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Encryption and Decryption of Audio by Changing Properties and Noise Reduction

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Abstract:- Encryption, the process of data hiding at the time of transmission, gives security to messages. Audio signal is vastly used for communication now a days. This paper is about an algorithm of audio file encryption in image format by usingprivate keyand decryption into audio. Audio encryption which is bulky in size can be overcome by processing audio signal to image. It ensures secured transmission of data by changing its features. Here, in this algorithm, dimensions of raw datahave been changed and the reshaped format has made signal privy. This technique provides lossless data processing as well as renders the choice of selection of any types of audio file (mp3, wave, m4a etc.) in mono or stereo. Here security enhancementis done by using private key and changing properties of data from audio to image. Use of compression adds white noise which can be removed by using proper filter. It gives improved SNR, more than 18dBafter reception. For better communication system, this process is easier and better than other encryption techniques.

Keywords:- *Encryption, Decryption, Random private key, Mono, Stereo, Filter, SNR.*

I. INTRODUCTION

Encryption that gives security to data signals which can be hacked by the unwanted user and that will cause unsecured transmission of data. Usually, audio encryption is done from message audio to noise audio. If it is possible to make the audio[1] to image and we encrypt the formed image, encryption will be better.

By describing an algorithm of encrypting .wav files [2] in image format with randomly generated orthogonal key decrypting them after being passed through the channel with white noise. Encryption of the .wav data as JPEG, PNG [3] and different image file and hiding LSB bit [4] from the secret audio/image and encrypt it by steganography process [5]. RSA algorithm[6] is used as a very popular encryption technique where the data is changed by using public key. A private key [7] is given to the exact receiver to extract the encrypted data. For audio and image encryption it also used.

Generally, encrypted audio will also be large in size which will take more bandwidth and more time to transmit that can be reduced by forming into image [8]. Hence the transmission time will be less and reshuffled dimension of data matrix will make it more secured.

Using a random encryption private key, image data matrixencryption and decryption was taken place. After encryption, a lossless [9] data compression was done in .png &.tiff format.After decrypting, raw data Image has to be changed into the audio signal. Audio may be stereo or mono, needs proper condition to identify and encryption and decryption technique should have to be used.

A white noise [10] is produced because of the compression process. To remove the noise a white noise filter is used and regenerated signal is sent through the filter.

In this paper, the portrayed algorithm is feasible with wave, mp3, m4a different audio files to convert them into image and encrypted as image. Here compression of the audio fileshave also taken place. Encryption is made by changing value of array data that ensure the security of communication.

II. IMAGE AND AUDIO

Audio and image are two different types of signals with some different properties based on their dimension and array arrangement. Merging these two different signals can be the better way to enhance security.The wav, mp3, m4a different audio file of stereo and mono types were converted into image by reshaping their array and encrypted as image where compression will occur also. Encryption is made by changing value of array data. Hence encryption & decryption become less complex and the change of dimension of data makes the process more secured.

III. AUDIO FILE GENERATION AND COMPRESSION

At first an audio file of any format has to be read from the internal storage and collect array matrix form the audio signal. Here audio files of .wav, .mp3, .m4a etc. can be used to do the encryption and decryption which is converted into raw data image. There are many formats of image like '.tiff' '.png' '.jpeg' etc. from which .tiff and .png are lossless compression technique and has minimum bit error. So .tiff has been chosen as compression because of its flexibility, adaptability of handling images, so that decrypted signal has become close to accurate with a small amount of white noise which is cancelled by designing white noise filter between 3.8KHz to 4.0KHz frequency range.

There are two types of audios, 'Mono' and 'Stereo' where mono is column matrix and the stereo audio matrix have been reshaped into a column matrix to reshape the audio file matrix to square matrix to show as an image. But generally, it is rare to get a matrix from audio associated with squared number of elements. There was lack of a few data which might be solved by adding some ones or zeros at the end of the audio matrix.

IV. ENCRYPTION AND DECRYPTION

The raw data image in black and white form has got which might be easily understood. So that, effect on the intensity of the array elements has been used, change the image property which can be said as encrypted image.

Random integer generator is used to generate random private key in which the value of the private key is controlled to make sure the better quality of the audio signal after decryption.

To encrypt the image, random private encryption key is used by which the value of the matrix has been changed which ensures that at the decryption part, reverse operation along with the exact private key will give the proper audio message. Moreover, this encryption process abates fromdata loss which takes place at the time of compression.

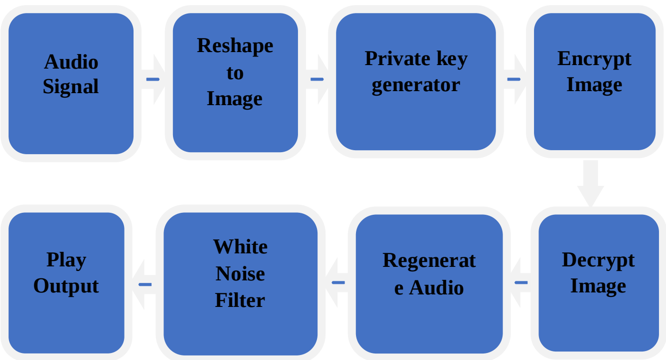


Fig. 1: Block diagram

In receiver part, decryption has been started by bringing back the original intensity of the array elements. Then the matrix was reshaped into column matrix. If the input audio was stereo type, one more array reshaping would be needed. Thus, the audio will be back with white noise. To get the proper audio removing of this white noise is important which is done by designing a white noise filter with appropriate frequency band.

