

Correlation of Ambiguity of Steganography with Cryptography in Text-Based Data Security

R. Fanry Siahaan^{1*}, Endra A.P. Marpaung², Gunung Juanda Tampubolon³, Ayu Pelita Lumban Siantar⁴

^{1,2,3,4}STMIK Pelita Nusantara
Jl. Iskandar Muda No. 1 Medan

*rfanry@gmail.com

Abstract

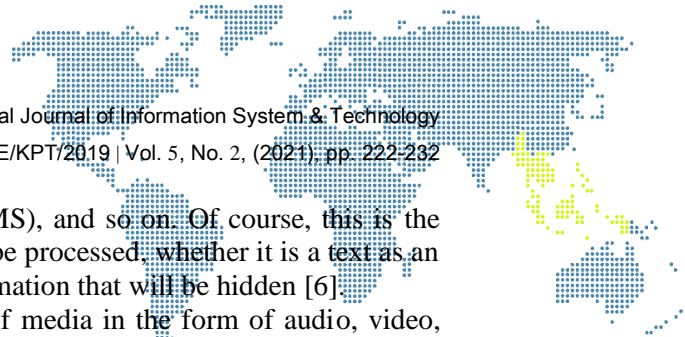
The development of information technology began with advances in the field of computerization. The early use of computers to simply write, create graphics and images and store incredible data has been transformed into a communication tool with a soft network that can cover the entire world. With the advancement of technology, the process of interaction between humans can reach the layers of society in the back of any world becomes increasingly open. Along with the advancement of technology all the information needed can be obtained easily, not least information that is confidential or top secret. Because with the help of technology all confidential information is locked or stored properly even though it can be opened and accessed by irresponsible parties. The most popular methods today are steganography and cryptography. Steganography is where confidential data is hidden or pasted in other data such as images, text, audio, or video so as not to cause suspicion of others or steganalyst. Unlike the cryptographic method, where secret data messages are scrambled or encoded so that they cannot be understood by others. And this raises suspicions from the other party or often called cryptanalyst. Based on the results or outputs of a text-based steganography (stegoteks) process against a message, text steganography in Indonesian patterns can evoke a correlation of ambiguity with cryptography in avoiding disclosure of confidential messages with a 100% accuracy rate.

Keywords: Correlation; Steganography; Cryptography; Ambiguity; Indonesian Sentence Pattern

1. Introduction

With advances in technology, the process of interaction between humans can reach all levels of society in any part of the world, it becomes increasingly open [1]. Along with advances in technology, all the information needed can be obtained easily, including top-secret information. Because with the help of technology, all confidential information that is locked or stored properly can be opened and accessed by irresponsible parties if the methods used in information security are simple or predictable. The methods that are quite popular today are steganography and cryptography. Steganography is where confidential data is hidden or inserted into other data such as images, text, audio, or video so as not to arouse suspicion of other parties or steganalysis [2][3][4]. This is different from the cryptographic method, where secret data messages are scrambled or encoded so that they cannot be understood by other parties, and this raises the suspicion of cryptanalysts [5].

With current technological developments, secret messages hidden in media or encrypted messages can be opened by steganalysis and cryptanalysts because the secret messages are only inserted or only encoded using certain methods. Text messages are information that is often exchanged in the world of telecommunications. Several technologies that involve text messages are one of the frequently used information data,



such as e-mail, fax, chat, short message service (SMS), and so on. Of course, this is the basis for using text messages as information data to be processed, whether it is a text as an insertion medium (cover text) and confidential information that will be hidden [6].

Research on steganography focuses on the use of media in the form of audio, video, text, and images as cover messages (state of the art). Nevertheless, research on the use of the medium continues to this day, including according to Y. Huang, C. Liu, S. Tang, and S. Bai, (2012) in "Steganography integration into a low-bit-rate speech codec,". The result of this research is to utilize low-bit-rate speech codes in VoIP audio streams. According to W. Luo, F. Huang, and J. Huang, (2010) in "Edge adaptive image steganography based on LSB matching revisited," Message embedding can be done well by using image media with Least Significant Bit (LSB) code matching. According to LM Marvel, CG Boncelet, and CT Retter, "Spread spectrum image steganography,

The purpose of research on steganography is not only to maximize algorithms on existing media but has also begun to lead to the exploration of other mediums that can be used as message intermediaries [7]. Some of these mediums include IP headers [8], TCP/IP protocols as well as UDP and ICMP, 3D images [9], ECG signal [10] as well as several other mediums [11]. The latest research on steganography has triggered the development of a branch of science in steganography and cryptography, namely the combination method of steganography and cryptography in securing information [12].

