Review on secured data capabilities of cryptography, steganography, and watermarking domain

Farah Qasim Ahmed Al-Yousuf, Roshidi Din
School of Computing, UUM College of Arts and Sciences, Universiti Utara Malaysia, Malaysia

ABSTRACT
Due to the increment of using Internet to transfer the critical and secret data, many studies interested in secured data and investigated many ways to secure the transferred information. This paper presents a review study on the field that used in a secured data domain. The main objective of this study is explore the capabilities of secured data that used widely by researchers. Furthermore, the benefits and the drawbacks for each of secured data domain are also studied. This paper concludes that cryptography techniques could be utilized with steganography and watermarking in secured data domain to enhance the security mechanisms.

Keywords:
Algorithm used
Secured data
Technique used

1. INTRODUCTION
The improvement of the digital communication has become an essential part of life, for example, in work or school environment and even in daily uses such as e-mail correspondence and instant messaging. With the development of technology on storing and exchanging data in different ways over the network from one location to another, the security of these data, namely secured data, try to protect the information from threats or a barrier resists. Securing the information should be accomplished by using a protection techniques that make the data secured among the authorized parties [1]. There are three fields used widely in the domain of secured data known as cryptography, steganography, and watermarking. Thus, this paper will try to review the secured data capabilities on cryptography, steganography, and watermarking domain.

Cryptography is a technique that secures the transferred data, which concerns about confidentiality, integrity, and availability of the information [2]. Besides that, steganography is the technique that conceal the data into the same or in a different form to create a cover that holds the secret data called the cover medium which is to protect them from spying attacks [3]. So, it is a technique to create a hidden communication [4]. Meanwhile, watermarking is used to classify and shield the content of the copyrighted media by coding the data into the main content [5]. Figure 1-3 shows the process for cryptography (Figure 1.), steganography (Figure 2.), and watermarking (Figure 3.) through their security processes.

There are some purposes for cryptography, steganography, and watermarking have been identified where each of field has its own strength and weaknesses points. Table 1 has present a general view on the secured data fields in term of purpose, strength, weakness and used-based.
Figure 1. Secured data processes: Cryptography process

Figure 2. Secured data processes: Steganography process

Figure 3. Secured data processes: Watermarking process

Table 1. General Capabilities for Secured Data

| Purpose                                                                 | Cryptography                                                                 | Steganography                                                                 | Watermarking                                                                 |
|------------------------------------------------------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------|
| **Purpose**                                                            | Provide information security and transfer them through insecure communication [6] | It is a private communication and protecting the data from alteration as an authentication purpose [8] | Copyright protection, broadcast monitoring, video authentication, and ID card security [9] |
| **Strength**                                                           | Secure the data as well as protect the privacy by using cryptography with another technique [10], for example, steganography [11] | Provide end-to-end data confidentiality for sensitive information and robust authenticity [13] | Enhance imperceptibility and computational complexity for the digital media [14] |
| **Weakness**                                                           | Complex key management, especially in public key infrastructure [15]          | By using only the text steganography, the scheme will be more natural to interrupt or deciphered [10] | Using a universal logo without encryption in the embedding algorithm [16]     |
| **Used-based**                                                         | Algorithm-based                                                               | Domain-based                                                                 | Application-based                                                            |

2. REVIEW OF TECHNIQUES AND ALGORITHMS IN SECURED DATA

This section mentions the current techniques and algorithms for secured data domain. There are different techniques used to increase the capabilities for each field in secured data. Table 2 illustrates the techniques and algorithms used by researchers in term of the domain used in secured data.
### Table 2. A Review of Techniques/Algorithms in Secured Data

| Domain                        | Techniques/Algorithms                                                                 |
|-------------------------------|---------------------------------------------------------------------------------------|
| Cryptography                  | Binary image encryption algorithm [17], Elliptic curve random generator and advanced encryption system [18], Entropy accumulation [19], and Rapid hyperchaotic system [20] |
| Coloured image                | Gyrorator transform [21] and Colour image encryption scheme and multiple piecewise linear chaotic map [22] |
| Cloud Environment             | Searchable encryption [23], Ciphertext-policy attribute-based encryption [24], and Attribute based encryption, distributed hash table network, and identity based timed-release encryption [25] |
| Communication, Protocol, Network, Mobile Wireless Networks | Cognitive cryptography [26]                                                        |
| Audio                         | Original speech encryption method [28]                                                |
| Proxy                         | Digital right management [29]                                                         |
| Storage                       | Commutative re-encryption techniques [30]                                              |
| Steganography                 | Adaptive neural networks with an adaptive [genetic algorithm] [31], Uniform embedding revised distortion [32], Image steganography algorithm and compressive sensing with sub-sampling [33], Absolute moment block truncation coding [34], Domain separation technique [35], Least significant bit [36], Adaptive steganography algorithm based on Gabor filters and anisotropic diffusion [37], Colour pixel vectors [38], Optimal asymmetric encryption padding and information dispersal algorithms [39] and Optimized efficient methodology [40] |
| Wireless Psychological Signal Synthetic Gene Circuits | Discrete wavelet transform [39]                                                     |
| Watermarking                  | Encryption then steganography [41]                                                    |
| Digital-based                 | Non-integer PE embedding approach [42]                                                |
| Image-based                   | Multiple colour-image fusion and watermarking [43]                                   |
| Video-based                   | Algorithm for invisible grayscale logo watermarking [44]                             |
| Audio-based                   | Self-embedding fragile image watermarking [45]                                        |
| Hybrid-based                  | Sparse domain-based information hiding [46]                                           |
| Hybrid-based                  | Medical image watermarking technique [47]                                             |
| Hybrid-based                  | Watermarking algorithm based on non-subsampled contourlet transform [48]              |
| Audio-based                   | Non-blind digital watermarking technique [49]                                         |
| Hybrid-based                  | Blind image watermarking based on redundant discrete wavelet transform [51]          |
| Audio-based                   | High-efficiency video coding [52]                                                    |
| Hybrid-based                  | Discrete cosine transform and singular value decomposition [53]                     |
| Hybrid and blind watermarking scheme [54] |

