MATLAB function circcorr.m

The MATLAB function `circcorr.m` is provided for computing the auto- and cross-correlations necessary for AAE575 Homework 1 and 2. This function computes the correlation between two discrete-time arrays, $x[k]$, $y[k]$, for all relative delays between them. This provides a numerical approximation of the continuous-time cross-correlation

$$R(\gamma) = \frac{1}{T_I}\int_0^{T_I} x(t)y(t+\gamma)dt \tag{1}$$

When provided with the sample period, `circcorr.m` will compute the delay in the same time dimensions as this period.

To illustrate the use of `circcorr.m`, a set of example data are provided in the MATLAB file `circcorrex.mat`. The array "x" contains samples of a BOC(1,1) signal, collected at a sample rate of **8 MHz** . The array is **7821** samples long, representing data collected for $(7821/8E6)$ = **9.7762E-4 sec.**. Before we look at generating the autocorrelation of this signal, the first 5 microseconds are plotted in figure 1 superimposed on the continuous-time BOC(1,1) signal. Observer that the sampling is not synchronous with the BOC(1,1) signal sub-carrier. In other words, the samples ('X') are not aligned with the start and end of each sub-carrier pulse. This should make sense, since the sample rate (8 MHz) is not an integer multiple of the sub-carrier frequency (1.023 MHz). It is very important to understand this possibility, as receivers generally do not sample at a rate equal to a harmonic of the transmitted signal. (You will see this in Homework 2, in which the provided data is sampled at approximately 5.7 MHz).

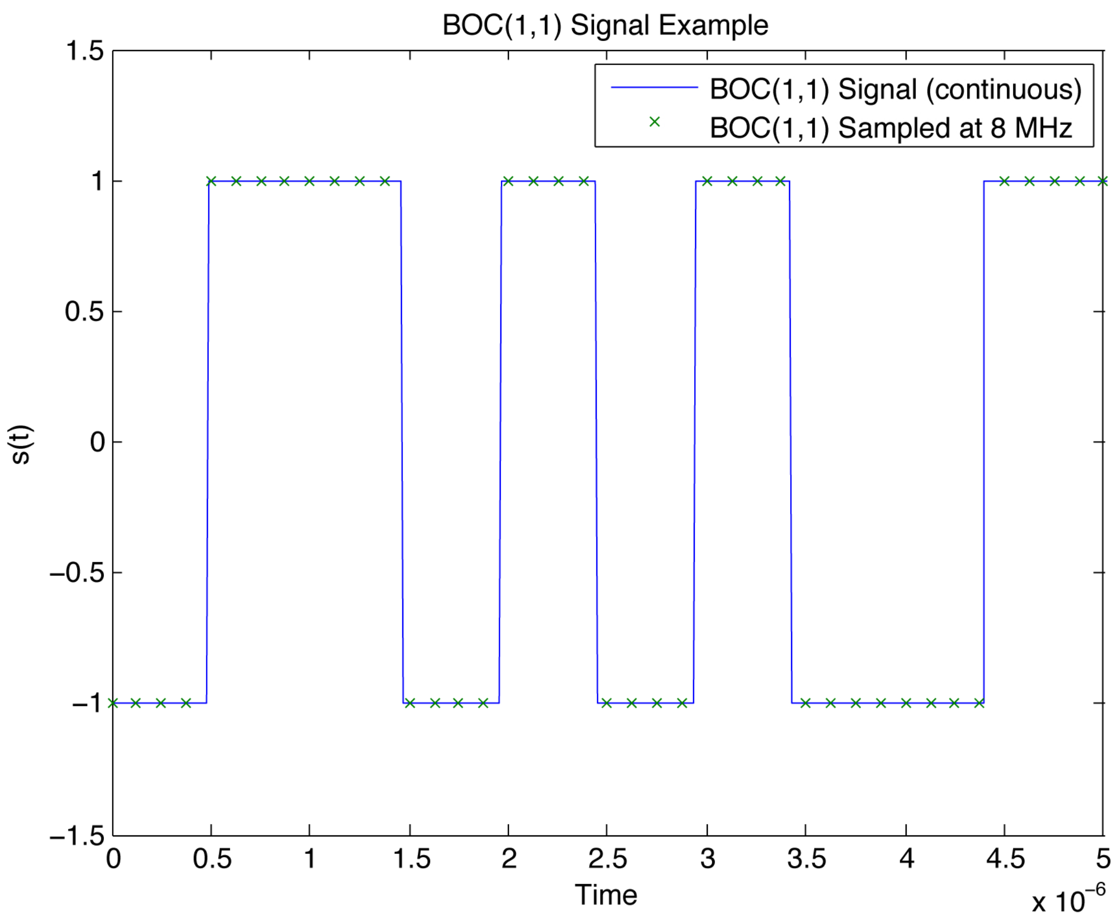

Figure 1: First 5 μs of data. Observe that samples (X) are not synchronous with the pulses in the continuous-time (solid-line) signal.

