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School of Electronics Engineering (SENSE)

Project Report

of

ECE2006 DIGITAL SIGNAL PROCESSING

Slot: C1

Digital Watermarking Techniques and Algorithms

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Abstract

Digital watermarking techniques are essential for the protection of multimedia information. The basic principle of the technique is that some information (just like the images and the strings), could be embedded into the original content by some special measures. On the one hand, intellectual property rights would be protected effectively; on the other hand, the embedded information wouldn't have any influence on the original content. We aimed to explore various algorithms and techniques to understand their advantages and shortcomings.In this project, we have researched various techniques of watermarking and have attempted to use Least Significant Bit(LSB) technique to use an image as a watermark to an audio signal. Furthermore, we made use of Discrete Cosine Transform(DCT) to watermark an image to another image.

Introduction

Watermarking is the process of embedding information into a signal (e.g. audio, video or pictures) in a way that is difficult to remove. If the signal is copied, then the information is also carried in the copy. It is a concept closely related to steganography, in that they both hide a message inside a digital signal.It is the process of embedding a digital code(watermark) into a digital content like image,audio or video.The embedded information, sometimes called a watermark, is dependent on the security requirements mentioned above.Watermarking has become increasingly important to enable copyright protection and ownership verification.Applications for digital watermarking include copyright protection, fingerprinting, authentication, copy control, tamper detection, and data hiding applications such as broadcast monitoring.

Components Required

- MATLAB
- Audio signal
- Image(to be watermarked)
- Image(to act as watermark)

Literature Review

S.No	Paper Title	Name of the Conference/Journal, Year	Technology Used
1.	Digital watermarking with improved SMS applied for QR code	Engineering Applications of Artificial Intelligence Volume 97, January 2021, 104049	This paper proposes an improved watermarking technology using meta-heuristic algorithm. Further, Quick Response code (QR code) is used as a carrier to transmit information. The improved Discrete Wavelet Transform-Singular Value Decomposition (DWT-SVD) is used to hide the watermark into the QR code. Therefore, digital watermarking is realized on the QR code.
2.	Digital watermarking scheme for copyright protection and tampering detection	international journal on information technologies and security,No1 (vol 11),2019	The study proposes a dual function watermarking scheme, one is copyright verification and tampering detection, the experimental results of this study show that even if half of the image is cropped ,the extracted tough watermark can clearly be seen. We will make a fragile watermark not just to have tamper but also serves as the basis for enhancing the strength of the robust watermark
3.	A Review Paper on Digital Watermarking Techniques for security Application	2018 IJCRT | Volume 6, Issue 2 April 2018 | ISSN: 2320-2882.	In this paper they have examine the latest literature on digital image watermarking .in the field of internet where data is transmitted from sender to receiver via many network so security of data is a primary issue for user to protect our data from unauthorized person

