ABSTRACT

A new method of computation of singular values and left and right singular vectors of arbitrary non-square matrices has been proposed. Singular Value Decomposition (SVD) being generalization of Eigen Value Decomposition (EVD) permits to compute singular (proper) values of non-square matrices. Despite of its generality and efficiency in some Time Series Analysis problems (we mean Singular Spectrum Analysis or SSA) it has not been used widely in many engineering fields, including mechanical engineering. Nowadays the method has only started to be used in several fields of science and economics: processing of: experimental data in finance, macro- and microeconomics, communication signals, geophysics etc.

Usage of classical Singular Value Decomposition (SVD) leads to necessity of calculation of Eigen values and Eigen vectors of high dimensional matrices. There are a lot of well-known and widely used methods of their computation. Despite of their very different nature all these methods can be characterized with similar disadvantages: necessity of big computations volume, not reliable stability and sensitivity for ill-conditioning of basics matrices. To avoid these computational problems a new method was elaborated which based on principally different approach.

On base of Eckart-Young theorem, it was shown that each second order r-rank tensor can be represent as a sum of the first rank r-order "coordinate" tensors. A new system of equations for "coordinate" tensor's generators vectors was obtained. An iterative method of solution of the system was elaborated. Results of the method were compared with classical methods of solutions of singular value decomposition problem.

Also a method of analysis of time series internal structures based on Singular Spectrum Analysis is proposed. It has been shown that in the case when the Time Series contains deterministic additive components, rank of the trajectory matrices equal to number of parameters of the components. Also it was proved that both eigen and factor vectors repeat shapes of the additive components and both eigen values and eigen vectors can be divided into additive groups. Some useful patterns of deterministic components were identified, which permit to provide graphical analysis of times series Internal Structures.

All theoretical results were verified by means of various time series; the latter permitted to make sure that elaborated method works perfectly as a nonparametric filter for non-stationary processes.