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Original Article

INSERTION METHOD USING MUSIC NOTES

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ABSTRACT

Communication signals are openly available as they are propagated. Secured transmission is always a question and various methods are devised. Use of music notes is not in wide use in encryption of data. Any musical note consists of seven basic keys. In this paper we propose an insertion method with the seven music keys are used as a tool of encryption.

Keywords: Music Note, Binary string, Encryption, Decryption.

INTRODUCTION

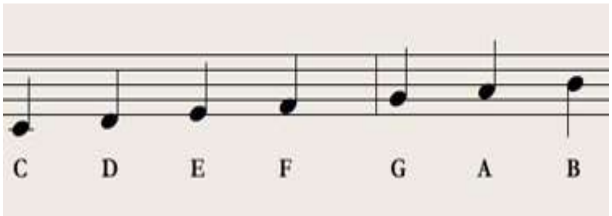
The word cryptography refers to the science and art of transforming messages to make them secure and immune to attacks. It is basically based on the concept of abstract algebra. Network security is mostly achieved through the use of cryptography. More generally, it is about constructing and analyzing protocols that overcome the influence of adversaries and which are related to various aspects in information security such as data confidentiality, data integrity, authentication, and non-repudiation. Modern cryptography intersects the disciplines of mathematics, computer science, and electrical engineering.

PRELIMINARY NOTE

In this section we provide the details of music notes required for encryption of a binary string using the proposed encryption scheme.

Music Notation

Musical notation is the representation of sound with symbols. Any music can be represented using these symbols. The basic notes in music are C, D, E, F, G, A and B. A pause in music is represented by -. The following diagram represents the musical notation from C to B [3].



Sheet music comprises of the following components:

Staff: All musical notation symbols are placed on the staff. The staff is an arrangement of five parallel lines and the spaces between them. Each line and each space represents a musical note.

Clef: The clef is a symbol which represents the pitch or range of the instrument in which the music must be played in. The music to be played in higher range is assigned the Treble symbol. The music to be played in lower range is assigned bass symbol.
Symbol and notation in Treble clef

The Treble, or G clef, is derived from an ornamental Latin letter G. The five lines, from the bottom up, represent the following notes: E G B D F. The four spaces, from the bottom up, represent these notes: F A C E.
Symbol and notation in Bass Clef

PROPOSED ENCRYPTION SCHEME

In encrypting any binary string the regular insertion method [2] is so familiar that anyone who wants to decode a binary string will attempt using insertion method. So any technique that is similar to insertion method, but not the regular insertion one gives rooms for a wrong decryption of the message by any hacker and hence safe for encryption. In this paper we propose two insertion methods using musical notes.

To convert the sheet music to binary digital form, consisting of only 0s and 1s, we use the following substitution.

Table 1 – Binary Conversion Table

Music note	Binary String
-	000
C	001
D	010
E	011
F	100
G	101
A	110
B	111

Method 1 (Binary as Fake Music Note using insertion method)

In this method we use music notes to improve the insertion method. For regular insertion method we refer to [2].

Let S be the binary string to be encrypted.

Encryption Algorithm

Step 1 Choose any fake binary string of length = 3 | S |, where | S | represents the number of

elements in S and use the regular insertion method on S to obtain a string S1.

Step 2 Convert S1 into a fake musical note M using the binary conversion table.

Step 3 Send M to the receiver.

To decrypt the message we reverse the encryption method.

Method 2 (Binary as Fake Music Note Using Bass Clef).

In this method we improve the security of insertion using chords as defined in table 3. In usual insertion method we always prefix the message to be encrypted into the fake binary string. We introduce a method of inserting the message into the fake binary string. We first consider the Bass Clef of the music note. This divides the fake music note into different segments of size k = 12. We then insert the message into the string as shown in table

To decrypt the message we reverse the encryption method.

Table 2 – Position of Insertion Using Chord

Chord	Position of insertion	Position of insertion for sample string 111
C	Between first and second bit	1↓11
F	Between second and third bit	11↓1
G	Prefix to the string	111↓

Encryption Algorithm

Step 1 Choose any music note M and the Treble Clef of the music note.

Step 2 Using the Bass Clef split the music note into segments of size k = 4.

Step 3 Obtain the binary conversion S1 of M using the binary conversion table 1.

Step 4 Now insert S into S1 using the Bass Clef table 2 (that is insert the string in the

positions as given in table 2, that is for segment corresponding to B between first two bits, for segment corresponding to F between second and third position, for segment corresponding to G suffix the string) to obtain S2.

Step 5 Convert S2 as a fake music note M1.

Step 6 Send M1 to the receiver.

EXAMPLE

In this section we illustrate the proposed encryption methods by an example

Method 1

Let S: 1 0 1 1 0 1 0 0 1 0 1 1 0 1 0 1 0 1 0 0 1 1 0 1 1 1 1 1 0 1 0 1 0 1 1 1 0 1 0 0 1 1 1 0 1 1 0 1 be the binart string to be encrypted.

