



**FACULTY OF SCIENCE**  
**ACADEMY OF COMPUTER SCIENCE AND SOFTWARE ENGINEERING**

<b>MODULE</b>	IT28X07: BIOMETRICS
<b>CAMPUS</b>	AUCKLAND PARK CAMPUS (APK)
<b>ASSESSMENT</b>	JUNE 2020

**DATE:** 2020-06

**SESSION:** 08:30 - 10:30

**ASSESOR(S):**

PROF D.T. VAN DER HAAR

**EXTERNAL MODERATOR:**

PROF S. VIRIRI (UKZN)

**DURATION:** 120 MINUTES

**MARKS:** 100

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 a zip archive named in the following format.  
STUDENTNUMBER\_SURNAME\_INITIALS\_SUBJECTCODE\_ASSESSMENT e.g.  
202012345\_SURNAME\_IAM\_IT28X07\_FSAO.zip
5. Additional time for submission is allowed for as per the posted deadlines on EVE. If you are experiencing technical difficulties related to submission please contact me as soon as possible.
6. 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/u4yVG2H>).
7. This paper consists of 5 pages excluding the cover page.

## SECTION A - SHORT QUESTIONS

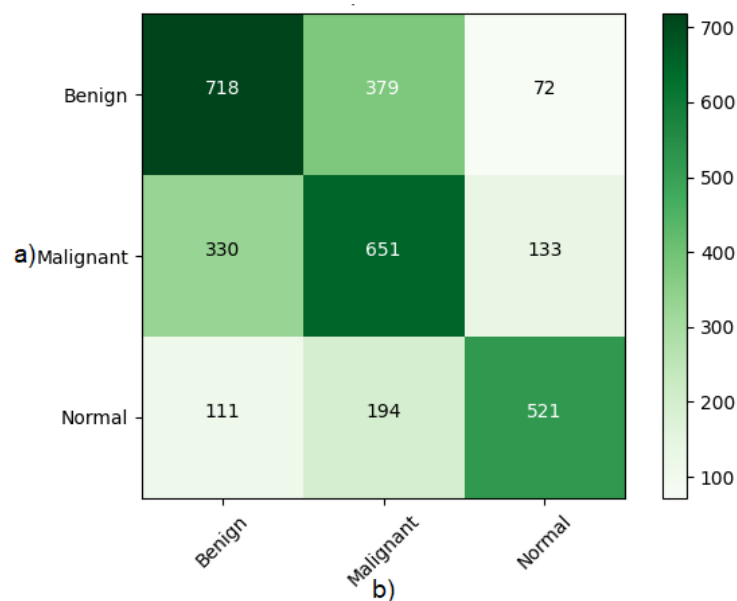
### QUESTION 1

#### *General Biometric Systems*

(a) Provide a score (low, medium or high) for **face recognition** against the follow four (4) **biometric requirements** for 2020 (i.e. as it stands today): (4)

1. Universality
2. Collectability
3. Acceptance
4. Circumvention

(b) Analyse the following image and answer the questions that follow: (6)



1. What does the above overall image depict? (2)
2. Label (a) and (b) axes. (2)
3. Describe a potential issue found when analysing the image (2)

Total: 10

### QUESTION 2

(a) Aside from alignment issues, list four (4) **other limitations** of hand geometry. (4)

(b) Provide the coordinates for **four** examples of bifurcations in the fingerprint binary image below: (4)

	0	1	2	3	4	5	6	7	8	9
0	1	1	0	1	1	0	1	1	0	0
1	1	0	1	0	0	1	1	0	1	1
2	0	1	1	1	1	0	1	0	0	0
3	1	1	0	0	0	0	1	1	1	1
4	1	1	1	0	1	0	1	0	0	1
5	0	1	0	1	1	1	0	1	0	1
6	1	0	1	0	0	1	1	1	0	1
7	0	1	1	1	0	1	0	1	1	0
8	0	1	0	1	1	1	0	1	0	1
9	1	1	0	1	1	0	0	0	1	0

