

The copyright © of this thesis belongs to its rightful author and/or other copyright owner. Copies can be accessed and downloaded for non-commercial or learning purposes without any charge and permission. The thesis cannot be reproduced or quoted as a whole without the permission from its rightful owner. No alteration or changes in format is allowed without permission from its rightful owner.



**AN EMBEDDING TRAIID-BIT METHOD TO IMPROVE THE  
PERFORMANCE OF ARABIC TEXT STEGANOGRAPHY**

**REEMA AHMED ABDALLA BIN THABIT**



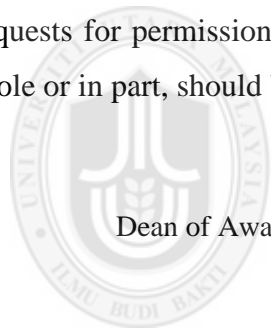
**UUM**  
Universiti Utara Malaysia

**SCHOOL OF COMPUTING  
UUM COLLEGE OF ARTS AND SCIENCES  
UNIVERSITI UTARA MALAYSIA  
2016**

## **Permission to Use**

In presenting this thesis in fulfilment of the requirements for a postgraduate degree from Universiti Utara Malaysia, I agree that the Universiti Library may make it freely available for inspection. I further agree that permission for the copying of this thesis in any manner, in whole or in part, for scholarly purpose may be granted by my supervisor(s) or, in their absence, by the Dean of Awang Had Salleh Graduate School of Arts and Sciences. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to Universiti Utara Malaysia for any scholarly use which may be made of any material from my thesis.

Requests for permission to copy or to make other use of materials in this thesis, in whole or in part, should be addressed to:



Dean of Awang Had Salleh Graduate School of Arts and Sciences

UUM College of Arts and Sciences

Universiti Utara Malaysia

06010 UUM Sintok

## Abstract

The enormous development in the utilization of the Internet has driven by continuous improvements in the region of security. The enhanced security techniques are applied to save the intellectual property. There are numerous sorts of security mechanisms. Steganography is the art and science of concealing secret information inside a cover media without drawing any suspicion to the eavesdropper so that the secret information can only be detected by its proposed recipient. This is done along with the other steganography methods such as image, audio, video, various text steganography methods that are being presented. The text is ideal for steganography due to its ubiquity. There are many steganography methods used several languages such as English, Chinese and Arabic language to embed the hidden message in the cover text. Kashida, shifting point and sharp\_edges are Arabic steganography methods with high capacity. However, kashida, shifting point and sharp\_edges techniques have lack of capability to embed the hidden message into the cover text. This study proposed new method called Traid-bit method by integrating three several types of methods such as kashida, shifting point and sharp\_edges to evaluate the proposed method in improving the performance of embedding process. The study presents the process design of proposed method including the algorithms and the system design. The study found that the evaluation of the proposed method provides good knowledge to steganographer to improve the performance of embedding process when the Arabic text steganography method is developed.

**Keywords:** Arabic Language, Text Steganography, Embedding Performance, Information Security.

## Abstrak

Perkembangan pesat dalam penggunaan Internet telah didorong oleh peningkatan berterusan dalam perihal keselamatan di alam maya. Teknik-teknik keselamatan yang sedia ada dipertingkatkan lagi yang bertujuan untuk menjaga dan menyelamatkan harta intelek. Terdapat pelbagai jenis mekanisme keselamatan, dan Steganografi adalah salah satu daripadanya. Steganografi adalah suatu seni dan sains yang bertindak sebagai mekanisme untuk menyembunyikan maklumat rahsia di dalam sesebuah media tanpa menimbulkan sebarang kekeliruan supaya maklumat rahsia hanya dapat dikesan oleh penerima. Perkara ini dilakukan bersama-sama dengan kaedah steganografi yang lain seperti imej, audio, video, dan pelbagai kaedah teks steganografi yang ada. Teks sesuai untuk digunakan untuk steganografi kerana kelebihannya. Terdapat banyak teknik steganografi digunakan beberapa bahasa seperti Inggeris, China dan Bahasa Arab untuk menyamarkan mesej yang tersembunyi dalam teks penutup. *Kashida*, *shifting point* dan *sharp\_edges* adalah teknik steganografi Arab dengan kapasiti tinggi. Walau bagaimanapun, *kashida*, *shifting point* dan *sharp\_edges* teknik mempunyai kekurangan prestasi untuk membenamkan mesej yang tersembunyi ke dalam teks penutup. Kajian ini mencadangkan kaedah baru dengan mengintegrasikan teknik teks steganografi Bahasa Arab untuk menilai kaedah yang dicadangkan dalam meningkatkan prestasi proses penerapan. Kemudian, kajian ini membentangkan reka bentuk proses kaedah yang dicadangkan termasuk algoritma dan reka bentuk sistem. Kajian ini mendapati bahawa penilaian kaedah yang dicadangkan menyediakan pengetahuan yang baik untuk steganographer dalam meningkatkan prestasi proses penerapan di dalam teknik teks steganografi Arabic dibangunkan.

