

# Simple, Qualities, Efficient and Secure Method to Encrypt Voice Signal

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## ABSTRACT

Voice signal cryptography is needed process to protect the voice signal from any third party, because the wave file may be confidential or may contain valuable secret information. In tis paper research we will introduce a method of voice signal encryption- decryption base on using a huge RGB color image as secret key, this image cab be easily used to create encryption-decryption private key. It will be shown that the proposed method will be qualities by destroying the original file to generate the encrypting one, and recovering identical to the original decrypted file. The efficiency the proposed method will be calculated to show the productivity of this method.

## Keywords

Voice signal, encryption, decryption, MSE, PSNR, throughput, RGB, YIQ, PK.

## 1. INTRODUCTION

Digital voice signal [14], [34] is a 1D matrix (mono speech) or 2D matrix(stereo speech), each element in the matix represents the amplitude value of the voice sample at a given time( see figure 1), these values usually between -1 and 1. Voice signals some time require encryption-decryption, beacuse they may contain secret information or may be private, so no other third party must not understand it[36-42].

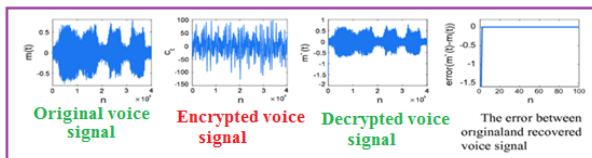


Figure 1: Voice signal encryption-decryption

Encryption means fully distruction of the original signal, amking the output of this process un undertandable and useless information, while the decryprtion means recovering from the decrypted signal the original one without losing any piece of information, the recovered signal must be identical to the original one. Here the encryption-decryption process must have the following quantitive parameters[15-25]:

- Mean square error (MSE) between the original signal and the encrypted one must have a large value.
- Peak signal to noise ratio (PSNR) between the original signal and the encrypted one must have a very small value.
- Mean square error (MSE) between the original signal and the decrypted one must be closed to zero.

- Peak signal to noise ratio (PSNR) between the original signal and the decrypted one must have a large value.

Symmetric cryptography as shown in figure 2 usual uses a private key known only by the sender and the reciever, this key can be a hige color image, here the sender and reciever must agree on the image and keep it saved to be used as a private key(PK)[26-37].

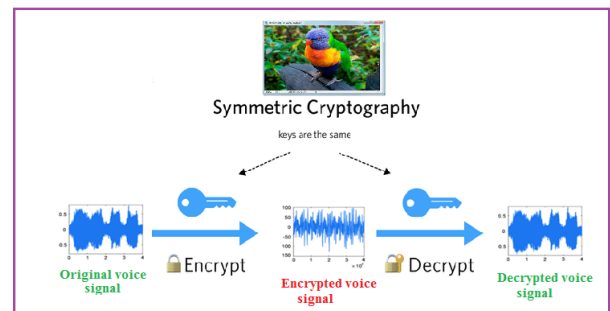


Figure 2: Symmetric cryptography

Digital RGB [1], [2],[3] color image usually represented by a 3D matrix, one 2D matrix for each color (red, green and blue), the value of each pixel is within the range 0 to 255, to make this image applicabile for voice processing we can convert this image to ntsc image with three channels(YIQ), here the range of YIQ image will be between -1 and 1, [4-14] the process of coversion RGB image to YIQ image can be implemented applying equation 1:

$$\begin{bmatrix} Y \\ I \\ Q \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ 0.596 & -0.274 & -0.322 \\ 0.211 & -0.523 & 0.312 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (1)$$

## 2. THE PROPOSED METHOD

The proposed method as shown in figure 3 can be implemented applying the following steps:

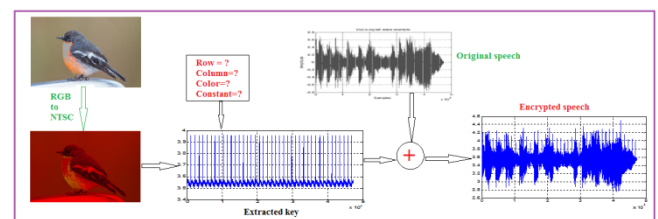


Figure 3: Proposed method diagram

Encryption phase:

This phase can be implemented applying the following steps:

Step 1: Key preparation

Here we have to do the following:

- Select the secret image which is to be used as a secret key.
- Convert the image to YIQ image.
- Select the row, column and color channel, where to start extracting the key.
- Extract the key with length equal voice file length.
- Add the constant to the key.

Step 2: Encryption:

Add the key to the voice file to get the encrypted voice file.

The decryption phase can be implemented applying the following:

Decryption phase:

This phase can be implemented applying the following steps:

Step 1: Key preparation

Here we have to do the following:

- Select the secret image which is to be used as a secret key.
- Convert the image to YIQ image.
- Select the row, column and color channel, where to start extracting the key.
- Extract the key with length equal voice file length.
- Add the constant to the key.

