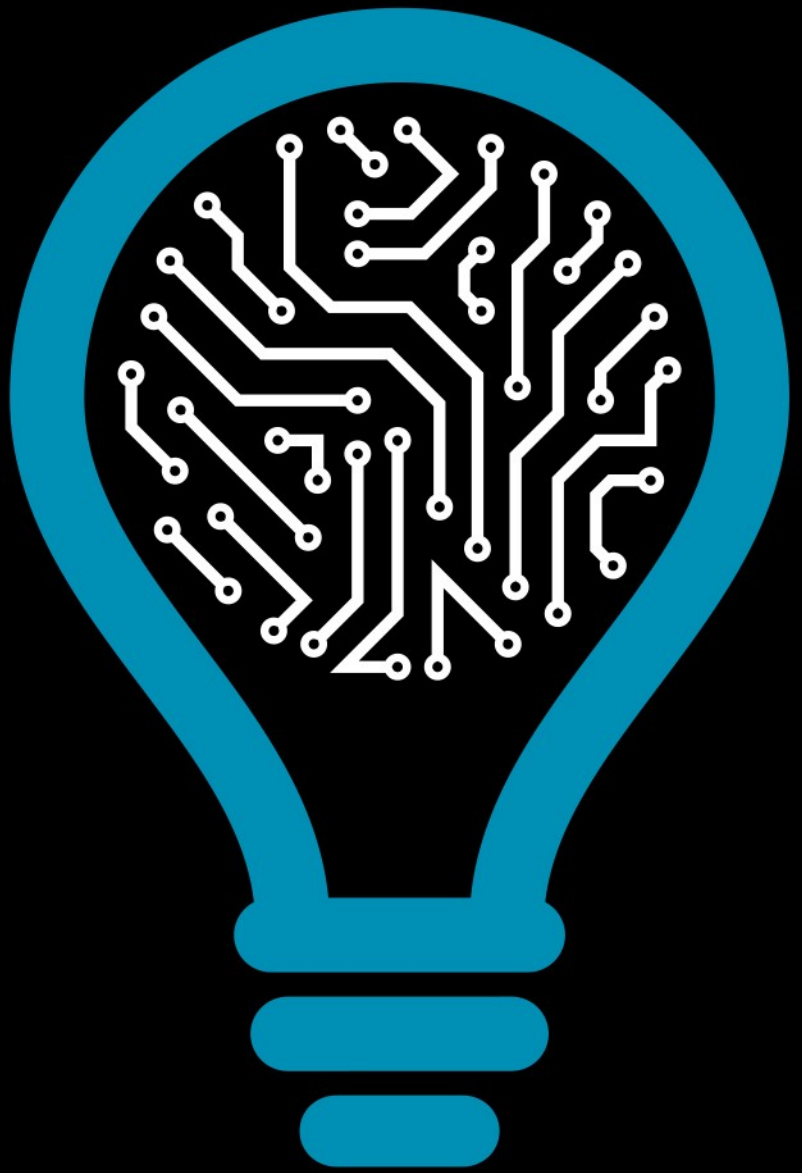
Fingerprint Indexing Based on Minutia Cylinder-Code



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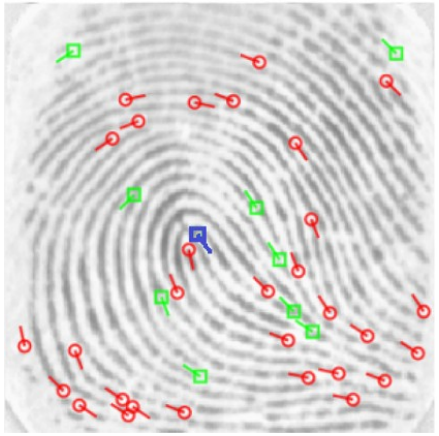
Introduction/motivation

- A fingerprint is composed by ridges and valleys which form specific locations, called minutiae (features), which can be used to determine the uniqueness of a person.

