

Virtual tomography simulator

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ABSTRACT

Applications of computational tomography are in the various fields of science and technology like material sciences, medicine, geophysics, etc. We represents non-commercial beta version of 2D tomography simulator. "Tomography Calculator" is a system integrating different technologies and allow to improve tomography experiments effectiveness and reconstruction quality. Software for Windows 95-2000 supports Graphic User Interface and simple in operation. It is possible to compute various tomography schemes and employ different reconstruction techniques. The main objective is to assimilate different theoretical and algorithmical tomography results. The software will be useful for nondestructive testing, medical tomography, Earth science and the like. Collection of tomography methods will provide practically significant export of technology from one field of physics and engineering to another. The software user version can be employed for educational purposes and as handbook on tomography. "Tomography Calculator" use step-by-step modelling of direct and inverse problem. Simulation starts with simulation of sounding signals propagation in accordance with selected experimental scheme. User can visually adjust the scheme of measurements and reconstruction properties. For instance it is possible change transmitters and receivers number and location, employ different models of specimen to be reconstructed, wave propagation peculiarity etc. Next step of reconstruction is forming mathematical description (matrix in linear case) of appropriate tomography problem. This matrix represents discrete approximation of integration operator. User can choose way of forming this matrix. In particular order of approximation. This order influences on error of approximation (difference between "real" and approximated data). When mathematical model is constructed it is necessary to choose reconstruction technique, possible parameters of numerical algorithm and apriori information if any (positive definition, mean values, error corridor, etc.). Then reconstruction program starts. It is possible to input real experimental data (from previously saved appropriate data file) instead of simulated earlier. User can observe internal information and correct numerical parameters of algorithm during reconstruction and compare reconstruction results with model. Many features of represented beta version is rather limited, nevertheless it is possible to use "Tomography Calculator 1.0" in education and research for optimising tomography experiments, simulation and prediction some results of non-destructive testing and atmosphere measurements. Along with software presentation we have prepared example of scientific application in atmosphere physics. The basic idea of ray ionosphere radio tomography consists in a numerical solution of a system of large number of integral equations. The variables are electron density in spatial points to be reconstructed and the write parts of equations are measured data (Doppler frequency of ionosphere sounding radio signal). Most frequently used reconstruction techniques are the iterative algorithms, i.e. family of algebraic reconstruction techniques (ART). We compare results of ART application versus regularization approach using represented software package. In this case the solution of initial system is constructed with a help of Tikhonov functional depending on regularization parameter instead of iterative reconstruction. Modelling consists of simulation of direct problem (radio ray propagation through spatially irregular ionosphere) and solving of inverse problems by different algorithms and parameters. Simple on-line (java) version of "Tomography Calculator" will appear on Web <http://tomography.euro.ru>.

Keywords: *tomography, reconstruction, software, inverse problem, simulation, regularization*

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