Kajian ini membentangkan reka bentuk proses kaedah yang dicadangkan termasuk algoritma dan reka bentuk sistem. Kajian mendapati bahawa penilaian kaedah yang dicadangkan menyediakan pengetahuan yang baik untuk steganographer untuk meningkatkan prestasi proses menerapkan apabila kaedah teks steganografi Arab dibangunkan.

**Keywords:** Bahasa Arab, Teks Steganographi, Menerapkan Prestasi, Maklumat Keselamat.

## Table of Contents

|   |          |
|---|----------|
| Permission to Use .....                         | i        |
| Abstract.....                                   | ii       |
| Abstrak.....                                    | iii      |
| Table of Contents .....                         | iv       |
| List of Tables .....                            | vii      |
| List of Figures.....                            | viii     |
| <b>CHAPTER ONE: INTRODUCTION .....</b>          | <b>1</b> |
| 1.1 Background of Study .....                   | 1        |
| 1.2 1 Motivation.....                           | 3        |
| 1.3 Problem Statement .....                     | 3        |
| 1.4 Research Questions .....                    | 4        |
| 1.5 Research Objectives .....                   | 4        |
| 1.6 Research Scope .....                        | 5        |
| 1.7 Significant of Study.....                   | 5        |
| 1.8 Outline.....                                | 5        |
| <b>CHAPTER TWO: LITERATURE REVIEW .....</b>     | <b>8</b> |
| 2.1 Introduction.....                           | 8        |
| 2.2 Related Work .....                          | 9        |
| 2.2.1 Format-based.....                         | 9        |
| 2.2.1.1 Random and Statistical Generation ..... | 11       |
| 2.2.1.2 Linguistic Method .....                 | 12       |
| 2.2.2 Natural Language steganography.....       | 18       |
| a. Word-Rule Based.....                         | 19       |
| b. Feature Based.....                           | 19       |
| 2.2.3 Arabic and Persian Based .....            | 29       |
| 2.2.3.1 Shifting Points Embedded technique..... | 30       |
| 2.2.3.2 Harakat Embedded technique.....         | 31       |
| 2.2.3.3 Kashida Embedded technique .....        | 34       |

|  |           |
|--|-----------|
| 2.2.3.4 Unicode Embedded technique .....   | 35        |
| 2.2.3.5 Sharp-edges Embedded technique .....   | 38        |
| 2.2.3.6 Poetry System Embedded technique .....   | 39        |
| 2.2.3.7 Changing Font Embedded technique .....   | 39        |
| 2.2.3.8 A brief review of Arabic Text Steganography Embedded techniques .....            | 40        |
| 2.2.3.9 Review on Used Evaluation of Arabic Text Steganography Embedded techniques ..... | 43        |
| 2.3 Conclusion .....   | 45        |
| <b>CHAPTER THREE RESEARCH METHODOLOGY .....</b>  | <b>46</b> |
| 3.1 Introduction .....   | 46        |
| 3.2 3.2 Phase I: Investigation Problem.....  | 47        |
| 3.2.1 Preliminary Study .....  | 47        |
| 3.2.2 Problem Statement .....  | 48        |
| 3.3 Phase II: Process Design .....   | 48        |
| 3.3.1 Input Design Preparation .....   | 49        |
| 3.4 Phase III: Evaluation Performance.....   | 53        |
| 3.4.1 Capability of Stego Text Size .....  | 54        |
| 3.4.2 Usage of Cover Text .....  | 54        |
| 3.4.3 Usability of Cover Text.....   | 54        |
| 3.4.4 Fitness Performance of Stego Key.....  | 55        |
| 3.4.5 3.4.5 Running Time .....   | 57        |
| 3.5 Phase IV: Result and Discussion .....  | 58        |
| 3.6 Summary .....  | 58        |
| <b>CHAPTER FOUR THE DESIGN OF TRIAD BIT OF METHOD .....</b>                              | <b>59</b> |
| 4.1 Introduction .....   | 59        |
| 4.2 Process Design .....   | 59        |
| 4.2.1 Embedding Process Design.....  | 59        |
| 4.3 Algorithm Design.....  | 62        |
| 4.3.1 Embedding Algorithm Design .....   | 62        |
| 4.4 Extracting Process Design.....   | 67        |

