Verbesserung des Zustandes der Weltraumumgebung zu lösen.Ein kluger Schachzug für Weltraumerhaltung für künftige Generationen wäre es jetzt mit den Maßnahmen zur Verringerung der Verschmutzung des Weltraumes zu beginnen.

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DESIGN OF A PARAMETRICAL FLYWHEEL WITH USE OF NEW TECHNOLOGIES

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ПРОЕКТИРОВАНИЕ ПАРАМЕТРИЧЕСКОГО МАХОВИКА С ИСПОЛЬЗОВАНИЕМ НОВЫХ ТЕХНОЛОГИЙ

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Article contains a optimization ways of a flywheel characteristics of the navigation executive body system of the small spacecraft on the basis of the a flywheel mathematical model analysis. The mathematical model allows to estimate mutual influence of his characteristics and to establish connection between them which directly aren't defined. The variation of a design parameters through parametrization with use of the specialized software realizing geometrical parametrization and a possibility effective calculation of the required characteristics is the most effective method of optimization of characteristics. The parametrical 3D model including calculation of operational characteristics is created. It is possible to receive an optimum complex of operational parameters a variation of a 3D model parameters. It is very actual at a design stage as allows to increase significantly quality of the designed device and to reduce the general time of design.

Статья содержит один из способов оптимизации характеристик маховика исполнительного органа системы ориентации малого космического аппарата на основе анализа математической модели маховика. Математическая модель позволяет оценить взаимное влияние его характеристик и установить связи между ними, которые напрямую не определяются. Наиболее эффективным методом оптимизации характеристик является варьирование параметров конструкции через параметризацию с использованием специализированного программного обеспечения, реализующего геометрическую параметризацию и возможность эффективного расчета требуемых характеристик. Создается параметрическая 3D-модель, включающая в себя расчет эксплуатационных характеристик. Варьированием параметров 3D-модели

возможно получить оптимальный комплекс эксплуатационных параметров. Это весьма актуально на этапе проектирования, поскольку позволяет существенно повысить качество проектируемого устройства и сократить общее время проектирования.

Introduction

A flywheel is a rotating mechanical device that is used to store rotational energy. Flywheel has a significant amount of inertia moment and thus resists changes in rotational speed. The amount of energy stored in a flywheel is proportional to the square of its rotational speed energy transferred to fly wheel by applying torque to it, thereby increasing its rotational speed hence its stored energy conversely, a flywheel released stored energy by applying torque to a mechanical load thereby decreasing it is rotational speed [1].

Calculation of flywheel parameters

The purpose of this work is to design a flywheel of small spacecraft executive body with the following parameters: the kinetic moment – H=0,2 of Nms, the maximum sizes – 70×70×45 mm, the maximum operating moment – M = 0,02 Nm.

Flywheel will be calculated for the servo electric motor which is shown in Fig.1. It consists of the massive rotor with obviously expressed rim established on multiball bearings and the electric motor bringing a flywheel into rotation, rotor is fixed on a flywheel and the stator – on the basis. The device has a protection cover.

For calculation of a flywheel parameters the following formulas were used:

- inertia moment: $J = \frac{H}{\Omega}$, where H - the angular momentum, Ω - angular velocity of rotation;
- inertia moment of the flywheel rim: $Ju = m \cdot Ru^2$, where m - mass, Ru - radius of gyration;
- mass: $m = V \cdot \gamma$, where V - volume, γ - specific gravity of the material of the flywheel;
- volume: $V = h \cdot \pi \cdot (R^2 - r^2)$, where h - height of the flywheel rim, R - radius of the outer rim flywheel; r - inner radius of the flywheel rim;
- inertia moment of the flywheel rim: $Ju = h \cdot \pi \cdot (R^2 - r^2) \cdot \gamma \cdot Ru^2$, where γ - specific gravity of the flywheel material; R -the outer radius of the flywheel rim; r - inner radius of the flywheel rim; h - height of the rim flywheel; Ru- the radius of gyration; m - mass flywheel rim [1].

