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SECURITY IN COMMUNICATION BY USING SUMUDU TRANSFORMS AND CRYPTOGRAPHY

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ABSTRACT

In this paper we will show that how to increase the security in communication between two persons by using Sumudu transform & cryptography .In the first part of the paper we will consider one plain text (original message) and convert it to cipher text(text in hidden form) by applying Sumudu transform to trigonometric cosine function. In second part we will convert this cipher text to plain text by applying inverse Sumudu transform.

KEYWORDS: Sumudu transform, Inverse Sumudu transform, Cryptography, Plain text, cipher text, encryption, decryption.

1. INTRODUCTION

The word Cryptography comes from the Greek word Kryptos which means hidden and graphein means 'to write'. Cryptography is the branch in which we study some techniques to convert our original message to such a message which could not be easily understandable without providing some additional information or formula. Original message which is to be converted to hidden form is called as plain text and the convertedform is called s cipher text.

The conversion of plain text to cipher text is called as encryption and the conversion from cipher text to plain text is called as decryption. After demonetization in 2016 people prefers cashless transactions like ATM, PaYTM, Mobile banking, internet banking, etc.Password or Code is necessary to operate all these facilities. In Mathematics there are some integral transforms like Laplace transform, Sumudu transform, Fourier transform etc. Integral transforms play an important role in the process of encryption and decryption. The main aim of this paper is to present method to create such a confidential text so that communication between two persons will be secured. Integral transforms play an important role in solving differential and integral equations and also in other sciences. In the process of cryptography there is a contribution of some integral transforms like Laplace transform, Sumudu transform, and Elzaki transform.

There are various kinds of techniques for the process of encryption and decryption found in literature [2], [4], A new cryptographic scheme was developed by applying L.T. to hyperbolic sine and cosine functions [2], [4].In this paper we have applied Sumudu transform and Inverse Sumudu transform to trigonometric sine function to derive such results regarding encryption decryption.

2. SOME IMPORTANT DEFINITIONS & THEOREMS

Def.1 [1] In 1990 Gamage K. Watugala has introduced new integral transform which is similar to Laplace transform [1] which is defined by

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$$G(w) = \int_0^\infty \frac{1}{w} e^{\frac{-x}{w}} f(x)dx$$

He introduced this transform to solve differential equations and control engineering problems [2]. Some fundamental properties of Sumudu transform were established [7].

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Def.2: [3] [The relation of congruent modulo n]

Let n be a positive integer. Then an integer α is congruent to an integer β modulo n if n divides $\alpha - \beta$ .If α is congruent to β modulo n then symbolically we write $\alpha \equiv \beta(\text{mod } n)$. If α is not congruent to β modulo n then we denote it as $\alpha \not\equiv \beta(\text{mod } n)$

Theorem 1:[2] Let $H_0, H_1\ H_2 H_3, H_4, \ldots\ldots$ be coefficients of $t^2 \sinh 2t$ then given plaintext in terms of H_i i=0, 1, 2, 3, 4,…… under Laplace transform of $Ht^2 \sinh 2t$ can be converted to cipher text $H_i{}' = r_i - 26k_i$ for i =0, 1, 2, 3,……. where $r_i = 2^{2i+1}(2i+2)(2i+3)\ H_i$ for i=0, 1, 2, 3, 4… and a key is given by

$$k_i = \frac{r_i - H_i{}'}{26} \text{ for i =0, 1, 2, 3, 4…}$$

Theorem 2:[2] The given cipher text in terms of $H_i{}'$With a given key k_i for $i = 0,1,2,3,4, \ldots\ldots$ can be converted to plain text H_i under the inverse Laplace transform of

$H\frac{d2}{dp2}\frac{2}{p^2-2^2} = \sum_{i=0}^{\infty} \frac{r_i}{p^{2i+4}}$ where $H_i = \frac{26k_i + H_i{}'}{2^{2i+1}(2i+2)(2i+3)}$ for i=0, 1, 2, 3, 4…... and $r_i = 26k_i + H_i{}'$

3. METHODOLOGY FOR ENCRYPTION & DECRYPTION

in this Paper we will use the method to convert the given plain text in to such a hidden text which could not Possible to crack without key by operating Sumudu transforms.