|   |   |            |
|---|---|------------|
| a.  | Preparation Required Inputs .....             | 67         |
| b.  | Selection Stego Key .....                     | 68         |
| c.  | Triad-bit Extracting Process .....            | 68         |
| 4.4.1   | Extracting Algorithm Design .....             | 71         |
| 4.5   | System Design.....                            | 73         |
| 4.5.1   | Physical Design.....                          | 73         |
| 4.6   | Logical Design .....                          | 81         |
| 4.6.1   | Embedding Logical Diagram .....               | 81         |
| 4.6.2   | Extracting Logical Design .....               | 85         |
| 4.7   | Summary .....                                 | 87         |
| <b>CHAPTER FIVE RESULT AND DISCUSION.....</b>       |   | <b>88</b>  |
| 5.1   | Introduction .....                            | 88         |
| 5.2   | Size Capability of Stego Text .....           | 88         |
| 5.3   | Usage Ratio of Cover Text.....                | 90         |
| 5.4   | Usability Ratio of Cover Text .....           | 92         |
| 5.5   | Fitness Performance of Triad-bit Method ..... | 94         |
| 5.6   | Running Time of Triad-bit Method.....         | 96         |
| 5.7   | Summary .....                                 | 98         |
| <b>CHAPTER SIX CONCLUSION AND FUTURE WORK .....</b> |   | <b>100</b> |
| 6.1   | Introduction .....                            | 100        |
| 6.2   | Discussion of Research Objectives .....       | 100        |
| 6.2.1   | Revisiting the Research Objectives1 .....     | 100        |
| 6.2.2   | Revisiting the Research Objectives 2 .....    | 101        |
| 6.3   | Limitation of the Research Work .....         | 101        |
| 6.4   | Contribution .....                            | 102        |
| 6.5   | Future Work .....                             | 102        |
| <b>REFERENCES .....</b>                             |   | <b>103</b> |



## List of Tables

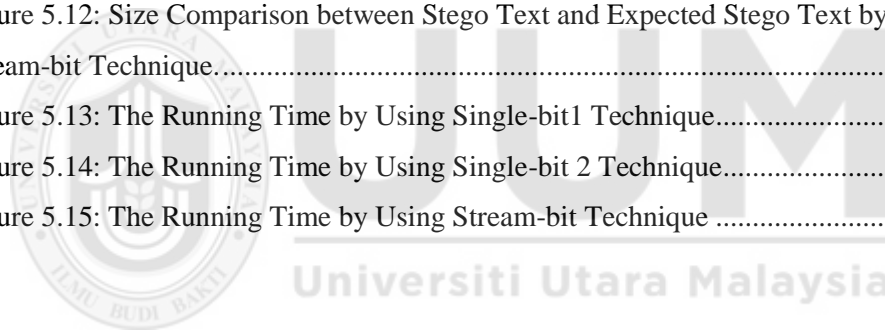
|  |    |
|--|----|
| Table 3.1: Letter Group of Sharb_Edges Embedded Technique .....    | 51 |
| Table 3.2: Letter Group of Shifting Point Embedded technique ..... | 52 |
| Table 3.3: Letter Group of Kashida Embedded Technique .....        | 52 |
| Table 4.1: Components of TBSS .....                                | 75 |
| Table 4.1: Components of Embedding Use Case Diagram.....           | 83 |
| Table 4.2: Components of Extracting Use Case Diagram .....         | 86 |