Let the random fake binary string be

010 101 111 010 101 010 010 101 111 101 010 100 101 010 001 111 101 011 011 010 101 111 101 010 100 101 101 111 010 101 010 010 101 010 100 101 010 001 111 101 001 111 101 011 011 010 101 111

Now, using insertion method, we encrypt the message to obtain S1

1010 0101 1111 1010 0101 1010 0010 0101 1111 0101 1010 1100 0101 1010 0001 1111 0101 1011 0011 0010 1101 1111 0101 1010 1100 1101 1101 1111 0010 1101 0010 1010 0101 1010 1100 1101 0010 1001 0111 0101 1001 1111 1101 0011 1011 1010 0101 1111

Divide S into segments, where each segment contains k = 3 bits.

Binary Cipher text into musical notes

101 001 011 111 101 001 011 010 001 001 011 111 010 110 101 100 010 110 100 001 111 101 011 011 001 100 101 101 111 101 011 010 110 011 011 101 111 100 101 101 001 010 100 101 101 011 001 101 001 010 010 111 010 110 011 111 110 100 111 011 101 001 011 111

Converting this into a fake musical note M using the binary conversion table we the following musical note that will be send to the receiver.

GCEBGCEDCCEBDAGFDAFCBGEECFGGBGEDAEEGBFGGCDFGGEC GCDDBDAEBAFBEGCEB

Method 2

Divide S into segments, where each segment contains k = 4 bits each

1 0 1 1| 0 1 0 0| 1 0 1 1| 0 1 0 1| 0 1 0 0| 1 1 0 1| 1 1 1 1| 0 1 0 1| 0 1 1 1| 0 1 0 0| 1 1 1 0| 1 1 0 1|

Let us choose M to be the musical note of jingle bells [4]. M and the corresponding Bass Chef is

|EEE-|EEE-|EGCD|E---|FFFF|FEEE|EDDD|ED--|EEE-|EEE-|EGCD|E---|

| C | C | C | C | F | C | G | G | C | C |C | C |

Binary representation

011 011 011 000 011 011 011 000 011 101 001 010 011 000 000 000 100 100 100 100 100 011 011 011 011 010 010 010 011 010 000 000 011 011 011 000 011 011 011 000 011 101 001 010 011 000 000 000

Inserting plain text

0111 0011 0111 0100 0011 0111 0011 0000 0111 1001 0101 0110 0011 0100 0000 0100 1000 1010 1000 1000 1100 0111 0011 0111 0111 0101 0101 0101 0110 0101 0000 0001 0011 0111 0111 0100 0011 0111 0011 0000 0111 1101 0101 0010 0111 0100 0000 0100

(It can be noted the the position of insertion is given in red color and matches with the Bass chef and has been carried out as in table 2).

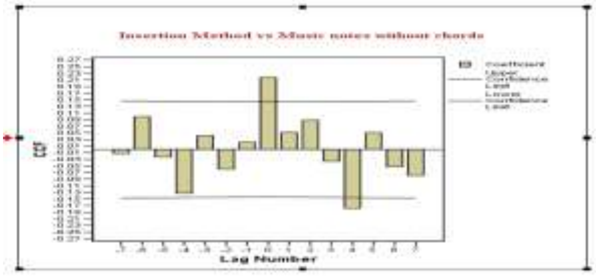


Fig. 1

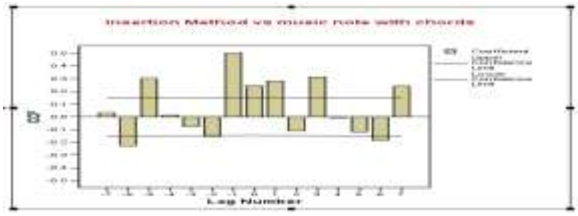


Fig. 2

We now divide the above string into segments, where each segment contains k – 3 bits each.

011 100 110 111 010 000 110 111 001 100 000 111 100 101 010 110 001 101 000 000 010 010 001 010 100 010 001 100 011 100 110 111 011 101 010 101 010 101 100 101 000 000 010 011 011 101 110 100 001 101 110 011 000 001 111 101 010 100 100 111 010 000 000 100

Converting this into fake musical note using binary conversion table 1 we get the following music note M2 to be sent to the receiver.

EFABD-ABCF-BFGDACG—DDCDFDCFEFABEGDGDGFG—DEEGAFCGAE-CBGDFFBD--F

CROSS CORRELATION RESULTS

For the 16 – bit string the cross correlation properties are measured and compared as shown above. The cross correlation is calculated in comparison with the regular insertion method. The results are shown in Figures 1, 2 and summarized in Table 3.

Table 3

Maximum Cross Correlation Value		
	Insertion Method	Music Note Method
Without chord	0.22	0.17
With chord	0.5	0.25

As seen from Table 3, we see that utilization of the music note improves the cross correlation property compared to the insertion method.

CONCLUSION

Two methods had been proposed and demonstrated, which is based upon a reference sequence known only to the sender and the receiver. This reference sequence can be selected from website for music notes. The insertion using music note approach provides additional improvements in the cross correlation property compared to that using insertion method.

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