Step 2: Decryption:

Subtract the key from the encrypted voice file to get the decrypted voice file.

### 3. IMPLEMENTATION AND EXPERIMENTAL RESULTS

A big RGB color image shown in figure 4 was selected as a secret image to be used to extract the private key, figure 5 shows the YIQ version of the original image:

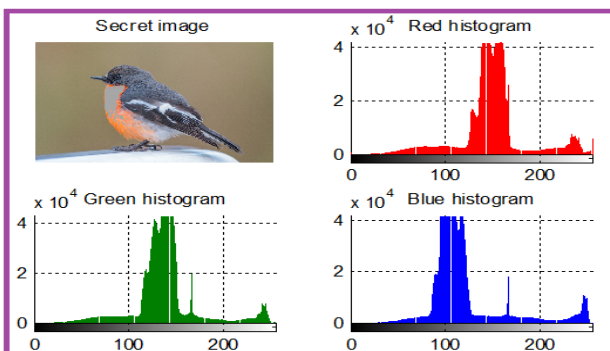


Figure 4: Selected RGB secret image

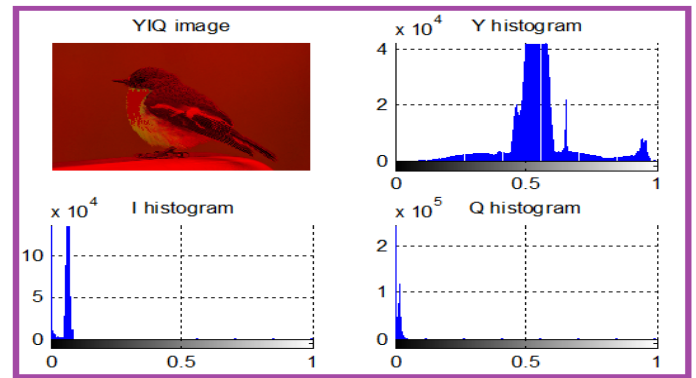


Figure 5: YIQ image

(here we have to notice that it is easy to change the secret image by onther image without adding any changes to the encryption-decryption process).

To test the qualitative parameters of the proposed method( Increasing MSE between the original and the encrypted signals and to decrease MSE between the original and decrypted signals) various voice signal were selected and they were encrypted-decrypted using the secret image shown in figure 4, table 1 shows the obtained experimental results:

Table 1: Obtained results of qualitative parameters

Voice signal number	Original and encrypted signals		Original and decrypted signals	
	MSE	PSNR	MSE	PSNR
1	12.6121	4.7445	6.9191e-034	756.7127
2	12.6390	3.0727	5.5202e-035	762.4994
3	12.6356	3.2529	2.3583e-035	768.7798
4	12.6374	2.9669	1.1278e-035	776.2908
5	12.6398	3.3253	4.9982e-035	764.8114
6	12.6324	2.5131	1.1464e-036	778.3464
7	12.6270	2.3912	0	infinite
8	12.6366	2.4409	0	infinite
9	12.6394	2.5242	2.1721e-036	785.9859
10	12.6079	3.2120	4.5150e-035	765.9874

From table 1 we can see that the proposed method has a good qualitative parameters values, here the method provides a good values for MSE and PSNR in the encryption and decryption phases.

The same voice signals were treated using the proposed method, table 2 shows the efficiency parameters values obtained in this experiment:

**Table 2: Obtained results of efficiency parameters**

Voice signal number	Size (samples)	Size(bytes)	Encryption time(seconds)	Throughput (samples per second)	Throughput (bytes per second)
	47315	378520	0.1930	2.4516e+005	1.9612e+006
1	321536	2572288	0.4340	7.4087e+005	5.9269e+006
2	200704	1605632	0.1940	1.0346e+006	8.2765e+006
3	227328	1818624	0.1920	1.1840e+006	9.4720e+006
4	430080	3440640	0.1960	2.1943e+006	1.7554e+007
5	430080	3440640	0.2020	2.1291e+006	1.7033e+007
6	172032	1376256	0.2410	7.1383e+005	5.7106e+006
7	133120	1064960	0.1900	7.0063e+005	5.6051e+006
8	212992	1703936	0.1940	1.0979e+006	8.7832e+006
9	272384	2179072	0.1940	1.4040e+006	1.1232e+007
10	17472	139776	0.1910	9.1476e+004	7.3181e+005

From table 2 we can see that the proposed method has a good efficiency parameters values, here the method provides a good values for encryption time and the throughput in the encryption and decryption phases.

#### 4. CONCLUSION

A simple and easy method of voice signal encryption-decryption was proposed, the method provides a high level of security by using a changeable secret RGB color image to generate a private key. The method was tested and implemented using various voice signals, the obtained experimental results showed that the proposed method is highly qualitative and efficient by providing a good value for the quality and efficiency parameters.

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