AMdecoderbitstring

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1 Program - AMdecoderbitstring

Decodes an AM modulated signal from a sound file, with name in the argument E.g.,: python AMdecoderbitstring.py amfile.wav

```
- Gerald Schuller, Januar 2015
```

- **Import the relevant modules:**

```
In [1]: import sound
        import scipy
        import scipy.signal
        import numpy as np
        import matplotlib.pyplot as plt
        import sys
        import cv2
```

```
In [2]: CHUNK = 1024

        print("filename=", sys.argv[1])
        sndfile = sys.argv[1]
```

```
('filename=', '-f')
```

- **Read in sound file:**

```
In [3]: [AM, FS] = sound.wavread(sndfile)
```

```
('Number of channels: ', 1)
('Number of bytes per sample:', 2)
('Sampling rate: ', 16000)
('Number of samples:', 156800)
```

- **Length of the sound:**

```
In [4]: lenAM = scipy.size(AM)
```

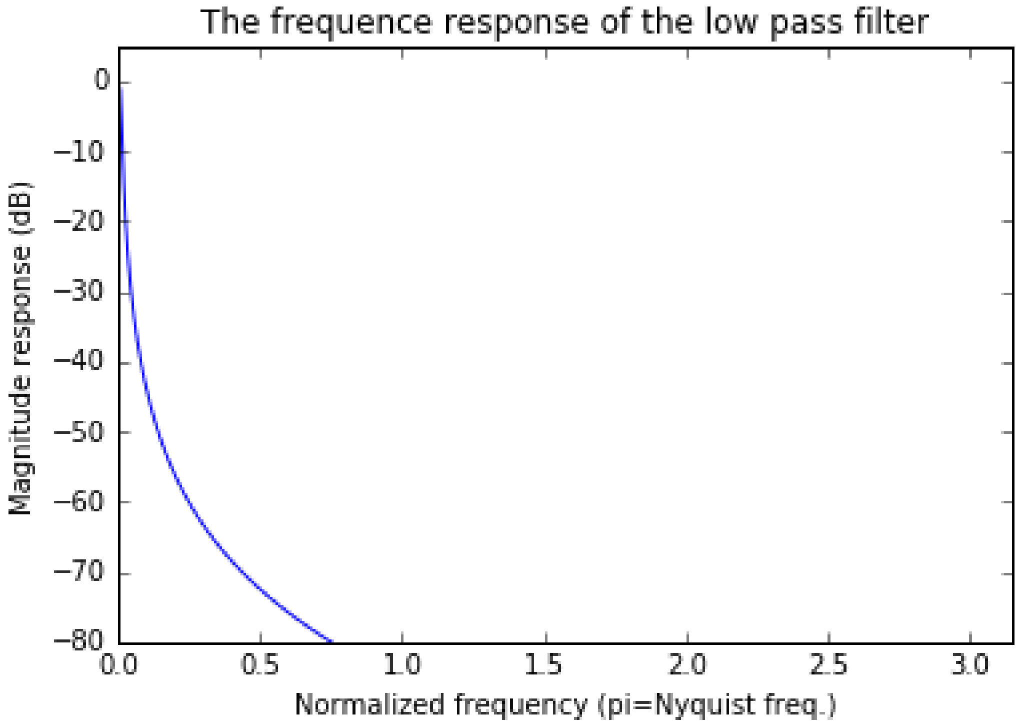
- **Compute the low pass filter coefficients, with 10 Hz cutoff frequency:**