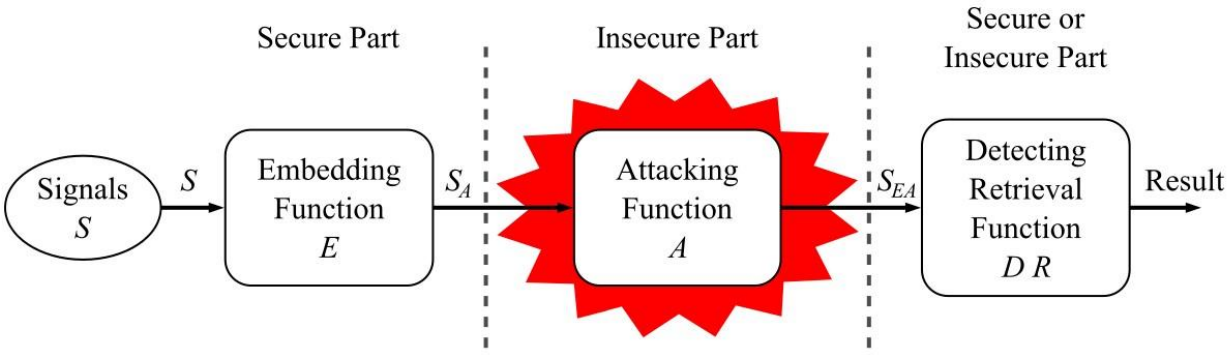
			and create a ownership of data and copyright control for this, watermarking is the best method
4.	**Comparison of digital watermarking techniques**	**International Conference for Convergence for Technology-2014, 2014, pp. 1-6, doi: 10.1109/I2CT.2014.7092189.**	**This paper performs a comparative analysis of different image watermarking techniques. The watermarking techniques based on DCT, DWT and a combination of DCT and DWT is implemented. These methods use Singular Value Decomposition (SVD) of the cover image and watermark for embedding the watermark. Different attacks are applied on the watermarked image in order to analyze the robustness of each algorithm.**
5.	**Digital watermarking: algorithms and applications**	**IEEE Signal Processing Magazine, vol. 18, no. 4, pp. 33-46, July 2001, doi: 10.1109/79.939835.**	**This is a paper which basically compares various watermarking techniques like spatial watermarking, document watermarking and graphical watermarking and the different methods in each form**
6.	**Digital watermarks for audio signals**	**IEEE international conference on multimedia computing and systems (pp. 473-480). IEEE.**	**Maximum length PN-sequence filtered by the approximate masking characteristics of the HAS and weighted in time.**
7.	**Performance Evaluation of Digital Audio Watermarking Algorithms**	**IEEE Midwest Symposium on Circuits and Systems (Cat. No. CH37144) (Vol. 1, pp. 456-459). IEEE.**	**A straightforward performance evaluation framework for comparing digital watermarking algorithms based on bit rate, perceptual quality, computational complexity, and robustness to signal processing operations**

Watermarking Systems

A watermarking system is usually divided into three distinct steps:

1. Embedding
2. Attack
3. Detection

In embedding, an algorithm accepts the host and the data to be embedded and produces a watermarked signal. The term attack arises from copyright protection applications, where third parties may attempt to remove the digital watermark through modification during transmission or storage. Detection (often called extraction) is an algorithm which is applied to the attacked signal to attempt to extract the watermark from it. If the signal was unmodified during transmission, then the watermark still is present, and it may be extracted.



The performances of the techniques are judged with respect to the robustness and imperceptibility (inaudibility) of audio watermarking. Inaudibility means the watermarked audio and original audio must be identical in nature to listen. Robustness means the resistance of the watermark against removal or degradation. The watermark should survive intentional attacks such as random cropping, noise addition, re-quantization, resampling, compression, filtering and its removal should degrade original audio.

Least Significant Bit Method

Each 8-bit pixel's least significant bit is overwritten with a bit from the watermark. In a digital image, information can be inserted directly into every bit of image information. This method is based on the pixel value's Least Significant Bit (LSB) modifications.

