NEURAL NETWORKS FOR MACHINE-TOOLS WITH A PARALLEL KINEMATICS

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НЕЙРОННЫЕ СЕТИ ДЛЯ СТАНКОВ С ПАРАЛЕЛЬНОЙ КИНЕМАТИКОЙ

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Показана возможность применения моделей на основе нейрочипов для управления процессами резания в станках с параллельной кинематикой. Проведен анализ систем программирования нейрочипов. Выявлены преимущества и недостатки известных алгоритмов прогнозирования временных рядов. Рассмотрены пути создания системы с обратной связью на основе метода окон. Показана возможность применения сетей Хопфилда для построения сети. Предложено применение многошагового прогнозирования с переобучением сети. Выявлены предпосылки успешного применения данного метода для управления точностью позиционирования станка с параллельной кинематикой.

Показана можливість застосування моделей на основі нейрочіпів для керування процесами різання в верстатах з паралельною кінематикою. Проведений аналіз систем програмування нейрочипів. Виявлено переваги та недоліки відомих алгоритмів прогнозування часових рядів. Розглянуті шляхи створення системи зі зворотнім зв’язком на основі метода вікон. Показана можливість застосування мереж Хопфілда для побудови мережі. Запропоновано застосування багатокрокового прогнозування з перенавчанням мережі. Виявлено передумови успішного застосування даного метода для керування точністю позиціонування верстата з паралельною кінематикою.

This article shows the possibility of using models with neural chips to control the process of cutting machine tools with parallel kinematics. The analysis of systems programming neural chips. The advantages and dis advantages of the known algorithm for time series prediction. The way of creating a system of feedback based on the method of windows. The possibility of using Hopfield networks for network construction. Provided the use of a multi-step prediction with retraining network. Identified prerequisites for a successful application of this method to control the positioning accuracy of the machine tool with parallel kinematics.

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In connection with mushroom growth of modern engineer, requiring treatment with high exactness, for one position, it is expedient to apply machine-tools possessing a hard enough spatial form with the use of parallel kinematics chains. Small number of connections on the way of shorting of forces in machine-tools with a parallel kinematics, results in less deformations and more high-fidelity of motion. In addition, such machine-tools possess enhance able reliability, possibility to manipulate the large loading. However, for providing of exactness of treatment it is however necessary to manage coordinates on that treatment is produced. Straight to manage errors, it is necessary to compensate revolting influences.

Apparently, such system with a counter coupling allows reacting on changes in the system, however will manage to liquidate consequences indignations that can happen in the system. On it all the expenses of time, plenty enough of the stages, will be required. Therefore banal principle of feed-back today does not allow attaining the required exactness. Stops in process such expensive equipment are un impossible [1–3].

In an order to conduct treatment of all surfaces of purveyance from one setting to the machine-tool with a parallel kinematics and besides to get sufficient exactness, it is necessary to forecast events in the system.

In the process of planning of trajectories of motion on the first plan problems go out related to treatment of beyond measure plenty of the states of the possible moving of device. Certain calculations must be executed in every state, for verification of being admission in it models. Thus, the methods of smoothing out of way splines or insufficient amount of calculations can result in problems with the errors of treatment during realization of trajectories on the separate areas of way.

In an order to forecast and foresee a future event in the system ticker-coil, it is recommended to apply a neural network that will react on rejections and guess future behavior on the basis of past experience, past working off after 10, 20 seconds, 1 minute etc. Depend on the capacity of memory in the computer system. Therefore, the neural network plugged in a feed-back will be able to give out a signal about working off yet then, when the consequences of indignation did not yet let know about itself, i. e. they can happen at the simultaneous working off a model, a necessary correction is produced as a result.