2. Research Methodology

Text steganography linguistic method is prepared for the construction of two system components apart from secret messages, namely dictionaries and patterns. Dictionaries, patterns, and secret messages will be processed at the message insertion stage. Inserting a message will produce a T stegoteks (one or more sentences in Indonesian). The output or the output of these T stegoteks will be tested in the correlation of word meaning with cryptography. Whether the word can be understood or contains meaning or not. The stages of research work are described in the following diagram.

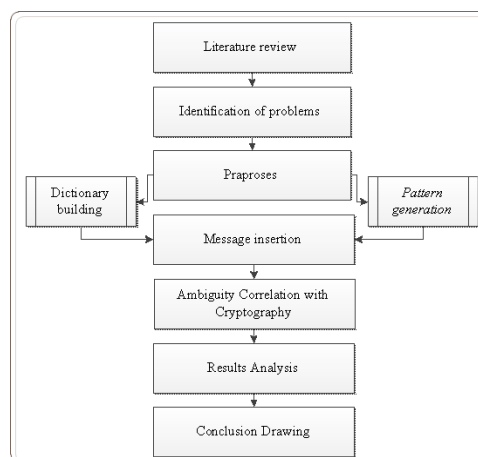


Figure 1. Stages of research work

2.1. Building a Dictionary of Words and Sentence Patterns

Word pairs with word types were obtained from an electronic dictionary that had been cleaned of word records that were not selected or not used. The word list in the electronic dictionary is grouped by word type from 7-word classes. The sentence pattern used is a combination of the grammatical functions of sentences in Indonesian, namely subject (S), predicate (P), object (O), complement (Pel), an adverb (K). The five grammatical functions form eight simple single sentence patterns [13], [14] namely SP, SPK, SPO, SPO-Pel, SPO-Pel-K, SPOK, SP-Pel, and SP-Pel-K.

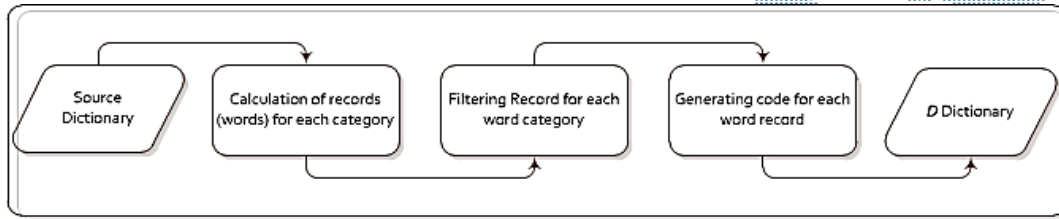
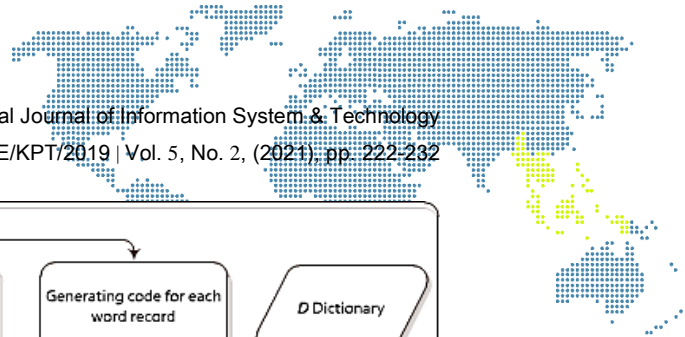