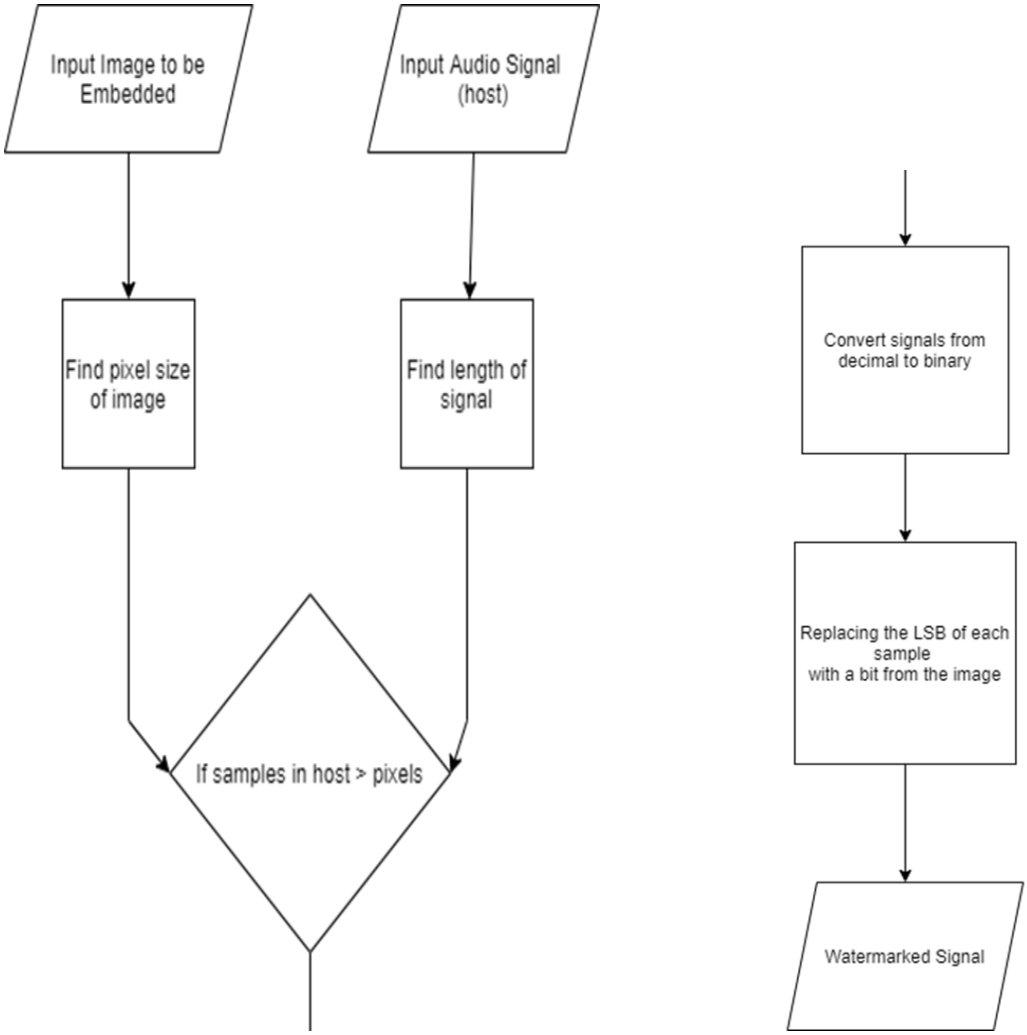
Advantages:

- It is a simple method.
- It can survive transformations like cropping, undesirable noise or compression.
- Security will be enhanced.

Disadvantages:

- A more sophisticated attack that could simply set the LSBs of each pixel to 1 can fully defeat the watermark with a negligible impact on the cover object.
- This way, the embedded watermark can be modified by the attacker.

Flowchart:


Input Image to be Embedded
Input Audio Signal (host)
Find pixel size of image
Find length of signal
If samples in host > pixels
Convert signals from decimal to binary
Replacing the LSB of each sample with a bit from the image
Watermarked Signal

Simulation:

