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THE NEURAL NETWORKS APPLY IN THE AREA OF DIAGNOSTIC SYSTEMS

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1. Introduction

Interest problems in the area of diagnostic systems is determination of technical conditions object if you like determination diagnoses object on basis analyses diagnostic signal acquired mensuration choice diagnostic quantity. Contribution deals with application neural network in area of diagnostic systems. In the concrete with acts about analyses signal diagnostic quantity, which contain information about technical conditions of object of diagnose. At concrete application of neural networks is necessary select acceptable type and network structure.

For these application get past Multilayer perceptron's - MLPs, which they are at of the process "learning of network" learning's on error free waveform of diagnostic signal or on concrete appearances disturbances that are inclusion in diagnostic signals. At application MLP network

Is necessity determine optimal number of neurons in separate network layers.

2. Multilayer perceptron's – MLPs

Multilayer perceptron's (MLPs) represent the most prominent and well researched class of ANNs in classification, implementing a feed forward, supervised and hetero-

associative paradigma. MLPs consist of several layers of nodes, interconnected through weighted acyclic arcs from each preceding layer to the following, without lateral or feedback connections. Each node calculates a transformed weighted linear combination of its inputs of the form, with the vector of output activations from the preceding layer, the transposed column vector of weights, and a bounded non-decreasing non-linear function, such as the linear threshold or the sigmoid, with one of the weights acting as a trainable bias connected to a constant input.

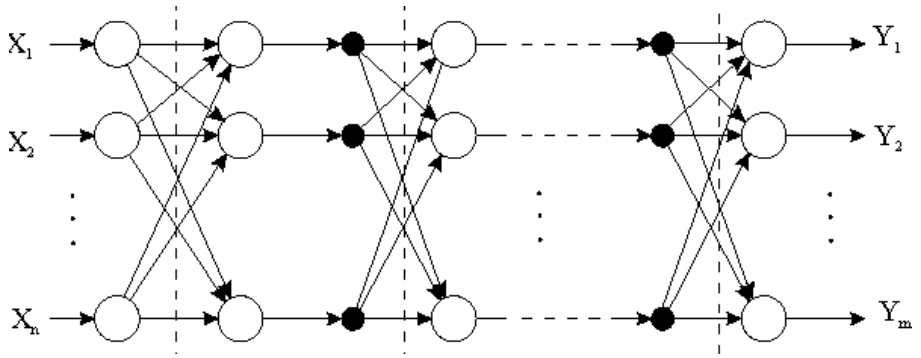

Fig. 1 Multilayer neural network

The multilayer network MLP has a highly connected topology since every input is connected to all nodes in the first hidden layer, every unit in the hidden layers is connected to all nodes in the next layer, and so on.

The input signals, initially these are the input examples, propagate through the neural network in a forward direction on a layer-by-layer basis, that is why they are often called feed forward multilayer networks.

Two kinds of signals pass through these networks:

- function signals: the input examples propagated through the hidden units and processed by their activation functions emerge as outputs;

- error signals: the errors at the output nodes are propagated backward layer-by-layer through the network so that each node returns its error back to the nodes in the previous hidden layer.

3. Using of multiply neural network for analyses of signals

Detection and localization disturbances if you like symptom disturbances in diagnostic signal is realized on basis testing signal with neural networks, that is of learnt on correct (failure-free) waveform of signal. If on entrance of such neural network inducted signal containing symptom of disturbances, approve oneself it in difference input

signal and signal predicate of neural network. Difference these of two signals obtaining so-called „difference signal“, in which are four-square evident places appearance symptom disturbances in signal.

