WRITING AN IMPACTFUL THESIS

Sharing of Experience

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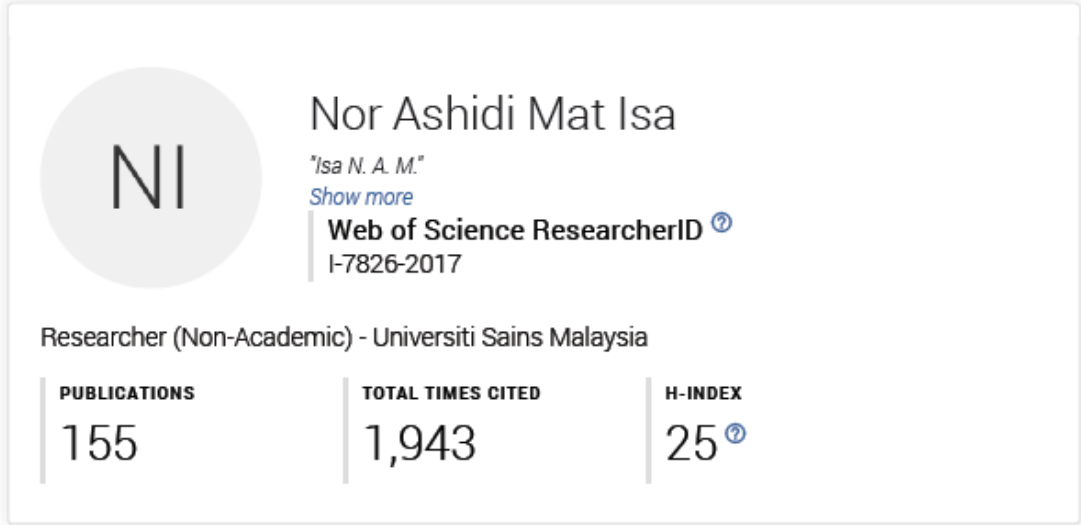
Disclaimer

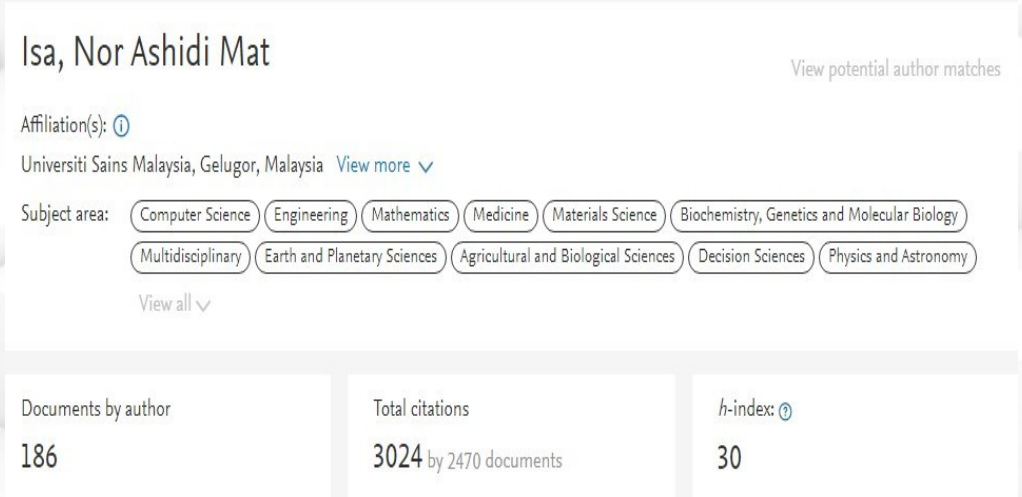
- Many of the examples come from my own experiences, hence, they are probably limited
- The presentation may be skewed toward my research background in Image Processing and Intelligent Systems.
- Many of the slides/pictures are taken from the internet. I am not claiming the slides/pictures copyright.