Figure 2. Development of *D* Dictionary

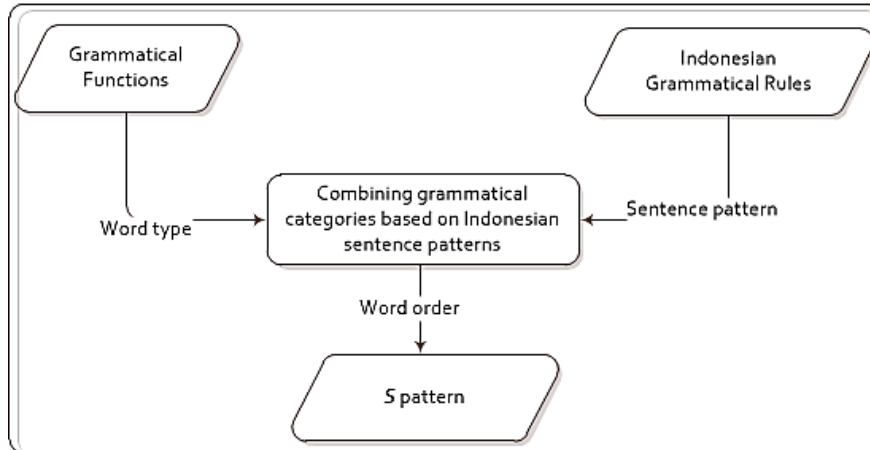


Figure 3. Construction of the *S* Pattern

Table 1. Word Class

Code	Word Class	Information
Adj	adjective	Adjective
Adv	Adverb	Adverb
number	noun	Noun
Num	Numerical	Number word
Par	Particle	Conjunctions
Pro	Pronominal	Pronouns, pronouns and question words
Ver	Verb	Verb

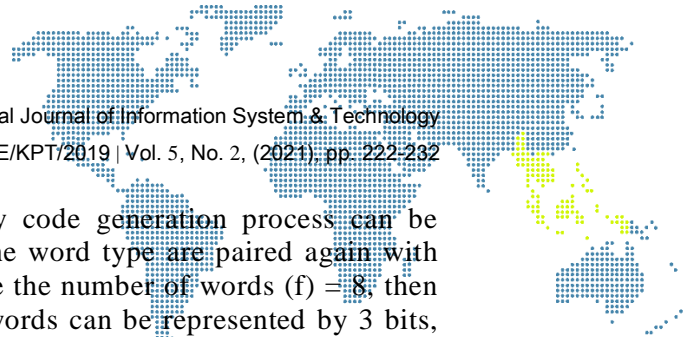
Table 2. Snippets of the Dictionary of Words

Code	Word Class	Example Words
000	adjective	Random
001	Adverb	measly
010	noun	Abacus
110	Numerical	Ampat
100	Particle	So that
101	Pronominal	Why
110	Verb	Absent
111	adjective	Abnormal

The number of words in each type of word (*f*) is limited to a number to the power of two with the calculation

$$g = \lfloor 2^{\log_2 f} \rfloor \tag{1}$$

Each type of word is represented by a binary value with a fixed bit length (*d*) of $\lfloor \log_2 f \rfloor$ bits by rounding down. This is done so that the record entry process stops at



a certain point (number 2n), so that the binary code generation process can be carried out. Words that have been paired with the word type are paired again with the binary that is generated sequentially. Suppose the number of words (f) = 8, then the number of words is encoded with d = 3 (8 words can be represented by 3 bits, because $2^3 = 8$). The first word is coded with 000, the second word is coded with 001, and so on the paired word with the last code 111. D dictionary that has been processed, will contain pair records (code, word type, word) each line.

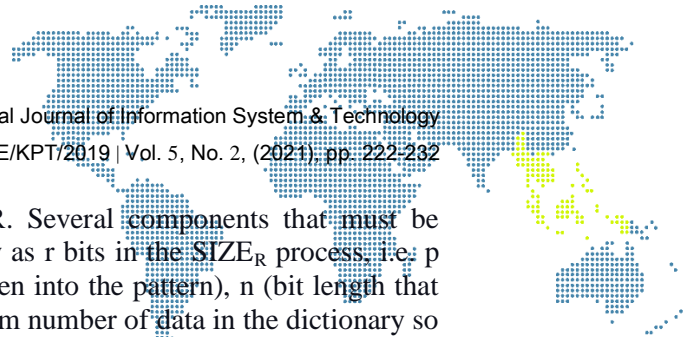
Table 3. Combination of grammatical elements of SP sentence patterns

Sentence Pattern	Part of Speech	Sentence Pattern	Part of Speech
Subject-Predicate	adj-adj	Subject-Predicate	adv-adj
	adj-adv		adv-adv
	adj-nom		adv-nom
	adj-num		adv-num
	adj-pro		adv-pro
	adj-par		adv-par
	adj-ver		adv-ver
Subject-Predicate	nom-adj	Subject-Predicate	num-adj
	nom-adv		num-adv
	nom-nom		num-nom
	nom-num		num-num
	nom-pro		num-pro
	nom-par		num-par
	nom-ver		num-ver
Subject-Predicate	pro-adj	Subject-Predicate	par-adj
	pro-adv		par-adv
	pro-nom		par-nom
	pro-num		par-num
	pro-pro		par-pro
	pro-par		par-par
Subject-Predicate	pro-ver	Subject-Predicate	par-ver
			ver-adj
			ver-adv
			ver-nom
			ver-num
			ver-pro
			ver-par
	ver-ver		