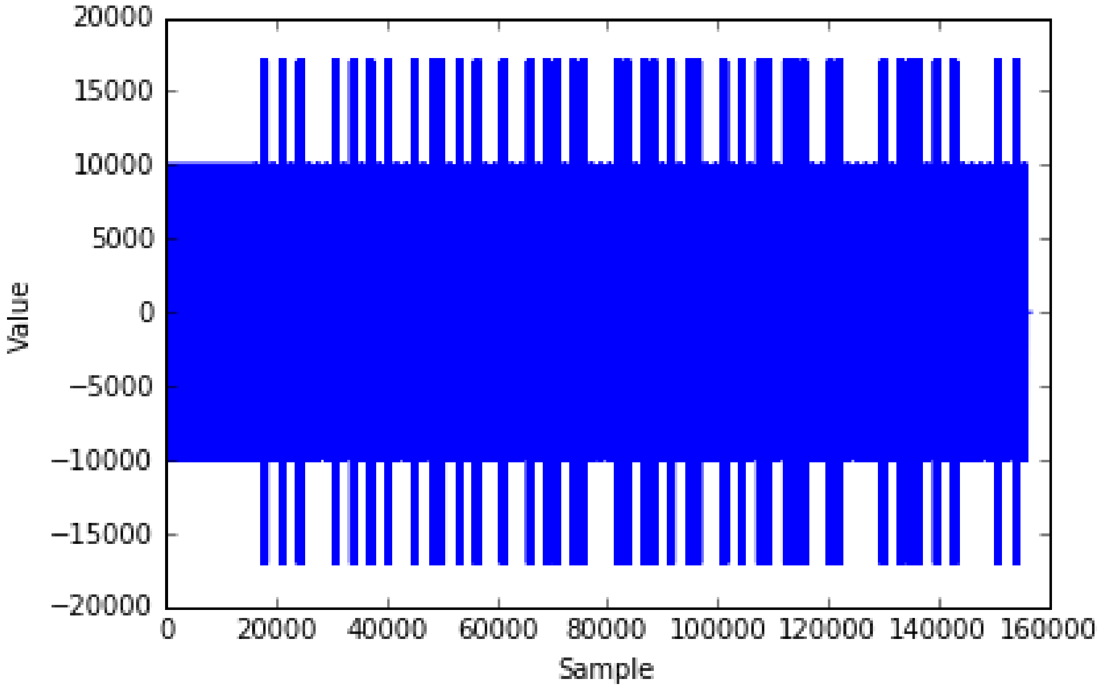
```
In [5]: [b,a]=scipy.signal.iirfilter(2, 20.0/(FS/2),rp=60,btype='lowpass')
        [w,H]=scipy.signal.freqz(b,a)
        Ha=scipy.absolute(H)
```

- **Plot in dB on normalized frequency axis w:**

```
In [6]: fig=plt.figure()
        #plt.plot(w,Ha)
        plt.plot(w,20*np.log10(Ha))
        plt.title('The frequence response of the low pass filter')
        plt.xlabel('Normalized frequency (pi=Nyquist freq.)')
        plt.ylabel('Magnitude response (dB)')
        plt.axis([0,3.15,-80, 5])

        fig=plt.figure()
        fig.canvas.set_window_title('Das AM Signal mit Clock- und Bit-Signal')
        plt.plot(AM)
        plt.xlabel('Sample')
        plt.ylabel('Value')
        plt.show()
```





- **Compute average power to remove silence:**

```
In [7]: p=scipy.signal.lfilter(b, a, scipy.power(AM,2))
        print("Filter the bit component:")
```

```
Filter the bit component:
```

- **Get the bit frequency component at 1 kHz by down mixing:sinus Traeger:**

```
In [8]: traegersin = scipy.sin(2*scipy.pi/FS*1000*scipy.arange(0,lenAM))
        downmixAMbits_sin=(traegersin*AM)
```

- **De-modulate by low pass filtering and taking abs value (bit and clock are always positive)**

```
In [9]: decAMbits_sin = scipy.signal.lfilter(b, a, downmixAMbits_sin)
```

- **Cosinus Traeger:**

```
In [10]: traegercos = scipy.cos(2 * scipy.pi / FS * 1000 * scipy.arange(0, lenAM))
         downmixAMbits_cos = (traegercos * AM)
```

- **De-modulate by low pass filtering and taking abs value (bit and clock are always positive):**

```
In [11]: decAMbits_cos=scipy.signal.lfilter(b, a, downmixAMbits_cos)
```

- **Berechne betrag der komplexen Demodulation:**

```
In [12]: decAMbits = np.sqrt(decAMbits_sin ** 2 + decAMbits_cos ** 2)
```

```
In [13]: fig=plt.figure()
         fig.canvas.set_window_title('Das demodulierte Bit Signal')
         plt.plot(decAMbits)
         plt.xlabel('Sample')
         plt.ylabel('Value')
```

```
Out[13]: <matplotlib.text.Text at 0x7f98672e2590>
```

