



ABSTRACTS

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Necessary minimum conditions and Fourier method for numerical solution of linear inverse problems

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Two different linear inverse problems are considered. First is an application of the quasisolution and Fourier method to a mixed initial-boundary problem for Laplace's equation (Problem I).

Second is a source identification problem for heat transfer equation in the case of given final observation data (Problem II). In the considered case the source density has the form $f(x)g(t)$, where the function $g(t)$ is given, and the function $f(x)$ is to be determined.

Because both of the considered problems are classical ones, there exists multiple references. We mention here only the closest to the considered topic ([1])-(10). The necessary condition of the minimum of the residual functional, which expresses unknown function through the solution to corresponding adjoint problem, is used ([2],[6]-[9]). Then, both problems are reduced to a system consisting of mutually dependent direct and adjoint problems as follows:

Problem I. Residual functional is defined as

$$J[r] = \frac{1}{2} \int_0^b (u_x(0, y; r) - g(y))^2 dy + \frac{1}{2} \beta \int_0^b r^2(s) ds \rightarrow \min, \quad (1)$$

coupled system of direct and adjoint problem is the following

$$\begin{cases} u_{xx} + u_{yy} = 0, \\ v_{xx} + v_{yy} = 0, \end{cases} (x, y) \in \Omega = (0, a) \times (0, b) \quad (2)$$

$$\begin{cases} v(x, 0) = 0, \quad v(x, b) = 0, \\ u(x, 0) = 0, \quad u(x, b) = 0, \\ v(a, y) = 0, \quad u(0, y) = 0, \\ \beta \cdot u(a, y) - v_x(a, y) = 0, \\ u_x(0, y; r) - v(0, y) = g(y). \end{cases} \quad (3)$$

Problem II. Corresponding residual functional equals to

$$J[f] = \int_0^1 (u(x, T) - u_1(x))^2 dx + \beta \int_0^1 f^2(x) dx \rightarrow \min, \quad (4)$$

and necessary minimum conditions yields to the following system

$$\begin{cases} u_t = \Delta u - \frac{g(t)}{2\beta} \int_0^T v(x, s) g(s) ds, \\ v_t = -\Delta v, \quad x \in \Omega, t \in (0, T) \\ u(x, 0) = 0, \quad v(x, T) = 2(u(x, T) - u_1(x)), \quad x \in \Omega, \\ \nabla u(x, t) = 0, \nabla v(x, t) = 0, x \in \Gamma_1 \\ \nabla u(1, t) + \mu u(1, t) = 0, \nabla v(x, t) + \mu v(x, t) = 0, x \in \Gamma_2, \quad \partial\Omega = \Gamma_1 \cup \Gamma_2 \end{cases} \quad (5)$$

The explicit formulas of the solutions are obtained by Fourier method when Ω is a rectangular. Then the series are calculated numerically. Computational experiments are performed for different type of syntetic data, and admissible parameter ranges are established.

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For Problem $g(t)$. In even accuracy, even functions are

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- [1] M.M.Lavr *Izvest.Ak*
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Numerical simulations have shown that the use of Fourier method is an efficient way to solve the Problem I. We have a choice either to use it directly ([1]) or to apply it with a quasisolution approach. It turns out that the use of small $\beta > 0$ leads to better results than those when we apply Fourier method directly by taking $\beta = 0$. In addition, the case $\beta > 0$ lets us consider more number of harmonics. We have determined more admissible values of main parameters such as a harmonic number and a regularization parameter. It turns out that the most useful range for β is above $10^{-15} - 10^{-16}$, and one for M is $15 - 18$.

For Problem II the accuracy of the solution strongly depends on the behavior of the function $g(t)$. In several cases a recovery of the unknown solution have been obtained with machine accuracy, even if a regularization parameter is equal to zero. Discontinuous and oscillating functions are recovered with sufficiently accuracy as well.

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References

- [1] M.M.Lavrent'ev, On the Cauchy problem for the Laplace equation, *Izvest. Akad.Nauk.SSSR, Ser.Mat.*, 20 (1956), pp. 819-842 (in Russian).
- [2] S.Kabanikhin, M.A.Bektemesov, A.T.Ayapbergenova, D.V.Nechaev, Optimization methods of solving continuation problems *Vichislitelnye tekhnologii, ISSN 1560-7534*,9(2004), p. 50-60.
- [3] L.Bourgeois and J.Darde, A duality-based method of quasi-reversibility to solve the Cauchy problem in the presence of noisy data, *Inverse Problems*, 26(2010) 095016
- [4] N.Zabaras and J.Liu, An analysis of two-dimensional linear inverse heat transfer problems using an integral method, *Numer.Heat Transfer*,13(1988), pp.527-33
- [5] F.P.Vasil'ev, Methods for Solving Extremal Problems, *Moscow,Nauka*, 1981
- [6] A.I.Egorov, Optimal control of thermal and diffusion processes, *Moscow,Nauka*, 1978 (In Russian)
- [7] L.S.Pontryagin, Selected works.Vol.4.The Mathematical Theory of Optimal Processes, *CRC Press*, 1987
- [8] O.G.Provorova, On a question of control process described by a quasi linear parabolic equation, *Upavliaemye sistemy, Nauka, Siberian Branch, Novosibirsk*, 1973 (In Russian)
- [9] B.D.Tajibaev, On optimality conditions in one control problem, *Upavliaemye sistemy, Nauka, Siberian Branch, Novosibirsk*, 1988 (In Russian)
- [10] V.S.Belonosov, Interior estimates for solutions to quasiparabolic systems, *Siberian Mathematical Journal*, 37(1996),1, pp. 17-32

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