My Research Background

- B. Eng – USM; PhD – USM
- Image Processing & Intelligent Systems
- Focusing on Intelligent Disease Diagnostic Systems – cervical cancer, breast cancer, malaria, chromosome, sperm etc.



WoS - ISI



SCOPUS

Google Scholar

My Research Background

Web of Science Categories | Refine | Exclude | Cancel | Sort these by: Record Count

The first 100 Web of Science Categories (by record count) are shown. For advanced refine options, use Analyze results .

- ENGINEERING ELECTRICAL ELECTRONIC (61)
- COMPUTER SCIENCE ARTIFICIAL INTELLIGENCE (51)
- COMPUTER SCIENCE INTERDISCIPLINARY APPLICATIONS (31)
- COMPUTER SCIENCE THEORY METHODS (24)
- COMPUTER SCIENCE INFORMATION SYSTEMS (19)
- TELECOMMUNICATIONS (16)
- COMPUTER SCIENCE HARDWARE ARCHITECTURE (11)
- IMAGING SCIENCE PHOTOGRAPHIC TECHNOLOGY (8)
- AUTOMATION CONTROL SYSTEMS (8)
- MULTIDISCIPLINARY SCIENCES (6)
- ENGINEERING BIOMEDICAL (6)
- COMPUTER SCIENCE SOFTWARE ENGINEERING (6)
- ENGINEERING MULTIDISCIPLINARY (5)
- PHYSICS APPLIED (3)
- OPTICS (3)
- MEDICAL INFORMATICS (3)
- RADIOLOGY NUCLEAR MEDICINE MEDICAL IMAGING (2)
- OPERATIONS RESEARCH MANAGEMENT SCIENCE (2)
- MINING MINERAL PROCESSING (2)
- MINERALOGY (2)
- MATHEMATICS APPLIED (2)
- ENGINEERING INDUSTRIAL (2)
- ENGINEERING CHEMICAL (2)
- WATER RESOURCES (1)
- SOCIAL SCIENCES INTERDISCIPLINARY (1)
- ROBOTICS (1)
- OCEANOGRAPHY (1)
- MEDICINE GENERAL INTERNAL (1)
- MATHEMATICS INTERDISCIPLINARY APPLICATIONS (1)
- MATHEMATICAL COMPUTATIONAL BIOLOGY (1)
- MATERIALS SCIENCE MULTIDISCIPLINARY (1)
- HEALTH CARE SCIENCES SERVICES (1)
- GEOSCIENCES MULTIDISCIPLINARY (1)
- GASTROENTEROLOGY HEPATOLOGY (1)
- ENVIRONMENTAL SCIENCES (1)
- ENGINEERING CIVIL (1)
- ECONOMICS (1)
- CONSTRUCTION BUILDING TECHNOLOGY (1)
- COMPUTER SCIENCE CYBERNETICS (1)
- BUSINESS FINANCE (1)
- BIOCHEMICAL RESEARCH METHODS (1)
- AGRICULTURE MULTIDISCIPLINARY (1)

My Research Background

SUPERVISION		THESIS EXAMINER	
Graduated PhD		**PhD Thesis**	
Main Supervisor	20	External	23
Co Supervisor	5	Internal	38
Graduated MSc		**MSc Thesis**	
Main Supervisor	22	External	18
Co Supervisor	2	Internal	18

PhD vs MSc (Research) vs MSc (Mixed)

Nature (scope) of study in general

PhD	MSc (Research)	MSc (Mixed)
Fundamental research	Fundamental or applied research	Applied research
Contribution to new knowledge	Contribution to new knowledge or new application	Contribution to new application
Very strong technical knowledge – focus in depth specific niche area	Strong technical knowledge in focus area	Medium to strong technical knowledge in focus area