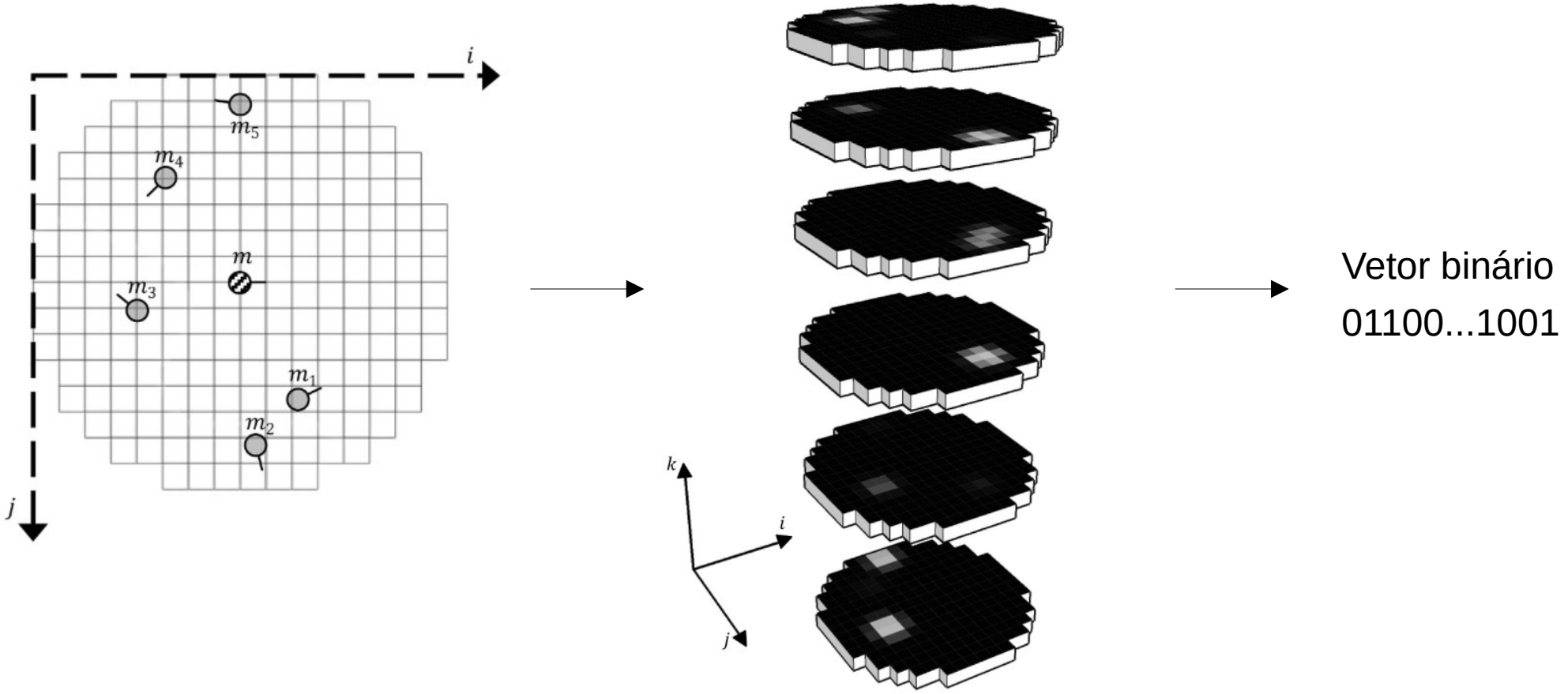


- In an automated fingerprint identification system (AFIS) the matching process of fingerprints is done against a database of known and unknown prints (1-N).

Objectives

- Develop a system capable of doing 1-N fingerprint indexing based on the Compact Binary Minutia Cylinder Code (CBMCC)

Minutia Cylinder Code (MCC)

