ного грунта 2,0 Вт/(м·К); теплоотдача наружному воздуху 20 Вт/(м·К).

Для участка канальной прокладки учтены значения величин теплоотдачи от поверхности теплоизоляции к воздуху канала 5 Вт/(м·К) и от воздуха внутри канала к внутренней поверхности канала 10 Вт/(м·К), а также значение теплопроводности стенок канала 1,55 Вт/(м·К) и их толщина 0,08 м.

Полученные результаты стали основанием теоретического обоснования температурного метода диагностики подземных теплосетей, сущностью которого является определение общего температурного состояния теплотрассы по характеру изменения температуры на поверхности грунта над ней.

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NEURAL NETWORK AIDED DIAGNOSIS BASED ON TEMPERATURE AT ACUPUNCTURE POINTS

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Possibility of applying of neural networks (NN) for diagnosing "an out of order" state of organism is described in this paper. The aim of research was to obtain a tool supporting a medical diagnosis. Data set used in the research included temperature values, which were measured at selected acupuncture points (AP) of both healthy and ill persons. Research has been concerned with a structure of neural network and preparing a learning set. Preliminary results revealed the correct recognition of 81% for category ill and 62 % for category healthy.

Introduction. In previous publications [1, 2, 3] it has been asserted that temperature value at AP reflects the state of health and fettle of organism. The use of an artificial neural network for the detection of disorder based on AP temperature was of interest because acupuncture points in traditional Chinese medicine are world-wide known as an effective tool for diagnosis. Moreover multilayer structures of perceptrons (NN) are very often used for classification applications. On Fig.1. the scheme of one-layer net is presented [4].

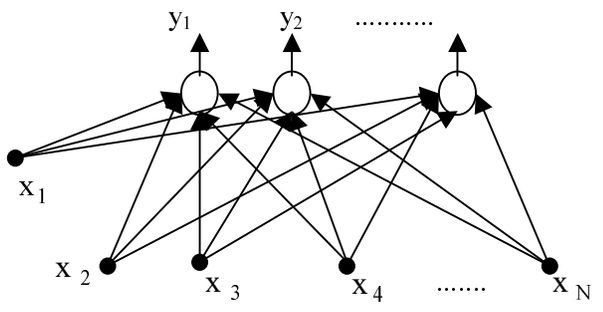

Fig. 1. Scheme of one-layer net: $x_{1\text{-}N}$ input signals, $y_{1\text{-}M}$ output signals [4]

In the net each neurone is biased (b_i) and has its weight W_{ij}. Selection of appropriate factors b_i and W_{ij} is realised during training. Training with the teacher is popular for learning the NN but it needs a large and representative database.

Material . Collected set of the values of temperature included 43 samples of healthy persons and 19 samples of ill persons [5]. Temperature was measured at three AP (Li4, Li5, and Li11) using non-contact method, with pirometer. For example histograms of temperature at point Li4 are presented for healthy and ill objects at figures 2 and 3 respectively. On this database training set for learning as well as a verifying set for testing NN was build. Testing set did not include data from learning one.

Neural network. The NN program named *Neural* offered in [6] was used for training and testing. Its model *CLASSIFY* allows a choice of structure of NN. The first chosen two-layer structure did not pass the examination: its recognition was not satisfactory correct. The net with three layers was the next step. This NN had the 6-3-2 structure (6 input neurones, 3 hidden and 2 output neurones). An

efficient recognition should mean: "1" for health and "0" for illness. Because training "with the teacher " needs a big database the existing samples of learning set were increased by multiplying them by factors 0.7 and 1.1 and then mixed. In the result the learning set was three times as large as testing set [5].

