Таблица. Результаты, полученные при моделировании работы вибродиагностической экспертной системы на нечетких нейронных сетях

M	Номер дефекта	$\overline{\mu}(1,\vec{X})$	$\overline{\mu}(2,\vec{X})$	$\overline{\mu}(3,\vec{X})$
300	1	0,0	0,0	0,0
	2	0,0	0,0	0,0
	3	0,0	0,0	0,0
400	1	9,999E-01	9,874E-04	5,741E-58
	2	1,277E-01	8,722E-01	2,466E-59
	3	1,676E-22	1,271E-24	1,0
500	1	9,999E-01	1,833E-06	5,956E-135
	2	2,857E-01	7,142E-01	4,977E-145
	3	2,094E-29	5,242E-38	1,0
600	1	9,999E-01	7,521E-06	0,0
	2	1,083E-01	8,916E-01	0,0
	3	6,804E-43	2,598E-42	1,0
700	1	1,0	9,361E-09	0,0
	2	7,777E-02	9,222E-01	0,0
	3	1,718E-32	5,139E-45	1,0

Полученные результаты показывают, что предложенная нейросетевая структура позволяет правильно идентифицировать дефекты ШП, начиная со значений длин обрабатываемых отрезков реализаций вибросигналов M=400 отсчетов и по мере увеличения длины отрезков эффективность вибродиагностической системы возрастает.

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MODELING OF HYDRAULICAL MACHINE UNIT WITH NONHOLONOMIC CONSTRAINTS

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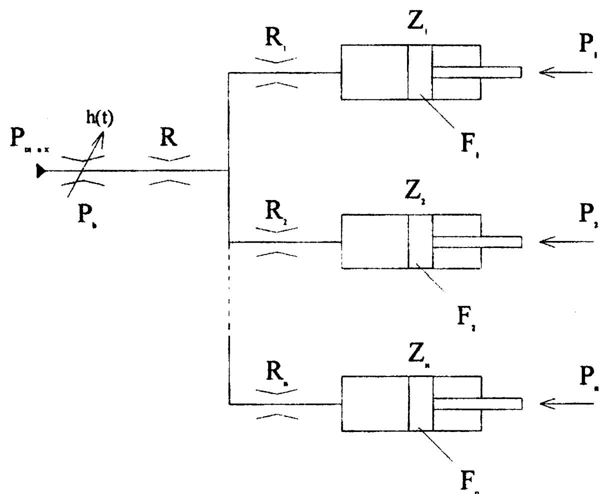
In the modern devices of robotics and also in the various machines with hydraulic power drive, for example, loaders, excavators, machine tools, cars , several hydromotors of a translation motion are often driven by one hydropump [1-3]. Example of such system is shown in fig. 3. Real pump capacity determines corresponding flow rate of working liquid that enables to set in motion of the hydropump pistons. By neglecting the liquid deformation and outflow through the gaps in the joints and connections of the parts and assuming that the everywhere liquid continuously fills in the hydraulic line and the operating pistons cavities, the instanteneous volumetric

$$Q=\sum_{i=1}^{n}F_i\dot{q}_i \tag{1}$$

where F_i-area is the areas of effective cross sections of lines, pistons, etc.; q_i is the co-ordinate determining the piston with respect to the hydrocylinder.



. 1. Machine unit-containing hydromotors of the translation motion and one hydropump

The equation (1) can be integrated provided that the flow rate Q is the obvious function of time parameter or Q is constant. In this case the primitive function for (1) will express dependence of the co-ordinates from time parameter and consequently nonstationary geometrical holonomic constraint. In the common case the flow rate depends on a dynamic state of the hydrosystem and can be only determined as the result of solving the equations reflecting completely the motion of the unit and its interaction. Such constraint depends on the internal forces, acting in the system, work of which at the virtual displacements, generally speaking, is not equal to as zero. Such constraints are reffered as servoconstraints and then the equation (1) will express the non-holonomic servoconstraints.

Motion of System with such constraints can be described by the following equations

$$\frac{d}{dt}\frac{\partial T}{\partial \dot{q}_j}-\frac{\partial T}{\partial q_j}=Q_j+D_j+F_j,\ j=1,2,... \tag{2}$$

where Q_j are the generalised forces for the generalised coordinates; D_j represent the generalised forces of the nonholonomic constraints reactions corresponding to term $\sum_{s=1}^{m}\lambda_s a_{sj}$; F_j are generalised dissipative forces.