Pattern made by listing all possible combinations (cross products) of grammatical elements from 8 basic sentence patterns. Each combination of grammatical elements of each pattern is placed in a pattern file. To overcome the issue of the length of the message being limited by the pattern length, the function is used

$$\text{SIZER}_R \rightarrow \bar{C}+C+R \quad (2)$$

To ensure that the secret message can be completely hidden, the SIZER function processes the binary C string of the ASCII coded message entered in the system, into a new binary string c (Stegoteks). The stegoteks generated by SIZER consist of a string with a certain length that represents the length of C (Cbit), followed by a binary message string



(C), then connected again with a random string R. Several components that must be considered in generating a random string R as many as r bits in the SIZE_R process, i.e: p (message length), s (number of bits that can be hidden into the pattern), n (bit length that represents the message length), which is the maximum number of data in the dictionary so that a maximum of n can be represented by 2n binary message bits, and r (number of random bits that can be raised), then:

- 1) If $p + n \leq s$, then $r = (s * x) - (p + n)$, is a pattern repetition variable that determines how many times the sentence with the pattern used will be generated so that all bits of the message can be transformed, so that: $x = \left\lceil \frac{p+n}{s} \right\rceil$ (3)
- 2) If $p+n>s$, then $r=0$ (4)

2.2. Message Insertion Process

The message insertion stage is illustrated in the following diagram.

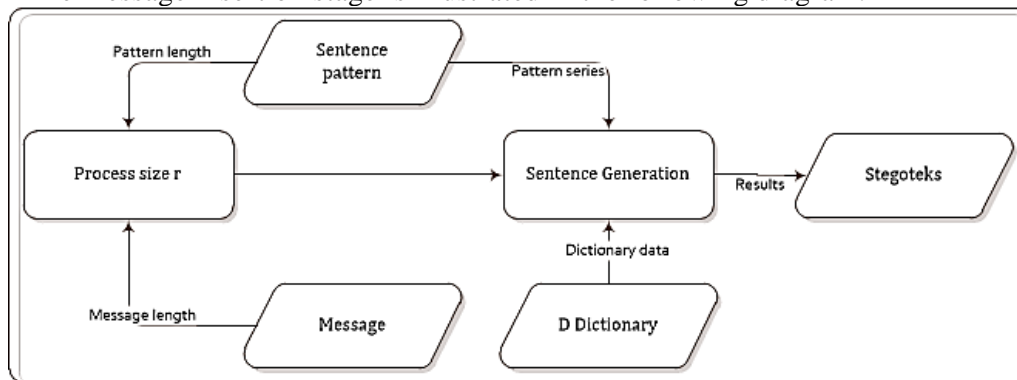


Figure 4. Message insertion process

3. Result And Discussion

3.1. Dictionary and Pattern Building

In this study, the total word dictionary used was 1,929 words, consisting of 1,265 words for noun (nom), 4 pronouns (pro), 232 words for adjective (adj), and adverb (adv) as many as 14 words, verb word class (ver) as many as 368 words, numeralia word class (num) as many as 5 words and particle word class (par) as many as 41 words.

Table 4. Number of words from KBBI used

Word Class	Total Word Dictionary
noun	1,265
Pronoun	4
adjective	232
Adverb	14
Verb	368
Numerical	5
Particle	41
Total:	1,929

Table 5. Group of pattern combinations used

Sentence Pattern	Fill Pattern
SP	adj-num
SOP	adj-num-par
SOP	nom-ver-pro
SOP	num-ver-nom
SPO-Pel	pro-adj-nom-num
SPO-Pel-K	nom-adj-pro-ver-par
SP-Pel	nom-ver-num
SP-Pel-K	adj-adv-nom-num-pro

Table 6. Bit Length and Pattern used

Code	Word Class	Bit Length
Adj	adjective	8
Adv	Adverb	8



number	noun	8
Num	Numerical	8
Par	Particle	8
Pro	Pronoun	8
Ver	Verb	8

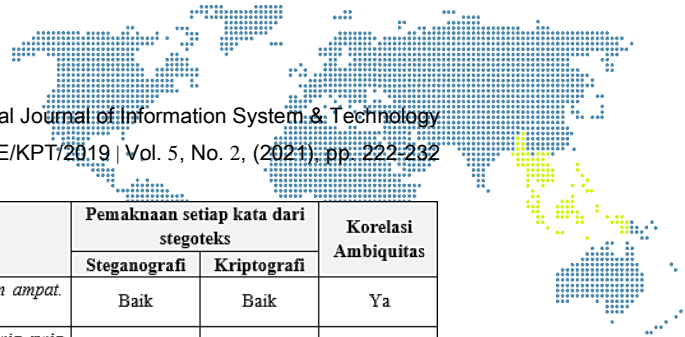
Table 7. Data used in the study

No.	ASCII messages	Message length (in characters)	Message length (in bits)
1	R	1	8
2	Siahaan	7	56
3	Every lecturer is obliged to carry out the tridharma of higher education, namely teaching, research and community service	121	968