Total: 8

**QUESTION 3***Face Recognition*

- (a) Briefly describe how appearance-based **face detection** works. (2)
- (b) Consider the "Eigenfaces" approach to face recognition and answer the questions that follow: (4)
1. What are the **features** that the algorithm extracts, and how does it compute them?
  2. What are the **weaknesses** of the approach?
- (c) List two (2) examples of **kernels** that can be used for Support Vector Machines. (2)

Total: 8

**QUESTION 4**

- (a) Briefly describe three (3) features used in **speaker recognition** systems. (3)
- (b) What does the equation below represent and what **role** does it play in speaker recognition? (4)

$$x_n = \frac{1}{N} \sum_{k=0}^{N-1} X_k \cdot e^{2\pi i k n / N}$$

Total: 7

**QUESTION 5***Ocular Biometrics*

- (a) Discuss one key contribution John Daughman made within the context of **iris** recognition, along with **why** it was so important. (4)
- (b) Describe two (2) eye **ailments or diseases** that affects conjunctiva biometrics systems, along **why** it impacts it. (4)

Total: 8

**QUESTION 6***Palm and Behavioural Biometrics*

- (a) For the greyscale pixels below derive the **local binary pattern** (*hint* use the centroid as a threshold) matrix/image (with radius=1, clockwise and zero padding parameters): (8)
- $$\begin{bmatrix} 229 & 85 & 116 & 50 \\ 165 & 64 & 211 & 56 \end{bmatrix}$$
- (b) Briefly describe the **ergotic** type of gesture. (2)

Total: 10

**QUESTION 7**

**Fingerprint-palmprint** multimodal recognition-based biometric systems have the potential to have mainstream success. One of the reasons behind this can be attributed to the fact that larger sensors have become cheaper. Discuss how you would implement a fingerprint and palmprint multimodal biometric system, the **types** of sensors, along with various **steps** required to capture, process, match and fuse the samples. For each step in your discussion be sure to elaborate on the following aspects:

- The different sensors that can be used to capture a sample.
- A brief description of the steps followed to process, match and fuse a sample.
- The algorithms used at each step (if necessary).

Total: 8

**QUESTION 8***Biometric Trends and Esoteric Biometrics*

- (a) Discuss **ear recognition**, along a brief description on **how** you would implement such a system. (4)
- (b) What sensor is used in **odour** recognition systems? (2)

Total: 6

**QUESTION 9***Vulnerabilities and Countermeasures*

**Draw** an **attack tree** that highlights the **weaknesses** that will typically be found for a **voice assistant** system such as Amazon Alexa, Google Assistant or Apple Siri **AND** provide a discussion on two **reasons** why you would want to subvert a biometric system, **ALONG** with two ways to **safeguard** against them.

Total: 10

**SECTION B - LONG QUESTIONS****QUESTION 10**

Near the end of last year a scientist published an article in the prestigious Cell journal on an alternative method for technique for creating a designer baby by selecting "superior" embryos by screening their DNA. The scientific and broader community has been in an uproar and recently that scientist has been sentenced to jail. However, there has been debate on the case and some scientists in South Africa are curious about the legal and ethical implications of his research. Write a report that pays special attention to the following:

- The common criticisms of DNA biometrics.
- The ethical considerations related to biometrics.
- The legal aspects related to biometrics and your opinion on the case study.

Total: 10

**QUESTION 11**

The recent surge of working from home transitions for many companies (especially multi-nationals) have many line managers deeply concerned about whether their employees are doing their work. An ex-government contractor (Company Y) has decided to edge into this space by providing an employment monitoring tool that works using employee smart phones. They have tasked you with writing up a report that proposes the best solution for their employee monitoring solution, along with how to compare your solution with other potential ideas. Comprehensively discuss 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 —