stdft

August 16, 2024

[7]:

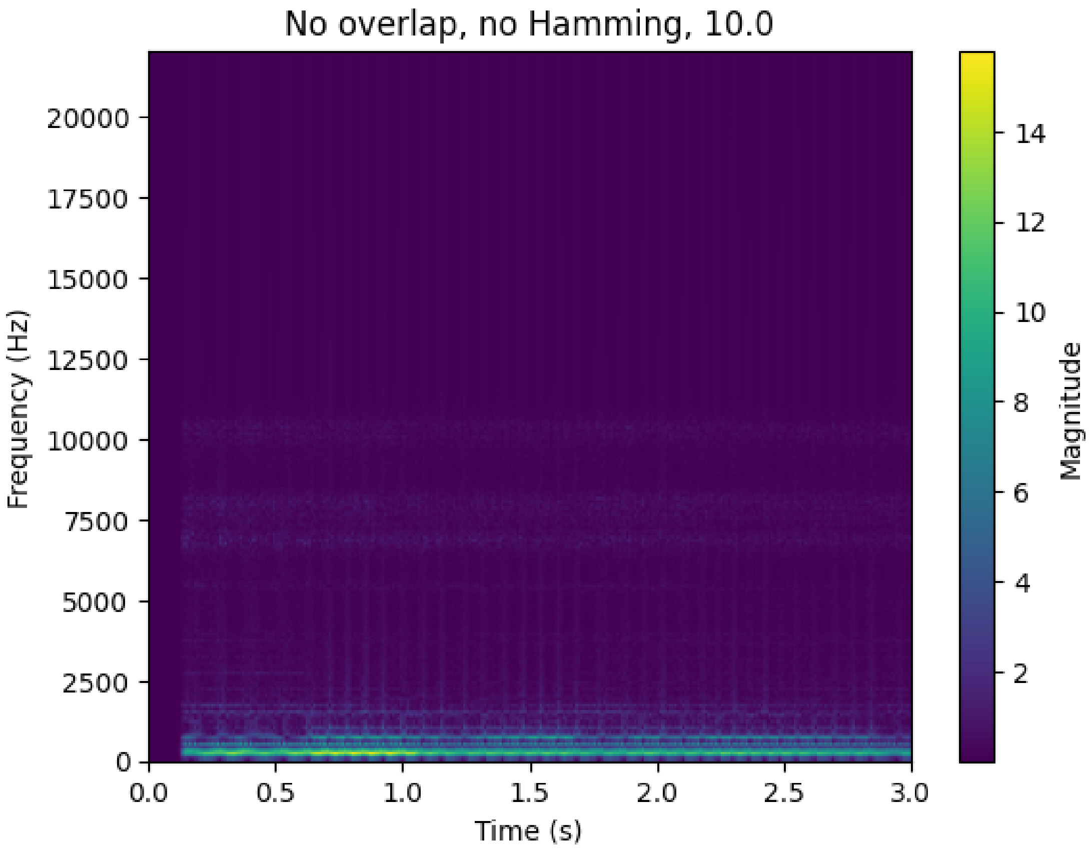
```python
from scipy.fft import fft, ifft
import soundfile as sf
import numpy as np
import matplotlib.pyplot as plt
from scipy.signal import hamming
import sounddevice as sd
from scipy.io.wavfile import write
```

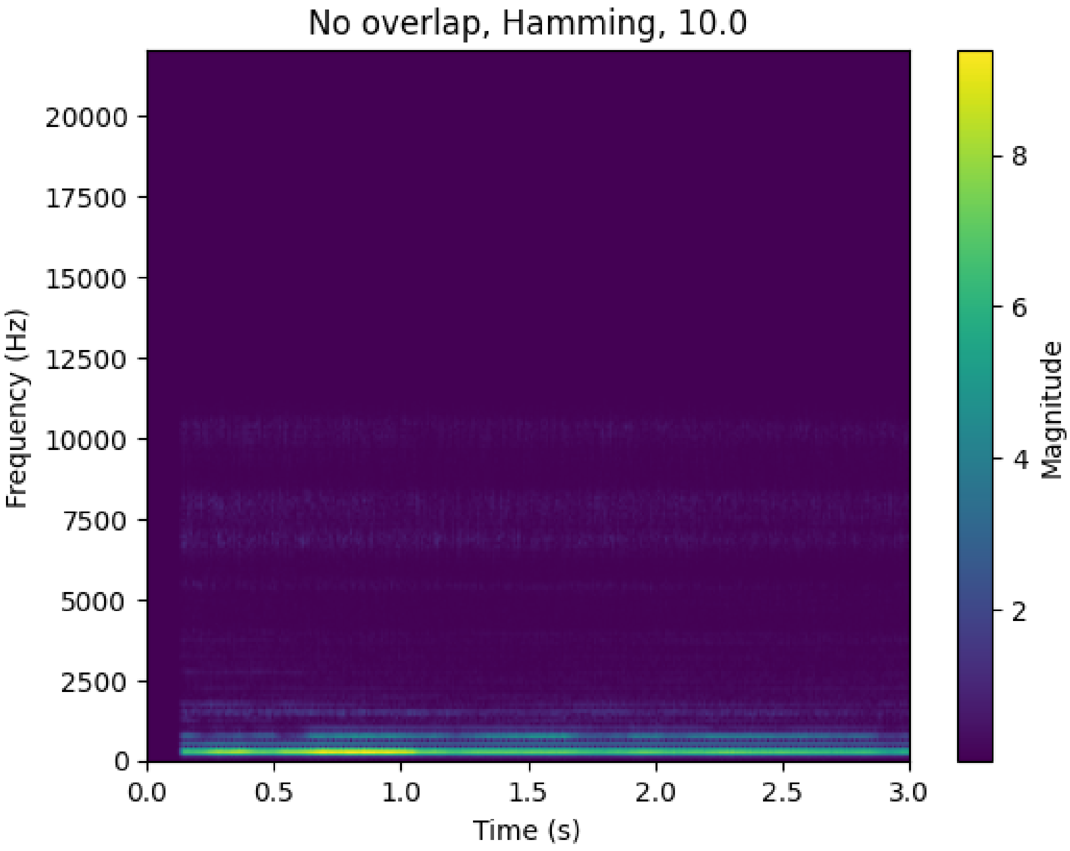
[10]:

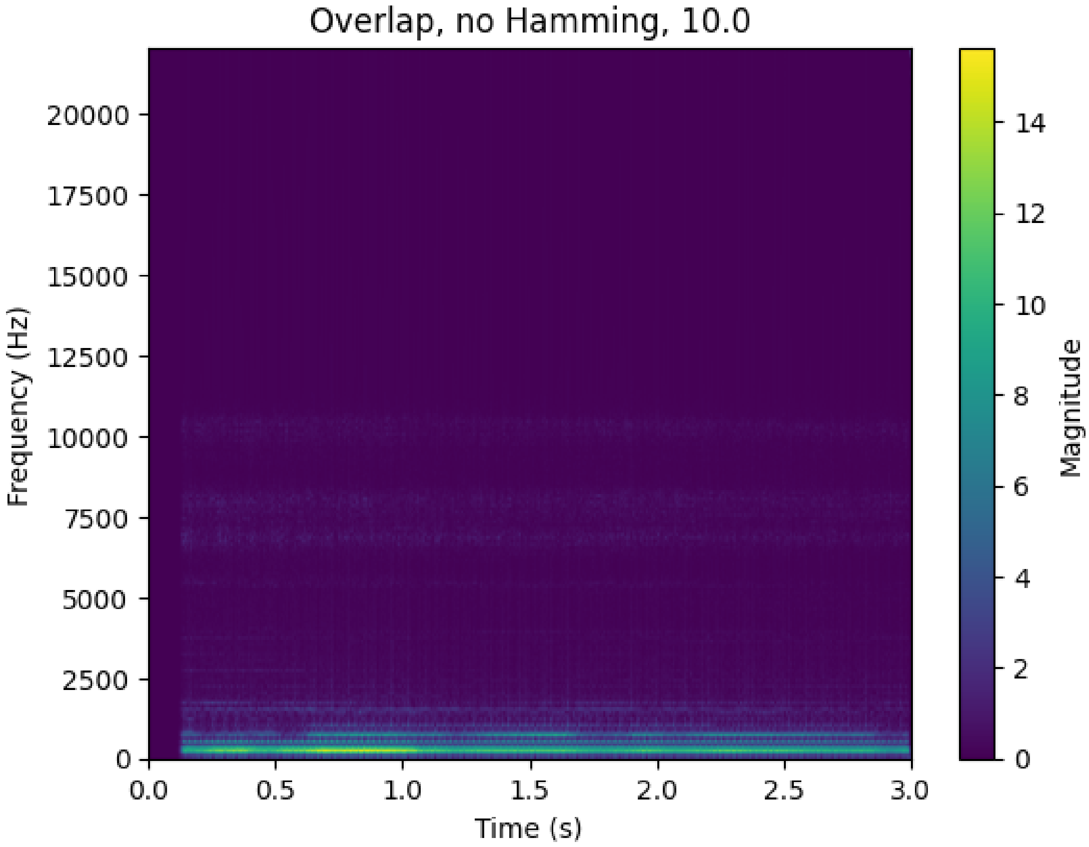
```python
def stdft(filename):

    data, fs = sf.read(filename)

    window_width = [10, 20, 50, 100]

    for i in range(0, len(window_width)):
        window_width[i] = int((window_width[i] * fs) / 1000)  #pretvori v sekunde

    for window in window_width:

        #kopiranje, ce je padding potrebno
        data_copy = data.copy()

        #pad, ce je potrebno
        while len(data_copy) % window != 0:
            data_copy = np.pad(data_copy, (0, 1)) #na koncu dodaj ničlo

        #brez prekrivanja, brez Hamminga

        Y = []

        for i in range(0, len(data_copy), window):

            section = data_copy[i:(i + window)]

            #izračunaj fft, vzemi samo pozitivne frekvence
            X = np.abs(fft(section))[:(int(window / 2))]
            Y.append(X)

        Y = np.asarray(Y).T

        #časovne in frekvenčne parametre za izris
        time = np.linspace(0, int(len(data) / fs), len(Y))
        frequency = np.linspace(0, (fs / 2), len(Y[0]))

        plt.imshow(Y, aspect='auto', origin='lower', extent=[time[0], time[-1],␣
↪frequency[0], frequency[-1]])
        plt.colorbar(label='Magnitude')
        plt.xlabel('Time (s)')
        plt.ylabel('Frequency (Hz)')
        plt.title(str("No overlap, no Hamming, " + str(window * 1000 / fs)))
        plt.show()

        #brez prekrivanja, Hamming

        hamming_window = hamming(window)

        Y = []

        for i in range(0, len(data_copy), window):

            section = data_copy[i:(i + window)] * hamming_window

            #izračunaj fft, vzemi samo pozitivne frekvence
            X = np.abs(fft(section))[:(int(window / 2))]

            Y.append(X)

        Y = np.asarray(Y).T

        #časovne in frekvenčne parametre za izris
        time = np.linspace(0, int(len(data) / fs), len(Y))
        frequency = np.linspace(0, (fs / 2), len(Y[0]))

        plt.imshow(Y, aspect='auto', origin='lower', extent=[time[0], time[-1],␣
↪frequency[0], frequency[-1]])
        plt.colorbar(label='Magnitude')
        plt.xlabel('Time (s)')
        plt.ylabel('Frequency (Hz)')
        plt.title(str("No overlap, Hamming, " + str(window * 1000 / fs)))
        plt.show()

        #prekrivanje, brez Hamminga
```

