Binaural Sound from Monoaural sound

Aman Tiwari (2017EE10436)
Anshul Yadav (2017EE10565)

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1 Binaural Sound From Monoaural Sound

Here we have used MIT's dataset of head-related transfer functions (HRTF) containing measurements of a KEMAR dummy head microphone. Binaural synthesis has been performed on monoaural sound.

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In [51]: from numpy import *
         from scipy import *
         from scipy.io import wavfile
         import matplotlib.pyplot as plt
         import warnings
         warnings.filterwarnings('ignore')

         def make_stereo(filename, sig_l, sig_r, fs=44100):
             sig = array([sig_l, sig_r]).T
             sig = sig / sig.max()
             wavfile.write(filename, fs, (15000*sig).astype(int16))

         def read_impulse(elev, azimuth, N=128):
             """ Accepts elev and azimuth in degrees, and returns closest impulse response and t

             elev, azimuth, flip = setangles(elev, azimuth)

             filename = "filters/MIT_KEMAR/full/elev"+str(elev)+"/L"+str(elev)+"e"+str("%03d" %
             fs, h_t_l = wavfile.read(filename)
             filename = "filters/MIT_KEMAR/full/elev"+str(elev)+"/R"+str(elev)+"e"+str("%03d" %
             fs, h_t_r = wavfile.read(filename)
             # print elev,azimuth TODO
             h_t_l = transpose(transpose(h_t_l))
             h_t_r = transpose(transpose(h_t_r))
             if flip:
                 return h_t_r, h_t_l
             return h_t_l, h_t_r

         def setangles(elev, azimuth):
             elev = int(elev)
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azimuth = int(azimuth)

#bring to multiple of ten
if elev != 0:
    while elev%10 > 0:
        elev = elev + 1

if elev > 90:
    elev = 90
if elev < -40:
    elev = -40

#Set increment of azimuth based on elevation
if abs(elev) < 30:
    incr = 5
elif abs(elev) == 30:
    incr = 6
elif abs(elev) == 40:
    incr = 6.43
    opts = [0, 6, 13, 19, 26, 32, 29, 45, 51, 58, 64, 71, 77, 84, 90, 96, 103, 109,
elif elev == 50:
    incr = 8
elif elev == 60:
    incr = 10
elif elev == 70:
    incr = 15
elif elev == 80:
    incr = 30
elif elev == 90:
    incr = 0
    azimuth = 0
flip = False

#bring into [-pi,pi]
while azimuth > 180:
    azimuth = azimuth - 180
while azimuth < -180:
    azimuth = azimuth + 180

#check if we need to flip left and right.
if azimuth < 0:
    azimuth = abs(azimuth)
    flip = True

if abs(elev) == 40:
    incr = 6.43
    num = incr
    while azimuth > num:
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            num = num + incr

        #azimuth = str(int(round(num)))
        azimuth = int(round(num))
        #special case for non-integer increment

    elif azimuth != 0:
        while azimuth % incr > 0:
            azimuth = azimuth + 1

    if int(azimuth) < 100:
        azimuth = "0" + str(int(azimuth))

    if int(azimuth) < 10:
        azimuth = "00"+ str(int(azimuth))

    return elev, int(azimuth), flip

def project(sig, elev, azimuth):
    h_t_l, h_t_r = read_impulse(elev, azimuth)

    Hw_l = fft(h_t_l, len(sig))
    Hw_r = fft(h_t_r, len(sig))

    f_diner = fft(sig)
    f_diner_l = Hw_l*f_diner
    f_diner_r = Hw_r*f_diner
    t_diner_l = ifft(f_diner_l, len(sig))
    t_diner_r = ifft(f_diner_r, len(sig))
    #t_diner_l = fftpack.convolve.convolve(sig, h_t_l)
    #t_diner_r = fftpack.convolve.convolve(sig, h_t_r)
    #print "dtype of t_diner_l in project", t_diner_l.dtype
    return t_diner_l, t_diner_r


def path(t_sig, start, end, duration=0, window_size=1024, fs=44100):
    """ Moves a sound from start to end positions over duration (Seconds)"""
    #print(window_size)
    M = (fs/2) / window_size
    w = r_[:fs/2:M]
    N = len(w)
    #print(len(w))
    #window = hamming_window(N)(r_[:window_size])
    window = hamming(N)#(r_[:window_size])
    #window = cut_gaussian(N) # TODO
    #window = sinc_times_gaussian(N) # TODO
    #print(window.shape)
    #print(window)
```

