. . .	. . .	6998
		5 5	. . . t	. . .	. . .	. . .	3499
		5 5	. . . t 2	. . .	. . . 3a	. . . †	2375
		5 5	. . . t	. . .	. . .	. . .	741
		5 5	. . . r	. . .	. . .	. . . s	3569
		5 5	. . . r†	. . .	. . . †	. . .	3562
		5 5	. . . a3	. . .	. . .	. . . sb	3132
		5 5	. . .	. . .	. . . †	. . .	293
Alw	alw	2 2	. . .	. . . 3	. . . vyl	. . . v	3614
	rll	9 5	. . . kv	. . .	. . . vy	. . . †	3622
	rlw	5 5	. . .	. . .	. . .	. . . v	3491
	ull	5 5	. . . k	. . .	. . . yl	. . . v	3575
		9 5	. . . kv	. . .	. . .	. . .	446
Ral	rll	5 5	. . .	. . .	. . .	. . .	3663
		5 5	. . .	. . . 3 †	. . . sb	. . .	3632
Raw	aal	5 5	. . . 3a	. . .	. . .	. . .	3616
Rll	aal	5 5	. . . 2a	. . .	. . . r	. . . d	3517
	rll	5 2	. . . 3	. . .	. . . r8	. . .	3595
		5 5	. . . 2at	. . .	. . .	. . .	2046
		5 5	. . . 2a	. . .	. . . vy	. . .	3566
		5 5	. . . 3	. . .	. . . v	. . .	3641
		5 5	. . . 4	. . .	. . .	. . . y	275
		5 5	. . . 4	. . .	. . . 2	. . . v	2350
		5 5	. . . 5	. . .	. . .	. . .	3518
		5 5	. . . 5 r	. . .	. . . r	. . .	3580
		5 5	. . . 5 y	. . .	. . .	. . .	6997
		5 5	. . . 5 kv	. . .	. . .	. . .	3509
		5 5	. . . a	. . .	. . .	. . .	6999

Examples of Minutia

BIFURCATION



RIDGE ENDING



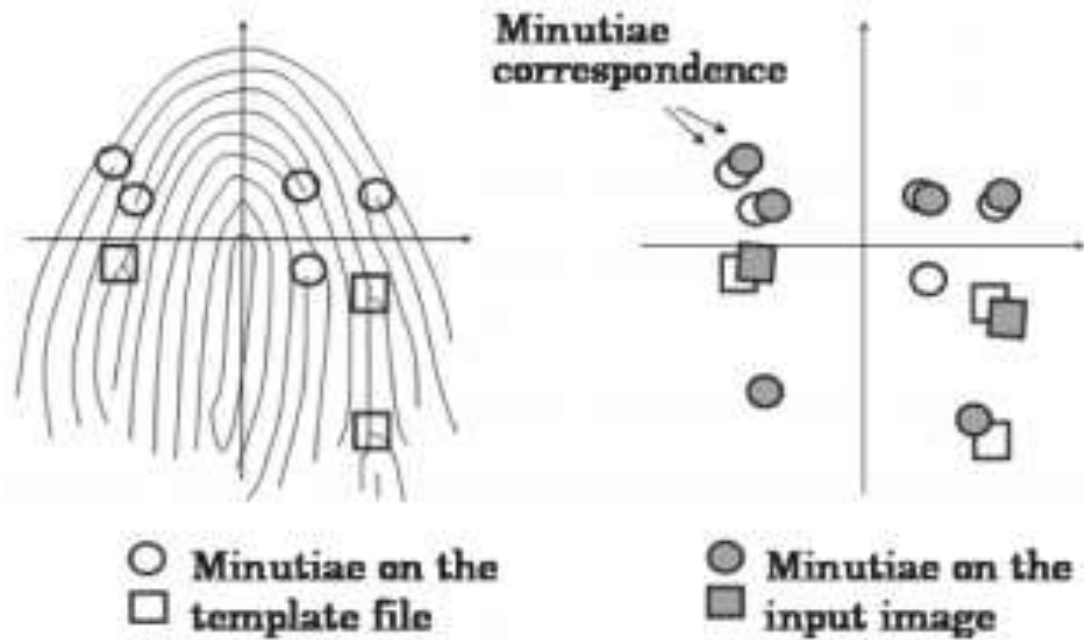


Fig. 5 Minutiae correspondence computation.