3.2. The Correlation of Steganographic Ambiguity to Cryptography

In analyzing the correlation between steganography ambiguity and cryptography, it is considered from the output or output of each original message that has been processed. The data used as a sample consists of one letter, one word and one sentence.

	Pola Kalimat	Stegoteks	Pemakaian setiap kata dari stegoteks		Korelasi Ambiguitas
			Steganografi	Kriptografi	
1	adj-num	<i>amikal aneka. agung aneka</i>	Baik	Baik	Ya
2	adj-num-par	<i>antagonis asta alhasil</i>	Baik	Baik	Ya
3	nom-ver-pro	<i>antagonis asta alhasil</i>	Baik	Baik	Ya
4	num-ver-nom	<i>aneka mengaso arloji</i>	Baik	Baik	Ya
5	pro-adj-nom-num	<i>badang akas badut awig-awig</i>	Baik	Baik	Ya
6	nom-adj-pro-ver-par	<i>apit bagus apakah menganjal abong-abong</i>	Baik	Baik	Ya
7	nom-ver-num	<i>akseptasi mengasingkan ampat</i>	Baik	Baik	Ya
8	adj-adv-nom-num-pro	<i>andilau berasonansi aneka</i>	Baik	Baik	Ya
9	adj-num	<i>bahari asta. awal ampat. ajaib aneka. abiotik ampat. amoral aku</i>	Baik	Baik	Ya
10	adj-num-par	<i>aus aneka ok. antusias aku ai. antap ampat antar</i>	Baik	Baik	Ya
11	nom-ver-pro	<i>alusio menangkap apakah. azan alip badang. adab awur apakah</i>	Baik	Baik	Ya
12	num-ver-nom	<i>aneka mengacu asabat. asta amang alantoikase. ampat berapi-pi absorben</i>	Baik	Baik	Ya
13	pro-adj-nom-num	<i>badang ancai angšana asta. mengapa asor agrogeologi asta. badang bacak argot aneka</i>	Baik	Baik	Ya
14	nom-adj-pro-ver-par	<i>bacang acapkali apakah mengangkat awat. apresiasi abrar mengapa berangga bahana</i>	Baik	Baik	Ya



Pola Kalimat	Stegoteks	Pemaknaan setiap kata dari stegoteks		Korelasi Ambiguitas
		Steganografi	Kriptografi	
15 nom-ver-num	<i>antasid mengabdikan ampat. pengapit mengazankan ampat. adai mengasa asta</i>	Baik	Baik	Ya
16 adj-adv-nom-num-pro	<i>audio sebaiknya autodidak ampat mengapa. asri awig-awig anemofili asta apakah</i>	Baik	Baik	Ya
17 adj-num	<i>akurat ampat. adaptif ampat. alaihiasalam aneka. bahari ampat. antagonis aneka. ayu ampat. akrofobia aneka. terbabang asta. asmaradania ampat. agraris ampat. akut aneka. ajun aneka. antap aku. adiabatias ampat. bagus aneka. afirmatif aneka. alim asta. abiotik aku. enggak aneka. ambivalen aneka. asli aku. abur ampat. terbagus aneka. asri aneka. abiotik aneka. audio aneka. absurd aneka. apik aneka. anom aneka. apas aneka. acak aneka. aneh asta. apik asta. ajek aku. ajun aku. ala-bihalal asta. aram aneka. adika ampat. akrab aneka. alaihiasalam aneka. argumentatif aku. adisional asta. asuntif asta. afektif aneka. abstrak aku. baka asta. ayal asta. antik asta. aprit asta. anti asta. angular ampat. absurd asta. aus aneka. babul asta. akut asta. awal aku. alfabetis asta. abai aku. apik asta. acuh aneka. ancah-ancah aneka. azizi aneka</i>	Baik	Baik	Ya
18 adj-num-par	<i>awah aneka abong-abong. anyir aneka apakala. analitis aneka awat. antropoid ampat bah. asepsis aneka awat. aprit ampat</i>	Baik	Baik	Ya
Pola Kalimat	Stegoteks	Pemaknaan setiap kata dari stegoteks		Korelasi Ambiguitas
		Steganografi	Kriptografi	
	<i>ahlan. adekuat asta asal. abuh ampat amin. apatis ampat abong-abong. awas aneka bagaimana. akrofobia ampat astaga. aflat asta ah. Almasih ampat awat. afirmatif aneka bah. abasah ampat bagaimana. antah berantah ampat sebagaimana. anti asta abong-abong. argumentatif ampat sebagaimana. asing asta bahana. abasah asta adapun. akrofobia aku adakan. adar asta bagaimana. autodidaktik ampat sebagaimana. adiabatias ampat astaga. areal aku arkian. aneka jenis aku bah. asasi ampat abong-abong. akut ampat amboi. Almasih asta amboi. angkara ampat alangkah. acap ampat awat. acuh aneka abong-abong. asasi asta atau. anteng ampat atau. alaihiasalam ampat aho. aflat ampat amin. ala ampat amin. alegoris aneka ah. akut aneka atau. android asta awat. abrar aneka amboi</i>			
19 nom-ver-pro	<i>anafilaksis terapung-apung mengapa. adenase mengatasi mengapa. adopsi anjur badang. arteriosklerosis berayal-ayalan mengapa. akor andum badang. alkoholometri mengatasi mengapa. amandel ambuh mengapa. pengantar atur badang. antidioksida mengasung badang. apresiasi angon badang. ancang-ancang mengangankan badang. azimat mengayam badang. automaton berapi-api mengapa. anodin antih mengapa. bahan membajak badang. akuifer mengandakkan mengapa. askokarp berbbadai badang. adrenalektomi bagat</i>	Baik	Baik	Ya