Adaptive feed-backs on the basis of neural networks can be built to the different degree of complication for example, neural network on the basis of microprocessor. It is a labor intensive enough process, although, at the construction of compact small network with the least number of calculable processes, it is possible to attain positive effect. For creation of neural network with the least amount of processes it is necessary to choose the less number of neurons, i. e. architecture of network must be minimized. The network of Hopfild, that are a matrix mathematical construction by means of that there is possibility of accumulation of experience in a form, corresponds this limitation. Such network can be built in the system, and it will perform the correcting calculable duty. Thus, it is a neuron calculable construction on the basis of ordinary computers with architecture Background of Neiman that works on the basis of matrix transformations.

The second way is the use of neuron chip, being an element base of perspective neuron calculator along with digital alarm processors (DAP). The use, both those and other, allows today to realize neuron calculators functioning real-time. On the type of logic of them it is possible to divide into digital, analog and hybrid. On the type of realization of neuron algorithm: with fully a vehicle realization and with programmatic vehicle realization (when neuron algorithm is kept in ROM). By the nature realization of nonlinear transformations: on neuron chip with the hard structure of neurons (hard warily realized) and neuron chip with the influenced structure of neurons. On possibilities of construction of neural network: neuron chips with a hard and variable neural structure (neuron chips in that the topology of neural network is realized hardly or flexibly).

Processor matrices (systole processors) are chips, usually near to the ordinary RISC processors and uniting in the composition some number of processor elements, all other logic, as a rule, must be realized on the base of peripheral charts.

In a separate class distinguish the so-called neuron alarm processors a kernel of that is a model alarm processor, and the additional logic realized on a crystal provides implementation of neural network operations (for example, additional vector processor etc.).

The generalized classification over of neuron chip is brought on fig. 1.