Fig. Images to be added as a watermark; 3KB size

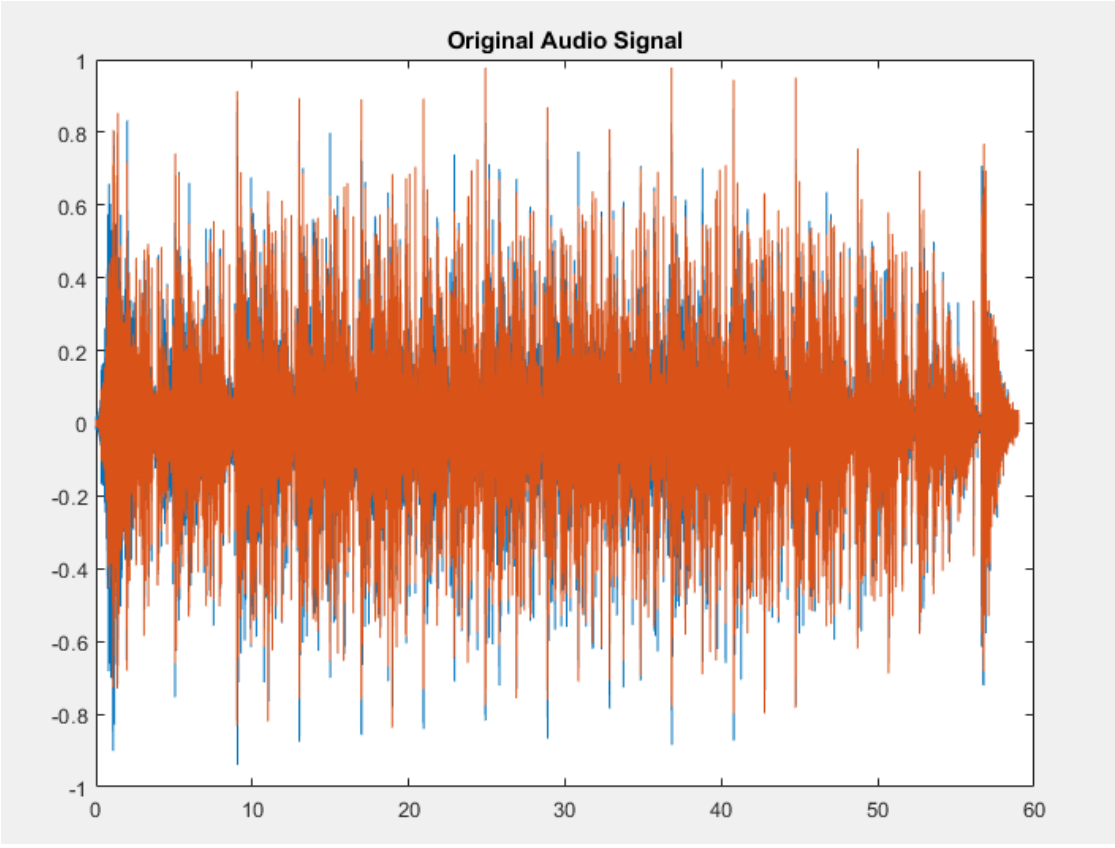


Fig. Audio signal that is to be watermarked; 10MB size

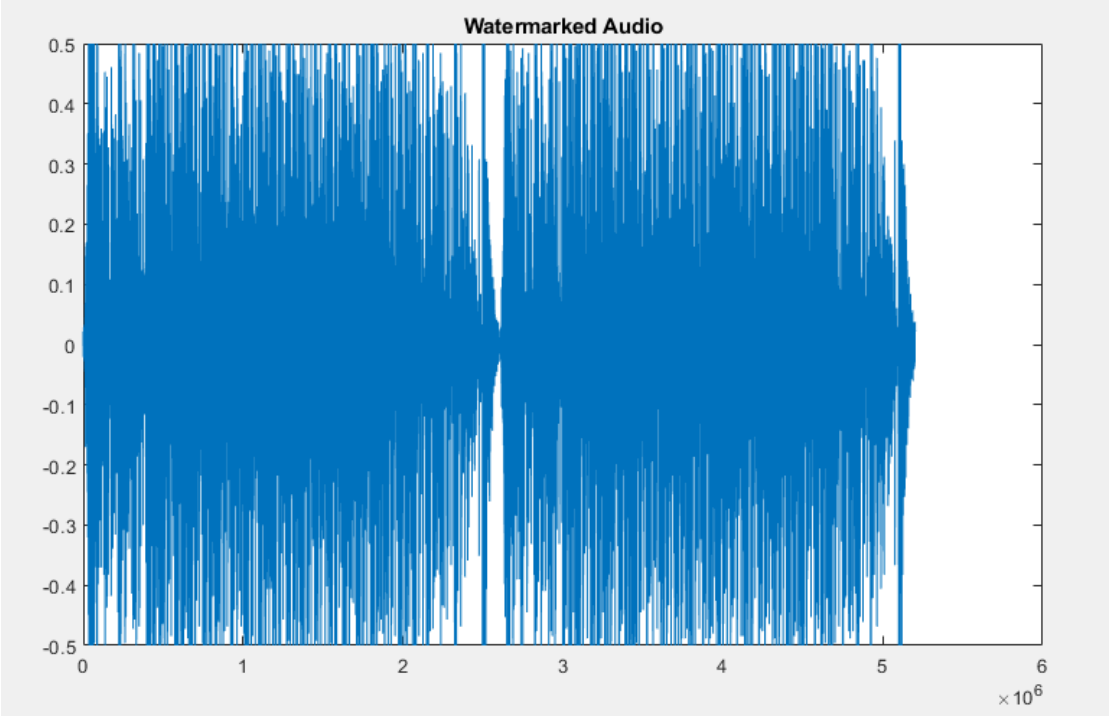


Fig. Audio signal that is watermarked with the image;

From the above output, it is clear that the watermarking is imperceptible to the naked eye. So, unless