- **Get the clock frequency component at 2 kHz:**

```
In [14]: traegersin = scipy.sin(2 * scipy.pi / FS * 2000 * scipy.arange(0,lenAM))
```

- **Down mix, magnitude:(for sin)**

```
In [15]: downmixAMclock_sin = (traegersin * AM)
         print("filter the clock component")
```

```
filter the clock component
```

- **De-modulate by low pass filtering:(for sin)**

```
In [16]: decAMclock_sin = scipy.signal.lfilter(b, a, downmixAMclock_sin)
         traegercos = scipy.cos(2 * scipy.pi / FS * 2000 * scipy.arange(0,lenAM))
```

- **Down mix, magnitude:(for cos)**

```
In [17]: downmixAMclock_cos = (traegercos * AM)
```

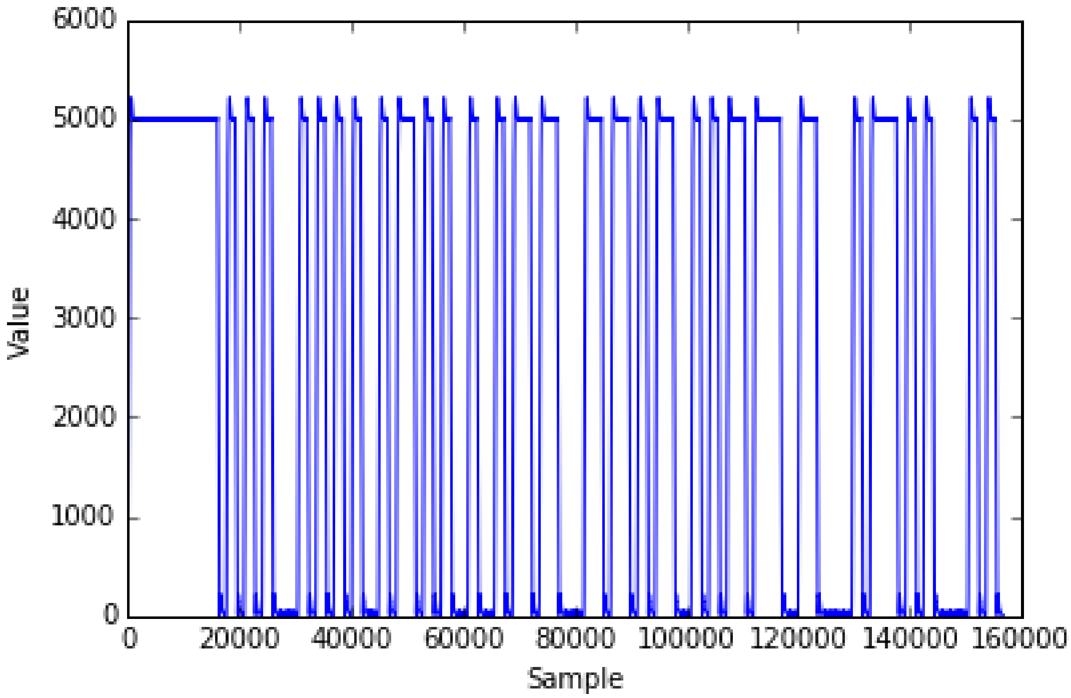
- **De-modulate by low pass filtering:(for cos)**