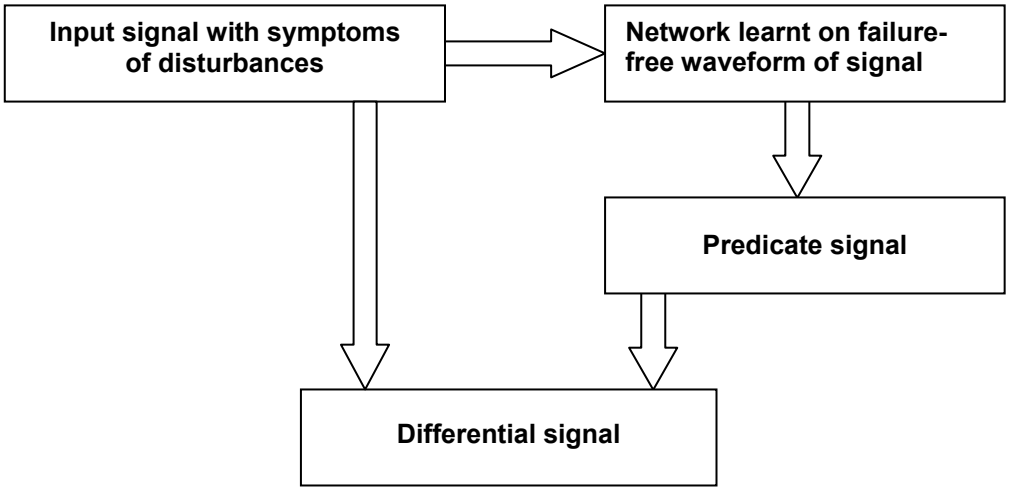

Fig. 2 Diagnostic system with neural network

Differential signal then provides basic information about occurrence symptom disturbances. On basis these information can only state, that in diagnose object with offer trouble. Indeed for full identification disturbances is necessary perform her classification. Then assignment concrete disturbances hers symptom in diagnostic signal. Diagnostic system is then designed on recognition in advance given of a number of reason about disturbances therewith, that every disturbance is feature symptoms in diagnostic signal.

Classification disturbances can realize by the help of several concurrently working neural networks, whereas is every net learnt on concrete symptom disturbances. If thought in system e.g . classification ten type disturbances, is necessary to diagnostic signal was fetch on inputs ten concurrently working neural network whereas every of these network will learnt on concrete fault signature. Incident to classification is effected on basis comparison outputs single networks namely so, that with discuss here errors for which has net smallest difference among input signal and his predicate of neural network.

Output error of network, then general sum partial deficiencies (difference input and predicate signal) can have form scalar or vector. In simple case, when for single types deficiencies exists single valued assignment disturbances to given value output deficiencies network suffices use scalar form. If with acts about deficiencies complicated and isn't possible perform classification disturbances on basis scalar recontouring, is necessary output sum difference signal express in vector similarities, e.g . per several

interval and for each interval it's effected sum difference signal separately, thereby get vektors form, which enables classification and complicated disturbances.