## List of Figures

|  |    |
|--|----|
| Figure 2.1: Three Basic Categories of Text Steganography .....   | 8  |
| Figure 2.2: The Linguistic Steganography Framework .....   | 8  |
| Figure 2.3. Natural Language Steganography Categories Classification.....                                | 19 |
| Figure 2.4: Feature Based Categories .....   | 20 |
| Figure 2.5 Embedded techniques on Arabic Text Steganography .....  | 29 |
| Figure 2.6: Vertical Shifting Point.....   | 30 |
| Figure 2.7: Some Letters with Mark and Their Pronunciation .....   | 31 |
| Figure 2.8 Steganography Example Adding Extensions after Letters .....                                   | 34 |
| Table 2.1: A Brief Review of Arabic Text Steganography Embedded techniques.....                          | 40 |
| Table 1.2: The Used Evaluation from previous Researches. ....  | 43 |
| Figure 3.1: Research Methodology Design.....   | 46 |
| Figure 3.2: Phase I(Investgation Problem) .....  | 47 |
| Figure 3.3: Phase II(Process Designen).....  | 48 |
| Figure 3.4: Example of hidden message .....  | 49 |
| Figure 3.5: Example of Cover Text .....  | 50 |
| Figure 3.6: Phase III(Evaluation Process).....   | 53 |
| Figure 3.7: Phase IV(Investgation Problem).....  | 58 |
| Figure 4.1: Modelling Process of Triad-bit Method .....  | 59 |
| Figure 4.2: Embedding Flow Process of Triad-bit method.....  | 60 |
| Figure 4.3: Extracting Flow Process of Triad-bit Method .....  | 70 |
| Figure 4.4: User Interface of TBSS .....   | 74 |
| Figure 4.5: Embedding Implementation of Single-bit1 technique.....                                       | 77 |
| Figure 4.6: Embedding Implementation of Single-bit 2 technique .....                                     | 78 |
| Figure 4.7: Embedding Implementation of Stream-bit Technique .....                                       | 79 |
| Figure 4.8: Extracting Implementation of Single-bit 1 Embedded Technique .....                           | 80 |
| Figure 4.9: Extracting Implementation of Single-bit 2 Technique .....                                    | 80 |
| Figure 4.10: Extracting Implementation of Stream-bit Technique .....                                     | 81 |
| Figure 4.11: Use Case Diagram for Embedding Triad-bit Method .....                                       | 82 |
| Figure 4.12: Class Diagram of Embedding & Extracting Triad-bit Method .....                              | 84 |
| Figure 4.13: Use Case Diagram for Extracting Triad-bit Method .....                                      | 85 |
| Figure 5.1: Size Comparison of Stego Text and Expected Stego Text by Using Single-bit1<br>Technique..... | 88 |

|   |    |
|---|----|
| Figure 5.2: Size Comparison between Stego Text and Expected Stego Text by Using Single-bit 2 Technique. ....  | 89 |
| Figure 5.3: Size Comparison between Stego Text and Expected Stego Text by Using Stream-Bit Technique. ....    | 89 |
| Figure 5.4: Cover Text Character Usage For Data Hiding Using Single-bit 1 Technique ....                      | 90 |
| Figure 5.5: Cover Text Character Usage for Data Hiding Using Single-bit Technique .....                       | 91 |
| Figure 5.6: Cover Text Character Usage for Data Hiding Using Stream-bit 1 Technique ....                      | 91 |
| Figure 5.7: Cover Text Character Usability For Data Hiding Using Single-bit 1 Technique                       | 92 |
| Figure 5.8: Cover Text Character Usability for Data Hiding Using Single-bit 1 Technique.                      | 93 |
| Figure 5.9: Cover Text Character Usability for Data Hiding Using Stream-bit Technique ..                      | 94 |
| Figure 5.10: Size Comparison between Stego Text and Expected Stego Text by using Single-bit 1 Technique.....  | 94 |
| Figure 5.11: Size Comparison between Stego Text and Expected Stego Text by using Single-bit 2 technique ..... | 95 |
| Figure 5.12: Size Comparison between Stego Text and Expected Stego Text by Using Stream-bit Technique.....    | 95 |
| Figure 5.13: The Running Time by Using Single-bit 1 Technique.....  | 96 |
| Figure 5.14: The Running Time by Using Single-bit 2 Technique.....  | 97 |
| Figure 5.15: The Running Time by Using Stream-bit Technique .....   | 97 |



# CHAPTER ONE

## INTRODUCTION

### 1.1 Background of Study

Nowadays, our communications are hardly private anymore. Intruders in communication and technology can get information in a readable and understandable form of system. The information disclosed by Intruders to others, may be used to launch attack or altered against the person or organization's want (Bhattacharyya, Banerjee, & Sanyal, 2011). Unauthorized people are increasingly interested in other people's conversations, especially with the Internet being an open system. Hence, added counter measures must be taken to ensure privacy rights. One of the solutions used to tackle this problem is Steganography.