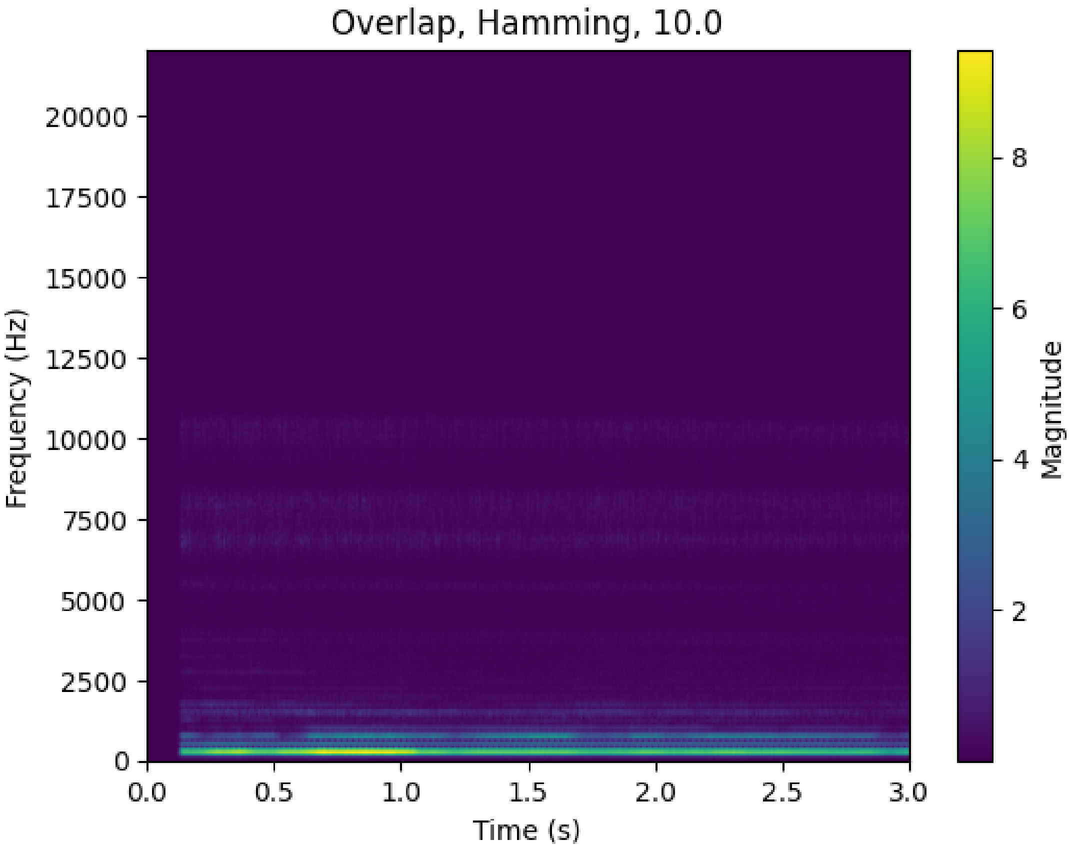
```
    overlap = int(window / 2)

    #kopiranje, ce je padding potrebno
    data_copy2 = data.copy()

    #pad, ce je potrebno
    while len(data_copy2) % overlap != 0:
        data_copy2 = np.pad(data_copy2, (0, 1)) #add one zero at the end

    Y = []

    for i in range(0, len(data_copy2), overlap):

        section = data_copy2[i:(i + window)]

        #izračunaj fft, vzemi samo pozitivne frekvence
        X = np.abs(fft(section))[:(int(window / 2))]

        Y.append(X)

    Y = np.array(Y).T

    #časovne in frekvenčne parametre za izris
    time = np.linspace(0, int(len(data) / fs), len(Y))
    frequency = np.linspace(0, (fs / 2), len(Y[0]))

    plt.imshow(Y, aspect='auto', origin='lower', extent=[time[0], time[-1],␣
↪frequency[0], frequency[-1]])
    plt.colorbar(label='Magnitude')
    plt.xlabel('Time (s)')
    plt.ylabel('Frequency (Hz)')
    plt.title(str("Overlap, no Hamming, " + str(window * 1000 / fs)))
    plt.show()

    #prekrivanje, Hammming

    Y = []

    for i in range(0, len(data_copy2) - window + 1, overlap):

        section = data_copy2[i:(i + window)] * hamming_window

        #izračunaj fft, vzemi samo pozitivne frekvence
        X = np.abs(fft(section))[:(int(window / 2))]

        Y.append(X)
        Y = np.asarray(Y).T

        #časovne in frekvenčne parametre za izris
        time = np.linspace(0, int(len(data) / fs), len(Y))
        frequency = np.linspace(0, (fs / 2), len(Y[0]))

        plt.imshow(Y, aspect='auto', origin='lower', extent=[time[0], time[-1],␣
↪frequency[0], frequency[-1]])
        plt.colorbar(label='Magnitude')
        plt.xlabel('Time (s)')
        plt.ylabel('Frequency (Hz)')
        plt.title("Overlap, Hamming, " + str(window * 1000 / fs))
        plt.show()
```

