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(54) **Title**: APPARATUS FOR ASSESSING A CONTROL VALUE

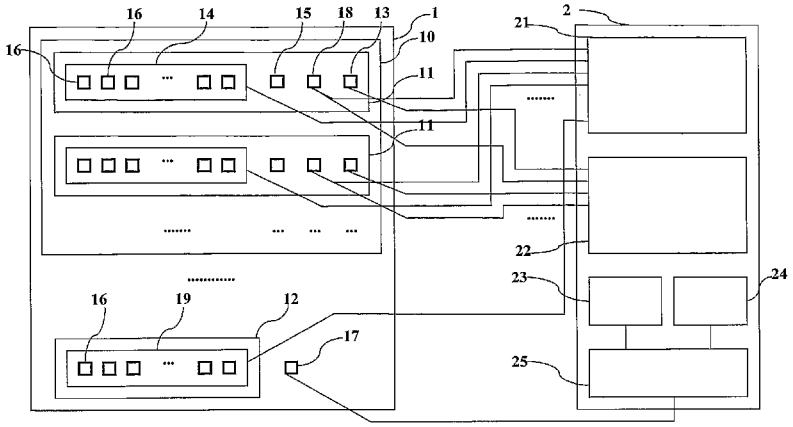

Fig. 3

(57) **Abstract**: The apparatus for assessing a control value consists of memory (1), transformation block (2) for assessing a control value, and a means (3) intended to transfer or store a control value. Memory (1) comprises at least one frame (10), one query row (12) composed of a block (19) of cells with at least one memory cell (16), and a cell (17) for representation of a control value. Every frame (10) comprises at least two rows (11) each of which is composed of a cell (15) for representation of a response, a cell (18) for representation of the distance, and a cell (13) for representation of a reciprocal value of succession and a block (14) of cells that includes at least one memory cell (16). Transformation block (2) for assessing a control value consists of a block (21) for assessing the distance of the blocks (14) of cells rows (11) from the block (19) of cells of the query row (12), a block (22) for assessing reciprocal values of ascending succession of the blocks (14) of cells of the rows (11), a block (23) for assessing the main numerator, a block (24) for assessing the main denominator, and a block (25) for assessing the ratio of the main numerator and the main denominator. The block (21) for assessing the distance of the blocks (14) of cells of the rows (11) from the block (19) of cells of the query row (12) is connected to the blocks (14) of cells of the rows (11), to cells (18) for representation of the distance of the rows (11), and to the block (19) of cells of the query row (12). Block (22) for assessing reciprocal values of ascending succession of the block (14) of cells of the rows (11) is connected to cells (18) for representation of the distance, and to cells (13)

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for representation of a reciprocal value of succession of the rows (11). Block (25) for assessing the ratio of the main numerator and the main denominator is connected through its dividend's input to the block (23) for assessing the main numerator, and through its divisor's input to the block (24) for assessing the main denominator, and through its output to the cell (17) for representation of a control value.

Apparatus for assessing a control value

Technical field

This invention relates to apparatus for assessing a control value on the basis of already known facts provided by a set of data stored in a memory.

Background art

There are many apparatuses that are used to assess a control value for a preset query point. They employ especially various approximation techniques such as, for example, polynomials, spline polynomials, neural networks of various types. In cases when affiliation to a specific class (classification) is substantial, other specialized apparatuses are known that make use of techniques such as k-nearest neighbour, Bayes method, kernel method. Some of these methods suffer from a so called "curse of dimensionality", i.e. demands of operations grow exponentially along with a task dimension, i.e. with a number of values that form a query point. These are the two reasons why new devices are constantly being searched for and consequently also new methods for solving this type of task. At the same time it is not expected that a universally "best" apparatus or method will be found, but rather an approach that will be optimal for a specific problem at hand.

Disclosure of the invention

The apparatus for data processing according to the invention solves the problem of the construction of an apparatus for assessing a control value. This apparatus creates a representation of a control value that serves for controlling or operating other devices, or for displaying. Processed data represents the dependence of a control value on a large number of other values (function of many variables) that are arranged in frames consisting of rows that comprise memory cells that represent the values of individual quantities. The apparatus creates a representation of a control value for a query row of values of many quantities.