Steganography is the art and science that deals with hiding of secret messages in order to protect the existence of the message being detected by human senses. It is also a sub-discipline of information hiding. It is often mistaken for cryptography, even though both are used to protect valuable information. The difference between them is that steganography is the study of hiding information to conceal its existence, while Cryptography is the art of cryptogram or secret writing, involving various methods or embedded technique to ensure the protection of message contents (Computing, Kumar, & Singh, 2015). This depicts that the use of steganography makes anyone looking at the object storing secret information not to expect the existence of a message in the object, thereby dismissing thoughts of decrypting the object.

Steganography originated from a Greek word which comprises of Steganos, meaning 'to cover' or 'secret', and Graptos which means writing or drawing. Hence, steganography literally means 'covered writing'. The art has been used centuries ago before it was known as steganography. An example of its ancient use: "*Greek history*

The contents of  
the thesis is for  
internal user  
only

## REFERENCES

- Aabed, M. a., Awaideh, S. M., Elshafei, A. R. M., & Gutub, A. a. (2007). Arabic diacritics based steganography. *ICSPC 2007 Proceedings - 2007 IEEE International Conference on Signal Processing and Communications*, (September 2015), 756–759.
- Ahmadoh, E. M. (2015). Utilization of Two Diacritics for Arabic Text Steganography to Enhance Performance, 3(1).
- Al-Alwani, W., Mahfooz, A. Bin, & Gutub, A. A. A. (2007a). A Novel Arabic Text Steganography Method Using Extensions. *Proceeding of World Academy of Science, Engineering and Technology*, 1(3), 483–486.
- Al-Alwani, W., Mahfooz, A. Bin, & Gutub, A. A. A. (2007b). A Novel Arabic Text Steganography Method Using Extensions. *Proceeding of World Academy of Science, Engineering and Technology*, 1(3), 502–505.
- Alginahi, Y. M., Kabir, M. N., & Tayan, O. (2012). An Enhanced Kashida-Based Watermarking Approach for Increased Protection in Arabic Text-Documents, 1–10.
- Al-Haidari, F., Gutub, A., Al-Kahsah, K., & Hamodi, J. (2009). Improving security and capacity for arabic text steganography using “Kashida” extensions. *2009 IEEE/ACS International Conference on Computer Systems and Applications, AICCSA 2009*, 396–399.
- Alla, K., & Prasad, R. S. R. (2009). An evolution of hindi text steganography. *ITNG 2009 - 6th International Conference on Information Technology: New Generations*, Alnazer, A., & Gutub, A. (2009). Exploit Kashida Adding to Arabic e - Text for High Capacity Steganography Objective y Proposed Approach, (October), 19–21.
- Al-Nazer, A., & Gutub, A. (2009). Exploit Kashida adding to Arabic E-text for High Capacity Steganography. *NSS 2009 - Network and System Security*, 447–451.
- Ammar, O., Khaled, E., & Miad, F. (2014). Steganography in Text by Using MS Word Symbols.
- Ardakani, S. B., Latif, A. M., & Mirzaie, K. (2015). Presentation a new method for Steganography in Persian text of an electronic document, 36.
- Atallah, M. J., McDonough, C. J., Raskin, V., & Nirenburg, S. (2000). Natural Language Processing for Information Assurance and Security: An Overview and Implementations. In *NSPW '00: Proceedings of the 2000 workshop on New securityparadigms*(pp.51–65).