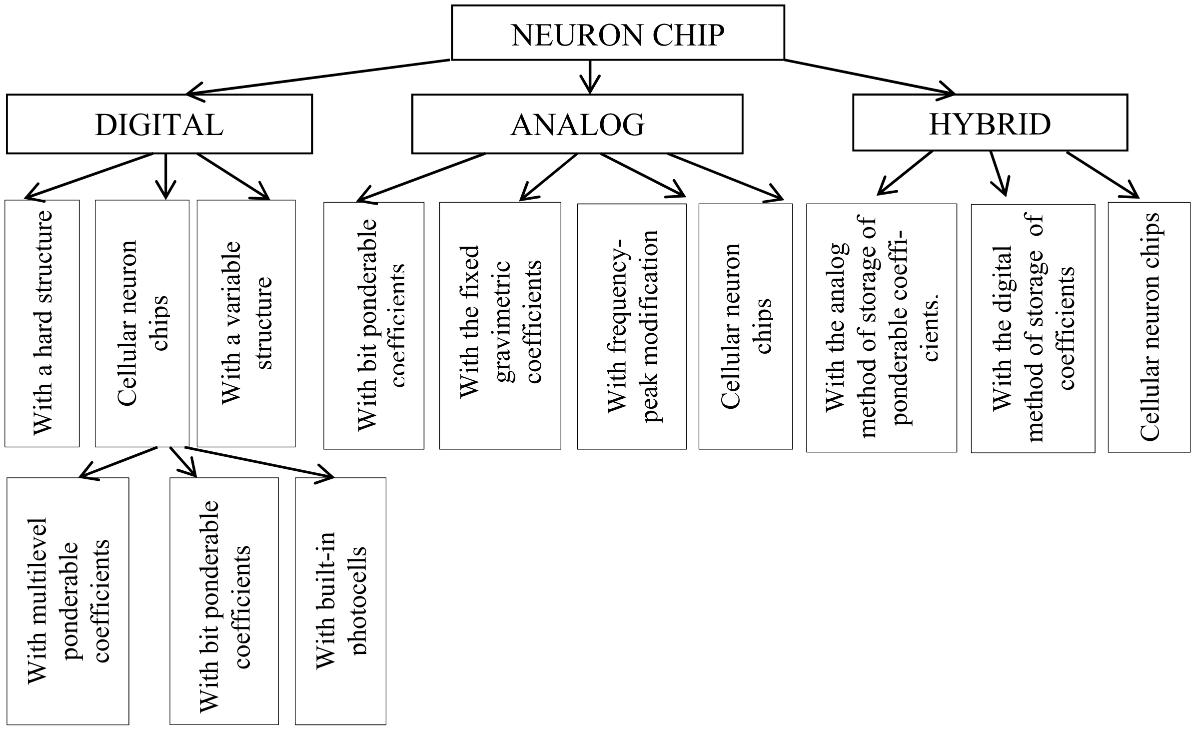

Fig. 1. Generalized classification of neuron chips

Development of neuron chips conducted in many countries of the world. For today distinguish two datum lines of development of the computer systems with mass parallelism: with the modified successive algorithms characteristic for uniprocessor algorithms of Fon Neiman on the basis of fundamentally new super parallel neuron algorithms of decision of different tasks (on the base of neuron mathematics).

Neuron chip a characterized a bit, maximal amount of synapses, maximal number of layers.

Now there are about 15 types of neuron chip, with built-in and external memory, working on different frequencies, by the different amount of conclusions and different form, measuring microcircuits.

For the estimation of the productivity of neuron calculators next indexes are used:

- CUPS (connections update per second) is a number of the changed values of scales in a second (estimates speed of educating).

- CPS (connections per second) is a number of connections (increases with an accumulation) in a second (estimates the productivity).

- CPSPW = CPS/Nw, where Nw is a number of synapses in a neuron.

- CPPS is a number of connections of primitives in a second, CPPS = CPS*Bw*Bs, where Bw, Bs is a bit of scales and synapses.

- MMAC – millions of increases with an accumulation in a second.

For a decision the set problem it is necessary to build a model on the basis of neuron chip. We will conduct the analysis of the well-known systems of programming of neuron chip. At plugging of neuron chip in ports of computer, programing them on the calculation of coefficients of neurons and applying prognostication on the short interval of time, it is possible to get the fast-acting of the system, exceeding in hundreds of one times. Thus, exactness of working off will be higher. For prognostication of temporal row it is possible to use classic approach, consisting in application of method of windows, that supposes the use of two windows of Wi and Wo with the fixed sizes on and m accordingly. These windows are able to move with some step on the temporal sequence of historical data, since the first element, and intended for access to data of temporal row, thus the first window of Wi, getting such data, passes them on the entrance of neural network, and second – Wo – on an exit. Turning out on every step pair of Wi - > Wo is used as an element of teaching selection (recognizable character, or supervision). The method of windows uses one-step and multistep prognostication. The task of one-step prognostication is taken to the task of reflection, when one entrance vector is represented in a weekend (fig. 2).

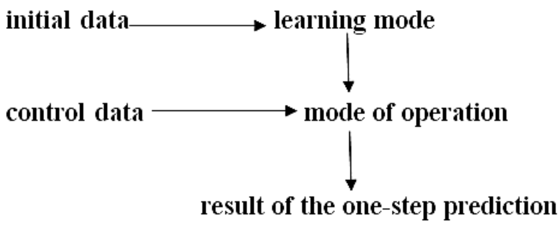

Fig. 2. Sequence of the use of neural network the tasks of one-step prognostication

Table 1

It is great Number of data for an oneself-reactance task

Entrance				Exit
$x(t_1)$	$x(t_2)$	…	$x(t_m)$	$x(t_{m+1})$
$x(t_2)$	$x(t_3)$	…	$x(t_{m+1})$	$x(t_{m+1})$
…	…	…	…	…
$x(t_2)$	$x(t_{i+1})$	…	$x(t_{i+m-1})$	$x(t_{i+m})$