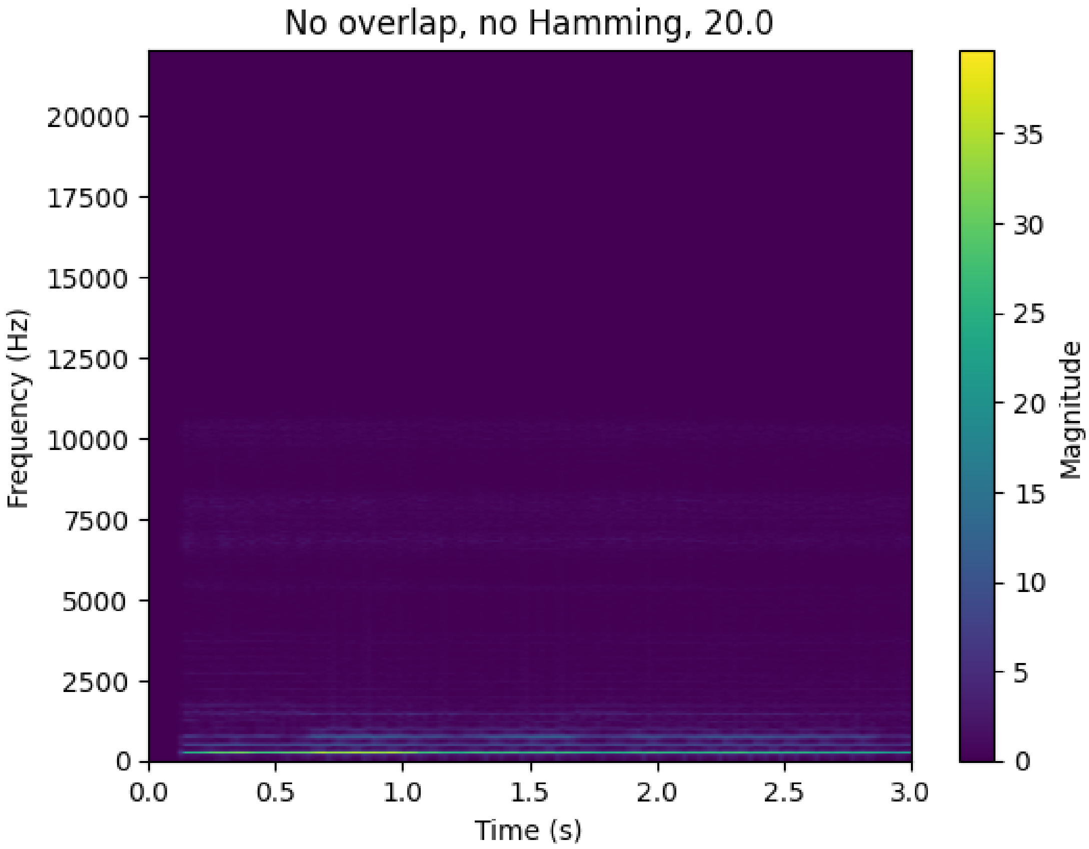
[216]:
```
stdft("a.wav")
```

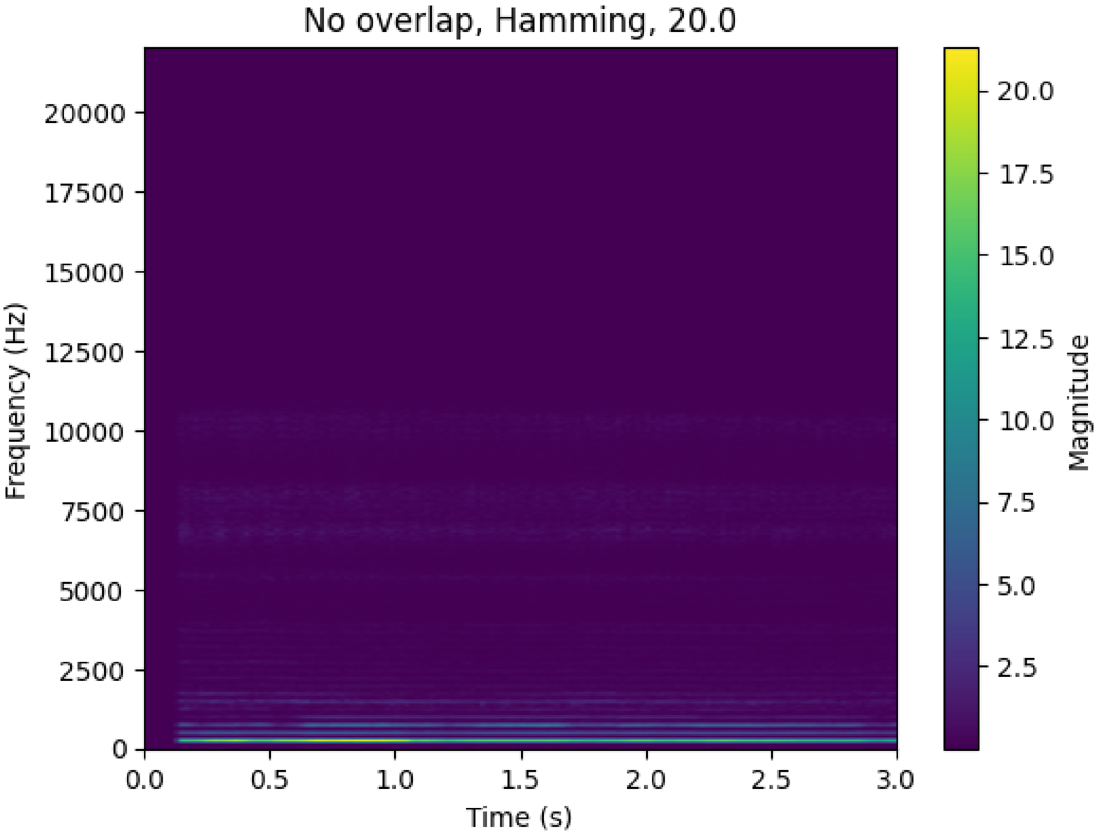


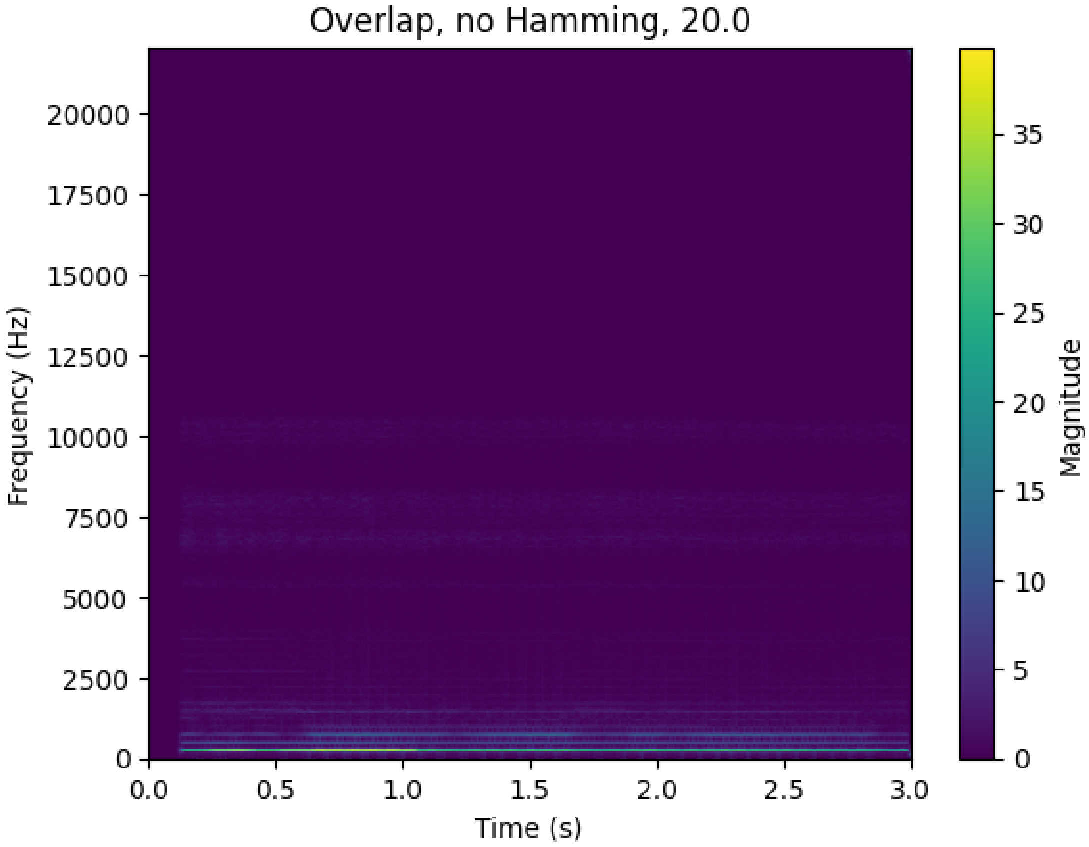

No overlap, Hamming, 10.0
Frequency (Hz)
20000
17500
15000
12500
10000
7500
5000
2500
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Time (s)
Magnitude
8
6
4
2

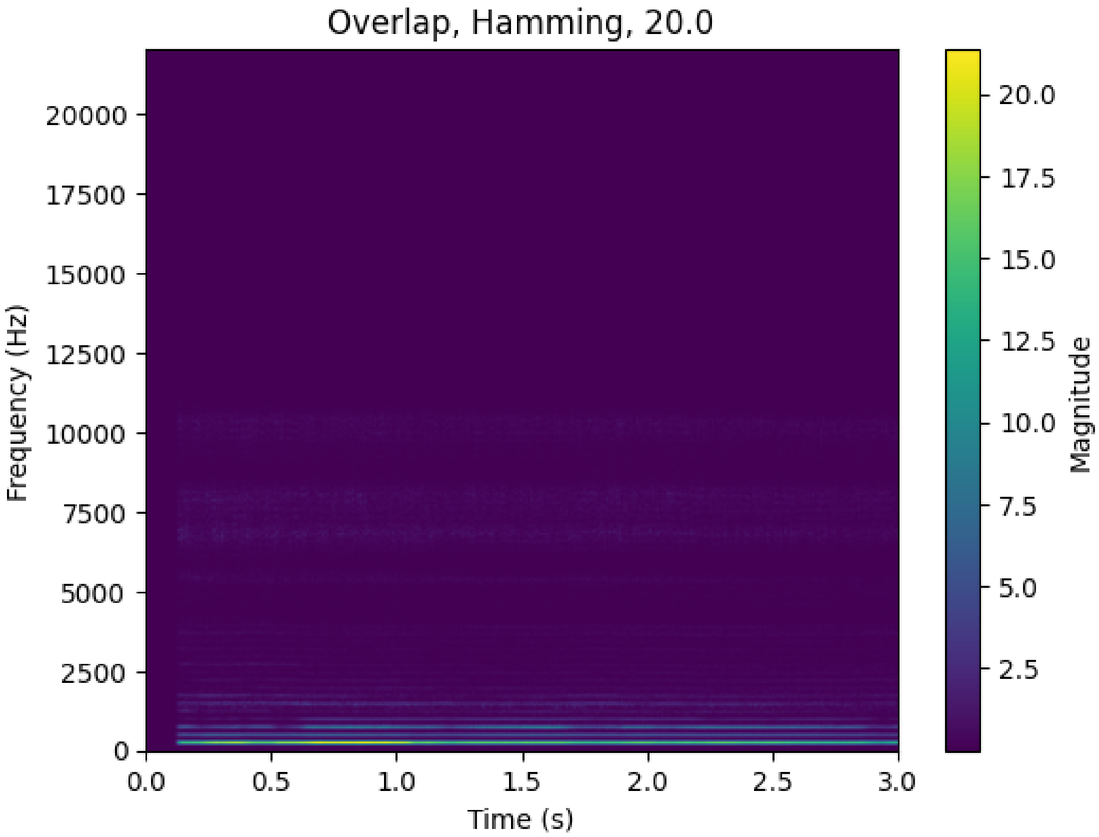

Overlap, no Hamming, 10.0
Frequency (Hz)
20000
17500
15000
12500
10000
7500
5000
2500
0
Time (s)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Magnitude
14
12
10
8
6
4
2
0