The apparatus for assessing a control value is made up of a memory, a transformation block for assessing a control value and a means for transferring or storing a control value. The memory is arranged so that it consists of at least one frame, one query row including a block of cells with at least one memory cell, and a cell for control value representation. The frame consists of at least two rows each of which comprises a block of cells including at least one memory cell, and a

cell for representation of a response, a cell for representation of the distance, and a cell for representation of a reciprocal value of succession. The transformation block for assessing a control value consists of a block for assessing a value of the distance of rows of blocks of cells from a block of cells of a query row, a block for assessing reciprocal values of an ascending succession of rows of blocks of cells, a block for assessing the main numerator, a block for assessing the main denominator, and a block for assessing the ratio of the main numerator and the main denominator. The block for assessing a value of a distance of rows of blocks of cells from a block of cells of a query row is connected to rows of blocks of cells, cells for representation of the distance of rows, and a block of cells of a query row. The block for assessing reciprocal values of an ascending succession of rows of blocks of cells is connected to cells for representation of the distance, and to cells for representation of reciprocal value of succession of rows. The block for assessing the main numerator consists of blocks for multiplication and a block for addition; the inputs of each of the blocks for multiplication being connected to the cell for representation of a response, and to cells for representation of a reciprocal value of succession of one row; outputs of blocks for multiplication are connected to the inputs of the block for addition the output of which is connected to a dividend's input of the block for assessing the ratio of the main numerator and the main denominator. The block for assessing the main denominator consists of a block for addition the inputs of which are connected to all cells for representation of a reciprocal value of succession of all rows of all frames and the output of which is connected to a divisor's input of the block for assessing the ratio of the main numerator and the main denominator. The output of the block for assessing the ratio of the main numerator and the main denominator is connected to the cell for representation of a control value.

The transformation can be expressed by the following formula:

$$A = \frac{\sum_{i=1}^{M} R_i \frac{1}{i}}{\sum_{i=1}^{M} \frac{1}{i}}$$

where i stand for succession, i.e. sequence number of a data sample or a row. The succession is determined by the distance of a data sample, i.e. a block of memory cells of a row from a query sample, i.e. from the block of memory cells of a query row. M stands for the total number of all samples, i.e. number of rows. R_i stands for a response of a sample, represented by the cell for representation of a response, that was assigned succession value i. At the same time $\frac{1}{i}$ is a reciprocal value of succession. In this case the number of classes, i.e. number of frames, is insignificant.

The apparatus can also perform another transformation. In which case its construction is modified so that the block for assessing the main numerator consists of a block for addition the inputs of which are connected to cells for representation of reciprocal value of succession of all rows of one frame and the output of which is connected to a dividend's input of the block for assessing the ratio of the main numerator and the main denominator. Simultaneously the block for assessing the main denominator consists of a block for addition the inputs of which are connected to all cells for representation of reciprocal value of all rows of all frames and the output of which is connected to a divisor's input of the block for assessing the ratio of the main numerator and the main denominator.

This transformation is suitable when there are at least two frames and all individual frames have the same number of rows. Control value can then be interpreted as the likelihood that a query sample, i.e. query row, belongs to the same frame as the frame that the block for assessing the main numerator is related to.

The transformation can be expressed by the following formula:

$$A = \frac{\sum_{i=1(C)}^{M} \frac{1}{i}}{\sum_{i=1}^{M} \frac{1}{i}}$$

where i stands for succession, i.e. sequence number of a data sample, i.e. a row. The succession is determined by the distance of a data sample, i.e. a block of cells of rows from a query sample, i.e. from the block of cells of a query row. M stands for the total number of all samples, i.e. number of all rows regardless of the frame they are located in. At the same time $\frac{1}{i}$ is a reciprocal value of succession. Symbol $i = 1(C)$ located under the symbol of a sum in the numerator of the present formula means that addition is performed across the rows of one frame, namely the frame that the block for assessing the main numerator is related to.

The apparatus can perform another different transformation. In which case its construction is modified so that the block for assessing the main numerator consists of a block for addition, a block for counting the number of rows, and a block for division; the inputs of the block for addition being connected to the cells for representation of a reciprocal value of succession of all rows in one frame and the inputs of the block for counting the number of rows being connected to cells for representation of a response of all rows of the same frame; the output of the block for addition is connected to a dividend's input of the block for division, the output of the block for counting the number of rows is connected to a divisor's input of the block for division the output of which is connected to a dividend's input of the block for assessing the ratio of the main

numerator and the main denominator. Simultaneously the block for assessing the main denominator consists of blocks for addition, blocks for counting the number of rows, a block for division and a block for secondary addition the output of which is connected to a divisor's input of the block for assessing the ratio of the main numerator and the main denominator and its inputs are connected to the outputs of all blocks for division; each block for division has a dividend's input connected to one block for addition the inputs of which are connected to cells of representation of reciprocal value of succession of rows in one frame, a divisor's input of the block for division is connected to output of the block for counting the number of rows the inputs of which are connected to cells for representation of a response of rows of the same frame.