The inputs to `circcorr.m` are the two arrays that are to be correlated, and the sample period. The sample period is the inverse of the sample rate. Applying to the example data with the matlab command:

```
[R, lag] = circcorr(x,x, 1/8e6);
```

will produce the correlation between x and x (autocorrelation) at 7821 delays (the same number of input points), in the array R. The corresponding 7821 delays are stored in the array "lag", which will have the same dimensions as the value given for the sample period (seconds in this example). Plotting R vs. lag (and scaling the x-axis to microseconds for clarity) produces figure 2. The analytical model for a BOC(1,1) signal, assuming infinitely-long random modulation, is also shown for comparison. The spacing between samples (X) is equal to the sample period of the original data $(1/8E6)$ sec **=0.125 microsec.**

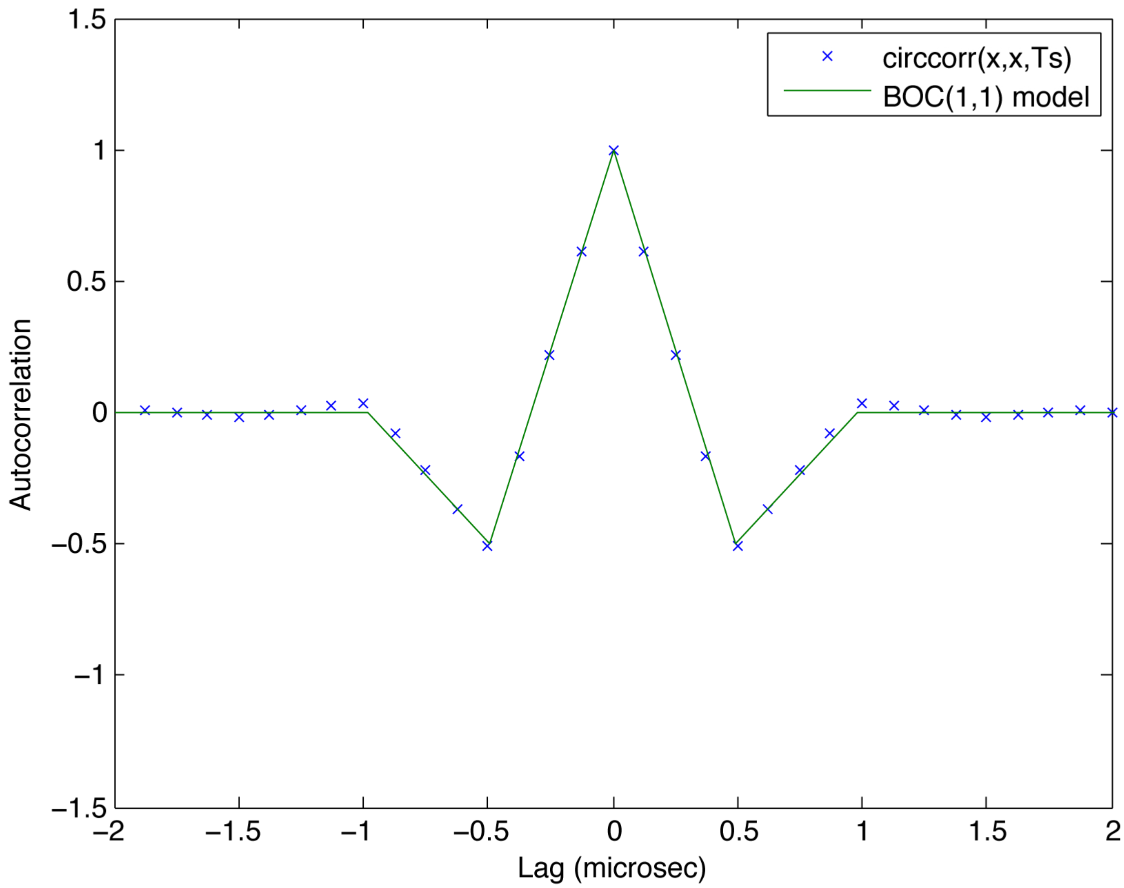

Figure 2: Autocorrelation of the signal x. Numerical values generated from circcorr.m are shown as ('X'), the continuous-time model (assuming an infinitely-long random modulation) is plotted as the solid line.