

# Super Encryption Concepts using Vigenere Cipher Modification to Produce Color Imaginary as Ciphertext

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**Keywords:** Super Encryption, Cryptography, Vigenere Cipher, Color, Image.

**Abstract:** For various reason data security and confidentially are needed. One way to improve data confidentiality in data communications by modifying the classic cryptographic algorithm into a difficult algorithm to solve. Vigenere Cipher is one of the most complicated classical cryptography algorithms to be solved, because it uses substitution techniques and keywords. Although so Vigenere Cipher still have weaknesses and the length of the keyword can be solved by using the kasiki's method. This paper discussed about modification of Vigenere Cipher, that is changing the contents of Vigenere square to decimal numbers 1...26, which then the decimal symbol of the encryption result are coded RGB color, so the final encryption result of the modification of Vigenere Cipher in this paper is a color image, so it becomes very difficult to solve. Because a cryptanalyst does not necessarily think the color image is an encryption that should be solved.

## 1 INTRODUCTION

Cryptography is a science and art to keep the message safe when message are sent, Cryptography comes from greek, namely crypto which means secret and graphia meaning writing (Stallings, 2014). The art word of the above definition comes from historical facts, that in the early days of the history of cryptography everyone has a unique way of keeping messages secret, so each way of writing a secret message has its own aesthetic value (Ariyus, 2007). In its development, cryptography developed into a discipline of its own because cryptographic techniques can be formulated mathematically to become a method.

For various reason data security and confidentially are needed in data communications. There are various ways to improve the security and confidentially of data. One of them with by modifying the classical cryptographic algorithm into a algorithm that is difficult to solve.

Super encryption can be done by modifying a simple classical cryptography method. Classical cryptography is character-based cryptography (Styaningsih, C. Iswahyudi and N. Widyastuti, 2011). Vigenere cipher is one of the classic cryptographic algorithms that encrypt plaintext using substitution techniques. Vigenere cipher is basically

quite complicated to solve. Although so vigenere cipher still have weaknesses. One of which is can be known the length of the keyword using Kasiki method (Putu, 2012). This is because there are repetitive phrases in the resulting ciphertext. This paper will discuss about modification of Vigenere Cipher to strengthen this algorithm so it is not easy to solve.

## 2 LITERATURE REVIEW

Some studies have discussed about the modification of vigenere cipher to overcome the weakness of the classic vigenere cipher. (Prabowo and Hangga, 2015) In their research discuss about encryption using vigenere cipher which keywords use encryption from caesar cipher, so there will be no repetition words in the final cipher text.

In research by (Styaningsih, C. Iswahyudi and N. Widyastuti, 2011) discuss about encryption using combination of vigenere cipher with playfair, to improve the security then used keystream generator method to randomize the sequence of keywords so cryptanalisis will find it difficult to get the keywords. In a study conducted by (M. Hidayatulloh and E. Insannudin, 2014) resulting in a modification of vigenere cipher which cipher text is ASCII symbol.

Different to the classical vigenere cipher which based on the alphabet, In the study was modified vigenere cipher based on ascii table where there are 256 character. So the encryption result is safer

### 3 PROPOSE METHOD

#### 3.1 Super Encryption

Super encryption is one of character based cryptography that uses modification or combining two ciphers. It aim to get a stronger cipher. In this study used vigenere cipher modified to produces ciphers in the form of color images.

#### 3.2 Vigenere Cipher

Vigenere cipher is a method of encoding alphabetic text by using a caesarean code sequence based on the letters on the keyword. Vigenere cipher technique can be done in two ways by numbers and letters. Method to perform encryption and decryption process on vigenere cipher that is using recta table or also called vigenere square.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
B	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
C	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	
D	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B
E	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C
F	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D
G	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E
H	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F
I	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G
J	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H
K	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I
L	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J
M	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K
N	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L
O	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M
P	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Q	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
R	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
S	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
T	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
U	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
V	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
W	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
X	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
Y	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
Z	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X

Figure 1 : Vigenere Square

The leftmost column of the square represents the keyword letters, while the top line represents the plaintext letters. Vigenere square is used to get ciphertext by using predefined keywords. If the length of the keywords is shorter than the length of the plaintext, then the keyword is repeated use (periodic system). For an example if the plaintext is THIS IS THE PLAINTEXT and the keyword is DANY, then the use of keys periodically is as follows.