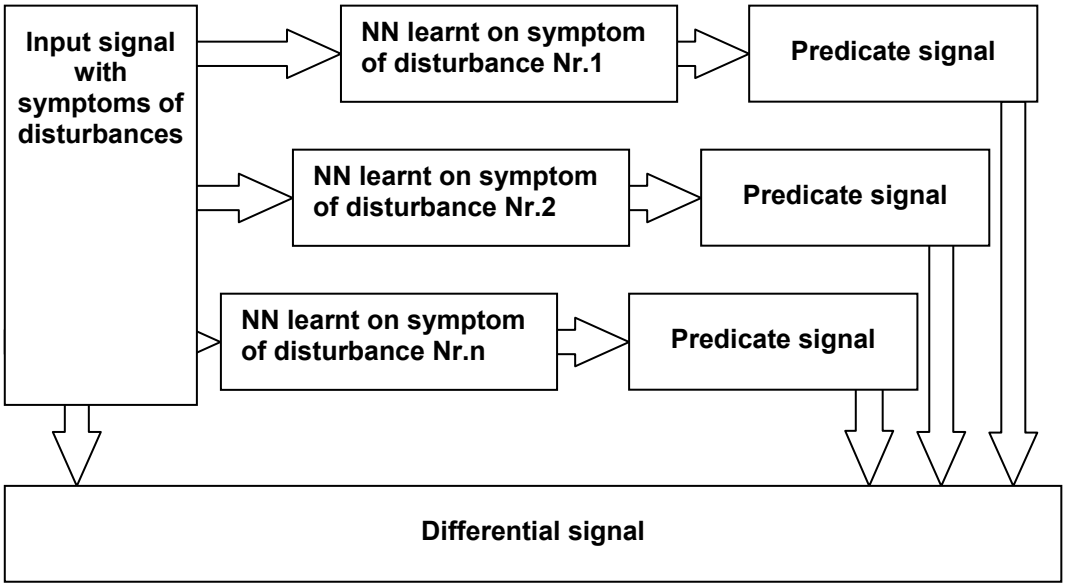

Fig. 3 Diagnostic system with parallel neural networks

4. Application in the area of analyse the diagnostic signals

Concrete application utilizing of neural networks for analyses signal is diagnostic of machine, that is of found on determination technical conditions object pursuant to vibration analysis hereof object. Standard diagnostics method they are found on FFT analyses signal vibration sensing on machine in the working condition. In the FFT spectrum answering in singles components (if need be and their harmonic multiple) vibration single sublayer machinery (in singles parts transmissive organism, unbalance shafting, motion piston compressor etc ..) At downgrade technical conditions some of the fragment machinery with this display manifest aggrandizement corresponding components in FFT.

System utilizing neural network be founded on utilize neural network to predicate course signal vibration. Tenet is such, that neural network is learnt on course signal corresponding vibration machinery in failure-free condition. As far as at operation machinery on entrance of network fetch real signal from sensor of vibration, network transacts predicate and on exit is collation input signal with predicate. If is machine in failure-free state is value distance vector minimum (will not quite zero, is it dependent upon textures signal and thereon how to perfection is neural network on signal learnt).

This is displayed on Fig. 4. On picks is strong line displayed input signal, thin line is displayed predicate signal and in bottom is displayed differential vector.

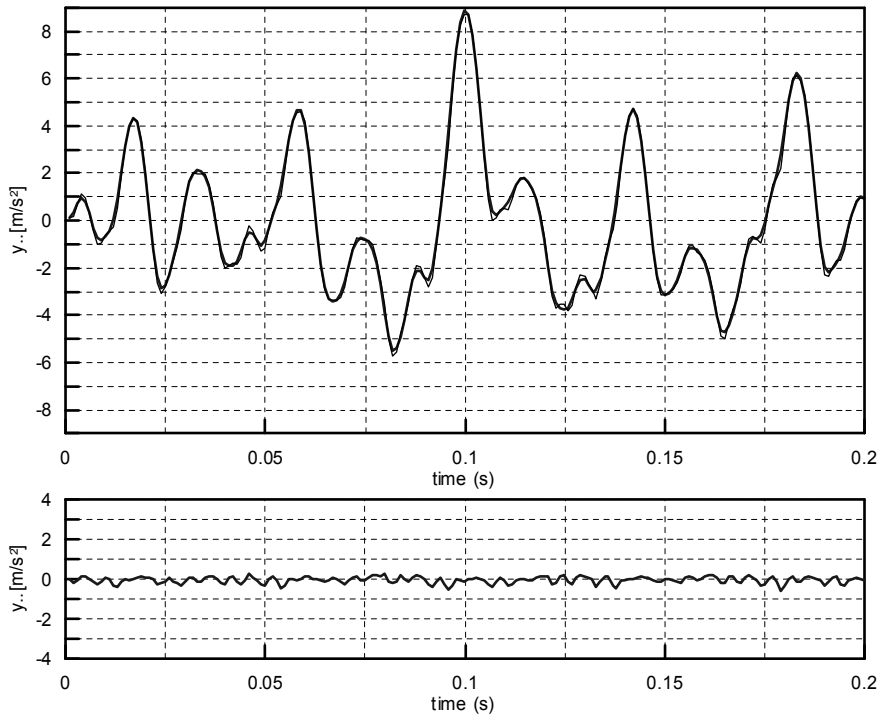

Fig. 4 Predication of failure-free waveform of signal and differential signal

If be on entrance network fetch signal corresponding vibration machinery in failure state is again provided predicate signal. Indeed here already with display manifest difference among input and predicate signal and this it stands to reson in distance vector - see Fig. 5. Difference they are due thereby, that net is learnt on failure-free waveform of signal. Thereby due then it is possible determine faulty and failure-free state diagnostic object - machinery. If indeed want concretize arose disturbances, then four-square determine part object in which with disorder be found, is necessity carry out unambiguous assignment fault signature in signal concrete parts object.