Suppose that we are given A B C D E F G H……Z. as a plain text. In the first step we have to give the following allotment to letters in the given plain text.

$A \to 0, B \to 1, C \to 2, D \to 3, E \to 4, F \to 5, G \to 6, H \to 7, I \to 8, J \to 9, K \to 10, L \to 11, M \to 12, N \to 13, O \to 14, P \to 15, Q \to 16, R \to 1 \to 18, T \to 19, U \to 20, V \to 21, W \to 22, X \to 23, Y \to 24, Z \to 25$

Consider the trigonometric sine series given by

$$\sin ny = ny - \frac{n^3y^3}{3!} + \frac{n^5y^5}{5!} - \frac{n^7y^7}{7!} + \frac{n^9y^9}{9!} + \cdots\cdots$$

$$\therefore y^m \sin ny = ny^{m+1} - \frac{n^3y^{m+3}}{3!} + \frac{n^5y^{m+5}}{5!} - \frac{n^7y^{m+7}}{7!} + \cdots\cdots \quad (1)$$

Let $H_0,\ H,\ H_2, \ldots$ be the coefficients of the eq^n (1)

∴ We write

$$Hy^m \sin ny = H_0\ ny^{m+1} - H_1 \frac{n^3y^{m+3}}{3!} + H_2 \frac{n^5y^{m+5}}{5!} \ldots\ldots\ldots (2)$$

By operating Sumudu transform to eq^n (2) we will obtain one equation having some new variable in denominator and some values in the numerator (we call them as resulting values say r_i) adjusting these resulting values such that $r_i \equiv K_i{}' \text{mod } 26$ for $i = 0,1, \cdots\cdots, j$ we obtain $K_i{}'$ which is our required cipher text.

As decryption is the reverse process of encryption we can obtain plain text by applying Inverse Sumudu transformof $S\{Ky^m \sin ny\}$.

To determine cipher text by applying Sumudu transformo trigonometric cosine function we may use the above method by considering some series of the form $Ky^m \cos ny$.

Example Let us consider one plain text given below

C H E M I S T R Y and by applying methodology 2 we will convert this plain text to cipher text

First suppose by our allotment given plain text be equivalent to

2 7 4 12 8 18 19 17 23

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Suppose that Let $H_0 = 2,\ H_1 = 7, H_2$=4, $H_3 = 12,\quad H_4 = 8, H_5, = 18, H_6 = 19, H_7 = 17 H_8 =$ 23be the coefficients of the eq^n (1)

Case 1. In this case by taking m=1&n=1 equation (1) becomes

Hysiny=$2y^2 - \frac{7}{!3}y^4 + \frac{4}{!5}y^6 - \frac{12}{!7}y^8 + \frac{8}{!9}y^{10} - \frac{18}{!11}y^{12} + \frac{19}{!13}y^{14} - \frac{17}{!15}y^{16} + \frac{23}{!17}y^{18}$

Applying Sumudu transform to both sides we have

$S[Hy\sin y] = 2S\{y^2\} - \frac{7}{!3}S\{y^4\} + \frac{4}{!5}S\{y^6\} - \frac{12}{!7}S\{y^8\} + \frac{8}{!9}S\{y^{10}\} - \frac{18}{!11}S\{y^{12}\} + \frac{19}{!13}S\{y^{14}\} - \frac{17}{!15}S\{y^{16}\} + \frac{23}{!17}S\{y^{18}\}$