Plain text	T	H	I	S	I	S	T	H	E	P	L	A	I	N	T	E	X	T
Kunci	D	A	N	Y	D	A	N	Y	D	A	N	Y	D	A	N	Y	D	A

To get the ciphertext from the plaintext and the keyword above, for the first plaintext letter T, drawn vertical line of the letter T, and drawn a horizontal line from column D, the intersection would be the first letter of ciphertext W. The same way is done on the plaintext letters and letters of the next keyword.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
B	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
C	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	
D	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B
E	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C
F	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D
G	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E
H	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F
I	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G
J	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H
K	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I
L	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J
M	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K
N	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L
O	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M
P	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Q	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
R	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
S	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
T	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
U	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
V	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
W	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
X	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
Y	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
Z	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X

Figure 2 : How to use vigenere square

The result of its encryption is as follows :

Plain text	T	H	I	S	I	S	T	H	E	P	L	A	I	N	T	E	X	T
Kunci	D	A	N	Y	D	A	N	Y	D	A	N	Y	D	A	N	Y	D	A
Cipher	W	H	V	Q	L	S	G	F	H	P	Y	Y	L	N	G	C	A	T

The decryption process is done by searching the cipher text letter on the plaintext line of the keyword letter. From the example above, then it can be concluded mathematical formula of encryption and decryption vigenere cipher is (1):

Encryption :  

$$C_i = (P_i + K_i) \text{ mod } 26 \tag{1}$$

Decryption :  

$$P_i = (C_i - K_i) \text{ mod } 26 ; \text{ for } C_i \geq K_i$$

$$P_i = (C_i + 26 - K_i) \text{ mod } 26 ; \text{ for } C_i < K_i$$

Explanation :  
 $C_i$  = Cipher text ;  $P_i$  = Plaintext ;  $K_i$  = Keyword

### 4 VIGENERE CIPHER MODIFICATION

Vigenere cipher has a weakness that makes it can be solve. One of them is to know the key length using kasiki method. The keyword length can be more



Decryption :

$$P_i = ((C_i - K_i) \bmod 26) + 1 ; \text{ for } C_i \geq K_i$$

$$P_i = ((C_i + 26 - K_i) \bmod 26) + 1 ; \text{ for } C_i < K_i$$

Explanation :

$C_i$  = Ciphertext ;  $P_i$  = Plaintext ;  $K_i$  = Kunci

Using plaintext example THIS IS THE PLAINTEXT and the keyword is DANY, then the calculation of encryption using vigenere cipher modification technique is, like this:

T	H	I	S	I	S	T	H	E	P	L	A	I	N	T	E	X	T
20	8	9	19	9	19	20	8	5	16	12	1	9	14	20	5	24	20

D	A	N	Y	D	A	N	Y	D	A	N	Y	D	A	N	Y	D	A
4	1	13	24	4	1	13	24	4	1	13	24	4	1	13	24	4	1

From the above example, the plaintext of the first letter T which has the value  $P_i = 20$  will be calculated by the key letter D which has  $K_i = 4$ , then the encryption process is as follows (3):

$$C_i = ((P_i + K_i) \bmod 26) - 1 \tag{3}$$

$$C_i = ((20 + 4) \bmod 26) - 1$$

$$C_i = (24 \bmod 26) - 1$$

$$C_i = 24 - 1 = 23$$

$$C_i = 23$$

Ciphertext results from calculation of vigenere cipher modification formula on the first letter is 23. Once done the calculation of the formula vigenere cipher modification according to the keyword on each letter until all the plaintext has been encrypted. Setelah semua huruf terenkripsi into ciphertext, then the results of cipher text is as follows :

Cipher	23	8	22	17	12	19	7	6	8	16	25	25	12	14	7	3	1	20
--------	----	---	----	----	----	----	---	---	---	----	----	----	----	----	---	---	---	----

After obtaining all ciphertext numbers result from the encryption process vigenere cipher modification, then the numbers from the encryption process are converted into RGB color codes , each sequence of three numbers into one color code then that color codes are converted into color images, the color images that appears is the final result of modified vigenere cipher. If the number of plaintext characters is even numbered then at the end of the plaintext is given an additional padding bit, which is symbolized by the number 27. Based on the example above, then the method to get the ultimate encryption result is :

Cipher	23	8	22	17	12	19	7	6	8	16	25	25	12	14	7	3	1	20
--------	----	---	----	----	----	----	---	---	---	----	----	----	----	----	---	---	---	----

From the cipher text above there are six RGB color codes, that is :

Code 1. R = 23  
G = 8  
B = 22

Color image :

Code 2. R = 17  
G = 12  
B = 19

Color image :

Code 3. R = 7  
G = 6  
B = 8

Color image :

Code 4. R = 16  
G = 25  
B = 25

Color image :

Code 5. R = 12  
G = 14  
B = 7

Color image :

Code 6. R = 3  
G = 1  
B = 20

Color image :

With the color image as a final result of encryption, The secret messages will be more difficult to solve and the secret message security level will be higher. This vigenere cipher modification technique can be a solution to cover the weakness of the classical vigenere cipher. A Color image as the final result of cipher text can be applied to an image, so that other people see it as just an ordinary picture and will not realize that there is a secret message in the picture, so others who are not entitled to the secret message will not attempt to solve it, because they think its

just as a regular picture. Technique of disguising secret message in a picture is also called steganography, not only images but also other media such as video and audio.