Pola Kalimat	Stegoteks	Pemaknaan setiap kata dari stegoteks		Korelasi Ambiguitas	
		Steganografi	Kriptografi		
	<p><i>badang. atenuasi ayum badang. andrasit mengacarakan mengapa. antipenawar mengganggu badang. arahan mengapa-apa mengapa. afridisiak mengabah mengapa. arteria ajuk badang. afwah mengajari mengapa. akselerator terabar badang. anleh agah badang. andur membacem badang. abomasum mengasa mengapa. aldosa mengarah mengapa. andilau alip badang. aferesis atung badang. amikron mengaur badang. aristokrasi agah badang. akar andam badang. ana mengabdikan mengapa. pembagian ampai badang. amidase mengacapi badang. alkoholometer menganduhkan mengapa. askar angan badang. anofeles berangsur badang</i></p>				
20	num-ver-nom	<p><i>aku mengasap andeng-andeng. aneka andal ambisi. ampat terangkap-angkep aerologi. aku andaikan agnostik. ampat apostasi ampel. aneka beracara perangkat. asta agah aral. asta menganyang alkoksida. aneka ampu asam-asaman. ampat mengasuh amit. asta mengarih astrologi. aneka mengajar akuntansi. ampat mengawamkan asmara. ampat mengarungi anoa. ampat babat arogansi. aneka acan acat. aneka anjal ambai. aku andaikan ajag. asta berbbadai angker. ampat mengacar baginda. aku menganggur acat. asta kebagian aril. asta terarah apapun. aku mengantup atrisi. asta menganggarkan bagat. aneka baca anemogami. ampat</i></p>	Baik	Baik	Ya
Pola Kalimat	Stegoteks	Pemaknaan setiap kata dari stegoteks		Korelasi Ambiguitas	
		Steganografi	Kriptografi		
	<p><i>membaca asam-asaman. aneka mengadakan acat. ampat mengadakan anjung-anjung. asta mengabdikan apung-apung. asta mengasramakan badal. asta angkat alpokat. ampat berartikulasi amiloform. ampat absen alkoksida. ampat berabang autosan. aneka mengapit alumina. ampat agih pengabenan. aku mengapi-apikan abiogenesis. ampat mengabjatkan api. ampat berartikulasi abc. asta mengapi baji-baji</i></p>				
21	pro-adj-nom-num	<p><i>mengapa akrofobia afotik aneka. mengapa ambung-ambung amplifikasi aneka. mengapa awahama aristokrat aneka. mengapa bacar anggur ampat. apakah aneka ragam adsorbat asta. badang abnormal agnosia ampat. badang antep pengausan aku. badang terbagus adrenal aneka. badang badung abuk-abuk aneka. badang asin atma aneka. badang akuatis apertometer aneka. mengapa arkais absolutisme ampat. mengapa adiabatik ajudan asta. badang awam adab ampat. mengapa arif adanya asta. mengapa ancai andika ampat. badang badung administrator ampat. mengapa arau anuitas ampat. badang arif afwah ampat. badang asosial bakau asta. mengapa ambivalen anafilaksis ampat. mengapa azmat apendisitis ampat. mengapa anagal alelomorfisme aku. badang alap aerologi asta. mengapa bahadun alis aneka. badang alang amikron ampat. badang apak ahlumujum</i></p>	Baik	Baik	Ya



