

AET 5410 Quiz 3

Digital Audio, Computer Programming, Signal Analysis

November 11, 2020

1 PERIODIC AND APERIODIC SIGNALS

Audio signals can be categorized as two types: *periodic* and *aperiodic*. A periodic signal is defined as a signal which repeats a cyclical pattern; one example is a square wave. An aperiodic signal does not repeat a pattern; one example is white noise. There are two common analyses audio engineers use to determine whether a signal is periodic or not: the zero-crossing rate and autocorrelation. For this problem you get to pick which one you want to use.

First, consider the zero-crossing rate. This measure is the number of times the signal's amplitude crosses zero per second. In other words, it is the number of times the amplitude switches from positive to negative (or vice versa) per second. The ZCR will generally be lower for periodic signals compared to aperiodic signals. For an aperiodic signal like white noise, the signal's amplitude could switch between positive and negative every other sample.

Next, consider autocorrelation. This analysis can be used to search for patterns in a signal by sliding the signal along itself over time. For periodic signals, the autocorrelation calculation will produce a large value for time lags when the pattern lines up with the repetitions. It will produce a smaller value for time lags when the pattern does not line up. An aperiodic signal could be described as a signal which is **not correlated** with itself, indicating it does not repeat. The autocorrelation function for aperiodic signals will produce values very close to zero for all calculations with a time lag.

1.1 PROBLEM

For this problem you will write a **script** to determine whether short sections of a signal are periodic or aperiodic. If a section is periodic, it should be labeled with a "1". If it is aperiodic, it should be labeled with a "0".

You should pick one type of analysis to use for the problem (zero-crossing rate or autocorrelation), not both. To help come up with a detection test to use, you might want to first experiment with the results on signals that you know are either one type or the other. Eventually, you will want to be able to take a long signal, break it up into short frames, and perform the periodicity analysis on each frame.

For this problem you will write a **script** (m-file) in MATLAB based on the following specifications:

- Name the script - `periodicity.m`
- A sound file is provided which alternates between white noise, a 440 Hz sine wave, and a 500 Hz square wave. Use this file to demonstrate your script works
- Specify a `bufferSize` in samples near the top of the script
 - You should use this `bufferSize` to break the signal up into segments for analysis
 - It is not necessary to have an overlap variable for this problem
- Create a loop to go through each segment of the signal
 - Within the loop use the ZCR or autocorrelation analysis
 - Based on that analysis determine if that segment is periodic or not
 - Save a “1” or “0” to an output array to label that segment
- After the loop, plot the output variable to see if your analysis is working correctly

2 SUBMISSION

To submit your quiz, put your MATLAB script and input sound file in a compressed zip folder: `xxxxx_Quiz3.zip`, where `xxxxx` is your last name. Email the file to: eric.tarr@belmont.edu when completed.