### 5 DECRYPTION VIGENERE CIPHER MODIFICATION

Decryption technique for this vigenere cipher modification is the keyword must be known by the recipient of the message, then the recipient can get the color code from the color image that is sent, by using image manipulation software like adobe potoshop. From the example obtained the color code as follows:

Cipher	23	8	22	17	12	19	7	6	8	16	25	25	12	14	7	3	1	20
--------	----	---	----	----	----	----	---	---	---	----	----	----	----	----	---	---	---	----

After getting the color codes and sorted in order of color code sent, then for its decryption process can use the mathematical formula (4):

Decryption :

$$P_i = ((C_i - K_i) \bmod 26) - 1 ; \text{ for } C_i \geq K_i \quad (4)$$

$$P_i = ((C_i + 26 - K_i) \bmod 26) - 1 ; \text{ for } C_i < K_i$$

$C_i$  = Ciphertext ;  $P_i$  = Plaintext ;  $K_i$  = Kunci

Cipher	23	8	22	17	12	19	7	6	8	16	25	25	12	14	7	3	1	20
Keyword	D	A	N	Y	D	A	N	Y	D	A	N	Y	D	A	N	Y	D	A
	4	1	13	24	4	1	13	24	4	1	13	24	4	1	13	24	4	1

Ciphertext = 23  
 $P_i = ((C_i - K_i) \bmod 26) + 1$   
 $P_i = ((23 - 4) \bmod 26) + 1$   
 $P_i = (19 \bmod 26) + 1$   
 $P_i = 20$

Ciphertext = 8  
 $P_i = ((C_i - K_i) \bmod 26) + 1$   
 $P_i = ((8 - 1) \bmod 26) + 1$   
 $P_i = (7 \bmod 26) + 1$   
 $P_i = 8$

So that the overall calculation of  $P_i$  =

$P_i$	20	8	9	19	9	19	20	8	5	16
	12	1	9	14	20	5	24	20		

The  $P_i$  calculation result from decimal 1...26 to character a...z

A = 1	B = 2	C = 3	D = 4
E = 5	F = 6	G = 7	H = 8
I = 9	J = 10	K = 11	L = 12
M = 13	N = 14	O = 15	P = 16
Q = 17	R = 18	S = 19	T = 20
U = 21	V = 22	W = 23	X = 24
Y = 25	Z = 26		

So finally obtained its plaintext result :

$P_i$	20	8	9	19	9	19	20	8	5	16	12	1	9	14	20	5	24	20
	T	H	I	S	I	S	T	H	E	P	L	A	I	N	T	E	X	T

THIS IS THE PLAINTEXT

### 6 IMPLEMENTATION

#### 6.1 Vigenere Cipher Modification Algorithm

The stages of the encryption algorithm with modified vigenere cipher:

Stage 1:  
 $a \leftarrow \text{GetTextLen}(\text{plainteks})$  // Calculate the number of arrays from the plaintext

Stage 2:  
 $b \leftarrow \text{GetTextlen}(\text{kunci})$  // Calculate the number of arrays of keywords

Stage 3:  
 $X \leftarrow 0$  // fill in the variable x with a value of 0  
 While  $x \leq a$   
 Begin  
 for  $j \leftarrow 1$  to b do  
 begin

Stage 4:  
 $P \leftarrow \text{Ord}(\text{plaintext}[x])$  // Change char to ASCII code

Stage 5:  
 $P \leftarrow p - 97$  // The ASCII code is changed (a to 0)

Tahap 6:  
 $K \leftarrow \text{ord}(\text{key}[j])$  // key becomes ASCII

Tahap 7:  
 $k \leftarrow k - 97$  // The ASCII code is changed (a to 0) // the operation of adding plaintext with its key.