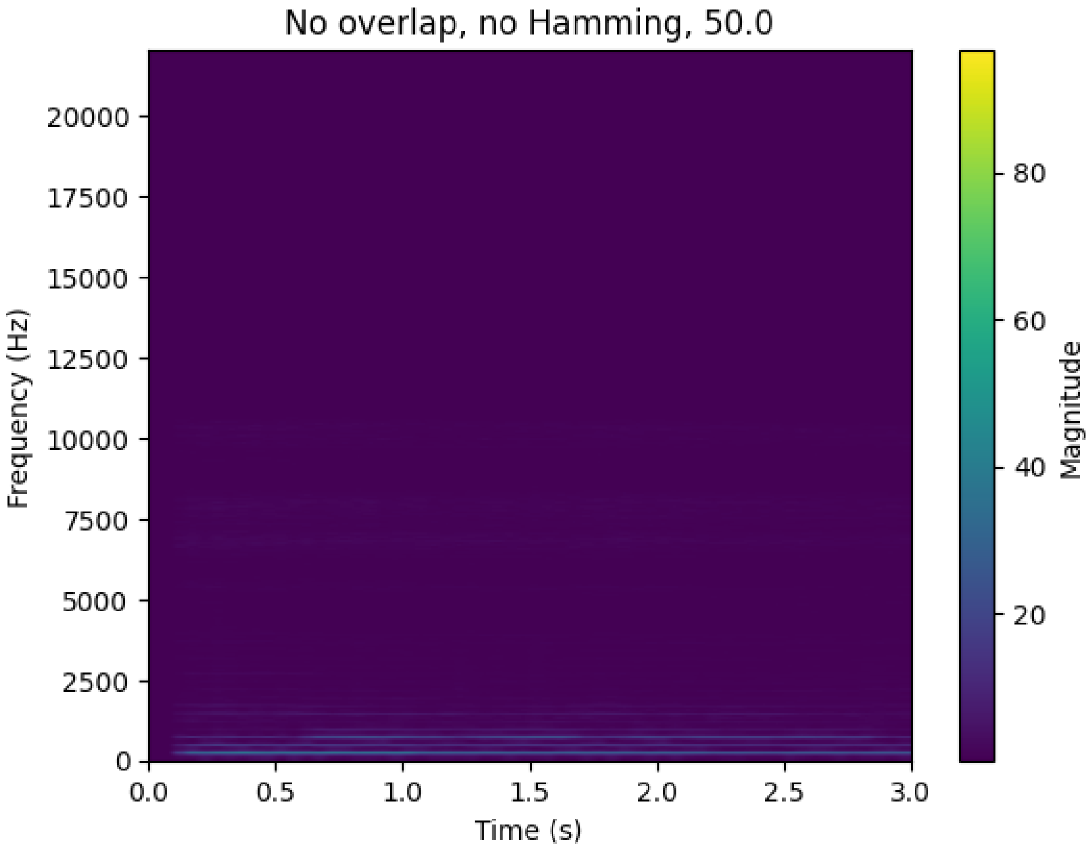

Overlap, Hamming, 10.0
Frequency (Hz)
20000
17500
15000
12500
10000
7500
5000
2500
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Time (s)
Magnitude
8
6
4
2

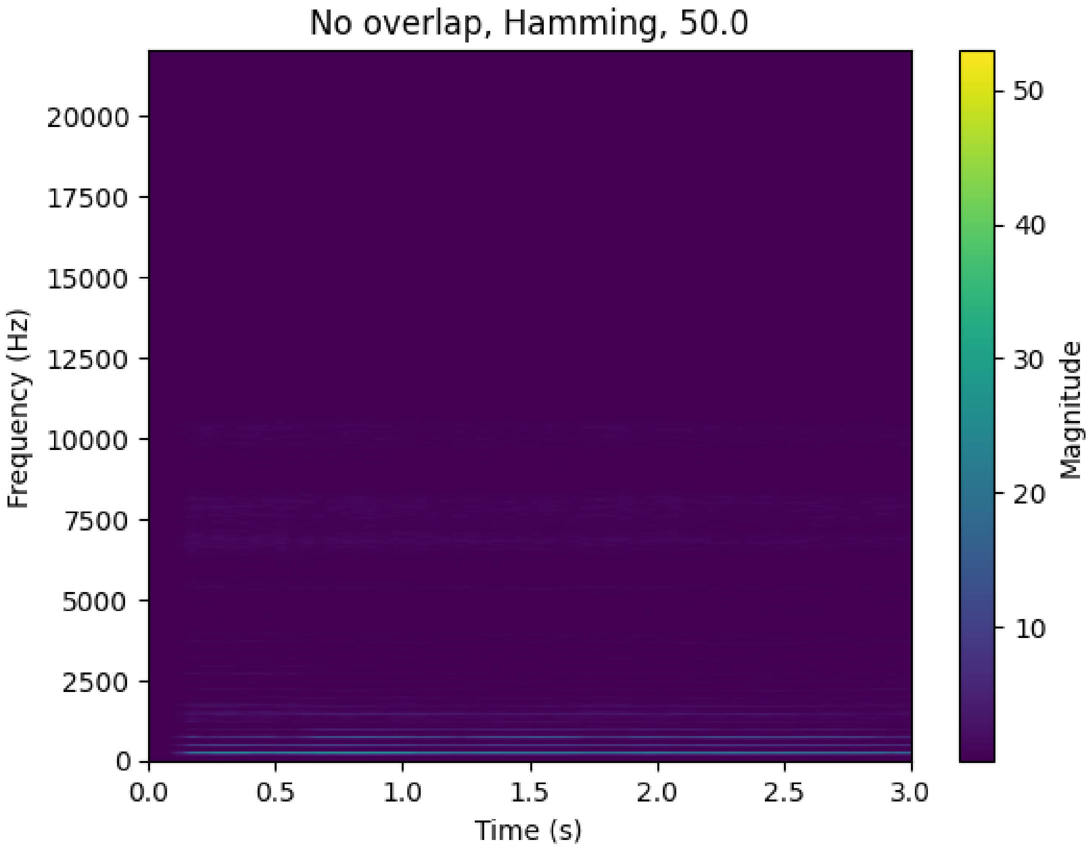

No overlap, no Hamming, 20.0
Frequency (Hz)
20000
17500
15000
12500
10000
7500
5000
2500
0
Time (s)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Magnitude
35
30
25
20
15
10
5
0

