EEE311: Signals and Systems

Lab #9: Random Processes

Objective: To verify some of the results on random processes.

1. Download the noises and flowgraphs available from the web page and save to hard drive on the computer.

2. Press the windows start button, type `GNU` and select *GNURadio Companion*.

3. From *GNU-Radio Companion*, open the flowgraph `EEE311_Lab9_Parts_04_07.grc` (available from the course web page).

4. Connect the spectrum analyzer to the output of the computer's soundcard as shown in figure 1 and set the frequency range from 0 Hz to 30 kHz. Make sure that the input is configured for DC and a 50 Ω impedance. For each of the noise waveforms,

   (a) double-click on Wav File Source block and select path to the desired noise waveform file,

   (b) run the flowgraph (F6),

   (c) Identify the probability density functions of the noise from the histogram within GNU Radio. Measure its power spectral density with the spectrum analyzer and verify that it is white-limited. You may select the "Trace Average" option available from the "Trace/Detector" button to obtain a better measurement of the power spectral density. The option "Clear Write" returns to the *normal* mode.

5. Connect an adjustable filter to the audio input/outputs of a computer as shown in figure 2.

   (a) Adjust the filter as a bandpass type between the frequencies of 500 Hz and 5 kHz.

(b) Open the flowgraph `EEE311_Lab9_Parts_05_06.grc` (available from the course web page).

(c) Double-click on Wav File Source block and select path to the uniform noise wave file.

(d) Run the flowgraph (F6),

(e) Measure the power spectral density of the filtered noise from 0 Hz to 10 kHz with the spectrum analyzer and verify that it is no longer white-limited (use the "Trace Average" option available from the "Trace/Detector" button to obtain a better measurement). Observe its histogram and notice that the probability density functions of the filtered noise is no longer uniform.

6. Repeat the previous part with the Gaussian noise and the same filter. Verify that the filtered noise is no longer white-limited. Observe the histogram and notice that the probability density functions of the filtered noise is still Gaussian.

7. Take uniform noise. Encode as mp3 with a constant bit rate of 128 kbps using *Audacity* and save to disk (you may require the library `lame_enc.dll` which is available from the web page). Close *Audacity*. Reload the mp3 into *Audacity* and save as a wave file. Select as Wav File Source block and run flowgraph `EEE311_Lab9_Parts_04_07.grc`. Get histogram and power spectral density using the spectrum analyzer from 0 Hz to 30 kHz (use the "Trace Average" option available from the "Trace/Detector" button to obtain a better measurement). Notice that the probability density functions of the filtered noise is no longer uniform.

8. Feed the output of *Agilent* signal generator noise (amplitude set to about 7 Vpp, offset of 0 V) into sound card and spectrum analyzer as shown in figure 3. Run flowgraph `EEE311_Lab9_Parts_08.grc`. Verify that it is Gaussian. The manufacturer claims that it is white-limited; what is the maximum frequency?

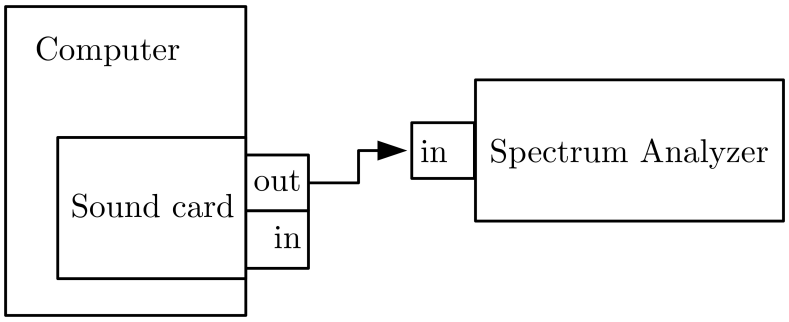

Figure 1:

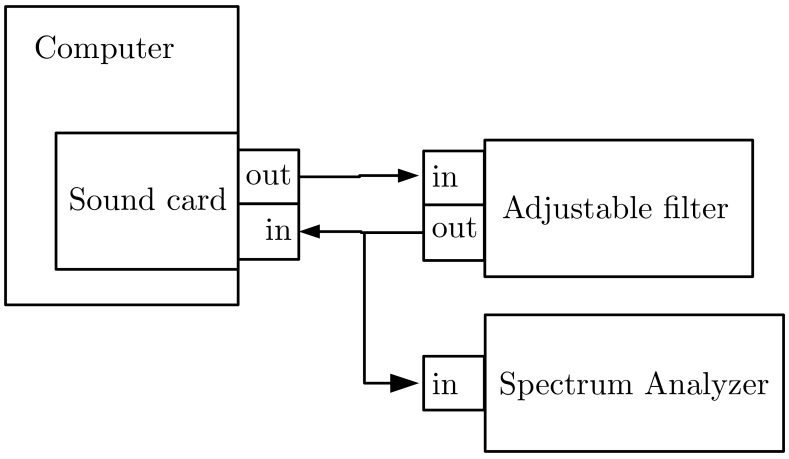

Figure 2:

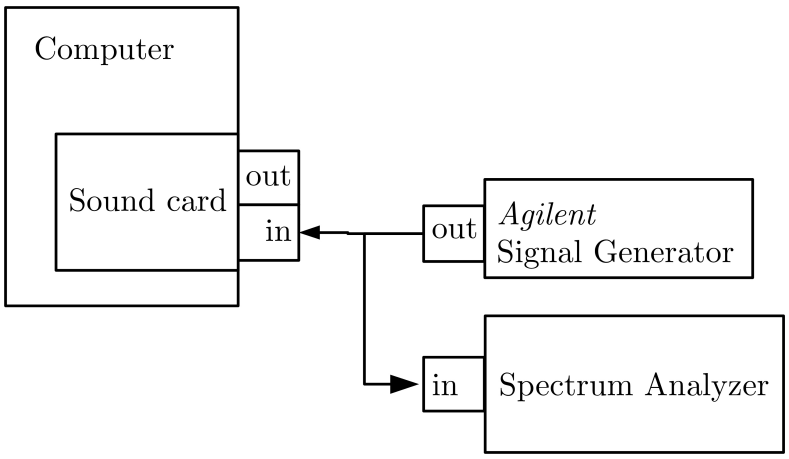
Computer
Sound card
out
in
out
Agilent
Signal Generator
in
Spectrum Analyzer

Figure 3: