XXI. DETECTION AND ESTIMATION THEORY*

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A. A STATE-VARIABLE APPROACH TO THE SOLUTION OF FREDHOLM INTEGRAL EQUATIONS

[This report summarizes research that will appear as Technical Report 459 of the Research Laboratory of Electronics.]

A method of solving Fredholm integral equations of the second kind by state-variable techniques is presented. The principal advantage of this method is that it leads to an efficient computer algorithm for calculating numerical solutions. The kernel of the integral equation is assumed to be the covariance function of the output of a linear system that has a white noise input. Also, the input-output relationship of this system is assumed to have a state-variable description.

Both the homogeneous and nonhomogeneous integral equations are reduced to equivalent first-order vector differential equations with associated sets of boundary conditions. The solution to the original integral equation follows directly from the solution to the corresponding vector differential equation. In the homogeneous case, a transcendental equation is found whose solutions are the eigenvalues of the integral equation. The eigenfunctions also follow directly. The solution to the nonhomogeneous equation is determined from a vector differential equation which is identical in form to the state-variable formulation of the optimum unrealizable filter, the interval estimator. In both cases, the techniques that have been developed lend themselves readily to computational methods of solution.

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