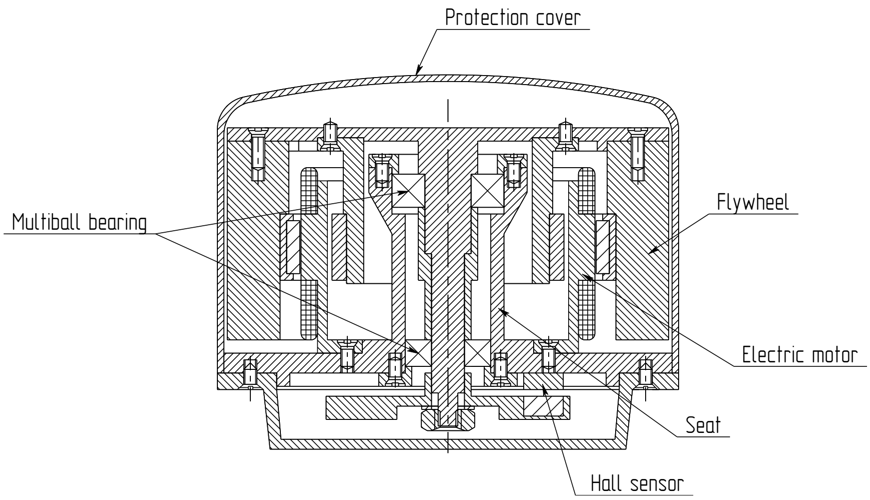


Fig. 1. Overall view of the servo electric motor

Parametrical variation of flywheel dimension and mass combination analysis depending on its angular speed was carried out for definition of rational constructive variation by the flywheel dimensions and mass. Table 1 shows weight dimension characteristics.

Table 1. Weight-dimension parameters of a flywheel at various angular rotation speeds and constant height of a flywheel rim h = 0,03 m.

The height of the flywheel rim h, m	The outer radius of a flywheel rim R, m	The inner radius of a flywheel rim r, m	Weight m, kg	Angular speed Ω, 1 / min
0,03	0,032	0.015	0,482	5000
0,03	0,033	0.017	0,443	5000
0,03	0,034	0.02	0,394	5000
0,03	0,035	0.023	0,370	5000
0,03	0,03	0.01	0,573	6000
0,03	0,031	0.013	0,512	6000
0,03	0,032	0.016	0,464	6000
0,03	0,033	0.018	0,400	6000
0,03	0,034	0.020	0,373	6000
0,03	0,035	0.023	0,382	6000

Figure 2 gives an example of the dependence of the flywheel mass from the outer diameter for different values of the flywheel rim height when the angular velocity Ω = 6000 1/ min.

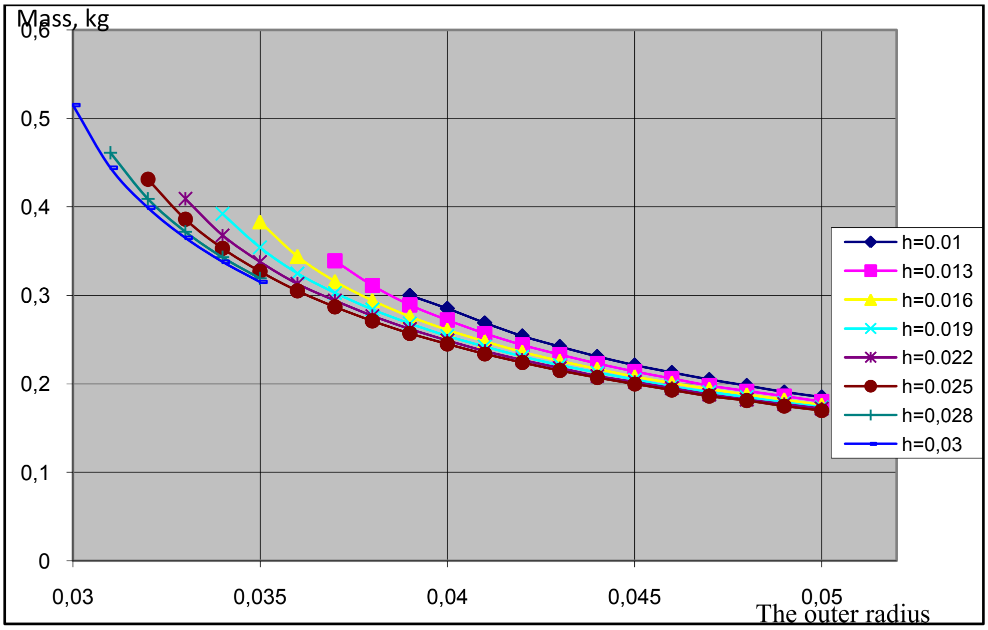


Fig. 2. Flywheel mass dependence of the outer diameter for various values of the rim height, Ω = 6000 min^{-1}

Parametrical 3D model of a flywheel

The parametrical 3D model has been created in the calculated parameters of a flywheel and given in figure 3.