This transformation is suitable when there are at least two classes, i.e. frames, and individual classes, i.e. frames, don't all have the same number of rows. Control value can then be interpreted as the likelihood that a query sample, i.e. query row, comes from the same class, i.e. belongs to the same frame as the class, i.e. frame, that the block for assessing the main numerator is related to.

The transformation can also be expressed by the following formula:

$$A = \frac{\left(\sum_{i=1(C)}^{M} \frac{1}{i}\right) \Big/ N_C}{\sum_{j=1}^{K} \left(\left(\sum_{i=1(j)}^{M} \frac{1}{i}\right) \Big/ N_j\right)},$$

where N_j stands for a number of samples, i.e. number of all rows of j^{th} class, i.e. j^{th} frame and N_c stands for a number of samples, i.e. number of rows (11) of a certain class C, i.e. a certain frame, and a sign $i= 1(C)$, or $i=1(j)$ means that summation is performed only for those indexes i for which the i^{th} sample, i.e. i^{th} row, belongs to class C, or j.

Figures

Figure 1 shows the overall arrangement of the apparatus according to the invention. Fig. 2 shows the diagram of memory structure. Fig. 3 shows the structure of transformation and links (connections) of parts of the memory and the block for assessing values of the distance, the block for assessing reciprocal values of ascending succession and the block for assessing the ratio of the main numerator and the main denominator. Fig. 4 shows the diagram that illustrates connection of parts of the memory and the block for assessing the main numerator and the block for assessing the main denominator and their inner structure in cases where the number of frames is insignificant. Fig. 5 shows the connection diagram of parts of the memory and the block for assessing the main numerator and the block for assessing the main denominator and their inner

structure in cases where there are at least two frames of the same size. Fig. 6 shows the connection diagram of parts of the memory and the block for assessing the main numerator and the block for assessing the main denominator and their inner structure in cases where there are at least two frames of different size.

Example

The apparatus consists of a memory (1), a transformation block (2) for assessing a control value, and a means (3) intended to transfer or store estimated values of digitally represented dependences. The memory (1) is arranged so that it is comprised of at least one frame (10), one query row (12) composed of a block (19) of cells with at least one memory cell (16), and a cell (17) for representation of a control value. Frame (10) comprises at least two rows (11) each of which is composed of a block (14) of cells (16), a cell (15) for representation of a response, a cell (18) for representation of the distance, and a cell (13) for representation of a reciprocal value of succession; at the same time the block (14) of cells (16) includes at least one memory cell (16). The transformation block (2) for assessing a control value consists of a block (21) for assessing the distance of the blocks (14) of cells of rows (11) from the block (19) of cells of the query row (12), a block (22) for assessing reciprocal values of ascending succession of the blocks (14) of cells of the rows (11), a block (23) for assessing the main numerator, a block (24) for assessing the main denominator, and a block (25) for assessing the ratio of the main numerator and the main denominator; at the same time the block (21) for assessing the distance of the blocks (14) of cells of rows (11) from the block (19) of cells of the query row (12) is connected to the blocks (14) of cells of the rows (11), to cells (18) for representation of the distance of the rows (11), and to the block (19) of cells of the query row (12); block (22) for assessing reciprocal values of ascending succession of the blocks (14) of cells of the rows (11) is connected to cells (18) for representation of the distance, and to cells (13) for representation of a reciprocal value of succession of the rows (11); and block (25) for assessing the ratio of the main numerator and the main denominator is connected through its dividend's input to the block (23) for assessing the main numerator, and through its divisor's input to the block (24) for assessing the main denominator, and through its output to the cell (17) for representation of a control value. The structure of transformation and linkage (connection) of parts of the memory (1) and the block (21) for assessing values of the distance, the block (22) for assessing reciprocal values of ascending succession and the block (25) for assessing the ratio of the main numerator and the main denominator are shown in Fig. 3. The block (21) for assessing values of the distance of the blocks (14) of cells of the rows (11) from the block (19) of cells of the query row (12) is