- Azawi, A. F. Al, & Fadhil, M. A. (2011). An Arabic Text Steganography Technique Using ZWJ Regular Expression 3(3), 419–424.
- Bensaad, M. L., & Yagoubi, M. B. (2011). High capacity diacritics-based method for information hiding in Arabic text. *2011 International Conference on Innovations in Information Technology*, 433–436.
- Bhattacharyya, S., Banerjee, I., & Sanyal, G. (2011). A Survey of Steganography and Steganalysis Technique in Image, Text, Audio and Video as Cover Carrier. *Journal of Global Research in Computer Science*, 2(4), 1–16.
- Chang, C.-Y., & Clark, S. (2010a). Linguistic Steganography Using Automatically Generated Paraphrases. *Human Language Technologies: The 2010 Annual Conference of the North American Chapter of the Association for Computational Linguistics*, (June), 591–599.
- Chang, C.-Y., & Clark, S. (2010b). Turn-taking and affirmative cue words in task-oriented dialogue. *Dissertation Abstracts International, B: Sciences and Engineering*, 70(8), 4943.
- Changder, S., Debnath, N. C., & Ghosh, D. (2010). A greedy approach to text steganography using properties of sentences. *Proceedings - 2011 8th International Conference on Information Technology: New Generations, ITNG 2011*, 30–35.
- Computing, M., Kumar, R., & Singh, a J. (2015). Understanding Steganography over Cryptography and Various Steganography Techniques, 4(3), 253–258.
- Cvejic, N., & Jic, C. V. E. (2004). *Algorithms for Audio Watermarking and. Processing*.
- Din, R., & Samsudin, A. (2011). A Conceptual Framework for Natural Language Steganalysis, 1.
- Gaur, M., & Sharma, M. (2015). A New PDAC ( Parallel Encryption with Digit Arithmetic of Cover Text ) Based Text Steganography Approach for Cloud Data Security, 1344–1352.
- Gutub, A. a, Ghouti, L. M., Elarian, Y. S., Awaideh, S. M., & Alvi, A. K. (2010). Utilizing Diacritics Marks for Arabic Text Steganography. *Kuwait Journal of Science & Engineering (KJSE)*, 37(1), 89–109.
- Gutub, A. A. A., Al-Haidari, F., Al-Kahsah, K. M., & Hamodi, J. (2010). E-text watermarking: Utilizing “Kashida” extensions in Arabic language electronic writing. *Journal of Emerging Technologies in Web Intelligence*, 2(1), 48–55.

- Ghouti, L., & Amin, A. (2007). Utilizing Extension Character “Kashida” With Pointed Letters For Arabic Text Digital Watermarking.
- Kamel, I., & Banawan, S. (2012). Hiding information in the placement of maneuverable words. *2012 International Conference on Innovations in Information Technology, IIT 2012*, 255–260.
- Khairullah, M. (2009). A novel text steganography system using font color of the invisible characters in microsoft word documents. *2009 International Conference on Computer and Electrical Engineering, ICCEE 2009, 1*, 482–484.
- Khan, E. A. (2014). Using arabic poetry system for steganography, *6*, 55–61.
- Khan, S., & Abhijitha, B. (2015). Polish Text Steganography Method Using Letter Points and Extension.
- Khan, S., Sankineni, R., Balagurunathan, P., Suresh, N., & Shree, D. (2015). Czech Text Steganography Method by Selective Hiding Technique, *1*, 1–4.
- Liu, G., Ding, X., Su, B., & Meng, K. (2013). A Text Information Hiding Algorithm Based on Alternatives. *Journal of Software*, *8*(8), 2072–2079. <http://doi.org/10.4304/jsw.8.8.2072-2079>
- Malik, S., & Mitra, W. (2015). Hiding Information- A Survey, *3*(3), 232–240.
- Memon, J. A., Khowaja, K., & Kazi, H. (2008). Evaluation of Steganography for Urdu / Arabic Text . *Pace Pacing And Clinical Electrophysiology*, 232–237.
- Mersal, S. (2014). Arabic Text Steganography in Smartphone, *03*(02), 441–445.
- Mohamed, a. a. (2014). An improved algorithm for information hiding based on features of Arabic text: A Unicode approach. *Egyptian Informatics Journal*, *15*(2), 79–87.
- Odeh, A. (2012). Steganography in Arabic Text Using Zero Width and Kashidha Letters. *International Journal of Computer Science and Information Technology*, *4*(3), 1–11.
- Odeh, A. (2015). ROBUST TEXT STEGANOGRAPHY ALGORITHMS FOR SECURE DATA COMMUNICATIONS.
- Odeh, A., Alzubi, A., Hani, Q. B., & Elleithy, K. (2012). Steganography by multipoint Arabic letters. *2012 IEEE Long Island Systems, Applications and Technology Conference, LISAT 2012*.
- Odeh, A., Elleithy, K., & Faezipour, M. (2013). Steganography in Arabic text using Kashida variation algorithm (KVA). *9th Annual*