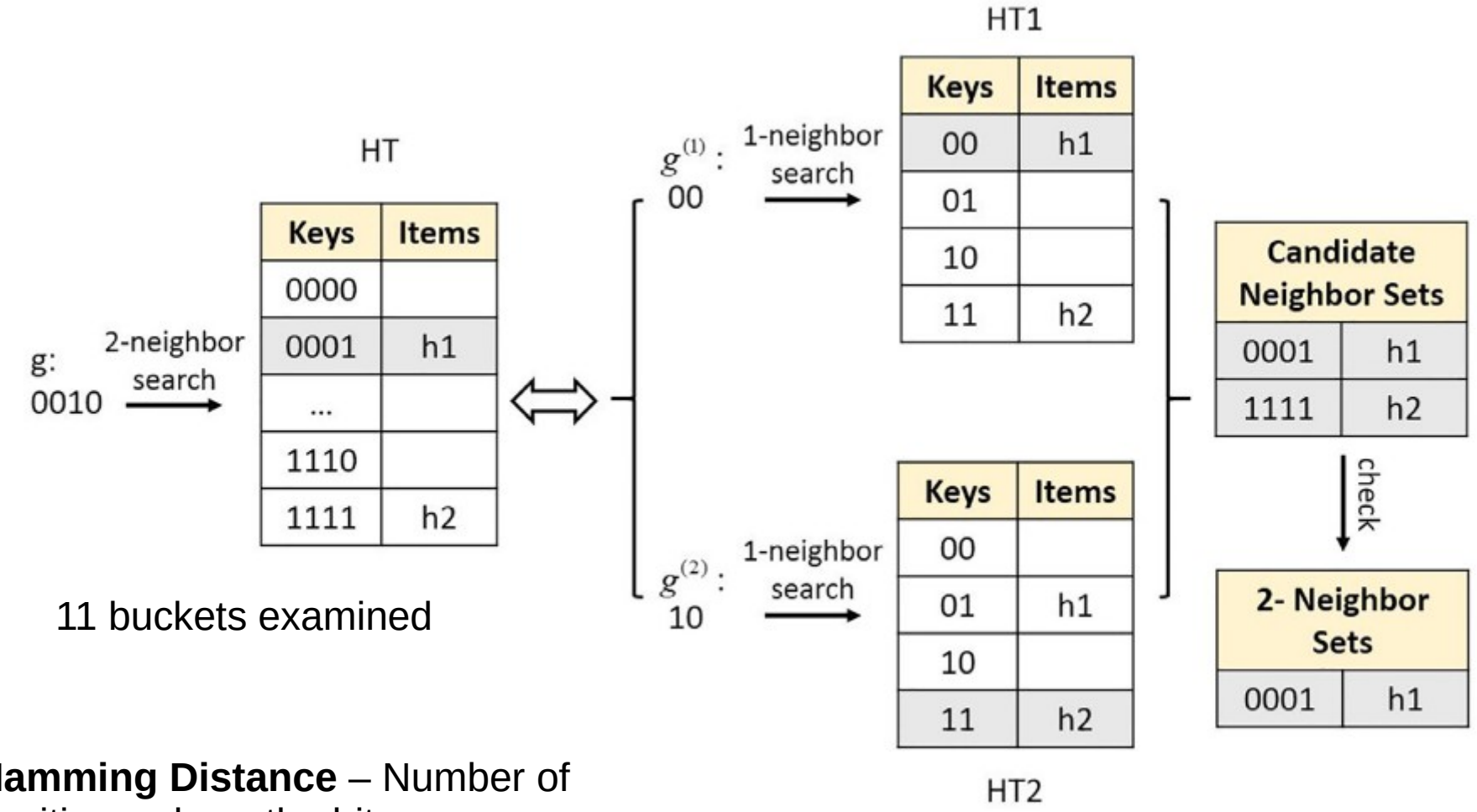


Vetor binário
01100...1001

Compact Binary Minutia Cylinder Code (CBMCC)