connected to the blocks (14) of cells of the rows (11), and to cells (18) for representation of the distance of the rows (11), and to the block (19) of cells of the query row (12). Block (22) for assessing the reciprocal values of ascending succession of the rows' (11) block (14) of cells is connected to cells (18) for representation of the distance, and to cells (13) for representation of reciprocal values of succession of the rows (11). Block (25) for assessing the ratio of the main numerator and the main denominator is connected through its dividend's input to the block (23) for assessing the main numerator and through its divisor's input to the block (24) for assessing the main denominator, and through its output to the cell (17) for representation of a control value. Fig. 4 shows the links (connections) of parts of the memory (1) and the block (23) for assessing the main numerator and the block (24) for assessing the main denominator and their inner structure in cases where the number of frames (10) is insignificant. At the same time the block (23) for assessing the main numerator consists of blocks (231) for multiplication and a block (232) for addition; the inputs of each of the blocks (231) for multiplication are connected to cells (15) of representation of a response and to cells (13) for representation of a reciprocal value of succession of one row (11), and the outputs of the blocks (231) for multiplication are connected to inputs of the block (232) for addition the output of which is connected to a dividend input of block (25) for assessing the ratio of the main numerator and the main denominator; block (24) for assessing the main denominator consists of a block (241) for addition the inputs of which are connected to all cells (13) for representation of a reciprocal value of succession of all rows (11) of all frames (10), and its output is connected to a divisor input of block (25) for assessing the ratio of the main numerator and the main denominator. The links (connections) of parts of the memory and block (23) for assessing the main numerator and block (24) for assessing the main denominator and their inner structures in cases when there are at least two frames (10) of the same size are shown in Fig. 5. At the same time block (23) for assessing the main numerator consists of a block (234) for addition the inputs of which are connected to cells (13) for representation of a reciprocal value of succession of all rows (11) of one frame (10), and the output of which is connected to a dividend input of block (25) for assessing the ratio of the main numerator and the main denominator. Block (24) for assessing the main denominator consists of a block (245) for addition the inputs of which are connected to all cells (13) for representation of a reciprocal value of succession of all rows (11) of all frames (10) and the output of which is connected to a divisor input of block (25) for assessing the ratio of the main numerator and the main denominator. Fig. 6 shows the links (connections) of parts of the memory and block (23) for assessing the main numerator and block (24) for assessing the main denominator and their inner structure in cases where there are at least two frames (10) of different size. At the same time block (23) for assessing the main numerator consists of a block

(235), for addition, a block (236) for counting the number of rows (11), and a block (233) for division; inputs of the block (235) for addition are connected to cells (13) for representation of a reciprocal value of succession of all rows (11) of one frame (10) and inputs of the block (236) for counting the number of rows are connected to cells (15) for representation of a response of all rows (11) of the same frame (10); output of the block (235) for addition is connected to a dividend input of block (233) for division, output of the block (236) for counting of the number of rows is connected to a divisor input of block (233) for division the output of which is connected to a dividend input of block (25) for assessing the ratio of the main numerator and the main denominator. Block (24) for assessing the main denominator consists of blocks (241) for addition, blocks (242) for counting the number of rows, blocks (243) for division, and a block (244) for secondary addition the output of which is connected to a divisor input of block (25) for assessing the ratio of the main numerator and the main denominator, and its inputs are connected to outputs of all blocks (243) for division, each block (243) has a dividend input connected to one block (241) for addition the inputs of which are connected to cells (13) for representation of a reciprocal value of succession of rows (11) of one frame (10), a dividend's input of the block (243) for division is connected to the output of the block (242) for counting the number of rows the inputs of which are connected to cells (15) for representation of a response of the rows (11) of the same frame (10).

Industrial applicability

The apparatus in its present form can be utilized as a component in classification systems, especially personalized information systems such as, for example, warning devices watching over the driver's state of activity and distinguishing his/her ability to drive a vehicle and detecting a state when his/her ability to operate a vehicle is reduced. Another example of possible application is the complex evaluation of the operating conditions of highly sophisticated machines, such as combustion engines, aimed to differentiate between normal operation and faulty operation requiring service.

The apparatus is suitable for processing digitally represented dependences on large amounts of data (dependences of high dimensions) and for dependences that other devices and approaches do not provide satisfactory results for.

The apparatus in its present form assesses a control value that can be further used to control, operate and supervise other machines and devices, for example to redirect unsolicited mail or display, for example, a warning signal to a tired driver.