```
    i = 1
    elev = start[0]
    elev_end = end[0]

    if duration == 0:
        duration = len(t_sig)/fs

    azimuth = start[1]
    azimuth_end = end[1]
    N_steps = int(len(t_sig) * 2 / window_size)
    elev_delta = float((elev_end - elev) / float(N_steps)) #deg/half-window
    azimuth_delta = float((azimuth_end - azimuth) / float(N_steps))

    output_l = zeros( len(t_sig) )
    output_r = zeros( len(t_sig) )

    while i*(window_size) < len(t_sig):
        ind_min = int((i-1.)*window_size)
        ind_max = int((i)*window_size)
        #p=t_sig[ind_min:ind_max]
        #print(p.shape)
        t_sig_w = t_sig[ind_min:ind_max] * window
        t_output_l, t_output_r = project(t_sig_w, elev, azimuth)
        output_l[ind_min:ind_max] =output_l[ind_min:ind_max] + t_output_l
        output_r[ind_min:ind_max]= output_r[ind_min:ind_max] + t_output_r
        elev = elev + elev_delta
        azimuth = azimuth + azimuth_delta
        i = i + 0.5
    return output_l, output_r

def inverse_transfer_function(Hw):
    max_Hw = max(Hw)

    inv_Hw = (Hw + 1./max_Hw ) ** -1
    return inv_Hw

fs, t_diner = wavfile.read('wav/sa1.wav')
#print(t_diner)
#fs2, t_diner2 = wavfile.read('wav/couchplayin.wav')
#print(t_diner2)
#fs, t_diner2 = wavfile.read('wav/sa2.wav')
print("original framerate (in Hz)", fs)

t_diner_l, t_diner_r = path(t_diner, (0, -90), (0, 90), 5, fs/10, fs)
#t_diner_l2, t_diner_r2 = path(t_diner2, (0,70), (0, -70), 0, fs/10., fs)

final_l = t_diner_l # TODO longest of the two
#final_l[:len(t_diner_l2)] += t_diner_l2
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        final_r = t_diner_r
        #final_r[:len(t_diner_r2)] += t_diner_r2
        make_stereo('wav/360_headphone.wav', final_l, final_r, fs)
        plt.plot(final_l)
        plt.plot(final_r)
        plt.savefig("fig/test.png")
```

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original framerate (in Hz) 16000
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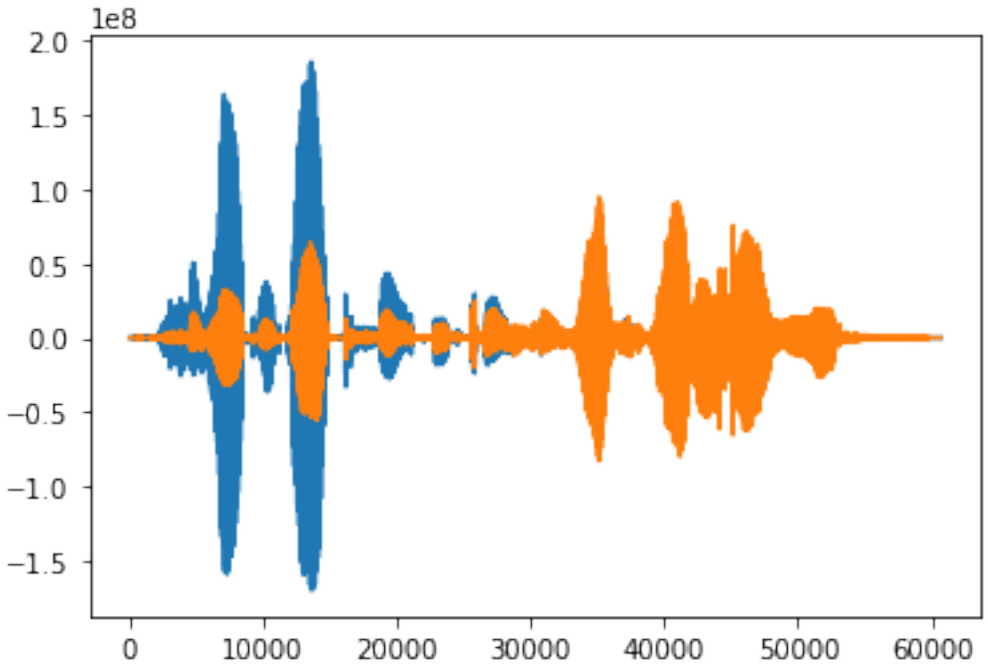

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