On the stable difference scheme for the time delay telegraph equation

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Abstract: In this study, the first order of accuracay difference scheme

$$\begin{cases} \frac{u_{k+1}-2u_k+u_{k-1}}{\tau^2}+\alpha\frac{u_{k+1}-u_k}{\tau}+Au_{k+1}=aAu_{[\frac{k}{N+1}]N}, \\ 1\le k<\infty,\ N\tau=1,(m-1)N\le k\le mN, m=1,2,... \\ u_0=\varphi, \quad ((1+\alpha\tau)I+\tau^2A)\frac{u_1-u_0}{\tau}=\psi \end{cases}$$

is considered for the approximate solution of the initial value problem for the telegraph equation with time delay

$$\begin{cases} \frac{d^2u(t)}{dt^2}+\alpha\frac{du(t)}{dt}+Au(t)=aAu([t]),\ 0<t<\infty, \\ u(0)=\varphi, \quad u'(0)=\psi \end{cases}$$

in a Hilbert space H with a self-adjoint positive definite operator A, $A>\delta I$. Here φ and ψ are elements of $D(A)$ and $[t]$ denotes the greatest-integer function and $\delta>\frac{\alpha^2}{4}$. The stability of this difference scheme is obtained and numerical results for a test problem are presented.

Keywords: Telegraph equation; time delay; difference schemes; stability.

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References

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