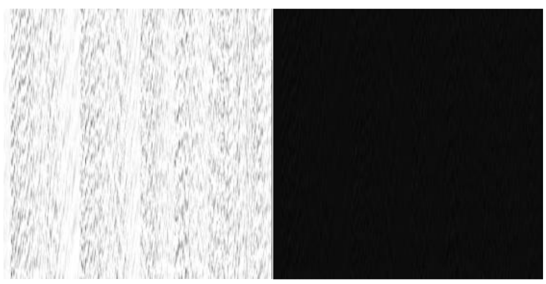
This technique is suitable for any format of audio signal of mono and stereo type which makes the process flexible to use in any types of secured speech communications. In this technique, data compression have been taken place. Hence transmission will be better in this process. Here a lossless data conversion technique is used and so that exact audio might be got. Mono and Stereo types audio can be processed.

V. ALGORITHM

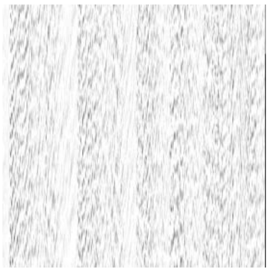
- **STEP 1:** Call audio file from the directory.
- **STEP 2:** Identify the audio as it is mono or stereo.
- **STEP 3:** Transform the stereo audio into column array.
- **STEP 4:** Generate a ones matrix with the same dimension of the input audio signal matrix.
- **STEP 5:** Make all negative values ofthe audiomatrix positive by adding generated onesmatrix with input array
- **STEP 6:** Add zeros at the end of the values of the new matrix until the number of the elementsof thearray will become a square number.
- **STEP 7:**Reshapethe column into two-dimensionalsquare matrix to form image.
- **STEP8:** Generate random numberand convert it to suitable integer for using as a private encryption key.
- **STEP 9:**Divide the elements of raw data square matrix by a private encryption key, turned into black image and intensity was decreased.
- **STEP 10:** Save the encrypted data in an image format.
- **STEP 11:** Call the saved image from the directory.
- **STEP 12:** Make it double formatmatrix from unit8 form.
- **STEP 13:**Multiply the matrix with the private encryption key and decrypt into the two-dimensional image format.
- **STEP 14:** Reshape the image matrix into audio matrix.
- **STEP 15:** Remove extra elements that was added as zero.
- **STEP 16:** Make audio mono or stereo as it was in the input.
- **STEP 17:** Ensure the presence of the negative value as it was in the input by subtracting ones matrix with same dimension.
- **STEP 18:**Design agaussian noise filter with appropriate frequencybetween 3.8KHz to 4.0KHz and use it to remove white noise from the regenerated audio.
- **STEP 19:** Use sampling frequency to generate audio from the regenerated matrix.
- **STEP 20:** Play the generated audio as decryptedoutput.

VI. RESULTS

A. Image of Raw, Encrypted and Decrypted data

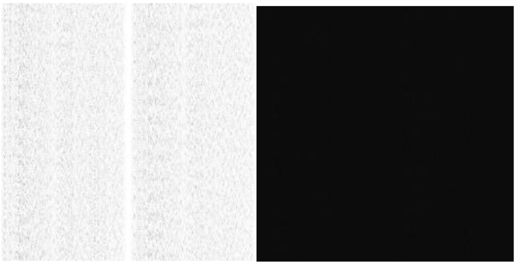


(a) (b)



(c)

Fig. 2: For Mono audio (.mp3) file
(a) Raw data image
(b) Encrypted image
(c) Decrypted image

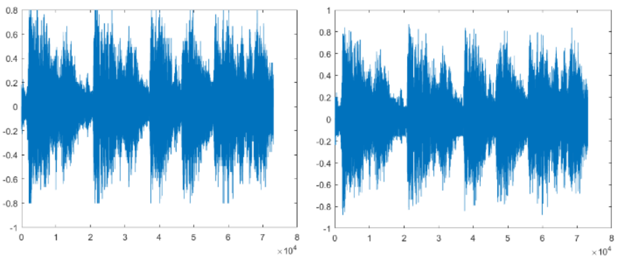


(a) (b)

(c)

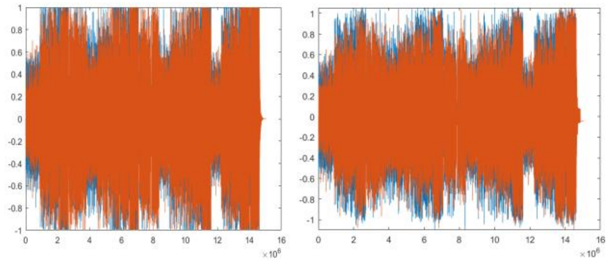
Fig. 3: For Stereo audio (.mp3) file
(a) Raw data image
(b) Encrypted image
(c) Decrypted image

B. *Graphical representation*



(a) (b)

Fig. 4: For *Mono audio (.mp3) file*
(a) Input signal.
(b) Output signal.



