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Summary:

In this project we are going to hide 9 digits in an audio, therefore no one except a specific receiver cannot have access to the digits, afterwards we use some lowpass filters with different frequencies and see whether we can recover the 9 digits or not.

Question 1:

One of the methods of watermarking is additive watermarking. Suppose that we are going to store I bit of w in a N vector of X={X1,X2,…XN}. W is either 0 or 1. So finally the information bit is :

$$Y = X + \alpha PN_w$$

N is a random vector of {-1,1}. Y is the vector that we want to send and alpha is the gain coefficient.

In this question we are going to run a function that the inputs are X the carrier, alpha, student id and the length and the output is the watermarked signal.

```
function Y = embedding( X, StdID, alpha, NLength )
```

First and foremost, we need to convert our 9 digits in to binary form, then we store it in an array 4*length of the first one, then by using a for loop, we determine whether the used bits in W are 1 or -1, if the bits were 1 it is PN1 and else it's PN2, after that due to the equation we multiple these vectors to alpha and then add them to X.

The audio file is: embedded.wav

Question 2:

In this question we are supposed to recover the 9 digits using another function.

```
function StdID = extracting( Y, alpha, NLength )
```

Like the previous question we initiate a vector to 0, this vector has a length of 36 and stores the 36 binary digits. We have decision rule here:

$$w^* = \begin{cases} 1, & Y^T PN_1 > 0 \\ 0, & Y^T PN_0 > 0 \end{cases}$$

Transpose of Y vector must be calculated and then we shall multiple it to PN.

Note: when alpha is increased, the noise over the audio is also increased and it is some kind of accumulative noise so it is easy to sense it. If we use a small alpha some data will be missed because of multiplication. By increasing N the channel capacity will decrease, therefore the data recovery will be much easier.

Question 3:

In this question we are going to determine the effects of increasing alpha and N on the errors.

Alpha:

First, we set alpha to 0.0001 and we use 10 points with 0.01 distance. An empty YS vector is defined in order to store the data in it and afterwards comparing it to X. The error is easily calculated with IMSSE syntax.

N:

We do all the previous steps for N.

Results:

Overall, by increasing N and Alpha the error is also increased. The increase Rate in alpha is way more than the N.

Question 4:

In this question fdatool is a wise choice. We define 5 lowpass filters with cut off frequency of 1000,1500,2000,3000,5000. Then these filters are added to watermarked signals. Finally, we can sense that by using the 5k filter the sound doesn’t have the same quality and the quality has increased