CLAIMS

1. The apparatus for assessing a control value consisting of memory, transformation block for assessing a control value and a means intended to transfer or store a control value, **characterized in that** memory (1) comprises at least one frame (10), one query row (12) composed of a block (19) of cells with at least one memory cell (16), and a cell (17) for representation of a control value; at the same time every frame (10) comprises at least two rows (11) each of which is composed of a cell (15) for representation of a response, a cell (18) for representation of the distance , and a cell (13) for representation of a reciprocal value of succession, and a block (14) of cells including at least one memory cell (16); a follow-up transformation block (2) for assessing a control value consists of a block (21) for assessing the distance of the blocks (14) of cells of the rows (11) from the block (19) of cells of the query row (12), a block (22) for assessing reciprocal values of ascending succession of the blocks (14) of cells of the rows (11), a block (23) for assessing the main numerator, a block (24) for assessing the main denominator, and a block (25) for assessing the ratio of the main numerator and the main denominator; at the same time the block (21) for assessing the distance of the blocks (14) of cells of the rows (11) from the block (19) of cells of the query row (12) is connected to the blocks (14) of cells of the rows (11), to cells (18) for representation of the distance of the rows (11), and to the block (19) of cells of the query row (12); block (22) for assessing reciprocal values of ascending succession of the blocks (14) of cells of the rows (11) is connected to cells (18) for representation of the distance, and to cells (13) for representation of a reciprocal value of succession the rows (11); and block (25) for assessing the ratio of the main numerator and the main denominator is connected through its dividend's input to the block (23) for assessing the main numerator, and through its divisor's input to the block (24) for assessing the main denominator, and through its output to the cell (17) for representation of a control value.

2. The apparatus according to claim 1, **characterized in that** block (23) for assessing the main numerator consists of blocks (231) for multiplication and block (232) for addition; inputs of each of the blocks (231) for multiplication are connected to cells (15) of representation of a response and to cells (13) for representation of a reciprocal value of succession of one row (11), and outputs of the blocks (231) for multiplication are connected to inputs of the block (232) for addition the output of which is connected to a dividend's input of the block (25) for assessing the ratio of the main numerator and the main

denominator; and at the same time block (24) for assessing the main denominator consists of the block (241) for addition the output of which are connected to all cells (13) for representation of a reciprocal value of succession of all rows (11) of all frames (10), and its output is connected to a divisor's input of the block (25) for assessing the ratio of the main numerator and the main denominator.

3. The apparatus according to claim 1, **characterized in that** block (23) for assessing the main numerator consists of block (234) for addition the inputs of which are connected to cells (13) for representation of a reciprocal value of succession of all rows (11) of one frame (10), and the output of which is connected to a dividend's input of the block (25) for assessing the ratio of the main numerator and the main denominator, and at the same time block (24) for assessing the main denominator consists of the block (245) for addition the inputs of which are connected to all cells (13) for representation of a reciprocal value of succession of all rows (11) of all frames (10) and the output of which is connected to a divisor's input of the block (25) for assessing the ratio of the main numerator and the main denominator.

4. The apparatus according to claim 1, **characterized in that** the block (23) for assessing the main numerator consists of the block (235) for addition, the block (236) for counting the number of rows (11), and the block (233) for division; inputs of the block (235) for addition are connected to cells (13) for representation of a reciprocal value of succession of all rows (11) of one frame (10) and inputs of the block (236) for counting the number of rows are connected to cells (15) for representation of a response of all rows (11) of the same frame (10); at the same time output of the block (235) for addition is connected to a dividend's input of the block (233) for division, output of the block (236) for counting of the number of rows is connected to a divisor's input of the block (233) for division the output of which is connected to a dividend's input of the block (25) for assessing the ratio of the main numerator and the main denominator; and at the same time block (24) for assessing the main denominator consists of blocks (241) for addition, blocks (242) for counting the number of rows, blocks (243) for division, and the block (244) for the secondary addition the output of which is connected to a divisor's input of the block (25) for assessing the ratio of the main numerator and the main denominator, and its inputs are connected to the outputs of all blocks (243) for division, each block (243) for division has a dividend's input connected to one block (241) for addition the inputs of which are connected to cells (13) for representation of a reciprocal value of succession of rows (11) of one frame (10), a

dividend's input of the block (243) for division is connected to the output of the block (242) for counting the number of rows the inputs of which are connected to cells (15) for representation of a response of the rows (11) of the same frame (10).

