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ESTIMATION OF PLANETARY REDUCTOR SENSITIVITY

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Abstract. *The results of the sensitivity of planetary transmitter are presented in this scientific work. The analysis of the sensitivity of planetary transmitter was performed by the statistical method of variance analysis. This method selects the parameters to which the system is significantly sensitive and the parameters to which the system is not sensitive. On the basis of this, some conclusions are drawn about the sensitivity of the system. A computer program in BASIC is done.*

Key words: *sensitivity, parameter, state.*

1. INTRODUCTION

Behaviour of the system for its determined parameters is very often not the only important thing for system analysis but the dependence of its behaviour on small variations of those parameters as well. The variation of the system response to a small change of some of its parameters is called the sensitivity of the system in relation to the change of its parameters [1]

The problem of the dynamics of stability is basically a non linear problem. When analyzing sensitivity we examine the influence of different parameters of dynamic systems, and as typical system parameters may be: the initial conditions, permanent coefficients, variable conditions, proper frequency, selection interval, etc.

In order to find the function of sensitivity we start by assuming that the information about the real system exist. This information may be given analytically, as a simulation model or as a real system. The most frequent case in practice is that the sensitivity has to be determined on the basis of a mathematical model.

Considering that a real system is chericterized by a great number of different parameters, that we wish to valuate, there emerges the problem of solving nonlinear large

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systems of equations. Further, the problem is the complexity of separation of important parameters from the less important ones or the unimportant parameters. The estimation of a nonlinear systems of higher order is not yet developed and also not solved. We solved this problem by applying the statistical method of variance analysis.

In this work we study the sensitivity of the planetary transmitter presented by a dynamic model with many parameters and elements of state. For such a model we make differential equations of motion and we valuate sensitivity using the variance analysis.

2. Sensitivity of the Dynamic System

The sensitivity analysis studies the effect of the variation of parameters on the behaviour of the dynamic system. The estimation of sensitivity of different states of the system to the parameters is a very complex problem demanding a very complex mathematical apparatus.

In mathematics it is assumed that there is a unique correspodence between the vectors of the parameters and the vectors of state, $P \to E$. The mapping $P \to E$ can be determined by a differential equation, the equation of state or on some way.

In technique, the values of the parameters can be determined only with a limited precision. But, the external conditions and time change the values of the parameters. In other words, in technics we operate with nominal values of parameters and their variations. For engeneer practice it is important, instead of the mapping $P \to E$, look at the mapping $D_p \to D_e$ where D_p is the space of the parametric variations in relation to the nominal value of the vector $p = p_0$. The subspace D_E represents the corresponding zone of the space states. The zone D_E is determined in a unique way if we know D_P by means of the general equation in vector form:

$$\begin{aligned} E &= f(E, p(t), t) \\ E(t_0) &= E_0 \end{aligned} \tag{1}$$

where E is the vector of the dimension N, $p(t)$ vector of the dimension M, and f vector function.

The relation of the zones D_E and D_P gives us the information about the sensitivity of the dynamic system on changes. However, on this way determined sensitivity of the dynamic system is inconvenient for more reasons. First of all, the direct solving of the equation (1) for all the elements of the set D_P, demands an infinite number of solutions and depends on the definition of the set D_P. therefore in engeneer practice we deal with this in another way.

It is the most convenient to represent the set D_P as a product of a characteristic function $u(E, p_0, t)$ and a given set of parametric variations D^P. Then , for small variations of the parameter vector p(t), the condition of continuity of the operetor $f(E,p,t)$ at the point p_0(t), can be also expressed as:

$$D_E \approx u(E, p_0, t) D_{\Delta p} \tag{2}$$

If we know $u(E,p_0,t)$ it is easy to calculate each element of the set D_E on the basis of the chosen value ΔP. This approach reduces the study of sensitivity to the definition and finding the function u. The function u is called the function of sensitivity of the dynamic system.