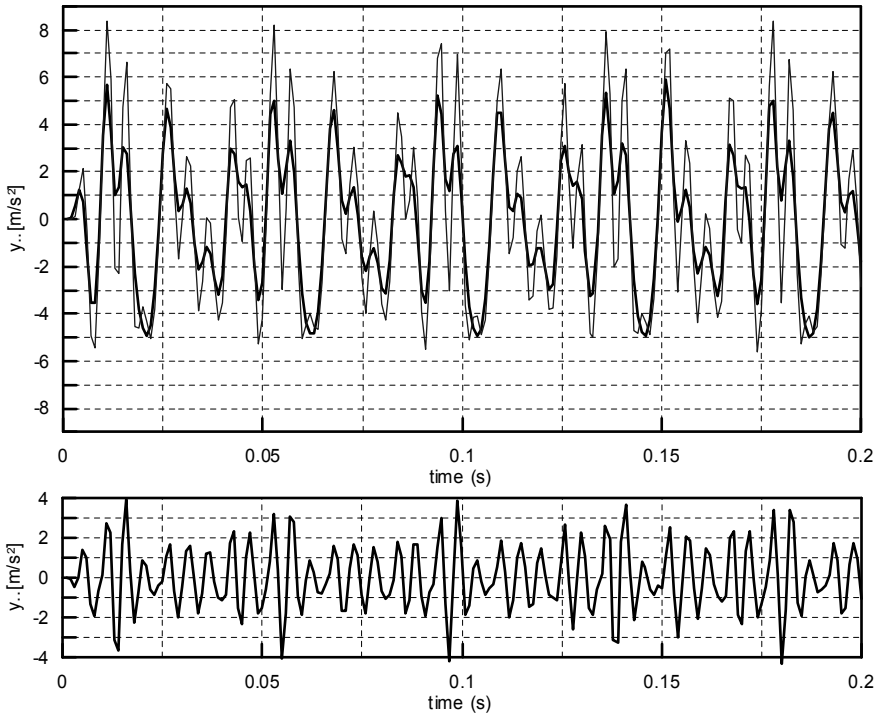

Fig. 5 Predication waveform of signal with symptom of disturbance – network is learnt on failure-free waveform of signal

For possibility classification disturbances of diagnose object is necessity set list reason about disturbances and four-square to every reason about disturbances assign corresponding symptom in signal. Neural network they are prosecution concurrently in ordering according to Fig.3, whereas every network is learnt on concrete disturbance signal (signal containing symptom of disturbances). Predicate signal with symptom disturbances is displayed on Fig. 6. Comparison of differential vector (by selection of minimum) is fixed term concrete disorder object.

