Digital Signal Processing (DSP) Lab

DSP topic: Study of application autocorrelation function for analysis of signals

Date of Experiment: 30th January 2019

Objective: Compute pulse rate (PR) from a PPG signal and pitch period of a speech signal using autocorrelation function (ACF) in real time Arduino prototype platform. (Use both offline and real-time test signals)

1. For PPG signal, assume sampling rate of 100 Hz, and resolution of 10 bit, and frame duration of 5 seconds to compute the pulse rate from a PPG signal
2. For speech signal, assume sampling rate of 8000 Hz, and resolution of 10 bit, and frame duration of 30 ms to compute the pitch period from a speech signal

Procedure:

A. Compute autocorrelation function (ACF) for each frame with a specific frame duration by using the following expression

$$R_m = \frac{1}{R(0)} \sum_{n=0}^{N-m-1} x(n) * x(n+m) . \quad \text{where m=0, 1,.....N-1.}$$

B. Find a maximum amplitude of ACF and its location from a first zerocrossing point (FZCP) as by following procedures as given below:
   i. Compute location of a first zerocrossing point (FZCP) of the ACF sequence
   ii. Construct a window having the ACF values from a first zerocrossing point to last values of ACF vector
   iii. Compute maximum value of a window and also obtain its maximum location, L_{max}
   iv. Compute the maximum amplitude location as given below,
      a. $L_{max1} = FZCP + L_{max}$.
   v. Compute a period of a signal as given below
      $P = L_{max1} / Fs$.

C. Display period of a PPG/speech signal for each frame

D. Store the estimated period of a PPG/speech signal for 1 minute

Experimental Result Verification (30th January 2019)

Pre-preparation for Completion of this Experiment

- Autocorrelation function and its properties
- Generation of speech signal (speech production system) and PPG signal
- Pulse period range and pitch period range for different genders and age groups

Final Submission (6th February 2019)

- Hard copy of the experiment report as per the format communicated to you
- Video demo of this experiment including the description of both concept and the source code.