Simulation Approach for Localizing Roots of Real Coefficients Complex Equation

Sasa Dimitrijevic, Bratislav Dankovic, and Dragan Antic

This paper presents a new approach for solving real coefficients complex equation based on simulation. The procedure is used for n-th order complex equation, in the form:

$$f(z) = a_n z^n + a_{n-1} z^{n-1} + \Lambda + a_1 z^1 + a_0 \tag{1}$$

where $a_i, i = 1, \Lambda, n$ are real coefficients, n is equation order and $z = x + iy$ is a complex variable. The technique relates solving complex equation:

$$f(x + iy) = 0 \tag{2}$$

what can be written in the form:

$$Re\{f(x + iy) = 0\} + iIm\{f(x + iy) = 0\} = 0 \tag{3}$$

The condition (3) is fulfilled if both absolute values of real and imaginary part are equal to zero:

$$\mid Re\{f(x + iy)\} \mid + \mid Im\{f(x + iy)\} \mid = 0 \tag{4}$$

Considering that this approach is used for localization of equation (1) roots, equation (4) model will be:

$$\varepsilon = \min_{x,y} \mid Re\{f(x + iy)\} \mid + \mid Im\{f(x + iy)\} \mid \tag{5}$$

The x, y values which correspond to minimum will be the roots of equation (1).

Simulation is conducted using block diagram simulation languages (SIMULINK, etc.) where $x = time$ and as a result of simulation value ε for $y = y_0 = const$ is obtained.

$$\varepsilon = \min_{y} \min_{x} \mid Re\{f(x + iy)\} \mid + \mid Im\{f(x + iy)\} \mid \tag{6}$$

Repeated simulations for different values of $y = y_0 = const$ are performed using MATLAB programming. When the desired accuracy is accomplished, the obtained values $x = x_0, y = y_0$, will represent one of the equation (1) roots. The procedure is then repeated for different values $y = y_i$. In that manner, all other roots can be localized.

References

[1] Karayanakis N. M., Computer-Assisted Simulation of Dynamic Systems with Block Diagram Languages, CRC Press, Boca Raton, 1993.

[2] Murray-Smith D. J., Continuous System Simulation, Chapman & Hall, London, 1995.

[3] Kuo F. F. ed., Computer Simulation of Dynamic Systems, Prentice-Hall, New Jersey, 1972.