If we deal with a constant change of parameters for equal values, then the function of sensitivity of the system, defined by the general vector equation, $E = f(E,p(t),t)$ is defined through the conception of simple derivative:

$$u(p_m) = \lim_{\varepsilon \to 0} \frac{E(p_m + \varepsilon, t) - E(p_m, t)}{\varepsilon} = \frac{\partial E}{\partial p_m} \tag{3}$$

The existance of the function of sensitivity in this case requires, as can be seen, the continuons dependence of the solution of the equation of the state on the parameters, irrelevant whether the parameter itself is constant or changeable.

2. 1. Calculation of the sensitivity function

In calculation of the sensitivity function we begin with the assumption that the information on the real system exists. This information can be given analytically, as a simulation model, or as a real system.

We shall explain the principle of calculating the function of sensitivity at first as a constant perturbation vector of the parameters of the continuons system. Vector equation of state (1) is already given. We need to calculate the matrix of sensitivity

$$u(p_m) = \frac{\partial E}{\partial E} = \left[\frac{\partial E_n}{\partial p_m} \right] \quad \begin{matrix} n = 1,2,..........N \\ m = 1,2,........M \end{matrix} \tag{4}$$

For constant variations of the parameters, $\Delta p_m = const$.

Differentiating the equation (1) with respect to p, we get a matrix differential equation:

$$\begin{aligned} &U(p) = G(\varnothing, p, t)U(p) + H(\varnothing, p, t) \\ &U(p, t_0) = 0 \end{aligned} \tag{5}$$

In case when the vector of the parameters of the system does not include the initial conditions as well.

The symbols in the equation (5) have the following meaning:

p – normal value of the parameter vector.

$\varnothing$ – nondisturbed solution of the equation (1).

U – vector of sensitivity in relation to the parameter p_m,

$$G = \left[\frac{\partial f_i}{\partial E_n} \right] \quad i, n = 1,2,...........N$$

$$H = \left[\frac{\partial f_n}{\partial p_m} \right] \quad \begin{matrix} n = 1,2,.............N \\ m = 1,2,.............M \end{matrix}$$

The equation (5) is a linear differential equation with coefficients changing with time. These coefficients and independent members are determined by the undisturbed solution of the system (1).

So, the determination of the sensitivity function can be reduced on the solving of the given and the derived system of differential equations. In this way, the procedure for the integration of differential equation (1) can be directly applied to the system (5).

Let's assume that the oscillating system is described by a system of nonlinear differential equations of second order:

$$f_i(\ddot{x}, \dot{x}, x, t, p) = 0 \tag{6}$$

where p stands for a specific parameter vector.

The system of equations of sensitivity in relation to an optional parameter p_i, has the following form /Tomović/:

$$\left[\frac{\partial f}{\partial \ddot{x}}\right]\{\ddot{u}\} + \left[\frac{\partial f}{\partial \dot{x}}\right]\{\dot{u}\} + \left[\frac{\partial f}{\partial x}\right]\{u\} + \left\{\frac{\partial f}{\partial p_i}\right\} = 0 \tag{7}$$

where: $u = \dfrac{\partial E}{\partial p_i}$ – function of sensitivity of the first order,

$\left[\dfrac{\partial f}{\partial \ddot{E}}\right]$ – matrix of the generalized masses of the system sensitivity,

$\left[\dfrac{\partial f}{\partial \dot{E}}\right]$ – matrix of the generalized masses of the system sensitivity,

$\left[\dfrac{\partial f}{\partial E}\right]$ – matrix of the generalized masses of the system sensitivity,

$\left\{\dfrac{\partial f}{\partial p_i}\right\}$ – matrix of the column of the generalized forces.

The matrix equation (7) represents the general expression for sensitivity of the first order of a nonlinear dynamic system. The system of differential equations (7) belongs to the class of linear nonhomogeneous differential equations with variable coefficients, since the matrices $\left[\dfrac{\partial f}{\partial \ddot{E}}\right]$, $\left[\dfrac{\partial f}{\partial \dot{E}}\right]$, $\left[\dfrac{\partial f}{\partial E}\right]$, depend on the solution of the basic system (6).