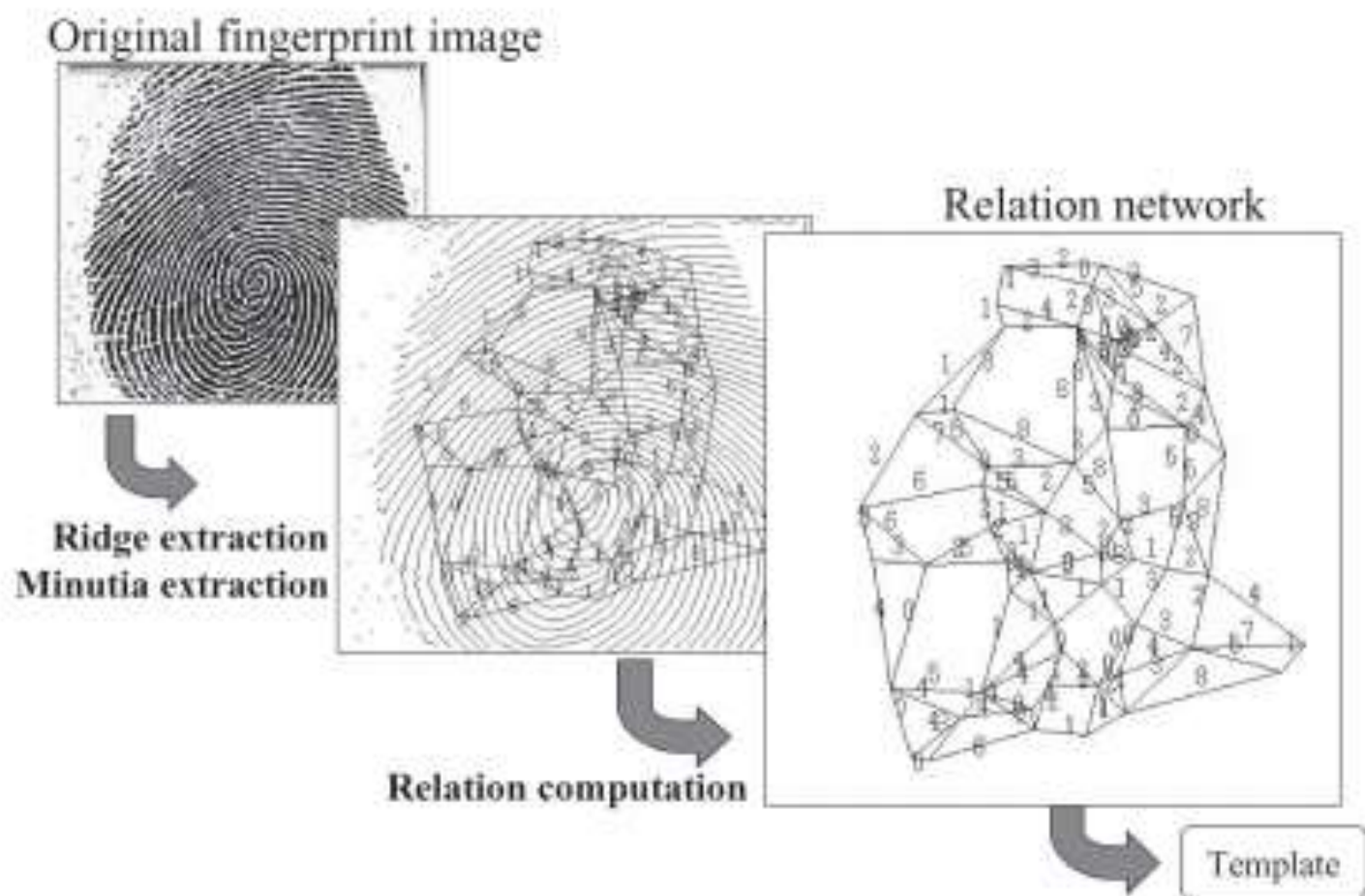


Fig. 7 Ridge extraction, minutiae location and "Relation" computation.

