Enhancement of Security through a Cryptographic Algorithm Based on Mathematical Representation of Natural Numbers

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Abstract—The paper deals with a new algorithm, which is based on mathematical idea. It is time efficient and easily understandable, as, it is the scheme used in cipher mathematics based. Here at encryption we consider cipher text as natural numbers and then the encrypted message is obtained by taking the cube, subtraction, division, hence for which we got a factor which is then transmitted, and then at decryption the reverse i.e. multiplication and cube root. In short we can say it as Mathematical data encryption and decryption (MDED). The decryption algorithm will be there for the receiver as the private key.

Index Terms—Encryption, cipher text, Decryption, private key

I. INTRODUCTION

Cryptography is the practice and study of hiding information. Modern Cryptography intersects the disciplines of mathematics, computer science and engineering. Applications of cryptography include ATM cards, computer passwords, and electronic commerce. In this paper, a mathematics-based, private-key, which we can call as decipher or decryption algorithm, is presented, which is modeled for implementing each character with a natural number.

Section 2 explains the algorithm of encryption and decryption of the text read from the file specified in the code itself. Section 3 describes an implementation with the help of a real example. Section 4 gives the Results related to the Algorithm which involves Execution Time and type of files on which it can be implemented. Section 5 comprises an analytical and conclusive discussion of the technique.

II. THE SCHEME

The algorithm of encryption and decryption technique of a

text message used during implementation of natural number algorithm is presented as follows.

A. Encryption Technique:

Step 1:- To encrypt a text message at first the given text is stored in a string variable, say *msg*.

Step 2:- The length of the message is stored in a numeric variable *x1*.

Step 3:- A one-dimensional array *e1[]* represents the equivalent coded natural number for each of the alphabets with a character for space in the string variable *msg*.

TABLE 2.1 EQUIVALENT NATURAL NUMBER FOR EACH OF CHARACTER

Serial No.	Character	Equivalent Natural Number
1.	a	1
2.	b	2
3.	c	3
4.	d	4
5.	e	5
6.	f	6
7.	g	7
8.	h	8
9.	i	9
10.	j	10
11.	k	11
12.	l	12
13.	m	13
14.	n	14
15.	o	15

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16.	p	16
17.	q	17
18.	r	18
19.	s	19
20.	t	20
21.	u	21
22.	v	22
23.	w	23
24.	x	24
25.	y	25
26.	z	26
27.	space	27

Step 4:- Each of the numbers in the array e1[] are cubed and stored in a numeric array e2[].

Step 5:- Then the array e1[] is subtracted from e2[] and kept in array e3[].

Step 6:- Each of the numbers in the numeric array e3[] is divided by 6 and the factors obtained are stored in the array cipher_text[]

Step 7:- The array ***cipher_text[]*** represents the encrypted message which is then sent to the receiver.

B. eNcryption Technique:

Step 1:- Initially after getting the encrypted message the receiver will use the private key i.e the decryption algorithm to get back the original message. Here we use the array cipher_text to decrypt the message received.

Step 2:- Each of the numbers in array cipher_text is multiplied by 6 and stored in the numeric array d1[].

Step 3:- We will take an array b1[] which will comprise of the cubes of first 27 natural numbers corresponding to each of the alphabets including a for a space.

Step 4:- Then we will run a loop in which we subtract the respective array d1[] with b1[] and keep the result in array c1[]

Step 5:- Then we will take the magnitude of the array c1[] and keep in the array g1[].

Step 6:- The receiver will take the minimum of the numbers in array g1[].

Step 7:-This array g1[] is the final array from which the decrypted message is obtained.

III. IMPLEMENTATION AND THE CODE AS DESIGNED IN MATLAB

For example we consider a message “**gandhiji was great**” to be sent. Now each character is decomposed into a natural number including a space. In section 3.1, encryption is discussed, in 3.2 the key generation part is shown and finally in section 3.3, decryption is shown.

A. Encryption

Here each character is replaced by one natural number starting from lets say 1. So the encrypted characters as natural numbers are shown in table 3.1.1.