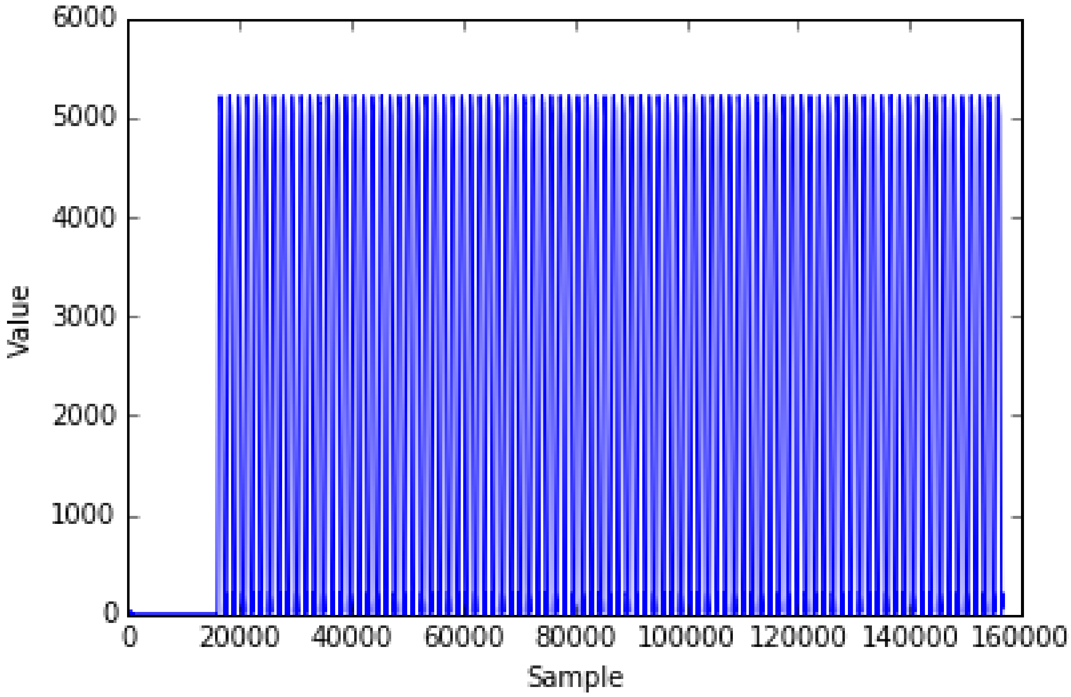
```
In [18]: decAMclock_cos=scipy.signal.lfilter(b, a, downmixAMclock_cos);
```

- **Taking complec magnitude:**

```
In [19]: decAMclock=np.sqrt(decAMclock_sin**2+decAMclock_cos**2)
```

```
In [20]: fig=plt.figure()
         fig.canvas.set_window_title('Das demodulierte Clock Signal')
         plt.plot(decAMclock)
         plt.xlabel('Sample')
         plt.ylabel('Value')
         plt.show()
```





- **Schwelle zwischen 0 und 1 fuer die clock:**

```
In [21]: schwellec = max(decAMclock)/2.0
```

- **Shwelle zwische 0 und 1 fuer die bits:**

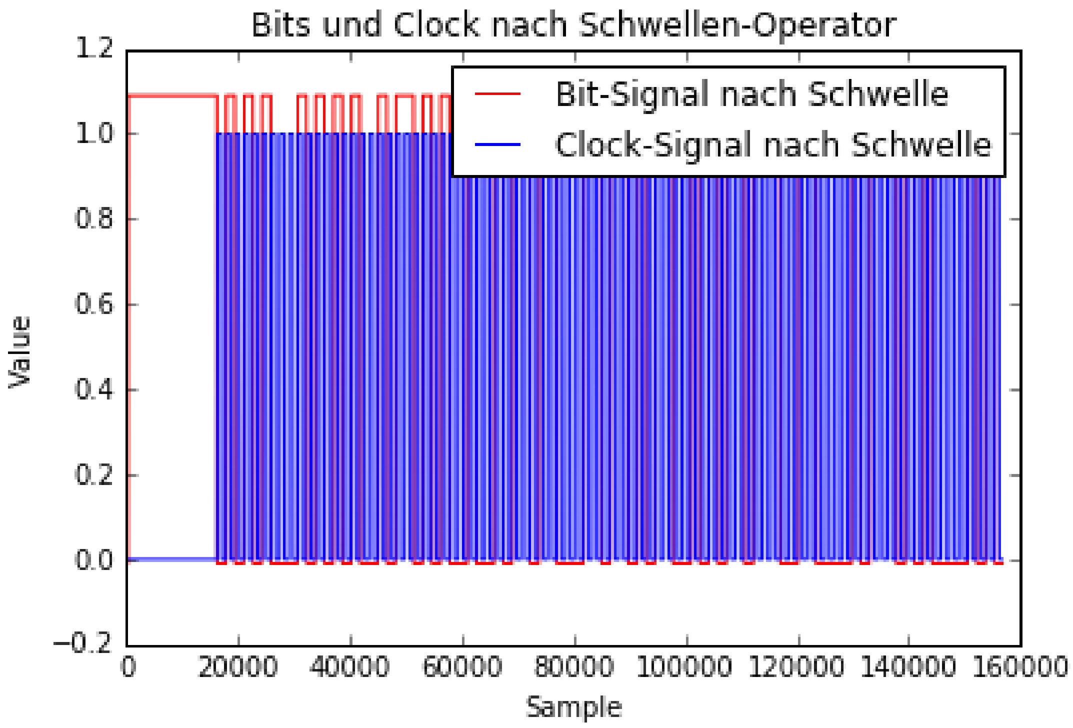
```
In [22]: schwelle = max(decAMbits)/2.0;
         print("schwelle=", schwelle)

('schwelle=', 2609.0060085009095)
```

