Analysis of numerical data in simulation the descent of a space probe with a brake screw in the martian atmosphere

Lyubimov V.V., Mammadov R.A.
Samara National Research University

Abstract-A mathematical model describing the uncontrolled descent of a space probe with a free-rotating brake screw in the atmosphere of Mars is considered. The aim of the work is a qualitative analysis of computer simulation data of the descent motion of the center of mass of the space probe. The numerical results presented in this paper can be used in the design of promising spacecraft carrying out descent in the atmosphere of Mars.

MATHEMATICAL MODEL OF PROBE MOTION

The nonlinear equations of the motion of the center of mass of the space probe with a freely rotating screw during descent in the atmosphere of Mars is written as follows

$$\frac{dV}{dt} = -\frac{C_{xv} q S}{m} - g\sin\theta + \frac{F_p}{m}, \qquad (1)$$

$$\frac{dH}{dt} = V\sin\theta, \qquad (2)$$

$$\frac{d\vartheta}{dt} = \frac{C_{yv} S q}{mV} - \frac{g\cos\theta}{V}, \qquad (3)$$

where V is velocity of the center of mass of the space probe, H is flight altitude of the space probe, θ is the angle of entry of the space probe into the atmosphere of Mars , F_p is the thrust force of the screw, calculated by the formula

$$F_p = 0.5 c_p \rho A \omega^2 r^2 . \qquad (4)$$

NUMERICAL DATA

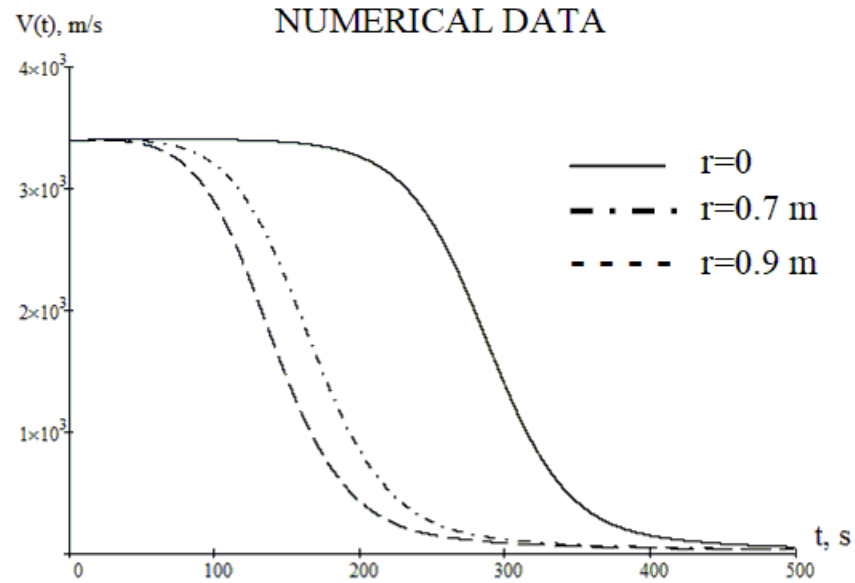

Fig.1. Changing the probe velocity for different sizes r of the brake screw

CONCLUSION

The presented work contains the results of a qualitative and quantitative analysis of numerical data describing the motion of the centre of mass of a space probe with an onboard braking device in the form of a two-bladed screw. Increasing the size of the screw blade increases the thrust force of the screw. In general, the analysis of the numerical results showed that use of a space probe design containing a freely rotating screw is an effective and simple way to increase the deceleration rate of the space probe to the values required.