

Homework 2 (Due: 11^h Nov.)

Note: Do not forget the extra question.

- (1) When using the scaled Gabor transform with window $\exp(-\pi\sigma t^2)$ to analyze a music signal, should we choose a larger or a smaller σ ? Why? (10 scores)
- (2) (a) Calculate the Wigner distribution function (WDF) of $\exp(-\pi t^2)$.
Hint: Using the fact that the FT of $\exp(-\pi t^2)$ is $\exp(-\pi f^2)$.
(b) Calculate the WDF of $\delta(2t - 1)$. (15 scores)
- (3) Compare the 4 methods to implement the STFT in terms of (a) complexity and (b) constraints. (c) Which methods can also be used for implementing the WDF? (15 scores)
- (4) Why (a) the windowed Wigner distribution function, (b) Cohen's class distribution, and (c) the Gabor-Wigner transform can avoid the cross term problem in some cases? (15 scores)
- (5) In what condition the output of Cohen's class distribution is real?
(Written the constraint for $\Phi(\eta, \tau)$) (10 scores)

(6) Write a Matlab program for [the scaled Gabor transform](#) (unbalanced form).

$y = \text{Gabor}(x, \tau, t, f, \text{sgm})$ (page 98) (35 scores)

x : input, τ : samples on t -axis for the input, t : samples on t -axis for the output

f : samples on f -axis, sgm : scaling parameter, y : output

(i) The Matlab or Python code should be handed out by NTUCool, (ii) Choose an input x (Use [*.wav](#)) , plot the output y . (iii) Also show the running time , (iv) Determine τ of the following example , (v) The running time should be as short as possible (for the following example, [within 1.5 seconds](#))

```
[a1, fs] = wavread('Chord.wav');  
x=a1(:,1).'; % only extract the first channel  
tau = (? Please think how to determine tau);  
dt = 0.01; df = 1;  
t= 0:dt:max(tau); f= 20:df:1000;  
sgm= 200;  
tic  
y= Gabor (x, tau, t, f, sgm);  
toc
```

(Extra): Answer the questions according to your student ID number.
(ended with 0, 1, 2, 4, 5, 6, 7, 9)