TeleBench™ Version 1.1 — Benchmark Name: Autocorrelation

Highlights

- **Calculation of a finite length fixed-point autocorrelation function.**
- **16 bit, fixed point (integer) arithmetic.**
- **Accumulation overflow protection (no pre-scaling).**
- **Multiple (3) data sets: sine, pulse, and speech.**

Application

Autocorrelation is one of the basic analysis tools in signal processing. It represents the second order statistics of a random process and is widely used for analysis and design in many telecommunications applications. The autocorrelation function R[k] is defined as the expected value of x[n]*x[n+k], where x[n] is random process (R[k] = E{x[n]*x[n+k]}, E – the expectation operator). In practical applications, the expected value operation is replaced by a sum operation, $R[k] = 1/N*\Sigma_n x[n]*x[n+k]$, over N samples as an estimation of R.

Practically, the autocorrelation coefficient at lag k R[k], represents the amount of correlation between two samples of the sequence x spaced by k samples apart. The amount of correlation can be translated into redundancy in compression applications, or system response in modeling and system identification.
Autocorrelation functions are widely used in many telecommunication applications such as speech compression, speech recognition, channel estimations, sequence estimation (maximum likelihood), system identification and for the solution of the well-known Yule-Walker equations.

Benchmark Description

This benchmark performs a fixed-point autocorrelation function calculation of a finite length input sequence according to the following formula:

$$AutoCorrData[k] = 1/N*\Sigma_n InputData[n]* InputData[n+k]. \quad k=0,1,\ldots K-1$$

InputData is the input sequence given in a 16-bit signed integer representation (“short”).
The benchmark implements a 32-bit wide accumulation along with an overflow protection (via scaling) and returns the K (NumberOfLags) length AutoCorrData sequence in 16-bit signed integer format (“short”).
The datasets for this benchmark comprises three signal shapes. These shapes are a sine wave of frequency Fs/32 and 1024 samples length, a 16 samples symmetric pulse function, and a segment of 500 samples voiced speech signal. The shape may not affect the timing and the accuracy of the output.

Analysis of Computing Resources

The arithmetic operations used in this benchmark are multiply, shift and add. The algorithm is implemented in two nested loops where the actual arithmetic is executed in the inner loop.
The benchmark explores the target CPU’s ability to efficiently perform multiply, parameterized shift, and add operations in a nested loop structure.

Special Notes

All of the data files must be run to obtain an EEMBC Telemark™ score.