$S[Hy\sin y] = 2\,!2\,w^2 - \frac{7}{!3}\,!4\,w^4 + \frac{4}{!5}!6\,w^6 - \frac{12}{!7}!8\,w^8 + \frac{8}{!9}!10w^{10} - \frac{18}{!11}\,!12\,w^{12} + \frac{19}{!13}\,!14\,w^{14} - \frac{17}{!15}\,!16\,w^{16} + \frac{23}{!17}\,!18\,w^{18}$

After simplification the above expression becomes

$S[Hy\sin y] = 4\,w^2 - 28\,w^4 + 24\,w^6 - 96w^8 + 80w^{10} - 216w^{12} + 266\,w^{14} - 272\,w^{16} + 414w^{18}$

Let us assume that r_0=4, $r_1 = -28, r_2 = 24,\ r_3 = -96,\ r_4 = 80,\ r_5 = -216,\quad r_6 = 266\ , r_7 = 272\ ,\ , r_8 =$ 414 and we will obtain H_i' such that $r_i \equiv H_i' \bmod 26$ as follows

$4 \equiv 4 \bmod 26, -28 \equiv -2 \bmod 26,\quad 24 \equiv -2 \bmod 26,$

$-96 \equiv -18 \bmod 26,\quad 80 \equiv 2 \bmod 26,\quad -216 \equiv -8 \bmod 26$

$266 \equiv 6 \bmod 26, -272 \equiv -12 \bmod 26\ , 414 \equiv -2 \bmod 26$

Let $H_0' = 4,\quad H_1' = -2,\quad H_2' = -2,\ H_3' = -18,\ H_4' = 2$

$H_5' = -8,\quad H_6' = 10\ H_7' = -12,\ H_8' = 0$Thus we have converted given plain text C H E M I S T R Y to cipher text i.e. in secret form as

4 2 2 18 2 8 6 12 2 i.e. E C C S C I G M C

Table (3.1)

i	H_i	$k_i = \frac{r_i - H_i'}{26}$	$r_i = (-1)^i(2i+2)H_i$	$H_i' = r_i - 26k_i$
0	2	0	4	4
1	7	-1	-28	-2
2	4	1	24	-2
3	12	-3	-96	-18
4	8	3	80	2
5	18	-8	-216	-8
6	19	10	266	6
7	17	-10	-272	-12
8	23	0	414	-2

From the above table (4.1) we may generalize the result on encryption given below.

Theorem (3) Let $H_0, H_1, \cdots\cdots$ Hbe coefficients of $y\sin y$ then the given plain text $H_i$under the Sumudu transform of $Hy\sin y$ can be converted to cipher text $H_i' = r_i - 26K_i$ where $r_i = (-1)^i(2i+2)K_i$ and key is given by

$K_i = \frac{r_i - H_i'}{26}$ for i = 0,1,2,3,4, … … . , j .

Now we will convert the obtained cipher text in to plain text by applying the same methodology.

Applying Inverse Sumudu transform to equation (2) we have

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$S^{-1}\{S[Hy\sin y]\}$ =4 $S^{-1}[w^2]-28S^{-1}[w^4]+24S^{-1}[w^6]-96S^{-1}[w^8]+80S^{-1}[w^{10}]-216S^{-1}[w^{12}]+266S^{-1}[w^{14}]-272S^{-1}[w^{16}]+414S^{-1}[w^{18}]$ then we obtain the same equation (1) thus we get plain text 2 7 4 12 8 18 19 17 23i.e.
C H E M I S T R Y Hence in general we have

Theorem (4) The given cipher text H_i' With a given key K_i Can be converted to plain text $H_1, H_2, \cdots\cdots, H_J$ under the. Inverse sumudu transform of S[$Hy\sin y$] where $H_i=(-1)^i\left[\frac{26+H_i'}{2i+2}\right]$ Where i $=0,1,\ldots\ldots,j$

4. CONCLUSIONS

From the above theory part proved it is clear that by applying sumudu transform and its inverse we can obtain different cipher texts for given plain text which cannot be easily cracked without providing some additional information. Thus Sumudu transform with cryptography plays an important role in communication security.

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