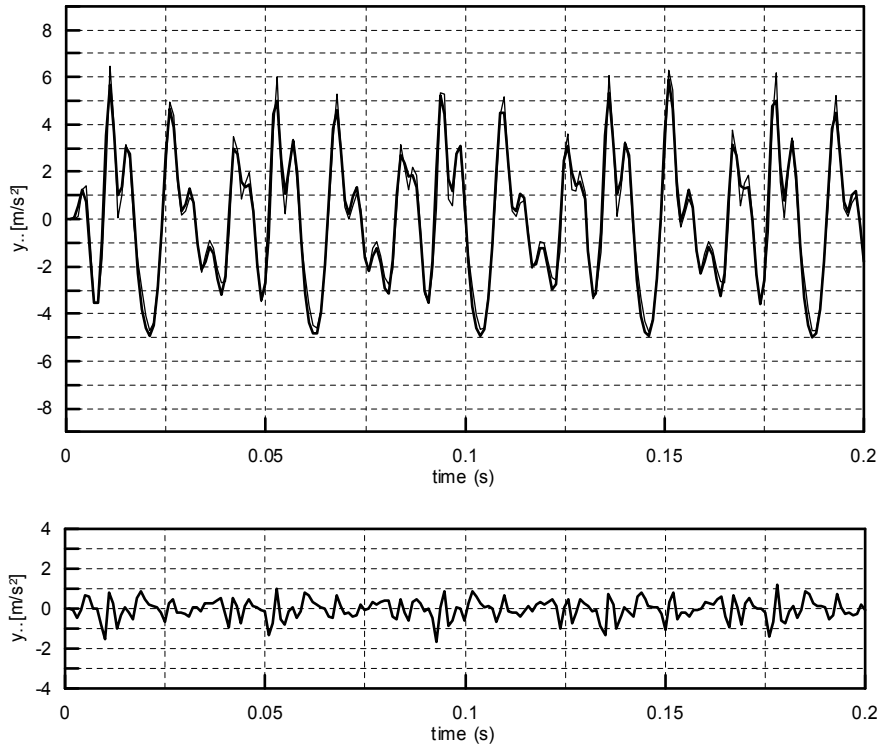

Fig. 6 Predication waveform of signal with symptom of disturbance – network is learnt on signal with symptom of disturbance

5. Result

A practical verification analyses of diagnostic signal was neural network further sifting from purposes quite unambiguous identification every reason about disturbances (symptom disturbances in signal). It stands to reason, that fundamental conditions for right fault identification are receipt network on symptom those disturbances in signal. System is then designed for identification in advance given of a number of reason about disturbances, in case rise in advance leave out disturbances is then only indication failure state whole object - no concrete disorder, indeed it can be on any further disturbances (her symptom) net learn. Problems in this area is rise multiple disturbances in system (then occurrence more disturbances at the same time). Here's necessity verify activity of neural network and in case that occurrence symptom more disturbances in signal.

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Resumé

APLIKACE UMĚLÝCH NEURONOVÝCH SÍTÍ V OBLASTECH DIAGNOSTICKÝCH SYSTÉMŮ

Michal MUSIL

Příspěvek se zabývá možností využití umělých neuronových sítí v oblasti diagnostických systému. Konkrétně jde o aplikaci rozpoznávání příznaků poruch ve vibrodiagnostických signálech. Neuronové sítě jsou naučeny na bezporuchový průběh signálu a dále na průběhy signálu s výskytem příznaků uvažovaných poruch v diagnostikovaném systému. Porovnáváním vstupních a predikovaných signálů a porovnáním výstupů jednotlivých sítí je identifikována konkrétní porucha v systému.

Summary

THE NEURAL NETWORKS APPLY IN THE AREA OF DIAGNOSTIC SYSTEMS

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This contribution deals with possibility exploitation artificial neural networks in the area of diagnostic systems. Is concerned application recognition symptom disturbances in diagnostic signals. Neural networks are learnt on failure-free waveform of signal and next waveform of signal with appearance symptom reason about disturbances in diagnostic system. Comparsion input and predicate signal and comparison output of separate networks is identified concrete disturbance in monitoring system.

Zusammenfassung

APPLIZIERUNG DER NEURAL NETZE IM BEREICH DER DIAGNOSTISCHE SYSTEME

Michal MUSIL

Beitrag sich betreibt Einsatzmöglichkeit künstlich Neural Netze im Bereich der Diagnosesystem. Konkret es geht um Applikation Erkennung Fehlerkennzeichen in vibrodiagnostickych Signal. Neural Netze sind gelernt an störungsfrei Ablauf Signal und weiter an Vorgänge Signal von Vorkommen Anzeichen nachdenken Defekte in diagnostizieren des Systems. Vergleich einläßlich und Prädikat Signal und vergleichsweise Ausstieg der einzelnen Netze ist identifiziert konkret Störung in des Systems.