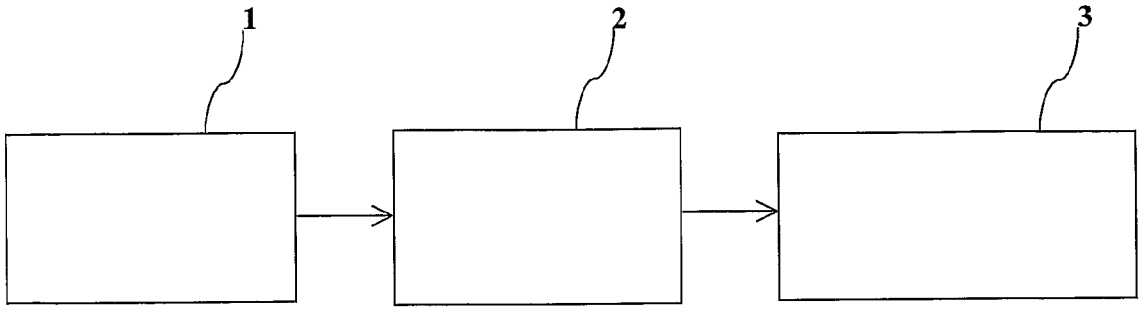

Fig. 1

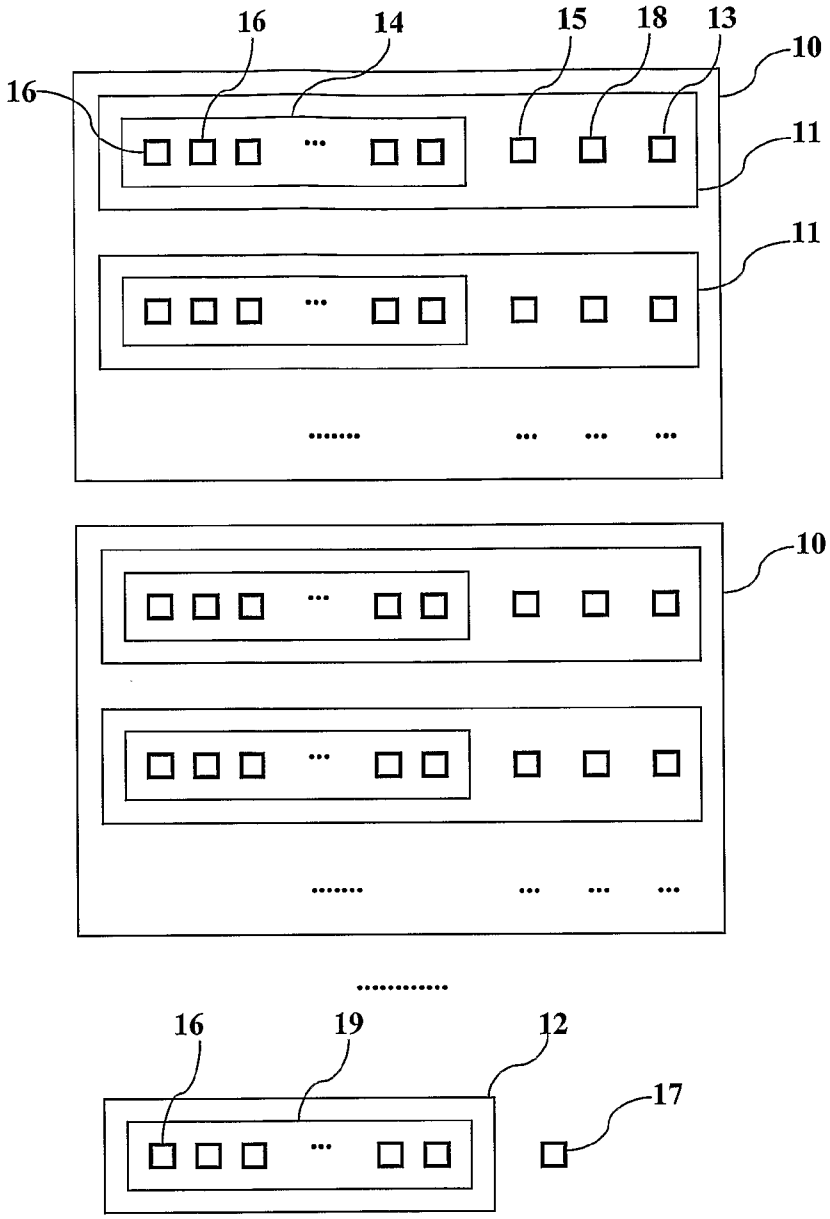

Fig. 2

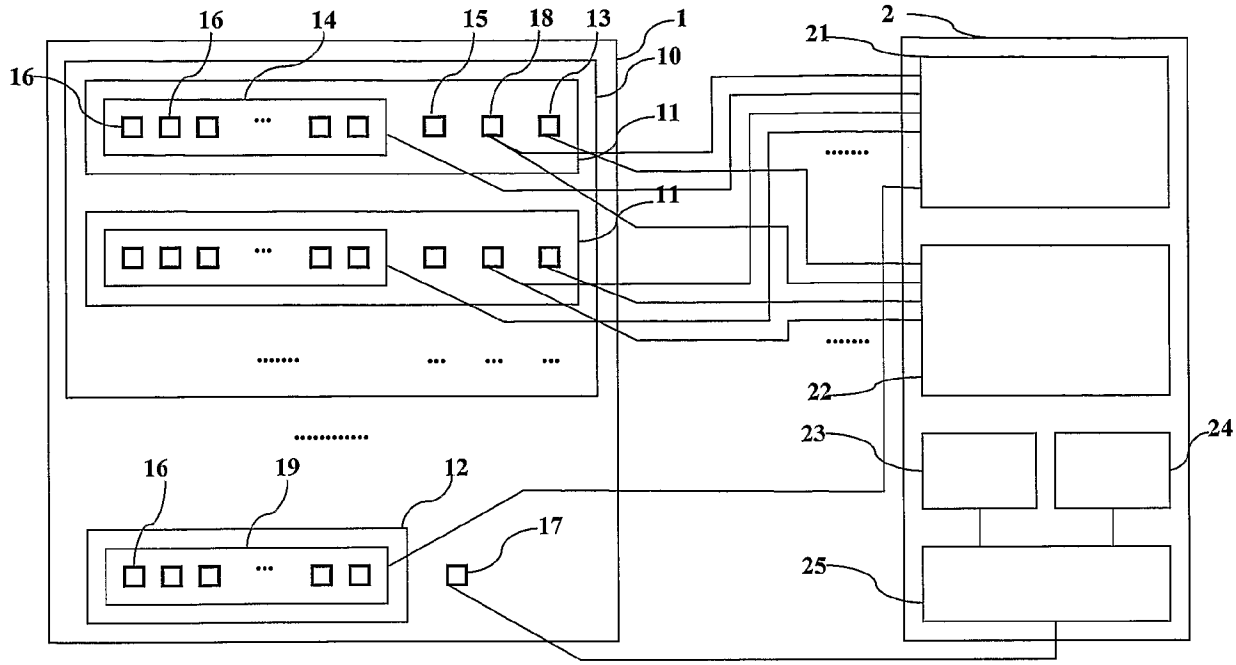