![Figure 4. Techniques used on secured data within last five years](image)

Besides that, Figure 4 has illustrated the number of the techniques and algorithms used by the researchers within last five years. In year 2015, cryptography had a minimum amount of applied techniques at two techniques/algorithms, while in same year steganography had the maximum at five techniques/algorithms. In the year 2016, the used of cryptography has been increased to three techniques/algorithms, while remaining unchanged in the year 2017 and the year 2018 at two techniques/algorithms. There was a sudden increase usage of cryptography in the year 2019 up to five techniques/algorithms, which makes it a standard secured data that used in data security.
3. ADVANTAGES AND DISADVANTAGES OF SECURED DATA

Most of the researchers in their studies have advantages of their proposed techniques. However, not all the proposed techniques solved all the issues. Table 3 has illustrated the benefits and drawbacks for the proposed scheme of secured data in the last five years from year 2015 to year 2019. As shown in Table 3, the benefits and drawbacks of the techniques on cryptography, steganography, and watermarking.

| Domain          | Methods            | Benefits                                                                 | Drawbacks                                               |
|-----------------|--------------------|-------------------------------------------------------------------------|----------------------------------------------------------|
| Cryptography    | AES, RSA, and MD5  | More secure when AES algorithm used alone [55]                           | High running time                                        |
|                 | Cloud Environment  | An efficient method to protect the data, low running time, and increased throughput [29] |                                                          |
|                 | Coloured Image     | More secured and accurate against attacks [25]                          | Inefficient with multiple colour image                   |
|                 |                    | Efficient for the colored image, strong resistance, strong computational load, time-saving [22] |                                                          |
| Steganography   | Image              | Less distortion in the sense of color correlation, equipped with the extended CMD strategy [38] | Cannot be directly applied to JPEG image with YCbCr images |
|                 |                    | Proper embedding in the noisy region improved in security [37]          | The performance should be improved; not enough edge information of the image is returned |
|                 |                    | Seven layers protection can be used to fight against statistical visual, structural and attacks [31] |                                                          |
| Watermarking    | Digital Image      | Adding Arnold scrambling security scheme before embedding [56]          | Less payload capacity, poor robustness. False-positive error, and less fidelity |
|                 |                    | Robust against attacks [57]                                             |                                                          |
|                 |                    | Efficient, secure, safe, and applicable for blind and fragile applications [50] | The watermark may be destroyed by image processing because of the fragility |

4. CONCLUSION

There are some evolutions in techniques that enhanced the features for each field in secured data. This paper introduced a comparison study between cryptography, steganography, and watermarking techniques that are widely used to ensure information is secured. Thus, secured data techniques try to offer numerous solutions for issues faced by researchers. In summary, cryptography can be used to improve security and prevent attackers and unauthorized persons from estimating the secret message. Hence, this paper found that cryptography techniques could be used to increase the security for other fields on the secured data domain. Consequently, it is expected that future efforts will provide a higher level of security by utilizing the use of integrated between cryptography and steganography techniques.

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BIOGRAPHIES OF AUTHORS

Farah Qasim Ahmed Alyousuf is an assistant lecturer in Lebanese Frenh University in department of information technology / Kudistan Region - Erbil - Iraq. PhD candidate in Information Technology – School of Computing (SOC) – Awang Had Salih Graduate School (AHSGS) – Universiti Utara Malaysia / Sintok - Kedah - Malaysia.

Assoc. Prof. Dr. Roshidi Din received his Bachelor of Information Technology and Master of Science in Information Technology degrees from Universiti Utara Malaysia (UUM) in 1996 and 1999 respectively. He later completed his Ph.D from Universiti Sains Malaysia (USM) in 2015. He is currently a Senior Lecturer at the School of Computing, UUM. His current research interests are more on the application of Discrete Mathematics in various areas especially in Information Security, Steganography and Steganalysis, and Natural Language Steganology.