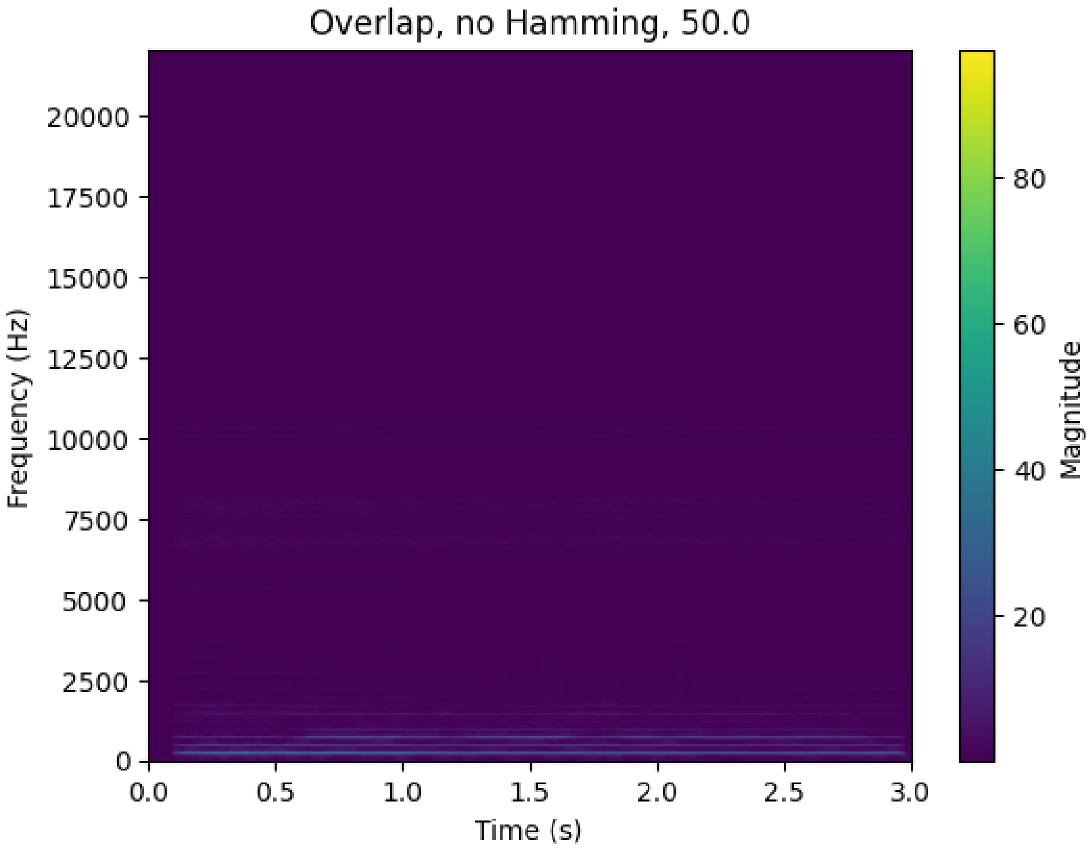

No overlap, Hamming, 20.0
Frequency (Hz)
20000
17500
15000
12500
10000
7500
5000
2500
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Time (s)
Magnitude
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5

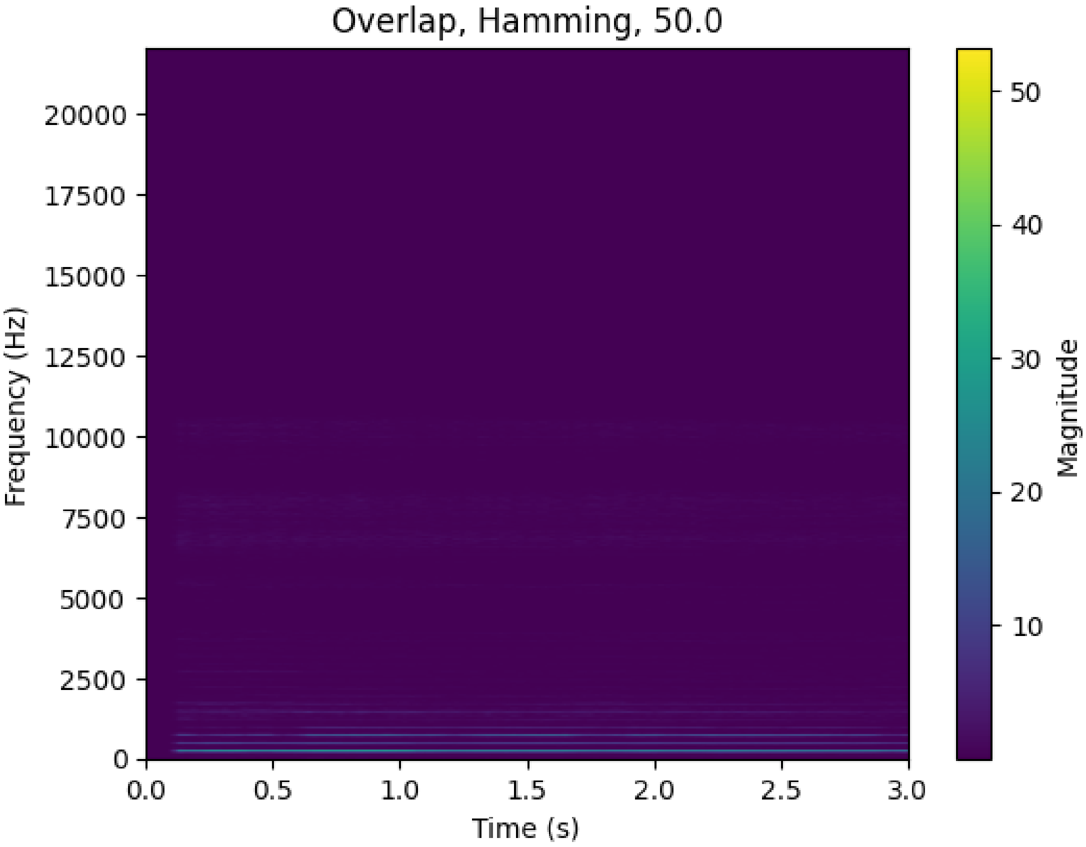

Overlap, no Hamming, 20.0
Frequency (Hz)
20000
17500
15000
12500
10000
7500
5000
2500
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Time (s)
Magnitude
35
30
25
20
15
10
5
0