- **Laenge des empfangenen geglaetteten Signals:**

```
In [23]: laenge=max(decAMbits.shape)

In [24]: fig=plt.figure()
         plt.plot((decAMbits>schwelle)*1.1-0.01,'r')
         #fig=plt.figure()
         plt.plot((decAMclock> schwellec),'b')
         #plt.axis([0,10000 , -0.1,  1.1])
         plt.title('Bits und Clock nach Schwellen-Operator')
         plt.legend(('Bit-Signal nach Schwelle', 'Clock-Signal nach Schwelle'))
         plt.xlabel('Sample')
         plt.ylabel('Value')
         plt.show()
```



- **Decodieren der Bits:**

```
In [25]: print("Decodieren der Bits:")
```

```
Decodieren der Bits:
```

- **Abtast-Intervall fuer geglaetetes Signal:**

```
In [26]: interv = 40
```

- **Bitcounter:**

```
In [27]: m = 0
```

- **Bit-array:**

```
In [28]: bitstring=''
         for n in range(interv,laenge,interv):
             #bei ueberschreiten der Schwelle des clock signales lese Bt aus:
             if ((decAMclock[n-interv] > schwellec) and  (decAMclock[n]< schwellec) ):
                 #Auslesen des bits:
                 print("clock detected at sample:",n)
                 if (decAMbits[n] > schwelle):
                     print("Bit detected: 1")
                     bitstring=bitstring+ '1'
                 else:
                     print("Bit detected: 0")
                     bitstring=bitstring+ '0'
                 m = m+1

         from writereadbits import writebinaryfile

         print "decoded bitstring= ", bitstring
         print "write to binary file"
         writebinaryfile('AMdecoded.bin', bitstring)
```

```
('clock detected at sample:', 17000)
Bit detected: 0
('clock detected at sample:', 18600)
Bit detected: 1
('clock detected at sample:', 20200)
Bit detected: 0
('clock detected at sample:', 21800)
Bit detected: 1
('clock detected at sample:', 23400)
Bit detected: 0
('clock detected at sample:', 25000)
Bit detected: 1
```

```
('clock detected at sample:', 26600)
Bit detected: 0
('clock detected at sample:', 28200)
Bit detected: 0
('clock detected at sample:', 29800)
Bit detected: 0
('clock detected at sample:', 31400)
Bit detected: 1
('clock detected at sample:', 33000)
Bit detected: 0
('clock detected at sample:', 34600)
Bit detected: 1
('clock detected at sample:', 36200)
Bit detected: 0
('clock detected at sample:', 37800)
Bit detected: 1
('clock detected at sample:', 39400)
Bit detected: 0
('clock detected at sample:', 41000)
Bit detected: 1
('clock detected at sample:', 42600)
Bit detected: 0
('clock detected at sample:', 44200)
Bit detected: 0
('clock detected at sample:', 45800)
Bit detected: 1
('clock detected at sample:', 47400)
Bit detected: 0
('clock detected at sample:', 49000)
Bit detected: 1
('clock detected at sample:', 50600)
Bit detected: 1
('clock detected at sample:', 52200)
Bit detected: 0
('clock detected at sample:', 53800)
Bit detected: 1
('clock detected at sample:', 55400)
Bit detected: 0
('clock detected at sample:', 57000)
Bit detected: 1
('clock detected at sample:', 58600)
Bit detected: 0
('clock detected at sample:', 60200)
Bit detected: 0
('clock detected at sample:', 61800)
Bit detected: 1
('clock detected at sample:', 63400)
Bit detected: 0
```

```
('clock detected at sample:', 65000)