Literature Review

	PhD	MSc (Research)	MSc (Mixed)
Reporting other works	Must have	Must have	Must have
Critically commenting other works	Must have	Must have	Nice to Have
Able to highlight research gaps	Must have – at least 2 clear research gaps	Must have – at least 1 clear research gap	Must have – at least 1 research gap
Ideal number of references	>150	> 100	> 30

PhD vs MSc (Research) vs MSc (Mixed)

Research Gaps & Objectives

	PhD	MSc (Research)	MSc (Mixed)
Designed from real world issues	Must have	Must have	Must have
Designed from current state-of- the-art methods	Must have	Must have	Nice to Have
Number of research gaps	2 – 3	1 – 2	At least 1
Number of research objectives	2 – 3	1 – 2	At least 1

Contributions - Methodology

Types of Contribution	PhD	MSc (Research)	MSc (Mixed)
New techniques / methods	Very High	Very High	Very High
Modified techniques / methods	High	Very High	Very High
New concepts / pipeline	High	Very High	Very High
Modified concepts / pipeline	High / Medium	High	High
'Hybrid' techniques / methods	Medium	High	High
'Integrated' techniques / methods	Low	Medium	High
Same techniques / methods with different applications	Very Low	Low	Medium

Analyses - Results

Item	PhD	MSc (Research)	MSc (Mixed)
Comparison with current state-of-the-art methods	Must have	Must have	Nice to Have
Comparison with conventional methods	Must have	Must have	Must have
Number of benchmark / standard datasets	Must have – ideally at least 4	Must have – ideally at least 3	Must have – at least 1
Real case studies	Must have	Nice to Have	Nice to Have
Qualitative and quantitative analyses	Must have	Must have	Must have

Thesis Content - Main Sections

Conventionally, the important sections in a thesis

- ✓ Title
- ✓ Abstract
- ✓ Chapter 1: Introduction
- ✓ Chapter 2: Literature Review
- ✓ Chapter 3: Methodology
- ✓ Chapter 4: Results and Discussion
- ✓ Chapter 5: Conclusion
- ✓ List of References

Title

Short / simple / concise and solid

Give the impression as to the level of work / intensiveness of work

Use catchy / bombastic words to attract attention to find out more about the thesis

Signify the type of research that has been performed: i.e. lab based, product based, fundamental etc.

Signify the niche area of the study: main keywords

Must reflect the work done

Title

Which one is the best title?

1. Signal integrity analysis of high-speed interconnects via a deep machine learning
   artificial intelligence algorithm
2. Theoretical formulation for signal integrity analysis of high-speed interconnects via a deep machine learning artificial intelligence algorithm
3. Theoretical formulation for signal integrity analysis of high-speed interconnects via a deep machine learning

Title #3

Title

Is it a good title?

Deep learning skin lesion detection method of dermoscopic images

Criteria	Status	Suggestion?
Short / simple / concise and solid	YES	OK
Give the impression as to the level of work	NO	Modification of existing idea / introduction of new idea
Use catchy / bombastic words	ACCEPTABLE	OK
Signify the type of research	NO	Development / formulation etc.
Signify the niche area	ACCEPTABLE	OK
Reflect the work	ACCEPTABLE	OK

Title

Is it a good thesis title?

CLASSIFICATION OF CERVICAL SQUAMOUS EPITHELIAL CELLS USING ARTIFICIAL NEURAL NETWORK BASED ON CHROMATIN PATTERN AND NUCLEAR MEMBRANE IRREGULARITY

Abstract

(one paragraph)

- Introduction and/or motivation (1-2 sentences)
- Problem statement(s) (1-3 sentences)
- Objective(s) (1-3 sentences)
- Methodology (2-4 sentences)
- Important / main results (2-4 sentences)
- Main discussion (2-4 sentences)
- Conclusion (1 sentence)
- Significance of the research (1 sentence)

Abstract

Introduction / motivation

(1 – 2 sentences)

- Introduce reader to the topic of research
- Highlight main state-of-the-art works that motivate your study

Problem statement(s) / research gap(s)