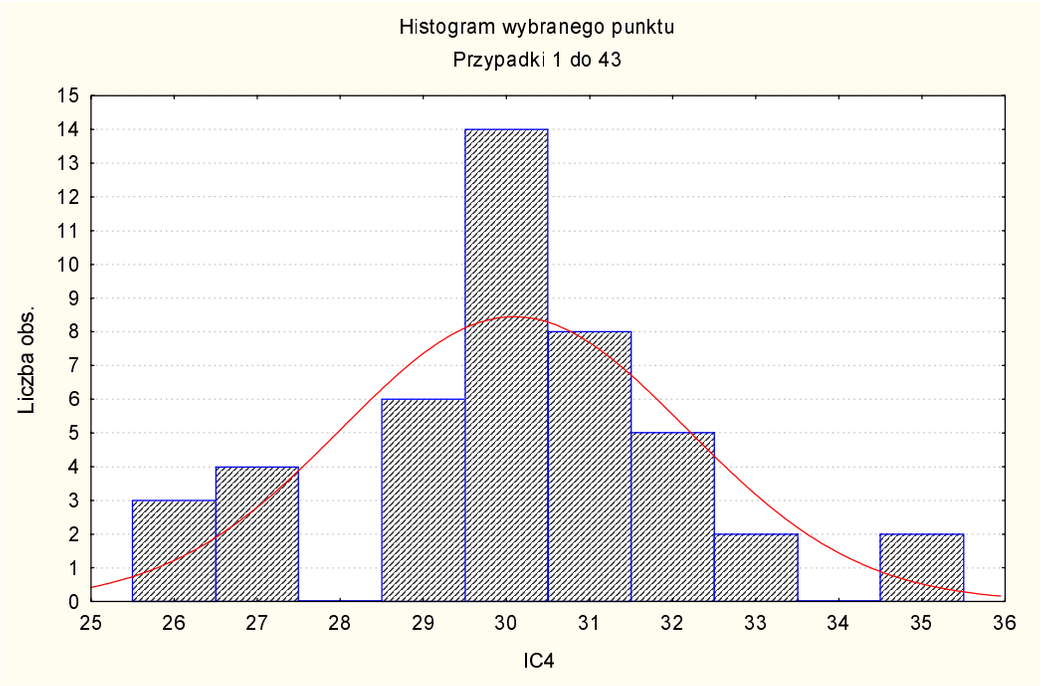

Fig. 2. Histogram of healthy persons' temperature [°C] at Li4 [5]

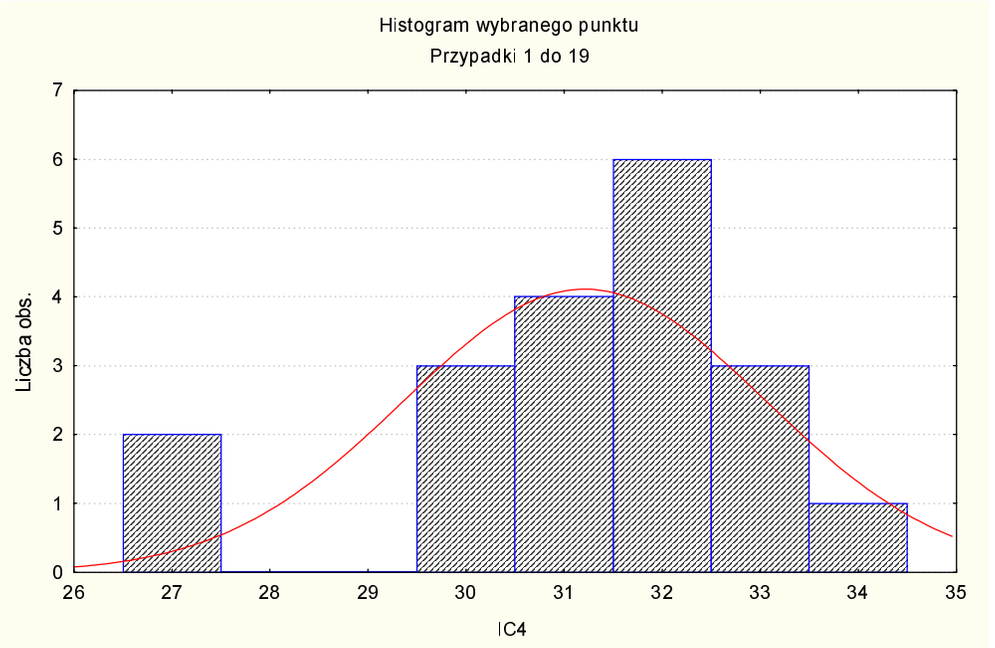

Fig. 3. Histogram of ill persons' temperature [°C] at Li4 [5]

Results and discussion. The test set was introduced to NN after learning. Obtained results are presented on table.

They revealed that neural network has classified correct 62% cases in health category and 81% cases in illness category. Network's diagnosis had average 71.5 % correct recognition. .

Calculated values for test set [5]

Calculated value for health category	Calculated value for illness category
0,9878	**0,5980**
0,9098	**0,6041**
0,9005	0,1733
0,8620	**0,6023**
0,9088	0,1543
0,9731	0,1547
0,9877	0,1544
0,5986	0,1806
0,5841	0,1796
0,6067	0,1540
0,9101	0,1541
0,9090	0,1540
0,6007	0,1542
0,5999	0,1543
0,1543	0,1545
0,8526	0,1450

Network's diagnosis was "I don't know" for 6 cases of health and 3 cases of illness. It is interesting and characteristic that percentage of correct recognised ill persons is much higher then healthy persons. Taking into account that collected database consisted of subjective statement of "good state of health"; probably measured persons were not 100% healthy. Bigger data set, better accuracy of measurement and optimisation of NN structure should improve correctness of NN diagnosis. Summing up these preliminary results assert that temperature at AP applied to learning neural network should create a tool supporting medical diagnosis.

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