- Conference on Long Island Systems, Applications and Technology, LISAT 2013.*  
<http://doi.org/10.1109/LISAT.2013.6578239>
- Por, L. Y., Ang, T. F., & Delina, B. (2008). WhiteSteg: A new scheme in information hiding using text steganography. *WSEAS Transactions on Computers*, 7(6), 735–745.
- Por, L. Y., & Delina, B. (2008). Information Hiding: A New Approach in Text Steganography, (September).
- Prasad, R. S. R., & Alla, K. (2011). A new approach to Telugu text steganography. *ISWTA 2011 - 2011 IEEE Symposium on Wireless Technology and Applications*, 60–65.
- Rafat, K. F. (2009). Enhanced text steganography in SMS. *2009 2nd International Conference on Computer, Control and Communication, IC4 2009*.
- Roslan, N. A., Mahmud, R., & Udzir, N. U. R. I. (2011). Sharp\_Edges Method in Arabic Text Steganography, 33(1).
- Roslan, N. A., Mahmud, R., Udzir, N. U. R. I., & Zurkarnain, Z. A. (2014). Primitive Structural Method for High Capacity , 67(2), 373–383.
- Roy, S., & Manasmita, M. (2011). A novel approach to format based text steganography. *Proceedings of the 2011 International Conference on Communication, Computing & Security - ICCCS '11*, 511.
- Sabir, A. S. (2013). A New Arabic Text ( Diacritics , non Diacritics ) Steganography, 31(3), 85–96.
- Samphaiboon, N., & Dailey, M. N. (2008). Steganography in thai text. *5th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology, ECTI-CON 2008, 1*, 133–136.
- Shirali-Shahreza, M. (2008). Text steganography by changing words spelling. *International Conference on Advanced Communication Technology, ICACT*, 3(MARCH 2008), 1912–1913.
- Shirali-shahreza, M. H. (2007). Text Steganography in chat. *Internet, 2007. ICI 2007. .... Retrieved from* [http://ieeexplore.ieee.org/xpls/abs\\_all.jsp?arnumber=4401716](http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4401716)
- Shirali-shahreza, M. H., & Shirali-Shahreza, M. (2006). A new approach to Persian/Arabic text steganography. *Proceedings - 5th IEEE/ACIS Int. Conf. on Comput. and Info. Sci., ICIS 2006. In Conjunction with 1st IEEE/ACIS, Int. Workshop Component-Based Software Eng., Softw. Archi. and Reuse, COMSAR 2006, 2006*, 310–315.
- Shirali-Shahreza, M. H., & Shirali-Shahreza, M. (2010).

Arabic/Persian text steganography utilizing similar letters with different codes. *The Arabian Journal for Science and Engineering*, 35(1), 213–222.

- Shirali-Shahreza, M., & Shirali-Shahreza, M. H. (2008a). An improved version of persian/arabic text steganography using “La” word. *Proceedings of IEEE 2008 6th National Conference on Telecommunication Technologies and IEEE 2008 2nd Malaysia Conference on Photonics, NCTT-MCP 2008*, (August), 372–376.
- Shirali-Shahreza, M., & Shirali-Shahreza, S. (2008b). Persian/arabic unicode text steganography. *Proceedings - The 4th International Symposium on Information Assurance and Security, IAS 2008*, 62–66. <http://doi.org/10.1109/IAS.2008.12>
- Singh, P., Chaudhary, R., & Agarwal, A. (2012). A Novel Approach of Text Steganography based on null spaces. *Iosrjournals.Org*, 3(4), 11–17.
- Wilson, a, Blunsom, P., & Ker, a D. (2014). Linguistic steganography on Twitter: Hierarchical language modeling with manual interaction. *Media Watermarking, Security, and Forensics 2014*, 9028.
- Yuling, L., Xingming, S., Can, G., & Hong, W. (2007). RFalse, 2094–2097.



UUM  
Universiti Utara Malaysia