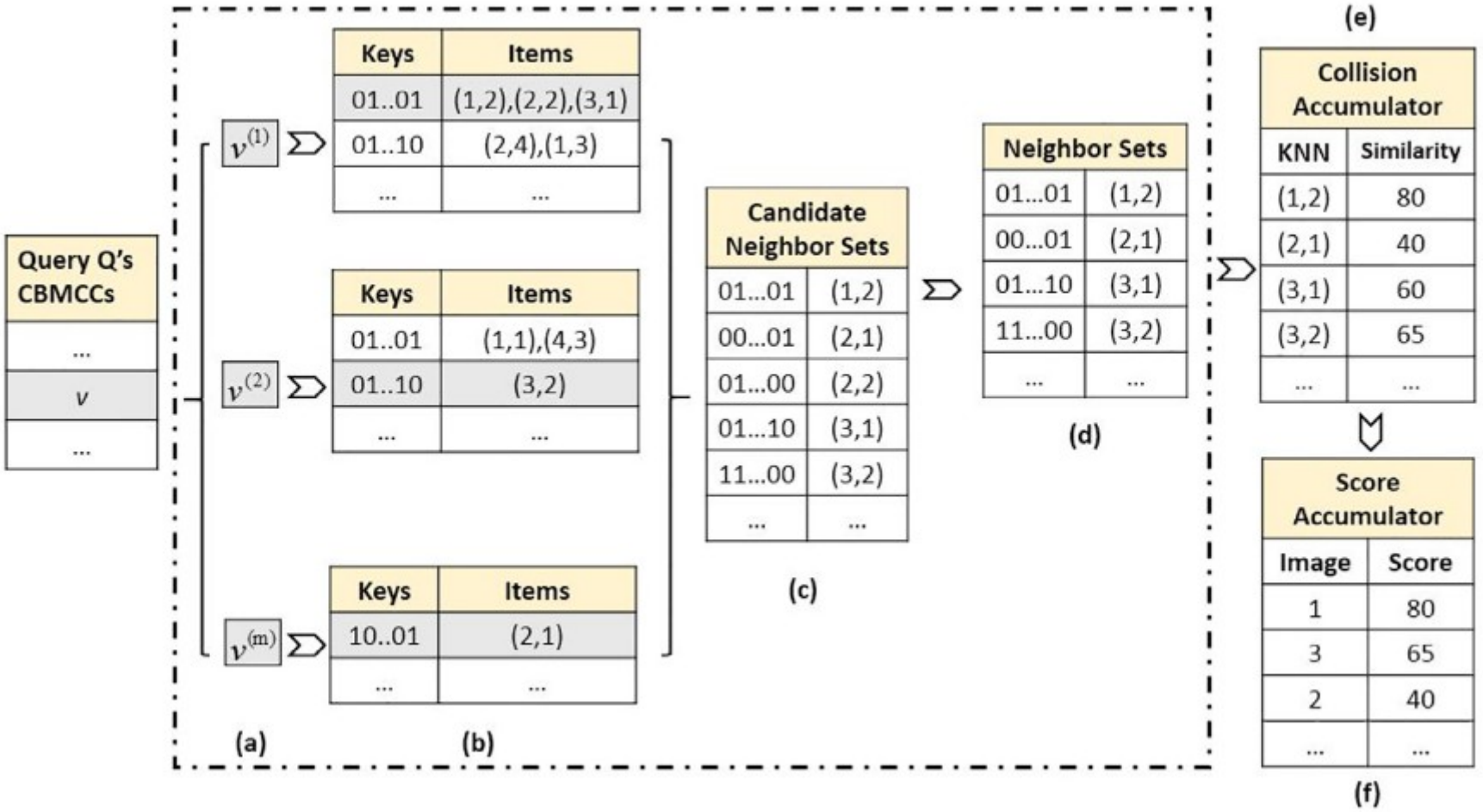
- Use of learning method do reduce MCC length
- Aims to decrease the amount of 0s in MCC
- It was partially implemented but was slow (using GSL – GNU Scientific Library)
- The work was developed with a provided MCC implementation instead

Multi Index Hashing (MIH)



Hamming Distance – Number of positions where the bits are different. Example: 0010 and 0001 have a hamming distance of 2

Multi Index Hashing (MIH)



Results obtained

- Results obtained in the following conditions:
  - Ryzen 5 3600X @ 3.8GHz
  - 16GB RAM
  - GCC 9.3.0 on Ubuntu 20.04(WSL2) with O3 flag

State-of-the-art (Neurotechnology): Claimed 200,000 fingerprints per second (unknown conditions)

Obtained Results (FVC2000)

DB1

k	EER	Precision @ k	Exec Time (s)		
			Retrieval	Scoring	Total
3	65.86%	75.81%	8.17	1.47	9.64
5	53.01%	64.06%	9.34	2.27	11.61
10	42.83%	39.46%	9.3	2.77	12.07
20	37.33%	21.66%	10.61	3.07	13.68
50	29.56%	9.67%	10.04	3.72	13.76
100	22.93%	5.34%	9.71	4.29	14
200	16.78%	2.92%	9.45	5.5	14.95
799	1.19%	0.88%	0	12.22	12.22

DB2

k	EER	Precision @ k	Exec Time (s)		
			Retrieval	Scoring	Total
3	63.52%	84.62%	10.83	1.86	12.69
5	45.98%	75.23%	11.37	2.86	14.23
10	32.97%	46.46%	13.25	3.56	16.81
20	27.90%	25.07%	12.53	4.34	16.87
50	21.70%	10.82%	11.97	4.59	16.56
100	16.91%	5.78%	13.61	5.4	19.01
200	12.83%	3.05%	13.65	6.78	20.43
799	0.50%	0.88%	0	13.79	13.79