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Fig. 3

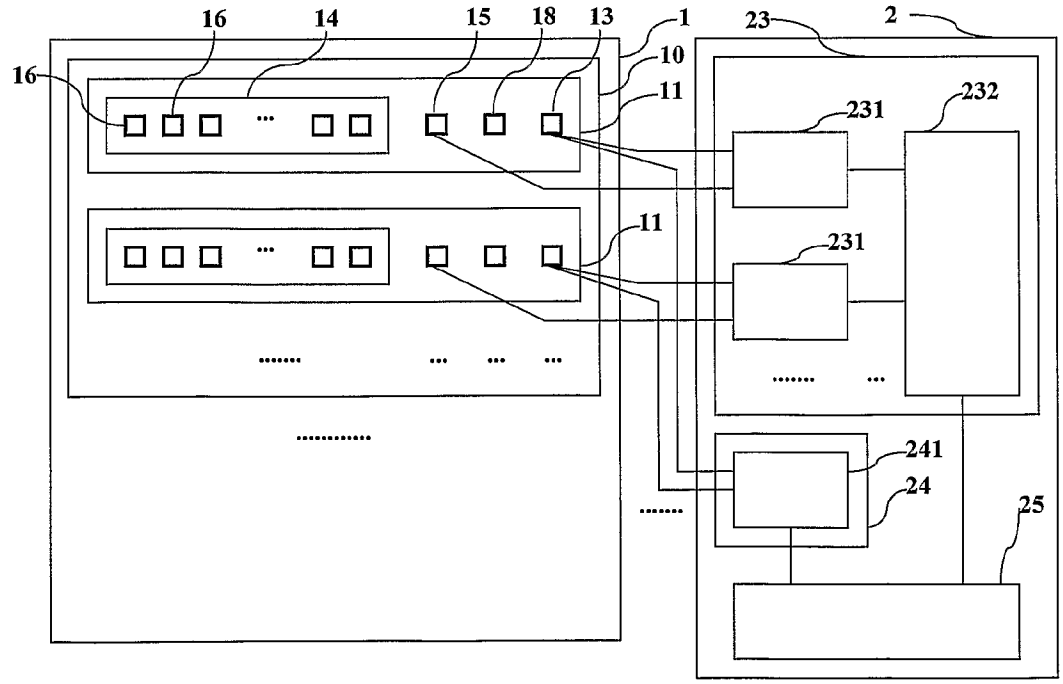
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Fig. 4