3. THE VARIANCE ANALYSIS

The term "dispersion analysis" includes a large number of standard statistical methods. The wide use of the dispersion analysis is consequence of it being not only the whole analytic perception, but also an elastic way of structuring statistical models of experiment material, which showed to be very precise in the most different cases.

The used model can be represented in the following form:

(*observed value*) =
Σ(*parameters describing the effects defined*) + (8)
+ Σ(*decidental qualities describing the non defined* (*the remaining*) *effects*).

By "defined effects" we understand the effects produced by the action of changes in the conditions taken into consideration. The more factors we consider (which depends on the experience) the less will be nondefined (the remaining) variability which has not taken into consideration. It is necessary to apply dispersion analysis in the beginning to construct the appropirate statistical model and make a list of questions which we will study by using the given model.

The dispersion analysis is based on the following assumptions on the accidental qualities and parameters appearing in the model (8).

1. The mathematical expectation of each remaining accidental quantity is equal to zero. This means that any variability in mathematical expectations includes the parameters (and possible accidental quantities) representing certain effects.
2. The remaining accidental quantities are independent beetwen each other. The purpose for this lies in the fact that there is no speciffic connection between different observations that can be explained through the members describing certain effects.
3. All the remaining accidental quantities have the same middle square deviation. This assumtion on uniformity of dispersion is very important.
4. Each and every remaining accidental quantity is distribued by the normal law. In general, this assumption is less probable that the previous three. But fortunately a considereble part of the dispersion analysis can be carried through without this assumption, necessary only to establish and use formaly correct criteria for the verification of impotance and the formula of valuation.

4. THE ESTIMATION OF SENSITIVITY OF A NONLINEAR SYSTEM USING THE VARIANCE ANALYSIS

The applicability of the variance analysis in estimation the sensitivity of a nonlinear system of a higher order is seen in the possibility of finding the parameters which the system is especially sensitive to. These parameters can be transformed and their speciffic effect on the system eliminated.

Practicaly this means that it is possible, based on the valuation of sensitivity of the system in relation to the parameters, to predict the corresponding behaviour of the system, which is certainly useful.

The vaulation of sensitivity of nonlinear system to different parameters can be made using the variance analyses, and specially for one parameter with more levels, for two, three or more parameters. The methods of the variance analysis having the special application are: The onefactor dispersion analysis, the twofactor analysis, analysis by an accidental block system, Latin square, Greek-Latin square and hyper Greek-Latin square.

4.1. The valuation of sensitivity by the method of oneparameter analysis

Let's assume that we examine the influence of one parameter, having two or more levels of the state E having the normal distribution $N(m;\delta^2)$. The elements of the statistical set are divided into groups. The first group consists of elements which are affected by the first treatment of parameters, the second group consists of those elements which are affected by the second treatment and so on. In each group we measure the value of the state E. Let's assume that these values are the values E_1, E_2, ... corresponding to the groups. If a parameter does not influence the state E, then, every group will have the same characteristics of the observed state. That means that the characteristics of the state in groups E_1, E_2, ... will be the same, and if the factor of sensitivity has the influence, then, the characteristics will be different. As a characteristics of the state E we will observe its average value and variance. We will have to make a difference between the differences in the groups in the state E and the average values and variances. The sensitivity of the system (specially the valuation of the sensitivity function of the system state and the system exit) , in this case, will be the states which we got by measuring the influence of certain parameters. The change of the first treatment can be obtained from the sensitivity function, E_1 - its influence over the function. By applying the variance analysis we determine either a very important influence of the factor or the lack of its influence. In case that the influence is important, it is possible to determine which treatments are helping this process. This could be performed by means of an additional analysis.

