Assignment 1

Digital Signal Analysis and Applications (DSAA) - IEC 239

Deadline: 25 January

January 18, 2016

1. An algorithm for the calculation of the square root of a number α is given by [1]

   $y[n] = x[n] - y^2[n-1] + y[n-1]$

   where $x[n] = \alpha u[n]$ with $0 < \alpha < 1$. If $x[n]$ and $y[n]$ are considered input and output of a discrete-time system, is the system linear or non linear? Is it time invariant? As $n \to \infty$, show that $y[n] \to \sqrt{\alpha}$. Note that $y[-1]$ is a suitable approximation to $\sqrt{\alpha}$.

2. Consider the following three operations.
   (a) Multiply the integer numbers: 131 and 122.
   (b) Compute the convolution of signals: {1,3,1}*{1,2,2}
   (c) Multiply the polynomials: $1 + 3z + z^2$ and $1 + 2z + z^2$
   (d) Repeat part (a) for the numbers 1.31 and 12.2
   (e) Comment on your results.

3. Apply convolution on cameraman image in matlab [im = imread('cameraman.tif')] using the following filter:

$$h = \begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{pmatrix}$$

   What do you think, this filter is doing? Explain.

4. Record your own sound and simulate it in three different environments using the concepts and examples considered in the class. You can download impulse response

characterizing the system (environment) from the internet (use freely available resources like http://www.openairlib.net/).

5. Input to your system is noisy signal *ip*, simulated in matlab as follows:

```
t = [0:0.001:0.5];
orig = 200*sin(30*t)+ 100*cos(54*t);
noise = 30*randn(1,501);
ip = orig+noise;
```

   Using the discussions in the class, propose three different ways to denoise this input signal. Compare results and discuss.

References

[1] Mikami, Naoki, Masaki Kobayashi, and Yukiko Yokoyama. "A new DSP-oriented algorithm for calculation of the square root using a nonlinear digital filter." Signal Processing, IEEE Transactions on 40.7 (1992): 1663-1669.