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Content

ALGORITHM FOR SOLVING THE INVERSE PROBLEM FOR THE HELMHOLTZ EQUATION

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We consider the initial-boundary value problem for the Helmholtz equation, which is ill-posed. We reduce the solution of the operator equation $Aq = f$ to the problem of minimizing the functional $J(q) = \langle Aq - f, Aq - f\rangle$. We construct an algorithm for solving the inverse problem [1].

Algorithm for solving the inverse problem

1. We choose the initial approximation $q^0 = (q_1^0, q_2^0)$;
2. Let us assume that q_n is known, then we solve the direct problem numerically
$$\begin{aligned} &u_{xx} + u_{yy} - \Big(\frac{\rho_x}{\rho}u_x + \frac{\rho_y}{\rho}u_y\Big) + \Big(\frac{\omega}{c}\Big)^2 u = 0, && (x,y)\in\Omega,\\ &u(0,y) = h_1(y), \quad u(1,y) = q_1^n(y), && y\in[0,1],\\ &u(x,0) = h_2(x), \quad u(x,1) = q_2^n(x), && x\in[0,1]. \end{aligned}$$
3. We calculate the value of the functional
$J(q_{n+1}) = \int\limits_0^1 \big[u_x(0,y;q_1^{n+1},q_2^{n+1}) - f_1(y)\big]^2 dy + \int\limits_0^1 \big[u_y(x,0;q_1^{n+1},q_2^{n+1}) - f_2(x)\big]^2 dx;$
4. If the value of the functional is not sufficiently small, then go to next step;
5. We solve the conjugate problem
$$\begin{aligned} &\psi_{xx} + \psi_{yy} + \Big(\frac{\rho_x}{\rho}\psi\Big)_x + \Big(\frac{\rho_y}{\rho}\psi\Big)_y + \Big(\frac{\omega}{c}\Big)^2 \psi = 0, && (x,y)\in\Omega,\\ &\psi(0,y) = 2\big(u_x(0,y;q_1,q_2) - f_1(y)\big), \psi(1,y) = 0, && y\in[0,1],\\ &\psi(x,0) = 2\big(u_y(x,0;q_1,q_2) - f_2(x)\big), \psi(x,1) = 0, && x\in[0,1]. \end{aligned}$$
6. We calculate the gradient of the functional $J'(q^n) = \big(-\psi_x(1,y), -\psi_y(x,1)\big)$;
7. We calculate the following approximation $q^{n+1} = q^n - \alpha J'(q^n)$;

REFERENCES

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