Mathematical model of the single-parameter-dispersion analysis is:

$$E_{ij} = \mu + \alpha_i + \varepsilon_{ij} \tag{9}$$

where α_i represents the influence of the i-treatment of the factor, E_{ij}–random variable which represents the influence effects of the all other unmeasurable parameters. In order to examine whether of the levels (treatments) have a different influence on E or not, we test the hypothesis of homogeneity that the treatments do not influence on E differently, i. e the hypothesis

$$H_0 \; : \; \alpha_1 = \beta_2 = . \; . \; . \; . \; . \; . \; . \; . = \gamma_k = 0$$

is linear, it determins geometrically the straight line w in the parameter field, where every point has its equal coordinates. This hypothesis is tested by F-test, its statistics is determined by the help of square forms, which demand the determining of the valuation by the method of the smallest square numbers for the unknown parameters.

Certain sums necessary for the variance analysis in this case can be calculated by the following procedure.

The total sum of the square numbers is :

$$Q = \sum\sum E_k^2 - n\overline{E}^2 \tag{10}$$

The sum of the square numbers of the treatment influence between the samples is:

$$Q_i = \sum n_i (E_i^2 - \overline{E})^2 \tag{11}$$

The residual sum of the square numbers among the samples is:

$$Q_u = \sum(\sum(\overline{E}_i - E_i)^2) \tag{12}$$

The final variability of all the samples , equals the summary of the variability of the samples and the variability amog the samples, i. e.

$$Q^2 = Q_E^2 + Q_i^2$$

If the hypothesis $H_0(\alpha_1 = \beta_2 = ... = \gamma_k = 0)$, is correct, the statistics Q_E^2 i Q_i^2 are independent and they have the expected values $(n - k)\delta^2$ and $(k - l)\delta^2$. The statistics $\delta^2 Q_E^2$ has H_i square distribution with $(n - k)$ levels of freedom. If the hypothesis H_0 is true, the statistics $\delta^2 Q_i^2$ has H_i square distribution with $(k-1)$ levels of freedom. Their ratio is the statistic

$$F = \frac{n-k}{k-1}\frac{Q_i^2}{Q_E^2} \tag{13}$$

which has the F distribution with $(k-1)$ and $(n-k)$ levels of freedom.

Due to the differences in the expected values of the statistics Q_i^2 and Q_E^2, it is clear that we should determine the critical value F_0 so that, with the level of importance α, we have the probability $P(F > F_0) = \alpha$. And by comparing the value F from the sample, and the critical value F_0, the decision either to accept or to reject the hypothesis. H_0 we should bring in the following manner:

– if $F > F_0$, then we should accept the hypothesis about the important influence of the parameter (reject the hypothesis H_0),

– if $F < F_0$, then we should reject the hypothesis about the important influence of the parameter (accept the hypothesis H_0).

When we valuate the sensitivity of the system function, E_1, E_2, ... on individual parameters p_1, p_2, ... we start from the certain supposition about the behaviour of the real system.

We will assume that the parameter influences on the sensitivity functions are generated by numbers. In the case it proves (a single factor or any other model) that the influence treatment is important we can determine which level (treatment) affected the important influence of the observed parameter. The essence of this is to find the group of the parameter, for example the group of two parameters which do not affect significantly the sensibility function. Then, if we add to those parameters a parameter more and if we complete the variance analysis, we can conclude that the system is not sensitive to that parameter or that it is sensitive significantly only on that particular parameter etc.

By means of the proceeding procedure, it is possible to single out all the parameters that are of significant influence for the system sensibility function.

