Project Proposal :

Modified Patchwork Algorithm : A Novel Audio Watermarking Scheme.

**Chervet Benjamin : 20086457**

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## I.Introduction

This ”project proposal“ is a description of the paper I m working on, and how I could work on it and get some benefits of it.

This project is a personal project and should be the implementation, of an algorithm or method described in a reference article closely related to digital speech signal processing. There are two goals to this project: 1) understanding, and discovering a paper and a new field by ourselves 2) Applicate some algorithm and method discovered during the lecture.

I have chosen the watermarking topic, related to the digital speech processing, however it does not contain directly a lot of major tools we have studied this semester, excepting Fourier Transform, and other frequency transform. Nevertheless I will try to use the tools studied during the lecture, and focus on the speech signal in order to extend the field of the studied work in this paper.

I will first introduce what the Watermarking is, and more specifically, the Audio watermarking and go on with the specificity of the above algorithm. Then I will talk about the methods used in this paper to do the watermarking. Next I will describe what I intend to implement and test during the project with a tentative of Schedule and I will try to anticipate what results I would be able to provide by the end of the project.

## II. Description of the Paper objectives

## What is Watermarking ?

The watermarking is a method that enables to add some information into a Video, Image, or Audio signal. The watermarking could be hidden or visible depending on the usage you want to do of the information. It is mostly use to track copyrighted materials.

For example if a radio owner, want to broadcast copyrighted material, that he receives but only for listening and not broadcasting purpose, the owner of the rights should be able to prove that he has not the right to broadcast that materials just by recording, and the studying the watermarks included in the broadcast signal, even if the signal has been strongly altered.

A good watermarking should have two characteristics: 1) be inaudible, we should not detect that something has been added to the speech signal 2) Robust, it should resists to all kind of modifications (pitch modification, time-scale) and encoding (lpc encoding for example).

## Specificity of the Audio Watermarking.

The audio watermarking tends to be harder than the other watermarking used in video, and image watermarking. Mostly because the human ear is more sensible to some added signal, especially when the signal is really weak. Nonetheless the Audio Watermarking studied there, is build upon the MPA Watermarking widely used in Image watermarking.

## c. The Novel Audio Watermarking Scheme

Our specific audio watermarking algorithm is based on the Patchwork algorithm developed by Arnorld, but is a huge improvement and refinement of it developed by In Kwon Yeo and Hyoung Joong Kim. The Arnold algorithm major breakthrough was to use the frequency domain, to write the watermarked information. The Novel Audio Watermarking Scheme has made the basic ideas behind the Arnold Algorithm effective mostly by adapting the watermark to the signal.

## III.Methods

The goal of this part is not to present the detailed calculus as they are available in the Article. Nevertheless I will briefly describe what algorithm and tools I should implement and how.

I will use Matlab to work on this subject. It is one of the software that I know the most, and the easiest to use and to debug without having to go through a huge learning sessions. Moreover a lot of basic function are implemented and work well without need to redesign it (graph, adaptative filter for examples).

## General

The basic ideas between the watermarking are to slightly modify two patches of the samples of the discrete cosine transform of the signal.

a\*= (d + 1 )a and b\*=(d+1)b;

Where a\* and b\* corresponds to the signal outputted after watermarking, d to the adaptative factor used to add the watermarked data, and b and a to the original signal. We assume, that the a and b distribution is normal.

## Embedding the Data

I will go quickly to this part, and no talk about the Information Theory behind the encoding. I will be more concentrated about talking about the signal speech processing.

To embedded the Data, we should first get the Discrete Cosine transform, which is not a hard job in Matlab, and then we should calculate the pooled sample standard error, of the DCT in order to get a the factor S. The watermarking signal modificator “d”, would then be proportional to “S”. The goal of this proportionality is to adapt the factor d to the signal in order to keep being inaudible without nonetheless letting the watermarked information be indefectible.

We would then be able to output with an inverse discrete cosine transform to rebuild the signal.

## Retrieving the embedded data

To retrieve the signal processing, we should do the inverse cosine transform, and do a lot of statistical study and implement an algorithm using some probabilistic methods to get the watermarked information back.

## d.Test

Most of my jobs, once the embedding, and deembedding algorithm done, will primarily consist in building some test, to see how the watermarked information reacts. It will include a lot of interesting algorithm to build including: echo addition, noise addition, pitch modification, time scale modification, lpc encoding, and synthesis in order to know if the watermarked information can be detected trough a phone. I will try to see what factor have an influence in the robustness of the watermarked information. I could as well try to encode in MP3, OGG VORBIS or different reduction encoder my speech.

## IV. Project Objectives

To summarize, my project objectives are:

-Build a watermarks embedder.

-Implement the watermark deembedder.

-Build a series of different test, most of them based on what we have learned during the lecture, to check the inaudibility and robustness of algorithm.

-Detect the main tendency in the robustness, and inaudibility of the watermarking.

And if I manage to get some extra time before December 19:

-Try to improve by minor modification, the robustness of the watermarking.

-See how the algorithm works, by using other transform (fourier, Hilbert, lpc , wawelet) (much more ambitious but most interesting).

-Try to find some close relation to work on it later, between digital speech and watermarking.

## IV. Tentative of Schedule

From the end of this week, till December 19 we have 4 weeks to go.

Week 1: Understand deeply the algorithm, all the paper, and build the embedder.

Week 2: Make the deembedder.

Week 3: Implements the tests, and collect the results.

Week 4: Make the presentation, detect the tendency and draw the main conclusions about the watermarking algorithm.

## V. Results to be presented

1. Code of the embedder and deember
2. Code of the implemented test.
3. Error rate of the watermarked information according to all the above cited modification of the signal.
4. Tendency and tentative of explication of the above results.
5. Conclusion

## VI.Conclusion

Watermarking seems to be a perfect task for 4 weeks, part time project leading to further investigations on the topic. It is feasible in 4 weeks, but not exhausted as they are a lot of different qualities needed for the watermarking algorithm to perform well. Moreover, it seems to be a still active and useful research area.