Pola Kalimat	Stegoteks	Pemaknaan setiap kata dari stegoteks		Korelasi Ambiguitas
		Steganografi	Kriptografi	
	<i>aneka. badang akil ayahanda aku. badang aco-acoan bagan asta. mengapa akas andrologi asta. mengapa asfal anu aku</i>			
22 nom-adj-pro-ver-par	<i>ajar akut apakah mengadakan bahana. abuh ayu badang apel amboi. baja agraris badang andam anti. akinet ancak-ancak badang membabar arkian. atenuasi akil apakah menganjal apa. anaforesis akademis badang adakan ah. keajukan aktual apakah beragan abong-abong. astakona awai apakah mengasung bah. pengadaab amis badang mengada-adakan apabila. akromatin artistik apakah ambal apalagi. andontia absolut badang amung bahwa. anjima ajaib apakah menganjurkan arkian. anjung aktif badang beradat aci-aci. antiariritik argumentatif badang mengantepi bah. astrologi agraris mengapa mengasi ala. alit absurd mengapa membadut bahwa. apiun angit badang mengasung agar. altar administratif mengapa terangkup-angkep bahwasanya. alelotrop asali badang andan adapun. asidimeter bahari badang angan antar. anyaman awal apakah menganulir adakala. autoskop ambung-ambung mengapa mengganggu tjak. acara albumese apakah ambur bahasa. aplikasi antep mengapa beranggul arkian. amatir adaptif badang ambur amin</i>	Baik	Baik	Ya
Pola Kalimat	Stegoteks	Pemaknaan setiap kata dari stegoteks		Korelasi Ambiguitas
		Steganografi	Kriptografi	
23 nom-ver-num	<i>abrak awur asta. amendemen mengacapkan aku. albuminuria atop ampat. akuarium membaham aku. alkalimerkurium mengasami ampat. armada mengangin-anginkan aneka. anju mengarak ampat. anyelir terangkat ampat. aposisi aju ampat. penganugerahan mengajar aneka. antrean mengganggu asta. angkur apel aku. amilase terantuk aku. absorben membacem asta. apatit terangkat aku. arabesk berawas-awas aku. atrium teraniaya aneka. ahad mengayun ampat. badai membadi aneka. automorfisme menganjal ampat. antakesuma beranggapan ampat. alienasi mengantuk aneka. acuhan megayap aneka. anghur membadut aneka. apion mengarahkan asta. amuk diajuk ampat. andan mengayomi ampat. artis beranjangkanya aneka. andi menganju asta. alpaka mengaruk asta. alam mengauskan ampat. amiksis mengganggu ampat. akuifer baca ampat. azotobakteri antih aneka. bagus membahas ampat. antidote berabad-abad aneka. aneksasi menganjurkan ampat.</i>	Baik	Baik	Ya
24 adj-adv-nom-num-pro	<i>anggun sebaiknya amina asta mengapa. aci bahkan avertebrata asta badang. arif amuh aruan aneka badang. antibiotik awat-awat audiovisual aneka mengapa. alap bahkan anumerita aneka mengapa. bagas amat adab aneka badang. abstraktif awig-awig arai ampat apakah. apes seadanya agrogeologi aku badang. apik apriori adjektiva asta badang.</i>	Baik	Baik	Ya
Pola Kalimat	Stegoteks	Pemaknaan setiap kata dari stegoteks		Korelasi Ambiguitas
		Steganografi	Kriptografi	
	<i>antep acap-acap alas asta badang. asasi seadanya angklung asta badang. afektif sebaiknya abakus aneka apakah. Almasih bahkan aur asta apakah. alegoris bakda atasan ampat apakah. akur bahkan astrolog asta badang. antisosial amat antena ampat mengapa. adaptif acap-acap angklung asta badang. awut-awutan bahkan artiodaktila aneka badang. adaptif sebaiknya amortisasi ampat badang. angker sebaik-baiknya anometer asta badang. aqfrasia awig-awig ameba aneka badang. azam awig-awig abses aku mengapa. asin awig-awig aborsi ampat badang. aneka jenis amat amperometer ampat mengapa. aus bakda api-api asta apakah</i>			