5. THE APPLICATION OF THE VARIANCE ANALYSIS IN SOLVING THE PROBLEM OF THE PLANETARY TRANSMITTER SENSITIVITY

Planetary transmitter is presented by a model on the Fig. 1, where 1 represents the cog-wheel or the sun, h-represents the porter or satelite, 2 represents the satelite & 3 represents the cog-wheel. Diferential equations of the movement of the planetary transmitter system are:

$$\begin{gathered}
A\ddot{\varphi}_1 + D\ddot{\varphi}_h + (mgr_1 + 4c_1' r_1^2 + c_1'' r_1^2)\varphi_1 - 4c_1' r_h r_1 \varphi_h = \\
mgr_1 \frac{\varphi_1^3}{6} - c_2[16 r_1 (r_1\varphi_1 - r_h\varphi_h)^3 + r_1^4 \varphi_1^3] - k[4r_1(r_1\dot{\varphi}_1 - r_h\dot{\varphi}_h) + r_1^2\dot{\varphi}_1] \\
D\ddot{\varphi}_1 + B\ddot{\varphi}_h + (4c_1' r_h^2 - mgr_h)\varphi_h - 4c_1' r_1 r_h \varphi_1 = \\
-mgr_h \frac{\varphi_h^3}{6} - 16c_2 r_h (r_h\varphi_h - r_1\varphi_1)^3 - 4kr_h(r_h\varphi_h - r_3\varphi_1)^3
\end{gathered} \tag{14}$$

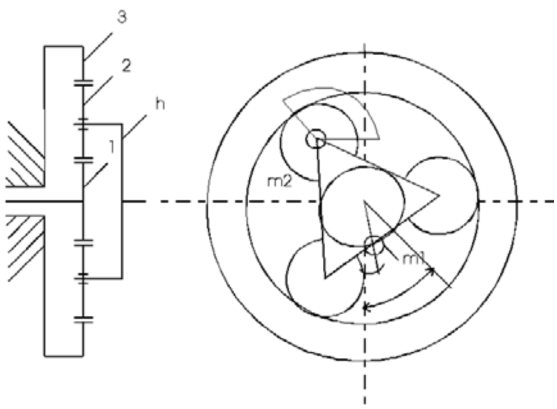

Fig. 1.

the introduction of some characteristics is made:

$$A = \frac{1}{2}[I_1 + m_1 r_1^2 3I_2 \frac{r_1^2}{r_2^2}]$$

$$B = [I_h + (3M_2 + m_2) r_h^2 + 3I_2 \frac{r_h^2}{r_2^2}]\dot{\varphi}_h^2$$

$$D = -3I_2 \frac{r_h r_1}{r_2^2}$$

M_1 and M_h – amplitudes of compulsory moment in entrance and exitance horizontal bar-frequency compulsory moments,

M_2 – mass of the satelite, m-added excentric masses (disorder factors)

I_1, I_2, I_n – axialy moment of inertia of the mass sun cog-wheel, of the satelite and the porter of satelite,

r_1, r_2 and r_h – the basic radii of the sun cog-wheel, of the satelite and the porter of satelite,

generalized coordinates are φ_1 and φ_h

– the angle of digression for the sun cog-wheel and the porter of satelite.

c_1 – the summary coeficient of inflexibility hold of the sun cog-wheel and of the satelite.

c_1'' – the summary coeficient of inflexibility hold of the satelite and epicycle.

c_2 – the coeficient "nonlinearity" of inflexibility hold.

k – the summary coeficient of muffler.

For the basic parameters of this planetary reductor: $r_1 = 4.0375$ cm, $r_2 = 4.675$ cm, $r_h = 8.7125$ cm, $M_2 = 4.246$ kg, $I_1 = 0.2728$ Ncms^2, $I_2 = 0.46398$ Ncms^2, $I_h = 17.9$ Ncms^2, $M_1 = 505000$ Ncm, $M_h = 9485000$ Ncm, $c_1' = 2{,}91\times106$ N/cm, $c_1'' = 1.\ 81\times106$ N/cm, $k = 13$ Ns/cm, $c_2 < 5\%\ c'$, $m = 0.3$ kg, $\omega_1 = 3385.448$ s^{-1}, $S_1^{(1)} = 1.815$ Sh$^{(1)}$, $S_1^{(2)} = 12.16\ Sh^{(2)}$, which correspond to the real object, we create the differential equations system for the amplitude and the phase in the first asimpthotic approximation [3], [4], [5].

