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Requirements and approaches for both harmonic analysis and related problems software for specialized nonlinear power systems

Abstract. *The modern requirements of harmonic analysis software implementation for specialized nonlinear power systems was considered. The available software solutions for partially tasks fulfilling was analyzed. Approaches to the creation and development of perspective calculation program for mentioned task was showed.*

Streszczenie. *Rozpatrzone i przeanalizowane obecnych wymagań w zakresie specjalistycznych zastosowań analizy harmonicznej systemów elektroenergetycznych. Analizowane liczba dostępnych rozwiązań oprogramowania wykorzystywane są częściowo spełnia wymagania. Wyświetlanie podejścia do tworzenia i rozwoju obiecujących programów adres tego zakresu zadań.*

Keywords: harmonic analysis, cluster calculations, the discrete schemes method.
Słowa kluczowe: Applications z analizy harmonicznej, obliczenia klastra, sposób syntetyczny systemów.

There is the recommendation document for engineers dealing with electromagnetic compatibility in the construction and maintenance tasks of offshore and marine power systems «ABS (American Bureau of Shipping) Guidance Notes for Control of Harmonics in Electrical Power Systems» which specifies key requirements for the harmonic software analysis functionality working with the considered nonlinear power systems. The guidance assembled the experience of nonlinear power systems using and optimization. It describes the following basic criteria: the availability of a large nodes number for system units, the analysis of systems with amplitude and phase imbalance, resonance points frequency scanning, a large number of nonlinear models (6-puls, 12-puls, 18-puls, etc.), availability of different filters models, modeling the mixed (3 and 4 wire) electrical systems [1].

Analysis of existing software solutions such as ERACS, SOLV, Power Design Pro, ETAP, HI_WAVE and so on [2, 3], Showed that they can only partially satisfy the above requirements. There is a conceptual approach to the construction of most that software. The key idea was to create suitable tools for switchgear selecting problems, cables, transformers, etc., with accent on extensive line load using, on the contrary harmonic analysis stuff is solved by injecting of frequency-independent current sources as a rule i.e. the task was seen as minor.

For these reasons, the authors began to develop the harmonic analysis software in the first place for systems enriched by different nonlinear loads. The main concept is to build program as much as possible meets the mentioned requirements. That is the problem of electromagnetic compatibility – the primary task.

As a basic electrical circuits method chosen the discrete scheme method [4] as far as it greatly simplifies the task of topology analysis for arbitrary circuits configuration, provides differential equations solutions A-stability, possibility of macromodels using. As the main method for determining the instantaneous values of both voltages and currents the topological method of nodal potentials is used. Although this method isn't without a several shortcomings (absence of conductivity matrix for an ideal transformer, specific problems with mutual inductance, etc.), but such approach provides several advantages. Quasi-linear feature of the discrete schemes method in which transformers are included, with the correct graph-matrix nodes numeration transforms A-matrix in matrix with cluster structure. Cluster structure allows to split the problem of finding the inverse matrix into subtasks of individual inverse matrices determination for each cluster with smaller dimensions, and for linear clusters (e.g. the EMF with liner filter connected with nonlinear load through transformer) inverse matrix need to be calculated just one time. Besides the structure of impedance matrix is symmetric with positive determinant, so to speed up finding the inverse matrix the Holetskyi method of LLT decomposition is used. For "heavy" systems, i.e. systems with many nodes and branches clusterisation will allow to easily separate CPU load between individual cores if multicore systems are available, or to design LAN-calculation extention.

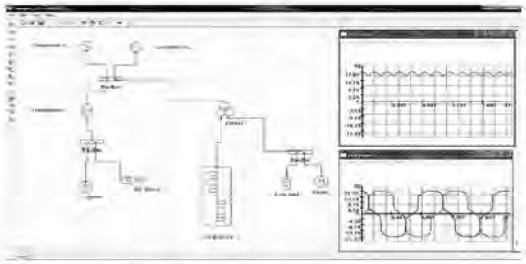

Fig.1 Calculation problem example

At the preprocessing stage of topological matrix formation determinating algorithm for both 3-wire and 4-wire systems belonging was implemented. Implemented algorithm, if necessary, allows using of different depth models with required electric circuits elements detailing.

In the near future, advanced computational program core will able to solve a number of related problems such as: optimization of reactors parameters, filters, checking compliance with the electromagnetic compatibility standard IEEE 519, etc.

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