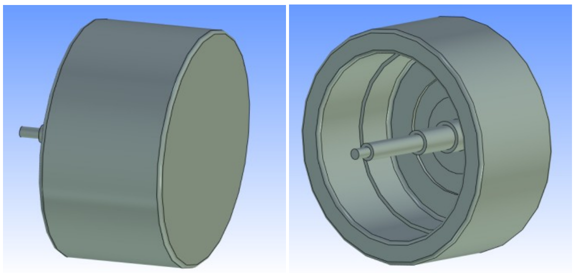


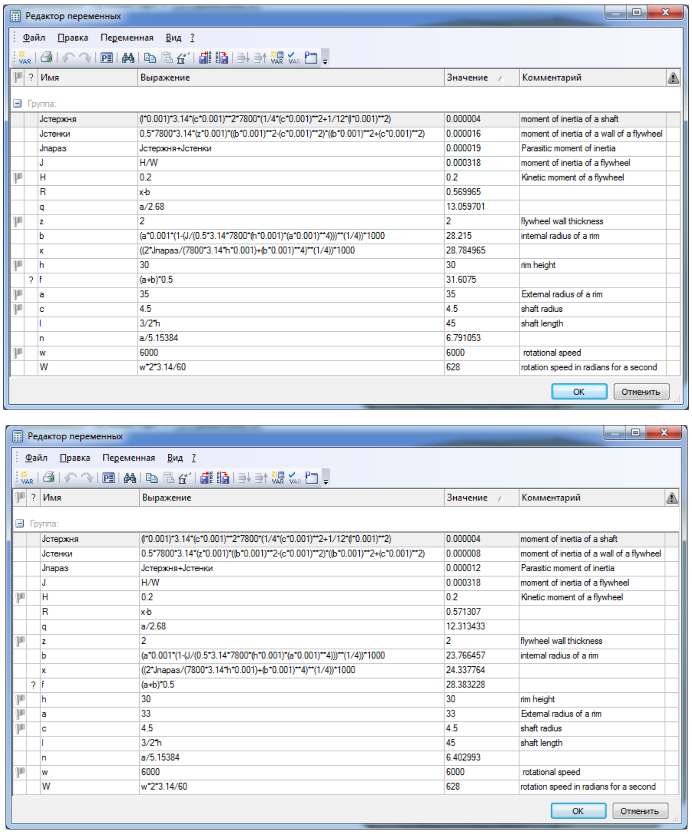
Fig. 3. Parametric 3D model of the flywheel

The inner radius of the flywheel is calculated according to the formula

$$r = R \cdot \sqrt{1 + \frac{J}{\frac{1}{2} \cdot \gamma \cdot \pi \cdot h \cdot R^4}},$$

where γ - specific gravity of the material of the flywheel; R - radius of the outer rim of the flywheel; r - inner radius of the flywheel rim; h - height of the flywheel rim; m - mass flywheel rim; J – inertia moment.

The model is completely reconstructed at change of external radius of a flywheel, at the same time there is a recalculation of the parameters depending on the geometrical sizes of a flywheel and the internal radius because a flywheel 3D model parametrical. Copies of the screen with the editor of variables at two values of external radius of a flywheel are shown in figure 4.



Редактор переменных

Файл Правка Переменная Вид ?

Группа:

?	Имя	Выражение	Значение	Комментарий
	Jстержня	(l*0.001)*3.14*(c*0.001)**2*7800*(1/4*(c*0.001)**2+1/12*(l*0.001)**2)	0.000004	moment of inertia of a shaft
	Jстенки	0.5*7800*3.14*(z*0.001)*((b*0.001)**2-(c*0.001)**2)*((b*0.001)**2+(c*0.001)**2)	0.000016	moment of inertia of a wall of a flywheel
	Jпараз	Jстержня+Jстенки	0.000019	Parasitic moment of inertia
	J	H/W	0.000318	moment of inertia of a flywheel
	H	0.2	0.2	Kinetic moment of a flywheel
	R	x-b	0.569965	
	q	a/2.68	13.059701	
	z	2	2	flywheel wall thickness
	b	(a*0.001*(1-(J/(0.5*3.14*7800*(h*0.001)*(a*0.001)**4)))**(1/4))*1000	28.215	internal radius of a rim
	x	((2*Jпараз/(7800*3.14*h*0.001)+(b*0.001)**4)**(1/4))*1000	28.784965	
	h	30	30	rim height
?	f	(a+b)*0.5	31.6075	
	a	35	35	External radius of a rim
	c	4.5	4.5	shaft radius
	l	3/2*h	45	shaft length
	n	a/5.15384	6.791053	
	w	6000	6000	rotational speed
	W	w*2*3.14/60	628	rotation speed in radians for a second