$$\frac{da}{dt} = -0.15a - \frac{220}{0.211(3385.44+\nu)}\sin\psi$$
$$\frac{d\psi}{dt} = 3385.44 - \nu + 11{,}3a^2 + \frac{220}{0.211a(3385.44+\nu)}\cos\psi \tag{15}$$

The differential equations for the amplitude and the phase (15) represent the states and they are marked as $E3$ and $E4$. Like states in our example we take the amplitude marked as $E1$ and the phase marked as $E2$. These states are determined by the help of the programme of the Runge-Kutta method. For the state $E5$ we take the angle of turning of the sun cog-wheel φ_1 for $E6$, the angle of the turning of the satelite porter is φ_h , $E7$ is the speed of the sun cog-wheel, $E8$ is the speed of the satelite porter, $E9$ is the acceleration of the sun cog-wheel and $E10$ is the acceleration of the satelite porter. The states from $E5$ to $E10$ are defined by the following equations:

$$E5 = \varphi_1 = 3837.8a\cos(\omega t + \psi)$$
$$E6 = \varphi_h = 2114.6a\cos(\omega t + \psi)$$
$$E7 = \dot{\varphi}_1 = 3837.8a\omega\cos(\omega t + \psi)$$
$$E8 = \dot{\varphi}_h = 2114.6a\omega\cos(\omega t + \psi)$$
$$E9 = \ddot{\varphi}_1 = 3837.8a\omega^2\cos(\omega t + \psi)$$
$$E10 = \ddot{\varphi}_h = 2114.6a\omega^2\cos(\omega t + \psi)$$

That way, the planetary transmitter is defined by 10 states given in the function of parameters. In our example, we included the following parameters $p1 = M1$; $p2 = M_h$; $p3 = \varepsilon$; $p4 = c_2$; $p5 = k$; $p7 = \omega$; $p8 = m$. The parameters affect on the planetary transmitter dynamics, which is complex system which movement can be described by the core system of differential equations (14), in different ways.

Since we have defined the states of the system and the parameters we are going to change, we use the following procedure. By simulation, we get 35 matrices in the form 75×10, for all the values of the parameters. Now we get the programme formation of the state matrices & the matrices of the change of the state 10 in total, by the form of 75×7. For the variance analysis we take the middle influences of the parameters (for example, parameter p_k takes the values p_{k1}, p_{k2}, p_{k3}, p_{k4}, p_{k5} and in the simulation procedure on the r-step of the simulation, the element E_s takes the values E_{s1}, E_{s2}, E_{s3}, E_{s4}, E_{s5} and the averaged influence of the parameter p_k on the element E_s will be the arithmetic mean of E_{s1}, E_{s2}, E_{s3}, E_{s4}, E_{s5}).

Concerning the fact that the tables 75×7 are clumsy for variance analysis, we take some to 75 values for E_s element and we form the table 10×7 which we analyse.

Case1: All the parameters are chaning around the basic-nominal values:

$p1$(4,5; 4,75; 5,05; 5,25; 5,50)
$p2$(80, 87, 94, 100, 105)
$p3$(0,0001; 0,0005; 0,001; 0,005; 0,01)
$p4$(1180; 2360; 5900, 8260, 11800)
$p5$(0,3; 1; 1,3; 2,5; 4)
$p6$(1000, 2000, 3385, 5000, 7000)
$p7$(0,1; 0,2; 0,3; 0,4; 0,5)

The obtained results are presented in table $N^0 1$.

