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EFFECT OF A GUIDED ROCKET OBJECT'S LATERAL MANEUVER ON THE FLIGHT RANGE AND LATERAL DEVIATION

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This paper presents the results of testing of mathematical models that analyze the mass-center and about-mass-center cooperative motion parameters of a guided rocket object in different trajectory portions and determine the time evolution of its mass-centering and aerodynamic characteristics. The paper presents a mathematical model that allows one to form a yaw angle variation program in any aeroballistic trajectory portion and study the motion parameters in lateral yaw angle maneuvers. Use is made of mathematical and numerical simulation, which allows one to assess, at the initial design stage and based on the key design parameters, trajectory parameters, and flight control programs, the controllability of a rocket object and its flight range and basic characteristics and study the motion of its mass center and its motion about the mass center in horizontal and vertical maneuvers. The guided rocket object under consideration is a single-stage solid-propellant rocket that is to deliver a payload of desired mass to a given point at given values of kinematic trajectory parameters. The aerodynamic and aeroballistic characteristics are determined for a "normal" layout scheme with aerodynamic rudders to stabilize and control the rocket in flight. A verification is made of the author's methodology for studying and characterizing a guided rocket object using a limited amount of available information of its mass and dimensions, the power characteristics of its solid-propellant sustainer engine, and the parameters of its aeroballistic trajectory. A study is conducted on the flight of a guided rocket object in lateral yaw angle maneuvers. The effect of a guided rocket object' lateral maneuver on the flight range is estimated.

Keywords*: guided rocket object, design parameters, trajectory parameters, flight control parameters, ballistic and aeroballistic trajectories, lateral maneuver, solid-propellant rocket engine, optimization methodology.*

1. Guided Operative-Tactical and Tactical Missile Systems of the World's Countries: a Review of 2008 - 2014 Home and Foreign Unclassified Publications and the Internet. Dnipropetrovsk, 2014. 162 pp. (in Russian).

2. Lockheed Martin's GMLRS+ Completes Successful Test Flight of Long-Range Motor, Aug. 9, 2011. URL: https://news.lockheedmartin.com/2011-08-09-Lockheed-Martins-GMLRS-Completes-Successful-Test-Flight-of-Long-Range-Motor (Last accessed on November 29, 2024).

3. HIMARS. The long-range, mobile, precision fires launcher. URL: https://www.lockheedmartin.com/en-us/products/himars.html (Last accessed on November 29, 2024).

4. Foreign Multiple-Launch Jet Systems: a Review of 1987 - 2016 Unclassified Publications and the Internet. Dnipropetrovsk, 2016. Part I. 205 pp. (in Russian).

5. ATACMS Advanced Military Rocket Technology. URL: https://www.lockheedmartin.com/en-us/products/army-tactical-missile-system.html (Last accessed on November 29, 2024).

6. Aksenenko A. V, Hurskyi O. I., Klochkov A. S., Kondratiuk Ye. A., Senkin V. S., Siutkina-Doronina S. V. Analysis of development trends of design parameters and basic characteristics of missiles for the advanced multiple launch rocket systems. Space Technology. Missile Armaments. 2020. No. 1 (119), Pp. 13 - 25. (in Russian).
https://doi.org/10.33136/stma2020.01.013

7. Fleeman Eugene L. Tactical Missile Design. Second Edition. Lilburn, Georgia: AIAA Education series. 2006. 469 pp.

8. Lebedev A. A., Chernobrovkin L. S. Flight Dynamics. Moscow: Oborongiz, 1962. 548 pp. (in Russian).

9. Krasnov N. F., Koshevoi V. N., Danilov A. N. et al. Applied Aerodynamics. Moscow: Vysshaya Shkola, 1974. 732 pp. (in Russian).

10. Krasnov N. F. Basics of Aerodynamic Design: Aerodynamics of Revolution Bodies and Lifting Control Surfaces. Moscow: Vysshaya Shkola, 1981. 496 pp. (in Russian).

11. Tewari Ashish. Advanced Control of Aircraft, Spacecraft and Rockets. Kanpur: John Wiley & Sons, 2011. 456 pp.
https://doi.org/10.1002/9781119971191

12. Siutkina-Doronina S. V. Optimization Methodology of the Basic Characteristics of Single-Stage Rockets with a Solid-Propellant Sustainer Engine. Ph.D. Thesis. Approved on June 29, 2021. Dnipro, 2021. 168 pp. (in Ukrainian).

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