OK Отменить

Редактор переменных

Файл Правка Переменная Вид ?

Группа:

?	Имя	Выражение	Значение	Комментарий
	Jстержня	(l*0.001)*3.14*(c*0.001)**2*7800*(1/4*(c*0.001)**2+1/12*(l*0.001)**2)	0.000004	moment of inertia of a shaft
	Jстенки	0.5*7800*3.14*(z*0.001)*((b*0.001)**2-(c*0.001)**2)*((b*0.001)**2+(c*0.001)**2)	0.000008	moment of inertia of a wall of a flywheel
	Jпараз	Jстержня+Jстенки	0.000012	Parasitic moment of inertia
	J	H/W	0.000318	moment of inertia of a flywheel
	H	0.2	0.2	Kinetic moment of a flywheel
	R	x-b	0.571307	
	q	a/2.68	12.313433	
	z	2	2	flywheel wall thickness
	b	(a*0.001*(1-(J/(0.5*3.14*7800*(h*0.001)*(a*0.001)**4)))**(1/4))*1000	23.766457	internal radius of a rim
	x	((2*Jпараз/(7800*3.14*h*0.001)+(b*0.001)**4)**(1/4))*1000	24.337764	
?	f	(a+b)*0.5	28.383228	
	h	30	30	rim height
	a	33	33	External radius of a rim
	c	4.5	4.5	shaft radius
	l	3/2*h	45	shaft length
	n	a/5.15384	6.402993	
	w	6000	6000	rotational speed
	W	w*2*3.14/60	628	rotation speed in radians for a second

OK Отменить

Fig. 4. Calculation of a flywheel internal radius at two values of external radius (33 and 35 mm) in the editor of variables

Conclusion

Flywheel 3D model which meets qualifying standards has been designed. As the 3D model of a flywheel is parametrical, the model completely reconstructs while flywheel changing of external radius. At once there is a recalculation of the parameters depending on the geometrical dimensions of a flywheel, in particular, of internal radius [2]. Application of modern computer design aids allows to project quickly and effectively elements of spacecrafts designs. Parametrization helps to carry out search of a flywheel optimum design with the best strength characteristics.

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DEVICE FOR CONTINUOUSLY MONITORING OF HEALTH OF COSMONAUTS

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УСТРОЙСТВО ДЛЯ НЕПРЕРЫВНОГО МОНИТОРИНГА ЗДОРОВЬЯ КОСМОНАВТОВ

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Cardiovascular disease can appear even absolutely healthy people. Particularly at risk are the cosmonauts, as a long stay in space has a negative effect on the heart. To prevent the occurrence of cardiovascular disease need to detect disease in the early stages, for which require constant monitoring. The article is devoted to the study of devices for the diagnosis of heart disease during the period of cosmonauts on the space station. Were studied devices that use American astronauts during training on Earth and in space. Research has shown that such devices are popular abroad, particularly in the US, but in Russia these analogues are used only in earthly conditions. On the basis of the information received has been offered the idea of a portable cardiograph, which can be used regularly in weightlessness.

Сердечно-сосудистые заболевания могут возникать даже у абсолютно здоровых людей. Особому риску подвержены космонавты, так как долгое пребывание в космическом пространстве отрицательно сказывается на сердце. Чтобы предотвратить возникновение сердечно-сосудистых заболеваний нужно отследить болезни на ранних стадиях, для чего требуется постоянный мониторинг. Статья посвящена изучению устройств, для диагностики сердечных заболеваний космонавтов в период нахождения на космической станции. Были изучены устройства, которые используют американские космонавты во время тренировок на Земле, а также уже непосредственно в космосе. Исследование показало, что подобные