Bit detected: 0
('clock detected at sample:', 66600)
Bit detected: 1
('clock detected at sample:', 68200)
Bit detected: 0
('clock detected at sample:', 69800)
Bit detected: 1
('clock detected at sample:', 71400)
Bit detected: 1
('clock detected at sample:', 73000)
Bit detected: 0
('clock detected at sample:', 74600)
Bit detected: 1
('clock detected at sample:', 76200)
Bit detected: 1
('clock detected at sample:', 77800)
Bit detected: 0
('clock detected at sample:', 79400)
Bit detected: 0
('clock detected at sample:', 81000)
Bit detected: 0
('clock detected at sample:', 82600)
Bit detected: 1
('clock detected at sample:', 84200)
Bit detected: 1
('clock detected at sample:', 85800)
Bit detected: 0
('clock detected at sample:', 87400)
Bit detected: 1
('clock detected at sample:', 89000)
Bit detected: 1
('clock detected at sample:', 90600)
Bit detected: 0
('clock detected at sample:', 92200)
Bit detected: 1
('clock detected at sample:', 93800)
Bit detected: 0
('clock detected at sample:', 95400)
Bit detected: 1
('clock detected at sample:', 97000)
Bit detected: 1
('clock detected at sample:', 98600)
Bit detected: 0
('clock detected at sample:', 100200)
Bit detected: 0
('clock detected at sample:', 101800)
Bit detected: 1
```

```
('clock detected at sample:', 103400)
Bit detected: 0
('clock detected at sample:', 105000)
Bit detected: 1
('clock detected at sample:', 106600)
Bit detected: 0
('clock detected at sample:', 108200)
Bit detected: 1
('clock detected at sample:', 109800)
Bit detected: 1
('clock detected at sample:', 111400)
Bit detected: 0
('clock detected at sample:', 113000)
Bit detected: 1
('clock detected at sample:', 114600)
Bit detected: 1
('clock detected at sample:', 116200)
Bit detected: 1
('clock detected at sample:', 117800)
Bit detected: 0
('clock detected at sample:', 119400)
Bit detected: 0
('clock detected at sample:', 121000)
Bit detected: 1
('clock detected at sample:', 122600)
Bit detected: 1
('clock detected at sample:', 124200)
Bit detected: 0
('clock detected at sample:', 125800)
Bit detected: 0
('clock detected at sample:', 127400)
Bit detected: 0
('clock detected at sample:', 129000)
Bit detected: 0
('clock detected at sample:', 130600)
Bit detected: 1
('clock detected at sample:', 132200)
Bit detected: 0
('clock detected at sample:', 133800)
Bit detected: 1
('clock detected at sample:', 135400)
Bit detected: 1
('clock detected at sample:', 137000)
Bit detected: 1
('clock detected at sample:', 138600)
Bit detected: 0
('clock detected at sample:', 140200)
Bit detected: 1
```

```
('clock detected at sample:', 141800)
Bit detected: 0
('clock detected at sample:', 143400)
Bit detected: 1
('clock detected at sample:', 145000)
Bit detected: 0
('clock detected at sample:', 146600)
Bit detected: 0
('clock detected at sample:', 148200)
Bit detected: 0
('clock detected at sample:', 149800)
Bit detected: 0
('clock detected at sample:', 151400)
Bit detected: 1
('clock detected at sample:', 153000)
Bit detected: 0
('clock detected at sample:', 154600)
Bit detected: 1
('clock detected at sample:', 156200)
Bit detected: 0
writereadbits.py
decoded bitstring=  0101010001010101001011010100100101101100011011010110010101101110011000010111
write to binary file
```