the watermark can pass undetected unless it is looked for specifically.

Discrete Cosine Transform Method

The DCT allows an image to be broken up into different frequency bands, making it much easier to embed watermarking information into the middle frequency bands of an image.

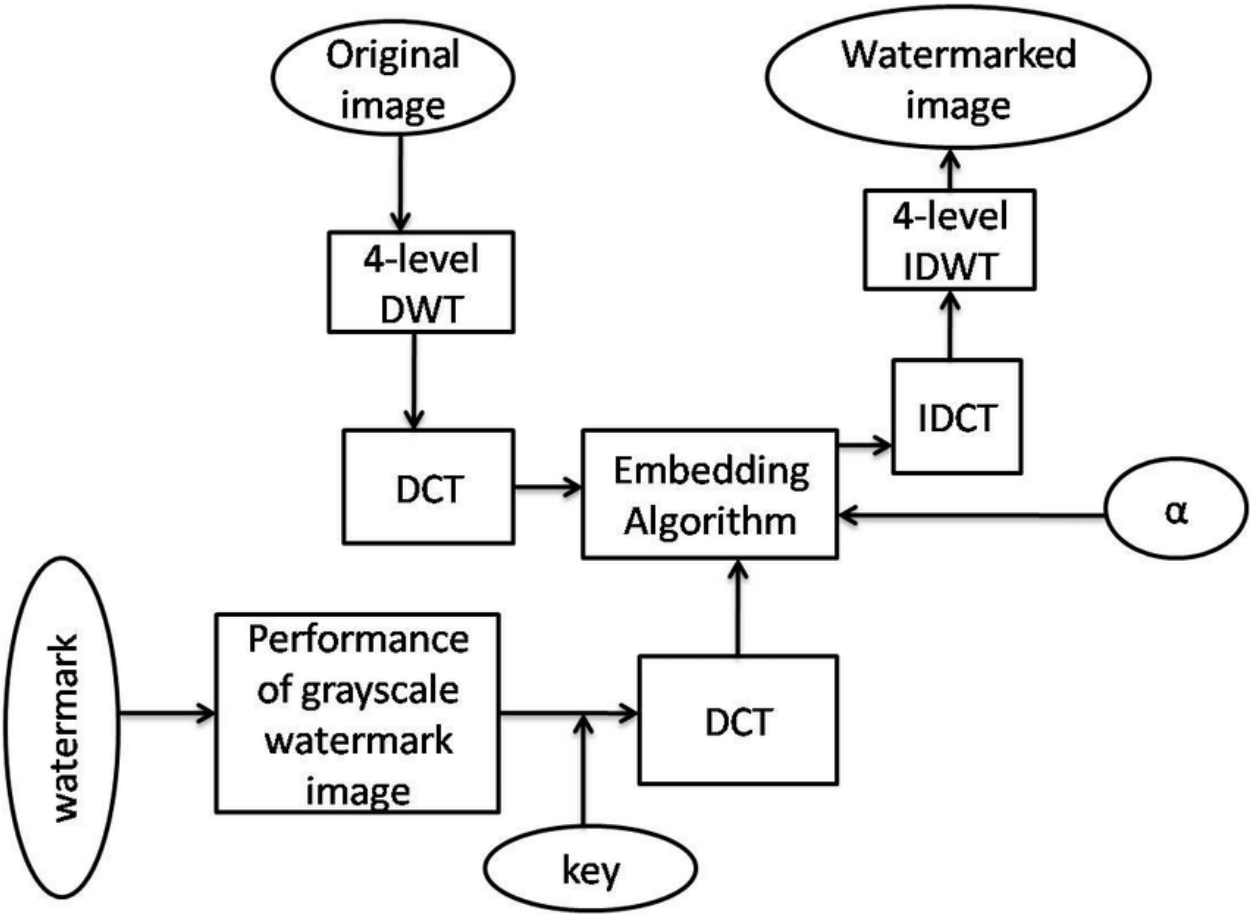
Advantages:

- improved resistance to attacks on the watermark
- implicit visual masking

Disadvantages:

- limited robustness

Flowchart:

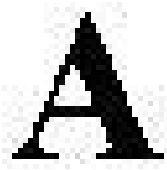


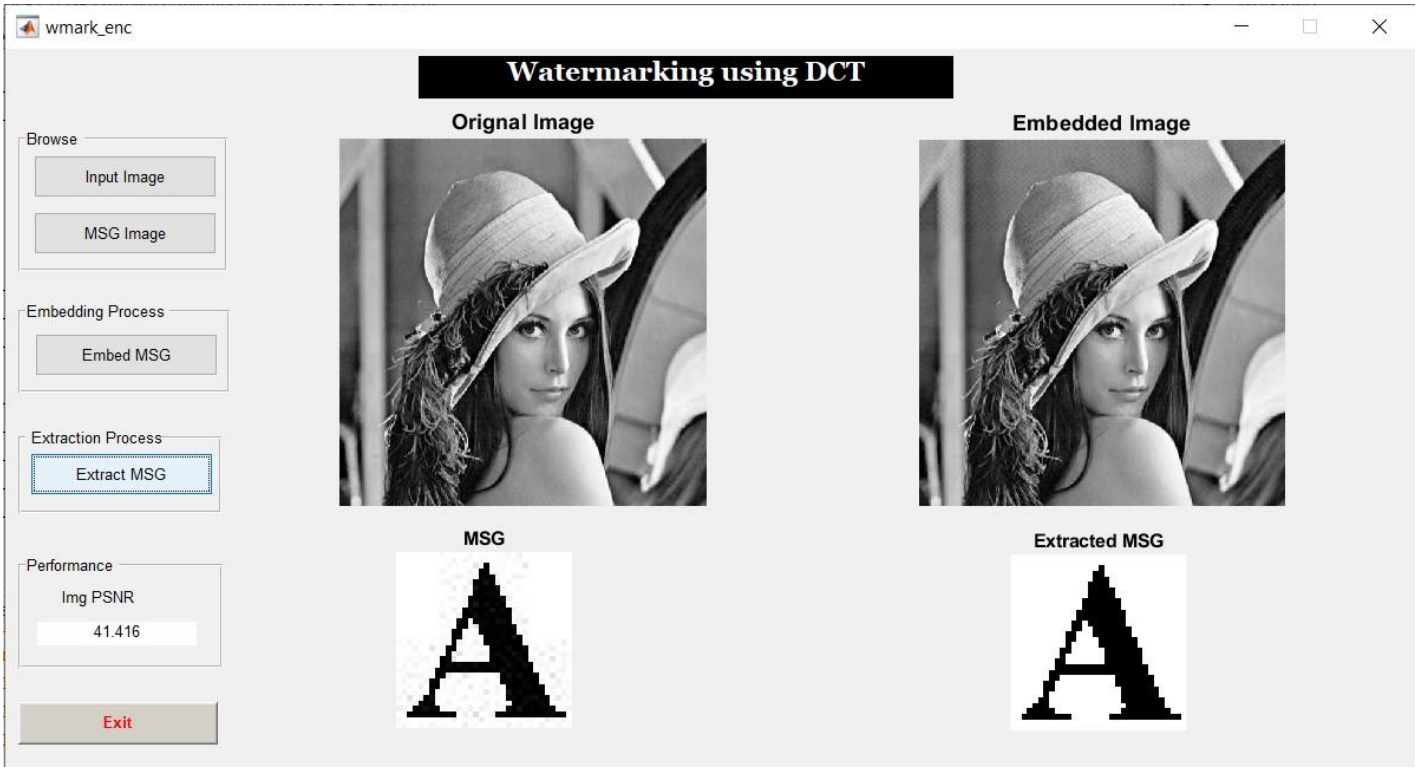
Simulation:

Features of the input:
Input image: 30KB size
Images to be watermarked: 1KB size

Input image:

Image to be watermarked:





Conclusion

In this project we have successfully watermarked an Audio signal with an image using Least Significant Bit (LSB) method and also watermarked an image with another image using Discrete Cosine Transform (DCT) technique. We have explored the various concepts of digital watermarking techniques to understand its importance in the protection of multimedia information. By using digital watermarking the intellectual property rights would be protected effectively; the embedded information wouldn't have any influence on the original content. We have explored various algorithms and techniques to understand their advantages and shortcomings.

References

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J. R. Aparna and S. Ayyappan, "Comparison of digital watermarking techniques," International Conference for Convergence for Technology-2014, 2014, pp. 1-6, doi: 10.1109/I2CT.2014.7092189.

Podilchuk, Christine & Delp, Edward. (2001). Digital Watermarking: Algorithms and Applications.

Begum, M.; Uddin, M.S. Digital Image Watermarking Techniques: A Review. Information 2020, 11, 110.

L. Boney, A. H. Tewfik and K. N. Hamdy, "Digital watermarks for audio signals," Proceedings of the Third IEEE International Conference on Multimedia Computing and Systems, 1996, pp. 473-480, doi: 10.1109/MMCS.1996.535015.

Appendix:

```
clc;
clear;
close all;
[host,f] = audioread('file_example_WAV_10MG.wav');

dt= 1/f;
t = 0 : dt : (length(host)*dt)-dt;

figure();
plot(t,host);
title('Original Audio Signal');

host = uint8(255*(host+0.5));

wm = imread('cr6.jpeg');
[r,c] = size(wm);
wm_l = length(wm(:))*8;

if length(host)<wm_l
   disp('Image pixel size is too large');
else
   host_bin = dec2bin(host,8);
   wm_bin = dec2bin(wm(:),8);
   wm_str = zeros(wm_l,1);

   for j = 1:8
      for i = 1:length(wm(:))
         ind = (j-1)*length(wm(:))+i;
         wm_str(ind,1) = str2double(wm_bin(i,j));
      end
   end
```

```
    for i = 1:wm_l
        host_bin(i,8) = dec2bin(wm_str(i));
    end

    host_new = bin2dec(host_bin);
    host_new = (double(host_new)/255-0.5);

    figure();
    plot(host_new)
    title('Watermarked Audio');

    audiowrite('host_new.wav', host_new,f);
    soundsc(host_new,f);
end
```