Multistep prognostication is characterized the increase of the discrete counting out of output size and, accordingly, increase of time, on that a prognosis (time of passing Tоп) comes true. At multistep prognostication Tоп = and*R, where R is an amount of steps of calculation of prognostication; and is a step of discretization of data-out (for example, year, month, day, etc.). Multistep prognostication is applied only for the phenomena the signs of that are presented as temporal rows. Multistep prognostication of temporal row comes true as follows (fig. 3). On the entrances of neural network the vector of well-known values of x (tn - 2) is given, x (tn - 1), x (tn). On an exit the forecast size of x* (tn+1) is formed, that determines the vector of the forecast exits and simultaneously added to the values of teaching great number, id est, accepted as reliable. Further on entrances the vector of x (tn - 1) is given, x (tn), x* (tn+1), and x* (tn+2) and next forecast values turns out on an exit.

Multistep prognostication allows doing short- and medium-term prognoses, as substantial influence on exactness has an accumulation of error on every step of prognostication. At application of long-term multistep prognostication there is the characteristic for many forecasting systems gradual fading of process, phase changes and other distortions of picture of prognosis. Such type of prognostication befits for stationary temporal rows with a small casual constituent.

Prognostication with teaching (fig. 4) allows at the large intervals of passing removing fading of прогностических properties of network due to permanent adjustment of gravimetric coefficients of synapse connections.

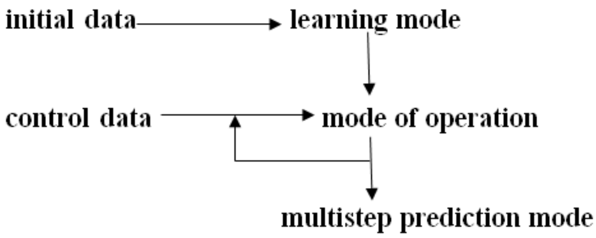

Fig. 3. Sequence of the use of neural network for the tasks of multistep prognostication

On included of network mode of functioning the last realization of teaching great number of x (tn - 2) enters, x (tn - 1), x (tn). The forecast value of exit of x* (tn + 1) is put aside in the vector of the forecast output values and as reliable added to the real values of teaching great number. A teaching great number increases on one temporal window. There is a process of teaching of network on a megascopic teaching great number during that the new gravimetric coefficients of k of synapse connections and polynomials of transmission functions of neurons are determined.

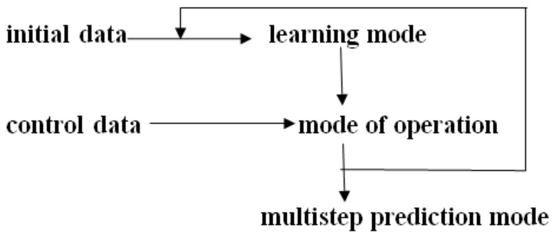

Fig. 4. Sequence of the use of neural network for the tasks of multistep prognostication with teaching

An algorithm of multistep prognostication with teaching of network for the traditional networks of direct distribution with the iterative educating is practically impracticable through large dwells necessary on retuning of coefficients of network.

Thus, building a neuron model on the basis of teaching selection it is possible to forecast behavior of the system in future moment of time. However, if to take into account that length of row cannot be endless, then it is needed to use an idea about the structure of temporal row. Here, important, a value acquires the concept of fractals. A fractal is a structure, consisting of parts that in some sense are similar to unit. At the use of detains more than 10 structure of temporal row is violated, thus an optimal amount (it separate research of authors is sanctified to) is equal to 7.

CONCLUSIONS

Thus, the increase of exactness can be even programed in the cycle of work of machine-tool with a parallel kinematics. It is possible to break up the problems of exactness on passage-ways, and if so that it can hammer in distribution of metal to providing of high exactness ticker-coil with a neuron chip management so that on this machine-tool it is possible to process the purveyance not robbed with maximal exactness. Having a hard machine-tool with this system, it is possible to decrease the economic loading on mechanical part of machine-tool and conduct preliminary and final treatment of purveyance on one machine-tool, that especially topically for a machine-tool with a parallel kinematics.

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