FACULTY OF SCIENCE
ACADEMY OF COMPUTER SCIENCE AND SOFTWARE ENGINEERING

MODULE	IT28X07: BIOMETRICS
CAMPUS	AUCKLAND PARK CAMPUS (APK)
ASSESSMENT	JULY 2021

DATE: 2021-07	**SESSION:** 08:00 - 10:00
ASSESOR(S):	PROF D.T. VAN DER HAAR
EXTERNAL MODERATOR:	DR D. BROWN (RU)
DURATION: 120 MINUTES	**MARKS:** 85

Please read the following instructions carefully:

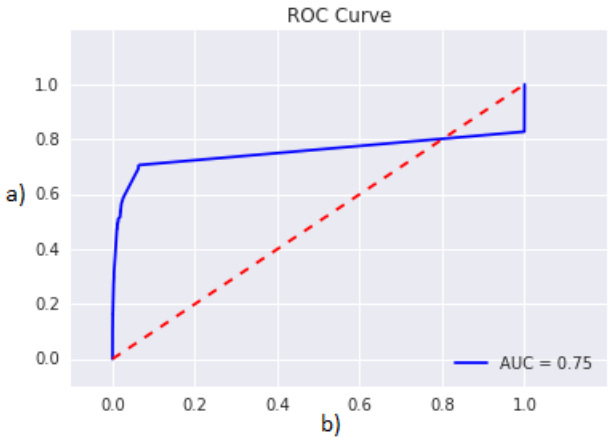
1. You must complete this assignment yourself within the prescribed time limits.
2. You are bound by all university regulations please special note of those regarding assessment, plagiarism, and ethical conduct.
3. You must complete and submit the *"Honesty Declaration : Online Assessment"* document along with your submission to EVE. No submissions without an accompanying declaration will be marked.
4. Your answers together with the declaration must be submitted in the following format. STUDENTNUMBER_SURNAME_INITIALS_SUBJECTCODE_ASSESSMENT e.g. *202012345_SURNAME_IAM_IT28X07_EXAM.pdf*
5. No communication concerning this test is permissible during the assessment session except with Academy staff members. The invigilator is available via email (dvanderhaar@uj.ac.za) and on the "UJ Biometrics" Discord server throughout the assessment (https://discord.gg/A6NQwemFqb).
6. This paper consists of 4 pages excluding the cover page.

SECTION A - SHORT QUESTIONS

QUESTION 1

General Biometric Systems

Analyse the following image depicting a ROC curve and answer the questions that follow:



1. Provide the labels for a) and b) (2)
2. What is wrong with the figure? (2)
3. How do you fix it? (2)

Total: 6

QUESTION 2

Fingerprint Recognition

(a) Provide the coordinates, in the format CR where C the column and R depicts the row (e.g. J0), for **four** examples of **bifurcations** in the fingerprint binary image below (where 1 depicts a ridge and 0 a valley): (4)

	A	B	C	D	E	F	G	H	I	J
0	0	1	1	1	1	1	1	0	1	1
1	0	0	0	1	0	0	0	1	0	1
2	0	0	0	0	0	0	1	0	0	0
3	1	1	0	0	0	0	0	1	1	1
4	0	1	1	1	1	1	1	0	1	0
5	0	0	1	0	0	0	0	1	0	1
6	0	0	0	0	0	0	0	1	1	1
7	0	0	0	1	1	0	1	1	0	0
8	1	1	1	1	0	0	1	1	0	0
9	1	0	1	0	1	0	1	0	1	1

(b) Define ELBP its role in fingerprint recognition. (2)

Total: 6

QUESTION 3

Face Recognition

(a) What are the core three (3) **contributions** in Viola and Jones' "Robust Real-Time Face Detection" article? (3)

(b) Briefly describe the **EigenFaces** algorithm. (3)

Total: 6

QUESTION 4

(a) Briefly describe two (2) **limitations** of speaker recognition. (2)

(b) If audio signal A is 0.1 $watt/m^2$ and audio signal B is 1.2 $watt/m^2$, what is its **power difference** (in watts dB)? Secondly, will a human experience **pain** listening to audio signal B? (4)

Total: 6

QUESTION 5

Iris recognition-based biometric systems are known to be accurate and can be used in highly secure environments. Discuss the **process** required to capture a iris sample, along with the **steps** required to process and match a sample. For each step in your discussion be sure to elaborate on the following aspects:

- The sensor that can be used to capture a sample.
- A brief description of the steps followed to process and match a sample.
- Examples of algorithms that can be used at each step.

Total: 6

QUESTION 6

For the grayscaled 4x4 pixels below derive the **local binary pattern** matrix (starting off at the top left corner with radius=1 in a clockwise direction):

$$\begin{bmatrix} 73 & 196 & 155 & 232 \\ 190 & 14 & 80 & 122 \\ 65 & 63 & 32 & 11 \\ 252 & 39 & 211 & 28 \end{bmatrix}$$

Total: 8

QUESTION 7

Multi-modal and Pervasive Systems

(a) For a finger and palmprint multimodal biometric authentication system discuss which level of **biometric fusion** would be best with a justification and with which methods can be used to achieve it. (4)

(b) What are the **disadvantages** of implementing a user owned based biometric system that uses smart phones? (4)

Total: 8

QUESTION 8

Biometric Trends and Esoteric Biometrics

(a) Discuss **brain wave recognition**, along a brief description on **how** you would implement such a system. (4)

(b) Provide two limitations of **facial thermography** based recognition. (2)

Total: 6

QUESTION 9

Vulnerabilities and Countermeasures

Draw an **attack tree** that highlights the **weaknesses** that will typically be found for a **in-screen fingerprint reader** system such as the one found in many flagship smart phone handsets (and the new iPhone 13), **ALONG** with two ways to **safeguard** against them.

Total: 8

SECTION B - LONG QUESTIONS

QUESTION 10

In South African law, the POPI act has just become enforceable from 1 July 2021. Many industries say that it will have far reaching consequences and it impacts everyone. How do you think it will impact the field of biometrics in South Africa? Write a report on the following:

- Biometrics within a legal context.
- POPI and its scope
- How POPI relates to biometrics
- Your opionion on whether it will be a big impact.

Total: 10

QUESTION 11

Studies have shown that pigs and cows that move more and eat well lead to a better quality meat product. Farmer Brown has approached you to help build a system that is built around this finding and can infer potential meat quality from certain animal candidates. Comprehensively discuss the design and implementation of an alternative way to achieve the same task (scratch detection because of itchiness). It should include which **biometric attribute** you would use, the **sensor(s)** and **algorithms** you would use and how you would **evaluate** the system. The report should pay special attention to the following:

- The biometric attribute you would use, along with the associated sensor(s)
- The algorithms you would use to implement it.
- Advantages and disadvantages of your selected biometric technology.
- The metrics that should be used to evaluate biometric systems.

Total: 15

— End of paper —