(1 – 3 sentences)

- State the common problem(s) of those state-of-the-art works
- Research gap(s) must be specific, clear and solid

Abstract

Objective(s)

(1 – 3 sentences)

- Related to research gaps
- Must be specific, clear and solid
- Measurable and achievable

Methodology

(2 – 4 sentences)

- Highlight the new or modified concepts/ideas/approaches/methods etc
- Specify theoretically how the proposed work could overcome the research gap(s) and achieve the objective(s)

Abstract

Main results

(2 – 4 sentences)

- Highlight the main results that answer all objectives and cover the thesis title
- Highlight both qualitative and quantitative results

Main discussion

(2 – 4 sentences)

- Highlight the main discussion for every result to prove and support the proposed ideas/approaches/methods etc
- Highlight advantages and limitations (if possible)

Abstract

Conclusion

(1 sentence)

- Conclude the whole research
- Does the proposed work overcome the research gaps and achieve the research objectives?

Significance of the research

(1 sentence)

- State the potential of the proposed work in terms of opportunities for future research and/or its potential applications to real world

Abstract – example

Cervical cancer is the second most common cancer among women in Malaysia. The implementation of Papanicolaou smear (Pap smear) results in significant reduction in mortality from cervical cancer. Nonetheless, Pap smear is prone to error due to the limitations in human. Furthermore, the diagnostic criteria of the reporting standards are highly subjective and the judgment heavily relies on the skill and experience of individual pathologist. The shortcomings of Pap smear have motivated the development of automated cytology screening system. The contributions of this study could be seen in two aspects: in the engineering and clinical applications. In addition to the algorithms in image enhancement and segmentation, the notable contribution is quantifying the diagnostic criteria of the reporting standards. This study proposed two image enhancement techniques, namely Bi-

Introduction

Research gaps

Research objectives

Abstract – example

techniques. A Fuzzy C-Means (FCM) clustering approach is proposed to quantify nuclear chromatin pattern. Chromatin distribution of cervical squamous epithelial cells from the class of negative for intraepithelial lesion or malignancy (NILM) is first presented at five sensitivity levels, imitating different degrees of chromatin detection as perceived by pathologists and cytotechnologists. The most representative sensitivity level is determined based on feedback from human experts and statistical analysis. Based on the chosen sensitivity level, the study is extended to the cells from the classes of low- and high-grade squamous intraepithelial lesions (LSIL and HSIL). The chromatin distribution model of NILM, LSIL, and HSIL that represents the visual perception of human experts is devised.

Methodology

Abstract – example

pathologists and cytotechnologists. The most representative sensitivity level is determined based on feedback from human experts and statistical analysis. Based on the chosen sensitivity level, the study is extended to the cells from the classes of low- and high-grade squamous intraepithelial lesions (LSIL and HSIL). The chromatin distribution model of NILM, LSIL, and HSIL that represents the visual perception of human experts is devised. The contradicting issue on the chromatin distribution in the reporting standards is addressed. Comparing to the Bethesda System, findings from this study favoured criteria in the British Society for Clinical Cytologists (BSCC) terminology. Six features, namely chromatin

Main results & discussion

Abstract – example

accuracy, 94.92% sensitivity, and 95.15% specificity. At the end of this research, a complete computer aided screening system for cervical cancer is successfully developed. The

proposed system is developed with the aim to assist pathologists and cytotechnologists and hence it is hoped that the incidence as well as the mortality rate due to cervical cancer in Malaysia can be reduced.

Conclusion

Significance of the study

Chapter 1: Introduction

1. Introduce reader about the whole thesis
2. Information to be included
   - ✓ Research background
   - ✓ Problem statements / research gaps
   - ✓ Objectives
   - ✓ Research scope
   - ✓ Thesis outline
3. The information should be brief but cover the all aspects of your thesis.