指紋

- 現場に残される
- 残り方が不完全かも
- オーバーラップ
- 回収

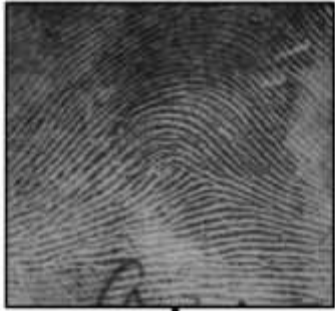
DNA

- 現場に残される
- 残り方が不完全かも
- 混合
- 回収・精製

指紋認証システムの利用イメージ



Input Image

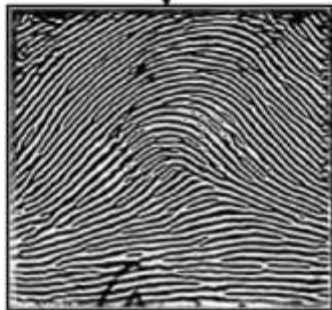


Local Contrast Enhancement

Local Orientation Estimation

Local Frequency Estimation

Contextual Filtering



Enhanced Image

指紋

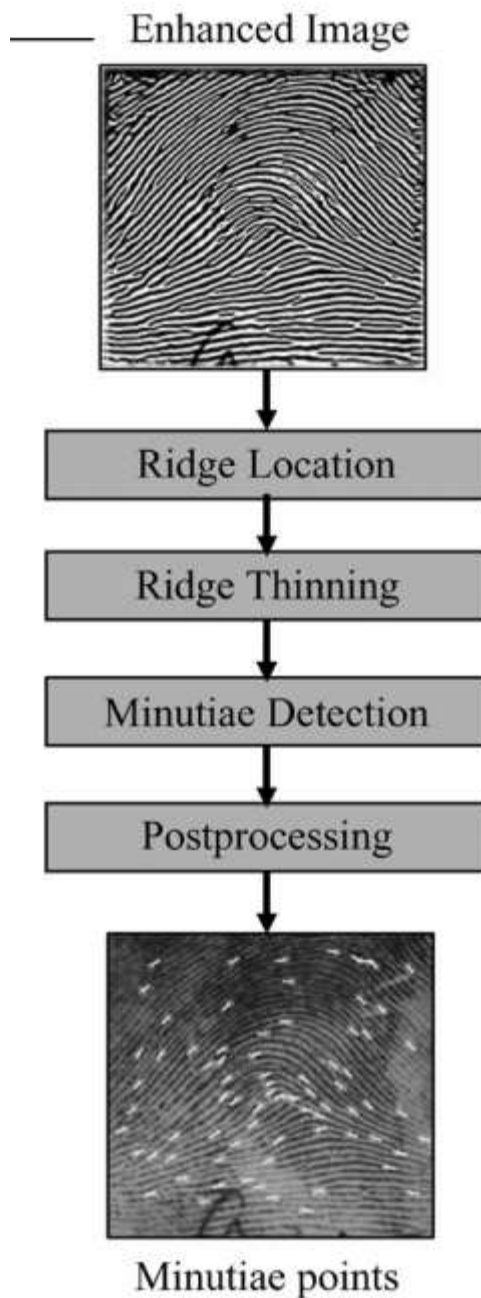
- くっきり・はっきり
- 光学機器

DNA

- PCR増幅
- 光学機器

指紋

- 使いたい特徴だけ使う
- Minutiae detection

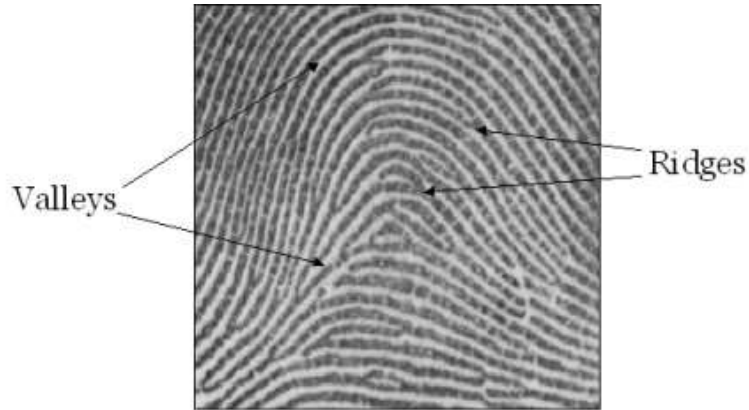


DNA

- 選ばれたマーカーを使う
- タイピング

指紋

- Ridge
- Valley



- 配置が作るより複雑なパターン単位

DNA

- SNP様のアレル 0/1
- MSアレル・ハプロタイプ

指紋

- 位置関係の依存性

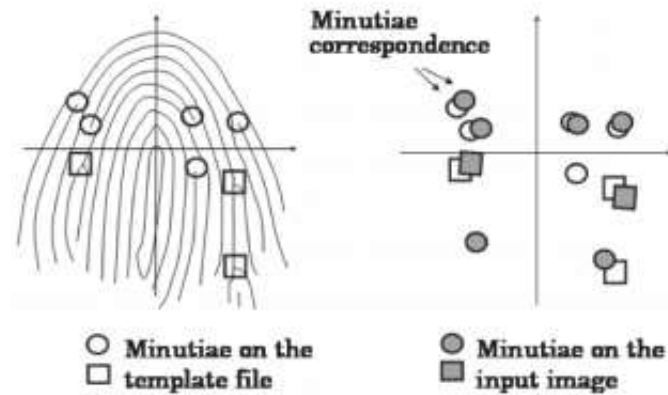


Fig. 5 Minutiae correspondence computation.

DNA

- ジェノタイプの相互依存関係(民族差・連鎖不平衡)

一致の確認

指紋

- FMR(False Match Rate)
 - 大規模な標本データベースでの偶然一致に基づく
- 偶然一致率が指紋によって大きく異なることを気にする

DNA

- 偶然にマッチする確率
 - 集団に推定したアレル・ジェノタイプ頻度に基づく
- 偶然一致率のDNA型別の違いをあまり問題にしない

參考資料

- <https://www.ncjrs.gov/pdffiles1/nij/225326.pdf>
AUTOMATED FINGERPRINT IDENTIFICATION SYSTEM (AFIS)
- http://www.nec.com/en/global/techrep/journal/nechistory/nh02/pdf/2005_0201_19-27.pdf Detection and Recognition Technologies Fingerprint Identification (NEC J. advanced Tech)
- **Probabilistic orientation field estimation for fingerprint enhancement and verification**
[10.1109/BSYM.2008.4655521](https://arxiv.org/abs/10.1109/BSYM.2008.4655521)
- **Minutiae Extraction from Fingerprint Images - a Review** [http://arxiv.org/abs/1201.1422](https://arxiv.org/abs/1201.1422)