Inverse Problems of Reactive Systems Diagnostics and Artificial Neural Networks

Victor S. Abrukov and Pavel V. Deltsov
Physico-Technical Faculty, Chuvash State University
victor@chuvsu.ru
Moskovsky prosp., 15, Cheboksary, 428015, Russia

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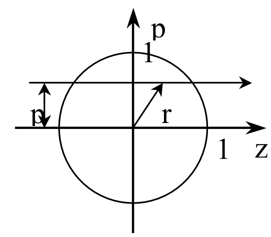
New ways for solving of inverse problems of various optical methods by means of artificial neural networks are represented. The solving of inverse problems consists in the solving of integral equation, i.e. in the determination of integrand by means of values of integrals. It involves the preliminary obtaining of the full discrete set of values of the function of signal intensity distribution in a plane of the registration (values of integral). It is a difficult task in particular for non-stationary object and it is impossible task if an object cannot be registered (visualized) as a whole.



In the paper the possibilities of usage the only value of the function of signal intensity distribution in a plane of the registration (only value of integral) are shown. The Neural Network Wizard (NNW) of BaseGroupLabs (www.basegroup.ru) was used. The possibility of NNW usage for solving of inverse problem is shown on the example of determination of the integrands for the case of cylindrical symmetry of object. The solving was carried out as follows. The dimensionless integral Abel equation (the case of cylindrical symmetry) can be written in the next form: $S(p) = 2\int_0^{\sqrt{1-p^2}} n(r)dz$, where *S(p)* is the signal intensity distribution (integral function) in the section of object, *n(r)* is the integrand, $z^2+p^2=r^2$, z is a signal path in the object, p is an aiming distance ($0 < p < 1$), and r is a variable radius, see fig. Using this equation, we have calculated the integrals *S(p)* from different integrands of form $n(r) = 1 + ar - br^2$, where a and b are the various constants. In total we have used seven different integrands that reflect some real distribution of local characteristics in object. Then the NNW training data were obtained by next way. For various r, the values *n(r)* were calculated as well as the values of *S(p)* were calculated for different p. The values of *S(p)*, p and r were as the input data for NNW training. The values of integrand corresponding to each set of *S(p)*, p and r are the target (output) values. After NNW training, the results of NNW testing show that the relative errors of NNW integrand calculation are not exceed 5% and NNW is a good tool for solving the inverse problem.

The basic advantages of the artificial neural networks usage for solving of inverse problems consist of the following. It will be possible to obtain the distribution of local characteristics by means of measurement the signal (integral value) in one point of a plane of registration (for example, the case of laser-diode technique). The determination in one point can be completely automated. Therefore it is possible to use an ANN-like chip (microprocessor) for automated control systems. One could mark also that the solving of inverse problems by means of ANN can be made for objects with any kinds of symmetry and the obtaining of the ANN for determination of distribution of local characteristics does not require to carry out the additional experiments. The data for training of the ANN can be obtained by the enough simple numerical calculations. Besides the ANN is the only means for solving of inverse problems in the case if an object cannot be registered (visualized) as a whole.

The further perspectives of the work are concerned with the implementation of ANN for solving the practical problems for diagnostics of high-speed reacting flows and control of combustion dynamics and propulsion systems, for example the pulse detonation engines.