(a) (b)

Fig. 5: For *of Stereo audio (.mp3) file*
(a) Input signal.
(b) Output signal.

C. *Data obtained at different stages of the operation*

Stages	Audio1	Audio2
Input audio data matrix	395760×1 double	5652336x1 double
Number of data extending with zeros	396900×1 double	5654884x1 double
Reshaped image matrix data	630×630 double	2378x2378 double
Encrypted image matrix	630×630 unit8	2378x2378 uint8
Decrypted image matrix	630×630 double	2378x2378 double
Output audio	395760×1 double	5652336x1 double
SNR(dB)	18.2937	20.3269

Table 1: Data of Mono audio (.mp3) file

Stages	Audio3	Audio4
Inputaudio data matrix	15059568×2 double	4961196×2 double
Number of data extending with zeros	30129121×1 double	9922500×1 double
Reshaped image matrix data	5489×5489 double	3150×3150 double
Encrypted image matrix	5489×5489 unit8	3150×3150 uint8
Decrypted image matrix	5489×5489 double	3150×3150 double
Output audio	15059568×2 double	4961196×2 double
SNR(dB)	18.1759	20.4876

Table 2: Data of Stereo audio (.mp3) file

VII. RESULT ANALYSIS

Here, in the data Table 1 and Table 2, elements of different stage of the experiment are shown. From the first table, data of mono audio can be got where the input and out data is equal. To change properties of array and forming square matrix extra bit have been added which was removed before taking the output. In the second table same procedure have been done for stereo audio. To abate

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complexity of the process, stereo audio has been turned into a column array before changing properties from audio to image. In the both, SNR of at the receiver are more than 18dB which are also good to dominate noise by the signal.

From Fig. 2.(a) and Fig. 3.(a) raw data image and Fig. 2.(c) and Fig. 3.(c) give the decrypted image of mono and stereo sound respectively. In the Fig. 2.(b) and Fig. 3.(b) is the encrypted image which are generated by using random private encryption key. As the private key changes randomly andboth of the encrypted images are same to look like which ensures the security of the raw data.

From the waveshapes of the audio signals, some changes in the output can be noticed which was taken place because of compression.Fig. 4.(a) and Fig. 4.(b) is the waveshape of mono audio input signal and output signal after decryption. Fig. 5.(a) and Fig. 5.(b) is for stereo audio. In the output signals some spikes turned into same level. It creates negligible noise which can be removed by using proper filter.

Here the number of theelements of the input signal is as same as the final output which was done by increasing element up to nearest square array. As a result, there is no data loss happened which makes the technique better than other. Audio message of any format is can be taken which can be mono type or stereo type which gives more flexibility of choosing data than other techniques. Moreover, this process is less complicated than any other encryption technique. But the use of random private key for encryption ensures the better security of the data.

There are some issues of noise in the output. In the imageformat, data omits values that more than.995 and less than .005. Value that more than .995 automatically turned into 1 and value less than .005 turned into 0. Hence a small amount of white noise has been taken place in the output. Again, the SNR values representthat the created noise is highly dominated by the signal. To remove the white noise a gaussian white noise filter is designed with 3.8×10^3Hz to 4×10^3Hzpassband frequency by which the noise is removed from the regenerated signal.

VIII. CONCLUSION

Algorithms, done for audio to image encryption, was lossy process. But in the above algorithm, the elements of data in input and output are same here and so there is no data loss.

The use of private key for encryption ensures more secured communication because of its randomness. Value of the private encryption key changes in every operation which increases the depth of the encryption technique.

This process is more efficient in noise reduction with good SNR.After decryption there are no data loss and for the image compressioncausesa very small white noise which was removed by using white noise filter.

Audio	SNR at .jpg(dB)	SNR at .tiff & .png(dB)
Audio1	4.4300	18.2937
Audio2	3.9028	20.3269
Audio3	3.3000	18.1759
Audio4	4.5836	20.4876

Table 3: SNR at .jpg, .png and .tiff compression

Data compression can be lossy or lossless. In .jpg lossy compression happens. Table 3 shows, SNR is very small after .jpg compression. On the other hand, SNR values become better and remains same after .png and .tiff compression. The .png compression is less lossy, so some bit error happens.But in the .tiff, compression, it is lossless and minimum bit error takes place and so, .tiff is chosen for the operation. Here the SNR is more than 18 dB where the existing method [2]it is only more than 1.

This process also gives the randomness in choice of audio file. Any kind of audio file like .wav .mp3 .m4a and any types of dimensions like mono or stereo audio can be chosen for the operation. Maximum amplitude of the signal remains same in the output of the decrypted signal, as a result, the intensity of the audio cannot be reduced extensively.

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