Now we shall address the research of motion of the hydraulic unit having the two hydromotors of translation motion driven by one hydropump. The equation (1) is adapted to such unit and that represents the non-holonomic constraint. Hence

$$F_1\dot{q}_1+F_2\dot{q}_2=Q \tag{3}$$

where F_1 and F_2 are the pistons areas of the cylinders of the hydromotors 1 and 4, $\dot{q}_1$ and $\dot{q}_2$ are the velocities of pistons motion, respectively. The generalised forces reduced to the longitudinal axes of piston rods symmetry denote $Q_1=Q_1(q_1,t)$ and $Q_2=Q_2(q_2,t)$ as functions of the piston position or the generalised co-ordinates and time parameter t. Let m_1 and m_2 be the reduced masses of the movable elements of hydromotors, p be the pump output liquid pressure. The pistons motion resistance forces proportional second power of the pistons velocity, friction forces are neglected. In the brake devices the surplus pressure is supposed to be equal to zero. Then two equations in the form (2) become

$$m_j\ddot{q}_j = PF_j - P_j - R_j\dot{q}_j \qquad (4)$$
$$F_j = 0,\ D_j = -R_j\dot{q}_j$$

where R_j are coefficients of resistances proportional first power of the pistons generalised velocities, $Q_j = pF_j - P_j$, where P_j represent the external forces of resistance's, applied to the piston rods from operating member of the unit. It should be noted that the values Q_j and D_j have the measure unit of force. In the equations (3) and (4) there are four unknown functions: the pistons displacements q_1 and q_2, liquid pressure p and flow rate Q. To these equation

$$Q = \frac{(p_k - p)}{k} \qquad (5)$$

where p_k is the liquid constant pressure what safety valve 7 opens, k is the constant coefficient. When from equations (3) and (5) the value of $p = p_{\mathfrak{h}} - k(F_1\dot{q}_1 + F_2\dot{q}_2)$ is substituted into the equation (4), the result is

$$m_j q_j = [p_k - k(F_1 q_1 + F_2 q_2)]F_j - P_j - R_j q_j,\ j = 1,2 \qquad (6)$$

The two equations (6) are the equations of motion for both pistons taking account of the non-holonomic constraints expressed by the equation (3).Now we consider application of these equations to determine effect of interaction of the hydromotors 1 and 4, under braking one of the pistons, what can be caused by action of the brake devices or sudden change of external forces P_1 and P_2. Let $m_1 = m_2 = m$, $P_1 = P_2 = P$ the force P_1 receives increment ΔP, i.e. $P_1 = P + \Delta P$, and the force P_2 keeps its value $P_2 = P$. In such case the first piston should move with decreasing velocity and the second pistons should move with increased velocity with keeping the invariable capacity of the hydropump 9.

The equations (6) then become

$$\begin{aligned} m_1\ddot{q}_1 &= p_k F - P - \Delta P - kF^2\dot{q}_1 - kF^2\dot{q}_2 \\ m_2\ddot{q}_2 &= p_k F - P - \Delta P - kF^2\dot{q}_2 - kF^2\dot{q}_1 \end{aligned} \qquad (7)$$

The velocity of a steady motion of the pistons can be determined from the equations (7) at $\Delta p = 0$, $\ddot{q}_1 = \ddot{q}_2 = 0$ by the following.

$$\dot{q}_{1y} = \dot{q}_{2y} = v_y = \frac{p_k F - P}{2kF^2} \qquad (8)$$

From the first equation of (7) we find

$$\dot{q}_2 = \left(p_k F - P - \Delta P - kF^2\dot{q}_1 - m_1\ddot{q}_1\right)\frac{1}{kF^2} \qquad (9)$$

Differentiating the expression (9) with respect to time we hare.

$$\ddot{q}_2 = -\ddot{q}_1 - \frac{m_1}{kF^2}\dddot{q}_1 \qquad (10)$$

Substituting the equations (9) and (10) intro the second equation of (7) gives at $m_1 = m_2 = m$

$$\dddot{q}_1 + \frac{2kF^2}{m}\ddot{q}_1 = -\frac{kF^2}{m^2}\Delta P \qquad (11)$$

This equation, when $t = 0$, $\ddot{q}_1 = 0$, is

$$\dot{q}_1 = -\frac{\Delta P}{m}\left(1 + e^{-\frac{2kF^2}{m}t}\right) \tag{12}$$

hence at $t = 0$ and $\dot{q}_1 = v_y$ we have

$$\dot{q}_1 = v_y - \frac{\Delta P}{2m}t - \frac{\Delta P}{4kF^2}\left(1 - e^{\frac{-2kF^2}{m}t}\right) \tag{13}$$