Tahap 8:

$c \leftarrow (p + k) \bmod 26$  // vigenere operation

Tahap 9:  
 Ciphertext  $\leftarrow$  Ciphertext + c // Write results in  
 Ciphertext inc (x) // x value  
 plus 1  
 end  
 end

## 6.2 Implementation of Modification of Vigenere Cipher Algorithm in Visual Basic

Super encryption implementation using visual basic programming language functions that are used to encrypt and decrypt plain text messages into text ciphers using the modified vigenere cipher algorithm:

```

Function Vigenere_Cipher(ByVal Text
As String, ByVal key As String, ByVal
Encrypt As Boolean)

    Dim Result As String = ""
    Dim temp As String = ""
    Dim j As Integer = 0

    For i As Integer = 0 To Text.Length -
    1
    If j = key.Length Then j = 0
        End If

        If
Char.IsLetter(key(j)) Then
            If Text(i) <> " " And
Char.IsLetter(Text(i)) Then
                temp += key(j)
                j += 1
            Else
                temp += Text(i)
            End If
        Else
            j += 1
            If j >= key.Length
Then
                j = 0
            End If
            i -= 1
        End If
    Next
    For i As Integer = 0 To
Text.Length - 1

        Dim N As Integer
        Dim NewAscii As Integer
    
```

```

        If Char.IsLetter(Text(i)) Then
            If Char.IsLower(temp(i)) Then
                N = Asc(temp(i)) - Asc("a")
            ElseIf
Char.IsUpper(temp(i)) Then
                N =
Asc(temp(i)) - Asc("A")
            End If

            If Encrypt Then
                NewAscii = N +
Asc(Text(i))
            Else
                NewAscii = 26 -
N + Asc(Text(i))
            End If
            If (NewAscii >
Asc("z") And Char.IsLower(Text(i))) Or
(NewAscii > Asc("Z") And
Char.IsUpper(Text(i))) Then
                NewAscii -= 26
            End If
        Else
            NewAscii =
Asc(Text(i))
        End If
        Result += Chr(NewAscii)
    Next
    Return Result
End Function
    
```

## 6.3 Form Kriptografi

Cryptographic forms are used to change the plain text of a secret message that will be sent into a text cipher using a modified vigenere cipher algorithm. The message is written in the text box that has been provided, then write the agreed keyword into the text box of the keyword and press the encryption key to perform the modified vigenere cipher algorithm function and get the cipher text result. While the decryption button is used to return the cipher text into plain text, the secret message is encrypted.



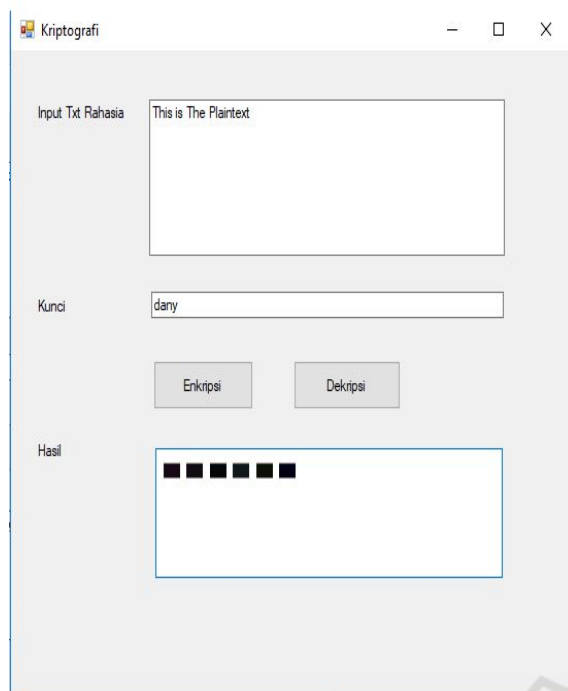


Figure 5: Cryptography Form

## 7 ANALYSIS

There are some advantages gained by using super encryption vigenere cipher modification compared with classical vigenere cipher, that is the cipher text of super encryption is more difficult to solve because the encryption process is twice or more, so that the cipher text result also experienced two or more changes [10]. Besides changing the character text to decimal also made a change from decimal to color image, so the possibility of a solution to be made to solve cipher text is also becoming more and more difficult

## 8 CONCLUSIONS

Based on the analysis that has been done before, can be drawn some conclusions related to the super encryption concept using modification vigenere cipher as described earlier, that is :

- The use of decimal as the contents of vigenere square, produces cipher text decimal which makes it more difficult to guess which keyword to use.
- Color images cipher text as the final result can be applied or inserted into an image so that it can become steganography, which causes others will not be aware of any

hidden messages during the process of sending secret messages.

- Color image as the cipher text causes cryptanalysts difficult to guess what cryptographic method is used, so the possibility cipher text to solved is very small.
- The cryptographic algorithm in this paper does not guarantee 100% unbreakable

The suggestion for using this algorithm is to apply it the image using steganography technique and implemented using the application so it is easier to use.

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