Chapter 1: Introduction

Research Background

- Introduce the research area
- Highlight the importance of the area
- Then, focus on limitations of that area in term of real world scenario

Chapter 1: Introduction

Introduce the research area
Highlight the importance of the area

The 20th century witnessed a dramatic reduction in incidence and mortality from cervical cancer in many developed countries due to the implementation of the Papanicolaou smear (Pap smear) (Sankaranarayanan et al., 2001). Pap smear enables early detection of abnormality cells growth in cervix and hence prevents the occurrence of invasive tumours. Following the conventional preparation, liquid-based preparation emerged as a result of the advancement in slide preparation, resulting in thinner cell layer and reducing the probability of cells overlapping (Chen et al., 2014, Cibas and Ducatman, 2009, Abulafia et al., 2003).

A Pap smear result is reported according to the Bethesda System for reporting cervical cytology (Nayar and Wilbur, 2015) or to the British Society for Clinical Cytologists (BSCC) terminology (Denton et al., 2008). The former reporting standard grades a Pap

Chapter 1: Introduction

Limitation of the research area in term of real world scenario

Despite its effectiveness in reducing the mortality rate due to cervical cancer, Pap smear suffers from several disadvantages. It normally takes a few days or weeks to prepare a Pap smear result as the screening process requires high level of concentration for an extended period (Bengtsson and Malm, 2014, Birdsong, 1996). Theoretically, the screening process looked simple. Cells demonstrate morphological changes during malignancy, i.e. increasing in N/C ratio, increasing in nucleus size, increasing in nuclear membrane irregularity etc.

Although the characteristics appeared to be easily interpreted, it is almost the human optical resolution limit to visually detect these tiny details. The nucleus diameter is approximately 10 micrometres. Screening begins at low resolution, i.e. 10x lens followed by

Problem Statements

- Highlight the state-of-the-art works that proposed to overcome the real world cases
- Then, highlight the research gaps of those works
- Ensure that the research gaps are the ones to be answered at the end of your research
- Ensure the research gaps are specific and clearly explained
- Must include appropriate references to support your research gaps

Chapter 1: Introduction

Problem Statement #1

Although Pap smear is proven to be effective to reduce cervical cancer, earlier studies reveal that the test suffers from some demerits. The late 90's witnessed the technical advancement in slide preparation, which ameliorated from conventional preparation to liquid-based preparation, leading to improved specimen adequacy. Liquid-based preparation is gaining popularity since it offers several clear advantages over conventional preparation. The contrast of the cervical squamous epithelial cell images, however, sometimes is insufficient to clearly distinguish the diagnostic features of a cell. Additionally, the manual smearing and staining unavoidably lead to large variations in specimen quality.

Chapter 1: Introduction

Problem Statement #2

It is well known that a phenomenon called pleomorphism occurred as one of the MACs observable (Dey, 2010). Nuclear shape of non-neoplastic cells is generally round, oval or bean shaped. On contrary, nuclear membrane irregularity, an aspect of pleomorphism in terms of variability in shapes, is commonly seen in malignant nuclei (Ginzburg et al., 2014, Chaddad et al., 2013, Zink et al., 2004, Gisselsson et al., 2001, Thiran and Macq, 1996). Malignant nuclei often have variation in shape and size. Due to uncontrollable division in the nuclear, the nuclear membrane can hardly retain its shape and the cell shape becomes irregular when there is malignancy. The irregularity may appear as nuclear grooving, nuclear molding or nuclear convolutions (Dey, 2010). Nuclear membrane contour of a cervical squamous epithelial cell is illustrated in Figure 1.1(a). Judgment of pleomorphism is highly subjective. The degree of membrane irregularity could be justified differently, depending on individual pathologist or cytotechnologist. Hence, there is a need to find ways to measure the membrane irregularity.