Figure 5. Correlation of steganographic ambiguity with cryptography

4. Conclusion

Based on the 3 input data (letters, words, and sentences) provided and 8 sentence patterns for each input, the results of the steganography process (stegoteks) provided can cause ambiguity or double meaning with cryptography with an accuracy rate of 100%. Where each result of the stegoteks generation provides an



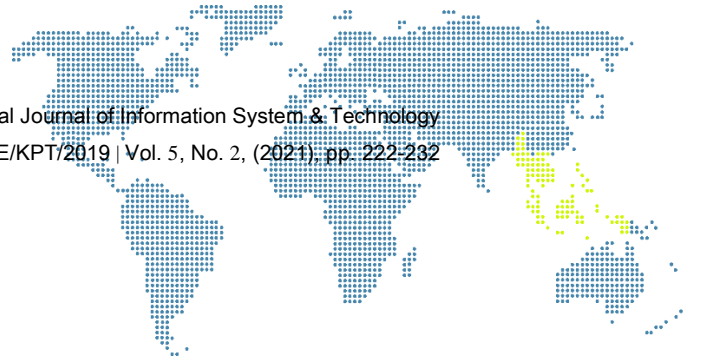
understandable meaning. This text steganography method can be developed to hide documents in text-based messages.

Acknowledgments

We would like to express our gratitude to the STMIK Pelita Nusantara institution which was facilitated through LPPM in carrying out this research.

References

- [1] Daryanto Setiawan, "Development of Communication Technology and Its Impact on Life," *J. Educator.*, 2017, doi: 10.1155/2015/146250.
- [2] LM Jannah, I. Santoso, and Y. Christyono, "Performance of End Of File Steganography Method on Digital Image Data," *Transient*, 2018, doi:10.14710/transient.7.1.34-39.
- [3] WJ Buchanan, *Cryptography*. 2017.
- [4] WJ Buchanan, S. Li, and R. Asif, "Lightweight cryptography methods," *J. Cyber Security. Technol.*, 2017, doi:10.1080/23742917.2017.1384917.
- [5] MM Amin, "Implementation of Classical Cryptography in Text-Based Communication," *Pseudocode*, 2017, doi:10.33369/pseudocode.3.2.129-136.
- [6] R. Fanry Siahaan, M. Zarlis, and BB Nasution, "Performance analysis of steganography alphanumeric text in the text based on Indonesian linguistic," *IOP Conf. Ser. mater. science. eng.*, vol. 420, no. 1, p. 012123, Oct. 2018, doi:10.1088/1757-899X/420/1/012123.
- [7] N. Hamid, A. Yahya, RB Ahmad, and OM Al-Qershi, "Image steganography techniques: an overview," *int. J. Comput. science. Secur.*, 2012.
- [8] R. Gawade, P. Shetye, V. Bhosale, and PN Sawantdesai, "Data Hiding Using Steganography For Network Security," *int. J. Adv. res. Comput. comm. eng.*, 2014.
- [9] MW Chao, CH Lin, CW Yu, and TY Lee, "A high capacity 3D steganography algorithm," 2009, doi: 10.1109/TVCG.2008.94.
- [10] S. Edward Jero and P. Ramu, "Curvelets-based ECG steganography for data security," *electrons. Lett.*, 2016, doi:10.1049/el.2015.3218.
- [11] D. Artz, "Digital steganography: Hiding data within data," *IEEE Internet Computing.*, 2001, doi:10.109/4236.935180.
- [12] NF Johnson and S. Jajodia, "Exploring steganography: Seeing the unseen," *Computer (Long. Beach. Calif.)*, 1998, doi:10.109/MC.1998.4655281.
- [13] IG NK Putrayasa, "Types and Patterns of Indonesian Sentences," <https://Repository.Unud.Ac.Id/Protected/Storage/Upload/Repository/C5Af5469574856E21718C34882583925.Pdf>, 2016.
- [14] A. Hasan, "Standard Grammar of the Indonesian Language," *Dep. Educator. and Kebud. Republic of Indonesia.*, 2007.



Authors



1st Author

R. Fanry Siahaan

Lecturer of STMIK Pelita Nusantara, Medan.

rfanry@gmail.com



2nd Author

Endra A.P Marpaung

Lecturer of STMIK Pelita Nusantara, Medan.

indra_only85@ymail.com