Modified Patchwork Algorithm: Anovel Audio Watermarking Scheme

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What is Audio Watermarking ?

- Embed Data into an Audio File

- Quality required
  - Not be perceivable by a listener
  - Robust again manipulation
  - Security
  - Statistically undetectable

Application of Audio Watermarking

- Monitoring a file
- Fingerprinting
- Can indicate content manipulation

Patchwork algorithm definition

- We modified two “patchwork” of an image/audio file
- We retrieve the information by calculating the difference between the two patchorwk.
- The patchworks are randomly chosen, and we have to keep the memory of the Patchwork in order to reconstruct the embeded data.

Exemple of Patchwork Algorithm for Image

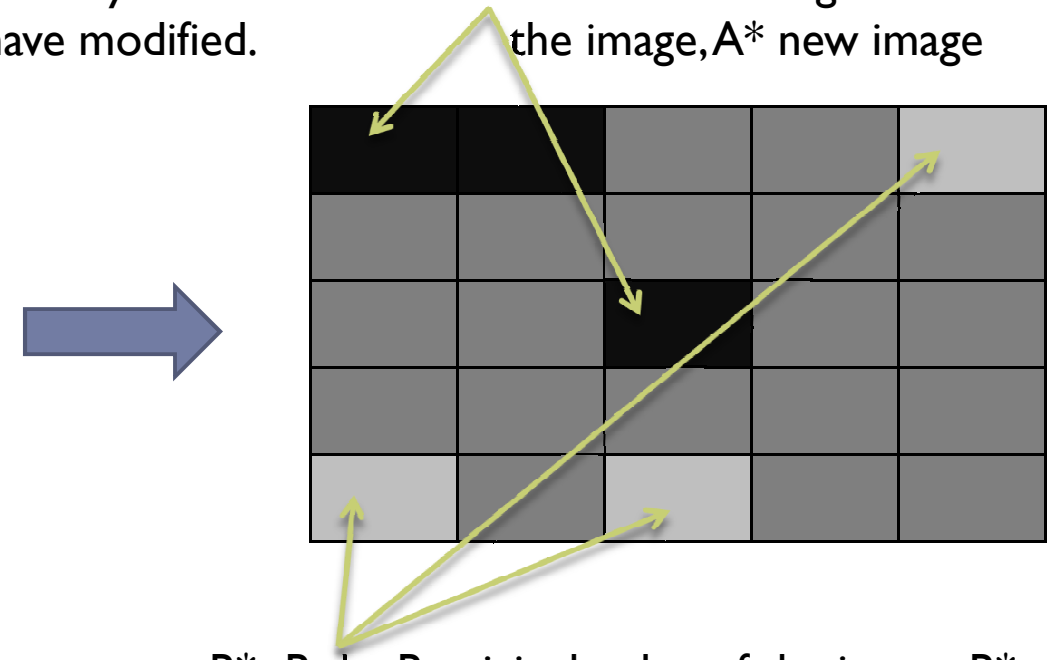
We darken some part, and light up some others part of the image

We keep in memory the Position of the pixel we have modified.

A*=A+d : A original color of the image, A* new image

A	A			B
		A		
B		B		

Original Image

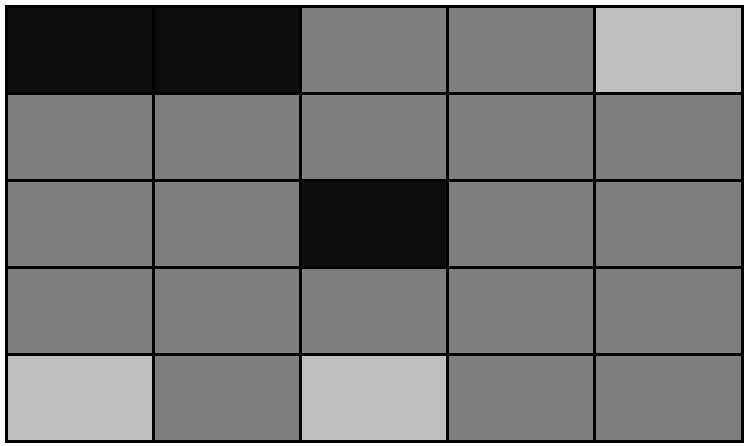


We assume that E[A-B]=0:

B*=B-d : B original color of the image, B* new image. We have decreased the darkness

Exemple of Patchwork Algorithm for Image

The image has been modified and we try to retrieve the original information.
Keep in mind: We know the location of the original modified pixel.



E[A*-B*]= E [(A+d) – (A-d)] = E[A-B] + 2d
And E[A-B]=0 as assumed. Thus we get :
E[A*-B*]= 2d
So we can retrieve d, and thus the embeded information.

But: don't work very well for audio signal.
Very sensitive to the modification.

Audio watermarking = same ideas but differencies

- Patchwork algorithm applicated to the frequency domain
- We use mean and variance to detect the watermarks
- Assume that the Distribution of the sample is gaussian
- We use A*=A(1+d) instead of A*=A+d
- d is decided adaptively.

Implemented Algorithm for embedding

- Apply a DFT, or DCT of size N on an audio frame an store the coefficients F.
- From a secret key, generate 2 Index with 2 n values pseudo-randomly chosen between 1 and N. Each index will represented 0 or 1.
- Define the subset A and B, with A=[F coefficients with subset equals to the first n elements of the Index of the desired values] . Same for B with the last n elements.

Implemented Algorithm for embedding (cont'd)

- Calculate the mean and the pooled sample standard error S of elements of A and B.

- Replace them by Ai*=Ai + sign(average(A-B))* C * S/2
  - C is a constant
  - Make the large value set larger, and small value set smaller
  - The distance between two sample is always bigger than square(C) *S

- Apply the inverse DCT. The signal is watermarked.

Exemple of the Algorithm:

- We apply the DCT to an audio frame:
  - F={2,4,3,4,4,5,5,1,0,0,3,8} of size N=12
- Random Generation of the Index I representing 0
  - I={2,4,5,9} of size 2n=4 (We keep that in memory)
    - Elements of I are >1 and <N=12
- We extract the coefficient of F, with subscript in I.
  - A={4,4} (2th and 4^{th} coeff of F according to first n elements of I) and B={4,0} (5^{th} and 9^{th} of F)
- We replace the elements of A and B by Ai* and Bi*
  - A={4+sign(Average(A-B))*C*S/2),….}
- We make the inverse operation, and replace the original F coefficient with the modified values
  - F={2,A1*,3,A2*,B1*,5,5,1,0,B2*,3,8}

Implemented Algorithm for deembedding

- Retrieve the modified DFT,DCT coefficient for the Index representing 0, and 1. A0 and B0 and A1 and B1.
- Compute the sample means and pooled sample error (S0,S1) for A0,B0…
- See what for what set we get the biggest values T:
  - $T0 = (ave(A0)-ave(B0))^2 / S^20$ or $T1 = (ave(A1)-ave(B1))^2 / S^21$.
- If T is bigger than a predecided threshold then we assume that the signal is watermarked.

Summarize: What I Have done so far ?

- Understanding globally what a Watermark is. Uses and Applications.
- Understand MPA Algorithm.
- Try to understand deeply the paper.
- Implemented the embedding algorithm
- Implemented the deembedding algorithm

Summarize: Still need to do ?

- Explain why the algorithm works well

- Does it satisfy the conditions
  - Transparency
  - Robust to pitch distorsion, passband filter…
  - Secure
  - Statistically Undetectable
  - Comparaisons between Watermarking applicated to speech and music.