Problem Statement #3

Koss and Melamed, 2006). Nonetheless, the diagnostic criteria related to chromatin pattern are highly subjective. Pathologists and cytotechnologists gained the skill and experience based on investigation of numerous slides. Depending on individual, each pathologist and cytotechnologist perceives chromatin pattern in a different way since there is no exact term to describe the appearance of the chromatin. Under such scenario, for the same slides, different justification and conclusion might be drawn, especially for borderline cases. Therefore, it is of paramount important to reduce the variation among individual human expert through quantifying and standardizing of the definition for chromatin pattern.

Chapter 1: Introduction

Summary of problem statements

The significance of nuclear membrane irregularity as well as chromatin pattern is outlined in the diagnostic criteria. Yet, judgment of these features is confined to the understanding and specialization of human experts. It is therefore utmost crucial to address the fundamental issue on the vagueness and ambiguity of the diagnostic criteria of the reporting standard and further reduce the discrepancies among individual pathologist and cytotechnologist. More specifically, two diagnostic criteria, which are the chromatin pattern and nuclear membrane irregularity, are the main concerns in this study.

Research Objectives

- Short, clear and straightforward
- Reflect the research gaps
  - ✓ Specific objective should be proposed for each research gap
- Objectives must be realistic, measurable and achievable

Chapter 1: Introduction

Research Gap #1

The contrast of the cervical squamous epithelial cell images, however, sometimes is insufficient to clearly distinguish the diagnostic features of a cell. Additionally, the manual smearing and staining unavoidably lead to large variations in specimen quality.

Research Objective #1

To propose image enhancement techniques to improve the contrast of the cervical squamous epithelial cell images and hence ease the scrutinization of diagnostic features.

Chapter 1: Introduction

Research Gap #2

of a cervical squamous epithelial cell is illustrated in Figure 1.1(a). Judgment of pleomorphism is highly subjective. The degree of membrane irregularity could be justified differently, depending on individual pathologist or cytotechnologist. Hence, there is a need to find ways to measure the membrane irregularity.

Research Objective #2

To study the significance of chromatin pattern and nuclear membrane irregularity of differentiating cervical squamous epithelial cells into negative for intraepithelial lesion or malignancy (NILM), low-grade squamous intraepithelial lesion (LSIL) or high-grade squamous intraepithelial lesion (HSIL) class.

Chapter 1: Introduction

Research Gap #3

based on investigation of numerous slides. Depending on individual, each pathologist and cytotechnologist perceives chromatin pattern in a different way since there is no exact term to describe the appearance of the chromatin. Under such scenario, for the same slides, different justification and conclusion might be drawn, especially for borderline cases. Therefore, it is of paramount important to reduce the variation among individual human expert through quantifying and standardizing of the definition for chromatin pattern.

Research Objective #3

To quantify nuclear chromatin pattern and devise a chromatin distribution model that represents the visual perception of pathologists.

Chapter 1: Introduction

Research Gap #4– Real case scenario

Despite its effectiveness in reducing the mortality rate due to cervical cancer, Pap smear suffers from several disadvantages. It normally takes a few days or weeks to prepare a Pap smear result as the screening process requires high level of concentration for an extended period (Bengtsson and Malm, 2014, Birdsong, 1996). Theoretically, the screening process looked simple. Cells demonstrate morphological changes during malignancy, i.e.

Research Objective #4

To study the applicability of the proposed cervical squamous epithelial cells' features in classifying cervical squamous epithelial cells into NILM, LSIL, and HSIL classes using artificial neural network (ANN).

Research Scope

- **State the boundary/scope of your research in terms of:**
  - ✓ Research type [application, fundamental or both]
  - ✓ Research area [specify the niche area to be focused]
  - ✓ Data samples [type (simulation, benchmark, real case studies), number etc.]
  - ✓ Research platform [hardware, software, type of programming language etc.]
  - ✓ Research level [simulation level, lab scale, real case studies etc.]

Chapter 1: Introduction

Thesis Outline

- Briefly explain the content of each chapter of your thesis
- As a guidance to the reader