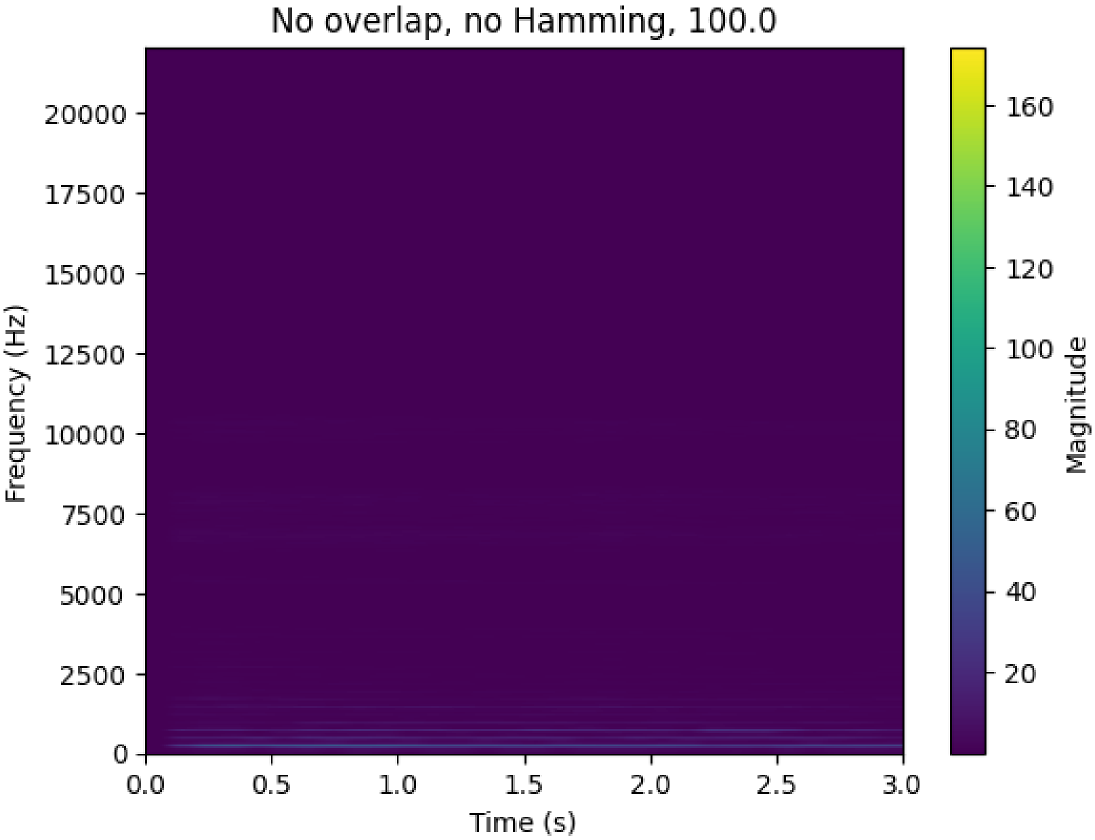

Overlap, Hamming, 20.0
Frequency (Hz)
20000
17500
15000
12500
10000
7500
5000
2500
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Time (s)
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
Magnitude

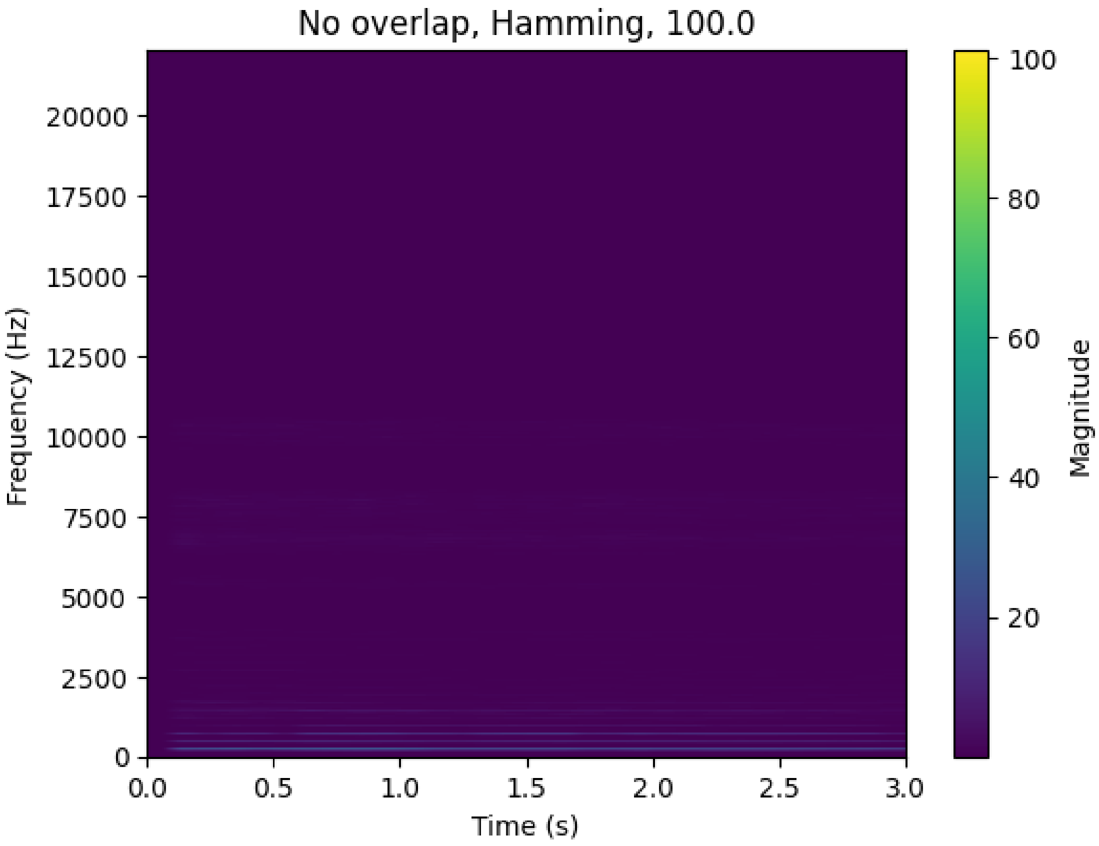

No overlap, no Hamming, 50.0
Frequency (Hz)
20000
17500
15000
12500
10000
7500
5000
2500
0
Time (s)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Magnitude
80
60
40
20