TABLE 3.1.1 TABLE SHOWING THE ENCRYPTION OF EACH ALPHABET

Text	Serial no.	letter	Replaced number
gandhiji was great	1	g	7
	2	a	1
	3	n	14
	4	d	4
	5	h	8
	6	i	9
	7	J	10
	8	i	9
	9	space	27
	10	w	23
	11	a	1
	12	s	19
	13	space	27
	14	g	7
	15	r	18
	16	e	5
	17	a	1
	18	t	20

So after replacing each character and space through a natural number we use the property of natural number that any number when cubed and subtracted by the number itself and hence divided by 6 gives the remainder

B. Key Generation

So now when we do the process of cubing, subtracting and hence the division the final factor on division left is our key which is sent to the receiver. The generated key is shown in table 3.2.1

TABLE 3.2.1 TABLE SHOWING THE KEY SENT

Serial no.	Character	Sent key
1	g	56
2	a	0
3	n	455
4	d	10
5	h	84
6	i	120
7	j	165
8	i	120
9	space	3276
10	w	2024
11	a	0
12	s	1140
13	space	3276
14	g	56
15	r	969
16	e	120
17	a	0
18	t	1330

C. Decryption

After we have got the key we do the reverse process i.e we multiply the key with 6 and then we see which number is coming as a perfect cube of any natural number around the number got by multiplying by 6.

Mathematically we multiply the key with 6 and then subtract the number from a set of cubes of 27 numbers. Then

we take the magnitude of the resultant and hence the minimum of all the numbers will be our final number to be obtained. A detail is shown in table 3.3.1

TABLE 3.3.1 TABLE SHOWING THE DECRYPTION TABLE IN DETAIL

Sl no.	Key * 6	Matched cube	Final number	Encrypted Character
1	336	343	7	g
2	0	1	1	a
3	2730	2744	14	n
4	60	64	4	d
5	504	512	8	h
6	720	729	9	i
7	990	1000	10	j
8	720	729	9	i
9	19656	19683	27	space
10	12144	12167	23	w
11	0	1	1	a
12	6840	6859	19	s
13	19656	19683	27	space
14	336	343	7	g
15	5814	5832	18	r
16	720	125	5	e
17	0	1	1	a
18	7980	8000	20	t

Decrypted message is “**gandhiji was great**” which is same as original message.

D. Results

Here we have ciphered each letter into some natural numbers and hence got keys and hence decrypted the keys to obtain the final character and hence the final message. We have also shown the execution time i.e time taken to execute the number of characters as per the length. We have seen that this algorithm works on all type of text files of any sizes as per the number of characters the file contains. It is shown in Table 4.1.

TABLE 4.1 COMPARISON OF THE EXECUTION TIME FOR TEXTS VARYING IN LENGTH

Number of letters in the text including blank spaces and special characters	Execution time in seconds
0	0
1	0.019235
8	0.020015
16	0.021678
32	0.022875
40	0.024565
48	0.028963
56	0.033455
64	0.038676
72	0.042459
80	0.046521
88	0.050983
96	0.055433
100	0.069873

Figure 4.1 A Relationship between execution time and Text length

IV. ANALYTICAL DISCUSSION AND CONCLUSION OF THE USED ALGORITHM

Using this Decryption NNA (Natural number algorithm) private key technique, we can encrypt any size of file, as well as any kind of file, as NNA protocol can be implemented to any file as each of the characters are represented by natural numbers so any type of message can be sent. There might be little bit more time taken to execute but still it is a very efficient algorithm as it is purely mathematics based and mathematics leads us to everywhere and moreover memory required is less. so having this easy and far more efficient algorithm with a great security aspect gives it a new shape and dimension in this era. The enhanced security is due to the peculiarity of the different manipulations and properties used in the algorithm which is quite incomprehensible to unauthorized person.

The only disadvantage is that it doesn't work on video files.

Time taken by the algorithm will depend on the platform on which the user is working.

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