Table l

	$p1$	$p2$	$p3$	$p4$	$p5$	$p6$	$p7$
$E1$	0	0	0	0	1	0	1
$E2$	0	0	0	0	1	0	1
$E3$	0	0	0	0	1	0	1
$E4$	0	0	0	0	1	0	1
$E5$	0	0	0	0	1	0	1
$E6$	0	0	0	0	1	0	1
$E7$	0	0	0	0	1	0	1
$E8$	0	0	0	0	1	0	1
$E9$	0	0	0	0	1	0	1
$E10$	0	0	0	0	1	0	1

Case 2: The parameter p1 is only changing (4,5; 4,75; 5,05; 5,25; 5,50) while all other parameters are constant $p2 = 94{,}85$; $p3 = 0{,}001$; $p4 = 11800$; $p5 = 4$; $p6 = 3385$; $p7 = 0{,}3$.

The obtained results are presented in the table N^0 2

Table2

	$p1$	$p2$	$p3$	$p4$	$p5$	$p6$	$p7$
$E1$	0	1	0	1	1	1	1
$E2$	0	1	0	1	1	1	1
$E3$	0	1	0	1	1	1	1
$E4$	0	1	0	1	1	1	1
$E5$	0	1	0	1	1	1	1
$E6$	0	1	0	1	1	1	1
$E7$	0	1	0	1	1	1	1
$E8$	0	1	0	1	1	1	1
$E9$	0	1	0	1	1	1	1
$E10$	0	1	0	1	1	1	1

Case 3: All the parameters are changing around the basic-nominal values:

$p1$(5,05; 5,05; 5,05; 5,05; 5,05)
$p2$(94,85; 94,85; 94,85; 94,85; 94,85)
$p3$(0,001; 0,008; 0,01; 0,02; 0,026)
$p4$(11800; 11800; 11800; 11800; 11800)
$p5$(4; 6; 8; 10; 12)
$p6$(3385; 3385; 3385; 3385; 3385)
$p7$(0,1; 0,15; 0,2; 0,25; 0,3)

The obtained results are presented in the table N^0 3.

Table3

	$p1$	$p2$	$p3$	$p4$	$p5$	$p6$	$p7$
$E1$	0	0	0	0	0	0	1
$E2$	0	0	0	0	0	0	1
$E3$	0	0	0	0	0	0	1
$E4$	0	0	0	0	0	0	1
$E5$	0	0	0	0	0	0	1
$E6$	0	0	0	0	0	0	1
$E7$	0	0	0	0	0	0	1
$E8$	0	0	0	0	0	0	1
$E9$	0	0	0	0	0	0	1
$E10$	0	0	0	0	0	0	1

6. Conclusion

By the method of a single parameter analysis of numeric experiments on the transmitter's planetary system we determine the influence of the parameters on the movement of the system. On the basis of the tables presented here we can draw the following conclusions:

1. The states of the planetary transmitter when the parameters are changing like in case 1 are sensitive to the parameters $p5$ and $p7$ i. e. they are sensitive to the damping coefficient in the contact between the cog tooth of a wheel and the disturbance factors presented in the additional masses.
2. When the parameters are changed, case 2, the elements of the planetary transmitter are not sensitive only to the parameters $p1$ and $p3$. When the parameters are changing, case3, the system is sensitive only to the parameter $p7$.
3. This method enables the establishing of the connection between the elements of the state of the system and the parameters. In the case that by using the established method about the sensitivity of the system on the parameter variations; it is possible to point the interval $[p_{k1}, p_{k2}]$ in which the system is significantly sensitive.
4. Further work would make it possible to make the connection between the values of the parameters and the way the system moves.

6. Supplement

Due to the length of the program we used to perform the numeric experiment, it will be not includes in this paper.

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OCENA OSETLJIVOSTI PLANETARNOG PRENOSNIKA

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Rezultati ocene osetljivosti planetarnog prenosnika na promene parametara su prikazani u ovom radu. Analiza osetljivosti planetarnog prenosnika izvedena je pomoću statističke metode analize varijanse. Metodom se selektuju parametri na koje je sistem značajno osetljiv i parametri na koje sistem nije osetljiv. Na osnovu toga su izvedeni zaključci o osetljivosti sistema.

Ključne reči: *osetljivost, parametar, stanje*