Difference of the equations (7) will enable to determine

$$\ddot{q}_2 = \ddot{q}_1 + \frac{\Delta P}{m} = \frac{\Delta P}{2m}\left(1 - e^{\frac{-2kF^2}{m}t}\right) \tag{14}$$

Integrating of the equations (14) over the variable t yields at $t = 0, v_2 = v_y$

$$\dot{q}_2 = v_y + \frac{\Delta P}{2m}t - \frac{\Delta P}{4kF^2}\left(1 - e^{-\frac{2kF^2}{m}t}\right) \tag{47}$$

After substitution of meanings (13) and (47) in (3) we shall determine the charge of a liquid

$$Q = 2v_y F - \frac{\Delta P}{2kF}\left(1 - e^{-\frac{2kF^2}{m}t}\right) \tag{48}$$

From the equation (12) it follows that at $t \to \infty$ the acceleration $\ddot{q}_1$ approaches the constant and that testifies the velocity of piston motion aspiration zero. Interval of time t_{fin}, for which the velocity decrease to zero, is determined from the equality (13) by equating the its right hand side to zero that results to the transcendental equation with respect to t_{fm}

$$\dot{q}_1 = \frac{\Delta P}{4kF^2} exp\left(-\frac{2kF^2}{m}t\right) - \frac{\Delta P}{2m}t + \frac{2(p_k F - P) - \Delta P}{4kF^2} = 0 \tag{49}$$

After a stop of the piston 1, movement of the other piston is determined by the second equation of (7) in which it is necessary to accept $\dot{q}_1 = 0$ .Then

$$m\ddot{q}_2 = p_k F - P - kF^2\dot{q}_2 \tag{50}$$

solution of this equation is $\dot{q}_2 = \frac{p_k F - P}{kF^2} + Cexp\left(-\frac{kF^2}{m}t\right)$. After determination an arbitrary constant C of integration at the initial conditions: $t = t_0$, $\dot{q}_2 = v_2$, the equality (50) the becomes

$$\dot{q}_2 = \frac{p_k F - P}{kF^2} + \left(v_2 - \frac{p_k F - P}{kF^2}\right) exp\left(-\frac{kF^2}{m}(t - t_0)\right). \tag{51}$$

At $t \to \infty$ from the formula (51) taking account (8) of the equation we find

$$\dot{q}_{2t\to\infty} = \frac{p_k F - P}{kF^2} = 2v_y \qquad (52)$$

It follows from stated above that , at a small increase of the motion resistance force P of one piston, its velocity approaches zero and the velocity of other piston approaches double value of steady motion velocity. Although the dissipative forces depending on motion velocity of the pistons, the friction forces under relative motion of the elements, the liquid leaks causing a fluid pressure decrease are neglected ,this research shows expedience of taking account of the non-holonomic constraints that enables well-groundedly to judge by processes occurring in the real machine units and more exactly to determine parameters of motions.

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АВТОМАТИЧЕСКАЯ УСТАНОВКА ДЛЯ ЛАЗЕРНОГО ФОРМИРОВАНИЯ 2D-3D ОБЪЕККТОВ В ПРОЗРАЧНЫХ ДИЭЛЕКТРИКАХ

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В настоящее время известны лазерные системы, предназначенные для поверхностной обработки материалов. Это системы лазерного фрезерования, резания, гравирования и маркировки, для которых уже разработано программное обеспечение в соответствии с их технологическими процессами. Рассматриваемая в настоящей работе установка отличается тем, что обеспечивает формирование трехмерных изображений в объеме.

Она состоит (рис. 1) из персонального компьютера с программным обеспечением, лазерной системы с платой управления лазером и трехкоординатной системы с ее контроллером. Установка работает следующим образом. Сфокусированный лазерный луч производит локальное нарушение (дефект) структуры в точечной области заготовки. Дефект является элементом строящегося трехмерного изображения. Множество таких дефектов формирует оболочку трехмерного объекта. Качество гравировки и производительность установки в первую очередь зависит от дискретизации трехмерных объектов. В связи с этим в настоящей работе решались следующие задачи:

– дискретизация плоских изображений, заключающаяся в отображении исходного растрового изображения в векторное путем формирования геометрических объектов в тех точках пространства, которым соответствует участок растрового изображения, преодолевший некоторый предел яркости,

– дискретизация объемных изображений, заключающаяся в отображении набора трехмерных объектов в множество точек, своим расположением повторяющих очертания объекта,

– отображение полученной точечной картины с возможностями настройки параметров отображения, позволяющее оператору комплекса видеть результат обработки,