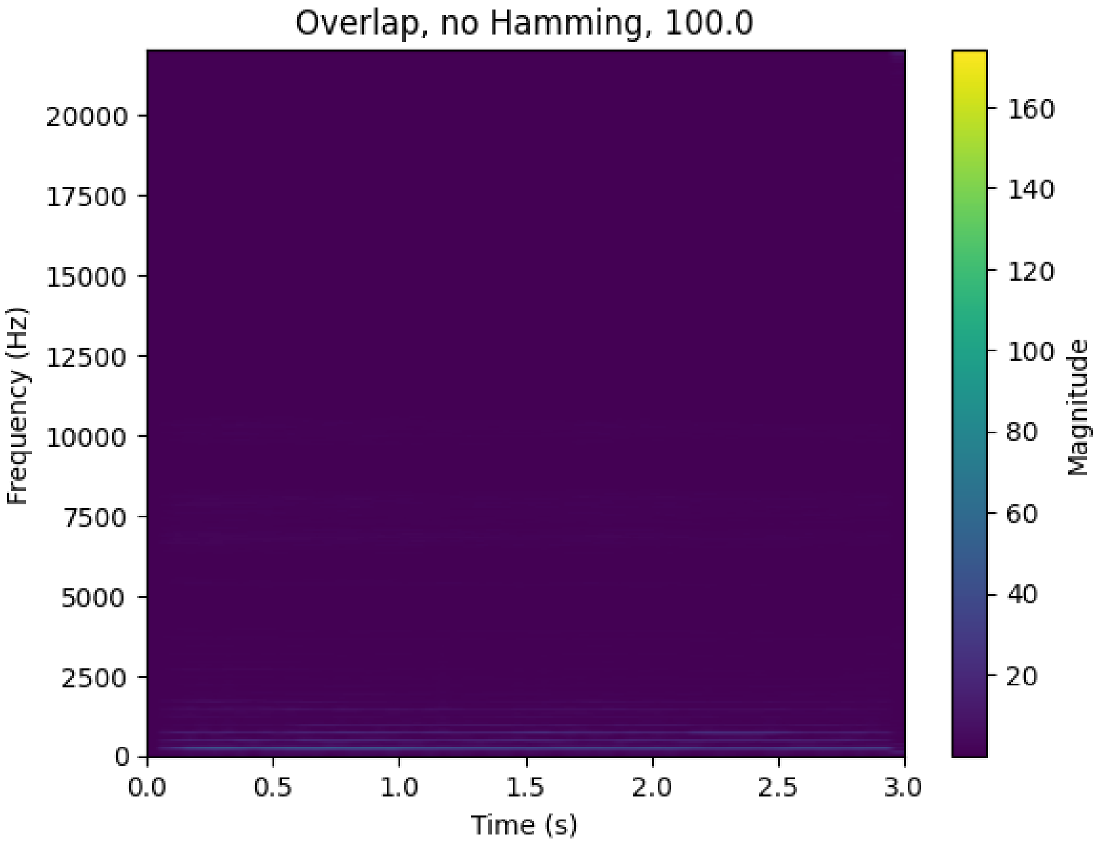

No overlap, Hamming, 50.0
Frequency (Hz)
20000
17500
15000
12500
10000
7500
5000
2500
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Time (s)
Magnitude
50
40
30
20
10

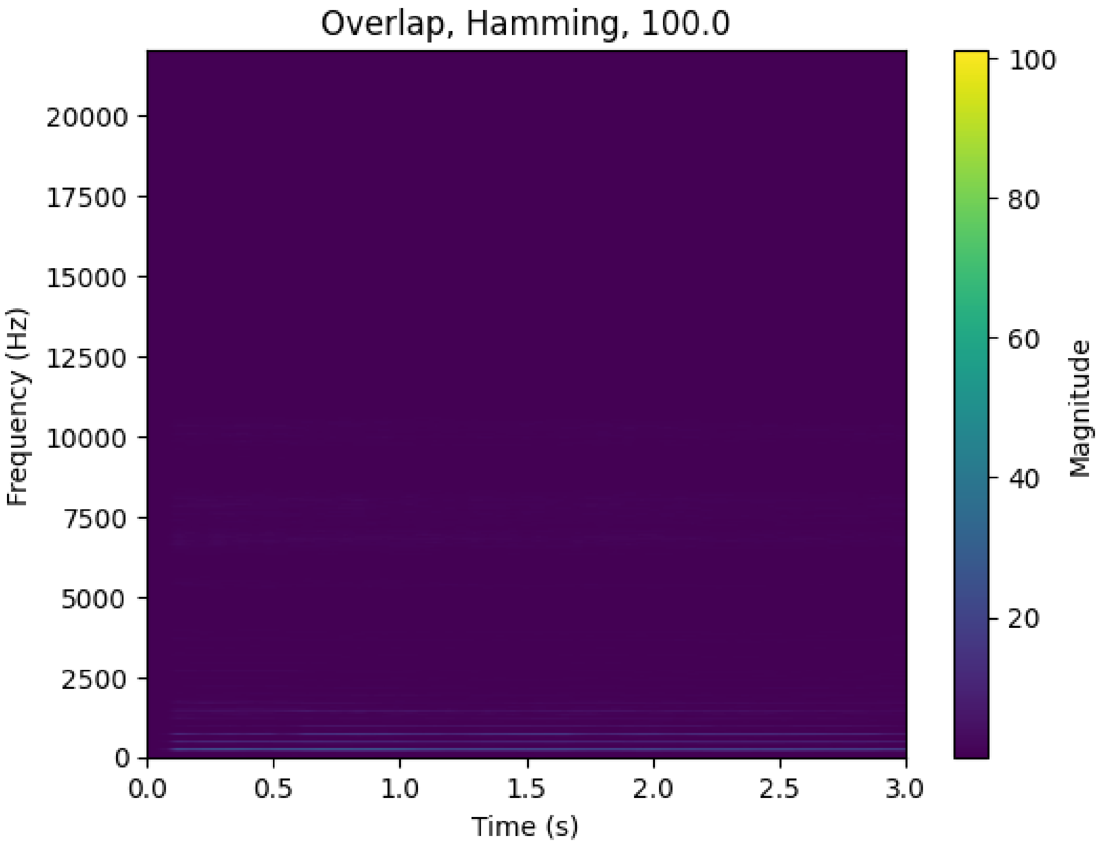

Overlap, no Hamming, 50.0
Frequency (Hz)
0
2500
5000
7500
10000
12500
15000
17500
20000
Time (s)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Magnitude
20
40
60
80


Overlap, Hamming, 50.0
Frequency (Hz)
20000
17500
15000
12500
10000
7500
5000
2500
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Time (s)
Magnitude
50
40
30
20
10


No overlap, no Hamming, 100.0
Frequency (Hz)
20000
17500
15000
12500
10000
7500
5000
2500
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Time (s)
160
140
120
100
80
60
40
20
Magnitude


No overlap, Hamming, 100.0
Frequency (Hz)
20000
17500
15000
12500
10000
7500
5000
2500
0
Time (s)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Magnitude
100
80
60
40
20


Overlap, no Hamming, 100.0
Frequency (Hz)
20000
17500
15000
12500
10000
7500
5000
2500
0
Time (s)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Magnitude
160
140
120
100
80
60
40
20



[13]:
```
# stdft("e.wav")
```

[14]:
```
# stdft("i.wav")
```

[15]:
```
# stdft("o.wav")
```

[16]:
```
# stdft("u.wav")
```

[17]:
```
# stdft("r.wav")
```

[18]:
```
# stdft("mama.wav")
```

[19]:
```
# stdft("eva_in_olu.wav")
```

[20]:
```
# def record(filename):
#     recording = sd.rec(int(3 * 44100), samplerate=44100, channels=1)
#     sd.wait()  # čakaj, dokler se snemanje ne konča
#     write(filename, 44100, recording)

# record("eva_in_olu_faster.wav")
# stdft("eva_in_olu_faster.wav")
```

[ ]:

```
#V zadnjem primeru je zelo zanimivo videti, kako lahko hitrost izgovorjave␣
 ↪vpliva na spektrogram signala.
#Tu lahko vidimo, da morajo biti okna manjša, da bi zajeli frekvenčno sliko iz␣
 ↪prejšnje slike, prekrivanje
#med njimi pa mora biti večje.
#Pri krajšem časovnem intervalu so višje harmonske bolj zmešane, pri daljšem pa␣
 ↪lahko vidimo jasnejše in
#natančnejšo črto na frekvenci, ki jo predstavlja.
```