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DETERMINATION OF A PITCH CONTROL PROGRAM FOR A SOLID-PROPELLANT MISSILE

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This paper analyzes the trends in the improvement of the performance characteristics of guided missiles with solid-propellant sustainer engines and identifies the features and requirements for flight trajectories, design parameters, and control programs. Within the framework of the optimal control theory, the comprehensive problem of simultaneous optimization of a missile's design parameters and control systems is formulated. An approach to the formation of missile flight control programs in the form of polynomials is developed further, thus making it possible to reduce the optimal control theory problem to a simpler problem of nonlinear mathematical simulation. The proposed approach to control program development is used at the initial design stage to form a wide range of guided missile trajectories. Use is made of a methodology for the ballistic and aeroballistic flight range optimization of the design parameters and flight control programs of a canard missile. The missile flight range depends essentially on the values of the design and trajectory parameters and control programs chosen for optimization. Because of this, the optimization of the chosen parameters (maybe, other parameters too) in the solution of specific target problems seems to be the indispensable initial stage of missile design. For the considered missile trajectories with a vertical launch where the Mach number takes different values, optimal programs of pitch time variation that maximize the flight range are determined. The analysis of the optimization results for different trajectories shows that the optimal program in active flight with a vertical launch is the linear time dependence of the pitch angle. The application package developed allows one to determine flight control programs optimal in a given class of functions and advisable design parameters and basic performance characteristics of guided missiles for various aerodynamic designs and flight schemes as early as at the initial design stage to an accuracy required for design studies. This makes it possible to analyze design alternatives, thus improving the quality of solution of problems arising at the initial design stage and reducing the time and the cost of design work on new missiles.

Keywords*: guided missile, solid-propellant sustainer engine, initial design stage, design parameters, trajectory parameters, flight control programs, objective functional, optimization methodology.*

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