DB3

k	EER	Precision @ k	Exec Time (s)		
			Retrieval	Scoring	Total
3	69.56%	73.57%	33.86	2.52	36.38
5	53.43%	66.66%	32.52	3.78	36.3
10	41.43%	41.66%	35.15	4.76	39.91
20	37.72%	22.19%	37.06	5.38	42.44
50	31.86%	9.69%	33.67	6.45	40.12
100	26.57%	5.21%	39.13	8.22	47.35
200	21.25%	2.78%	37.65	10	47.65
799	2.54%	0.88%	0	22.44	22.44

DB4

k	EER	Precision @ k	Exec Time (s)		
			Retrieval	Scoring	Total
3	77.01%	60.00%	5.56	0.98	6.54
5	67.39%	46.11%	5.92	1.31	7.23
10	61.58%	27.50%	5.75	1.51	7.26
20	56.50%	16.66%	5.97	1.91	7.88
50	48.12%	7.47%	5.87	2.48	8.35
100	40.91%	4.22%	6.42	3.17	9.59
200	33.56%	2.39%	6.35	4.31	10.66
799	1.58%	0.88%	0	10.26	10.26

	Sensor Type	Image Size	Set A (wxd)	Set B (wxd)	Resolution
DB1	Low-cost Optical Sensor	300x300	100x8	10x8	500 dpi
DB2	Low-cost Capacitive Sensor	256x364	100x8	10x8	500 dpi
DB3	Optical Sensor	448x478	100x8	10x8	500 dpi
DB4	Synthetic Generator	240x320	100x8	10x8	about 500 dpi

Obtained Results (FVC2002)

DB1

k	EER	Precision @ k	Exec Time (s)		
			Retrieval	Scoring	Total
3	68.93%	74.38%	10.39	1.71	12.1
5	55.32%	62.22%	11.02	2.39	13.41
10	47.19%	36.54%	11.29	2.79	14.08
20	43.11%	19.66%	11.09	3.18	14.27
50	37.80%	8.62%	10.83	3.92	14.75
100	33.39%	4.62%	11.35	4.51	15.86
200	27.52%	2.53%	11.57	5.94	17.51
799	0.87%	0.88%	0	14.57	14.57

DB2

k	EER	Precision @ k	Exec Time (s)		
			Retrieval	Scoring	Total
3	68.87%	78.95%	15.11	1.91	17.02
5	50.63%	70.60%	16.32	3.03	19.35
10	42.40%	40.34%	15.96	3.6	19.56
20	38.79%	21.33%	16.99	3.8	20.79
50	34.79%	9.14%	17.62	4.31	21.93
100	30.40%	4.88%	16.9	5.4	22.3
200	23.38%	2.68%	16.6	7.02	23.62
799	0.46%	0.88%	0	16	16

DB3

k	EER	Precision @ k	Exec Time (s)		
			Retrieval	Scoring	Total
3	75.52%	58.10%	6.84	0.97	7.81
5	65.86%	47.14%	6.09	1.3	7.39
10	59.11%	27.91%	6.27	1.63	7.9
20	54.83%	15.41%	6.04	1.96	8
50	48.12%	7.12%	6.67	2.46	9.13
100	41.90%	4.02%	6.47	3.19	9.66
200	34.08%	2.29%	6.8	4.53	11.33
799	2.50%	0.88%	0	11.74	11.74

DB4

k	EER	Precision @ k	Exec Time (s)		
			Retrieval	Scoring	Total
3	69.98%	71.62%	9.05	1.47	10.52
5	60.54%	55.54%	8.2	1.81	10.01
10	53.94%	32.53%	8.55	2.07	10.62
20	48.54%	18.17%	8.75	2.37	11.12
50	39.70%	8.50%	8.97	3	11.97
100	33.43%	4.68%	8.29	3.65	11.94
200	25.76%	2.62%	9.52	5.1	14.62
799	1.05%	0.88%	0	11.86	11.86

	Sensor Type	Image Size	Set A (wxd)	Set B (wxd)	Resolution
DB1	Optical Sensor	388x374 (142 Kpixels)	100x8	10x8	500 dpi
DB2	Optical Sensor	296x560 (162 Kpixels)	100x8	10x8	569 dpi
DB3	Capacitive Sensor	300x300 (88 Kpixels)	100x8	10x8	500 dpi
DB4	SFinGe v2.51	288x384 (108 Kpixels)	100x8	10x8	about 500 dpi

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Future work

- Reimplement CBMCC with a different library
- Overall program optimization
- Possible multithreading
- Tests in bigger databases