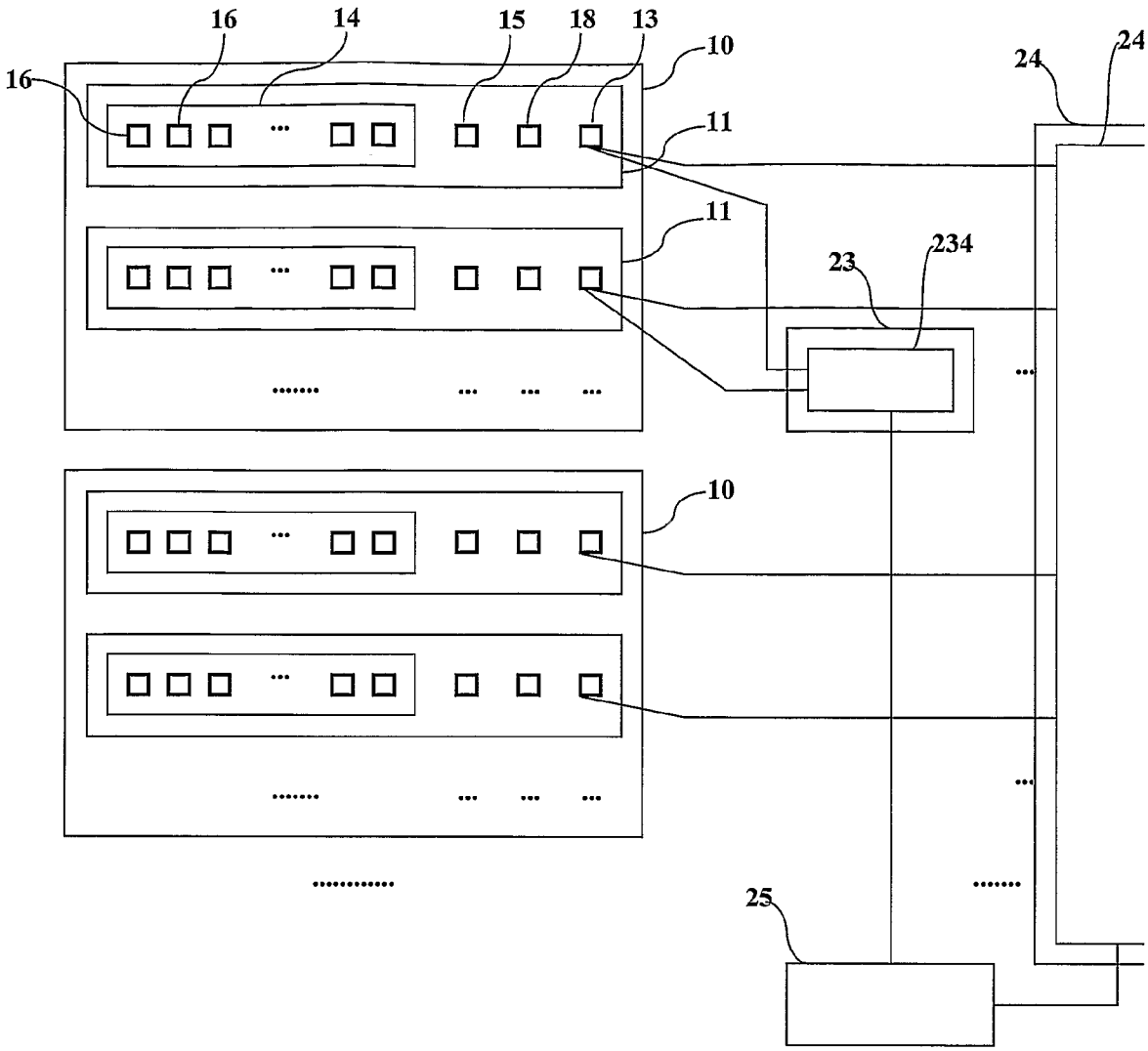

Fig. 5

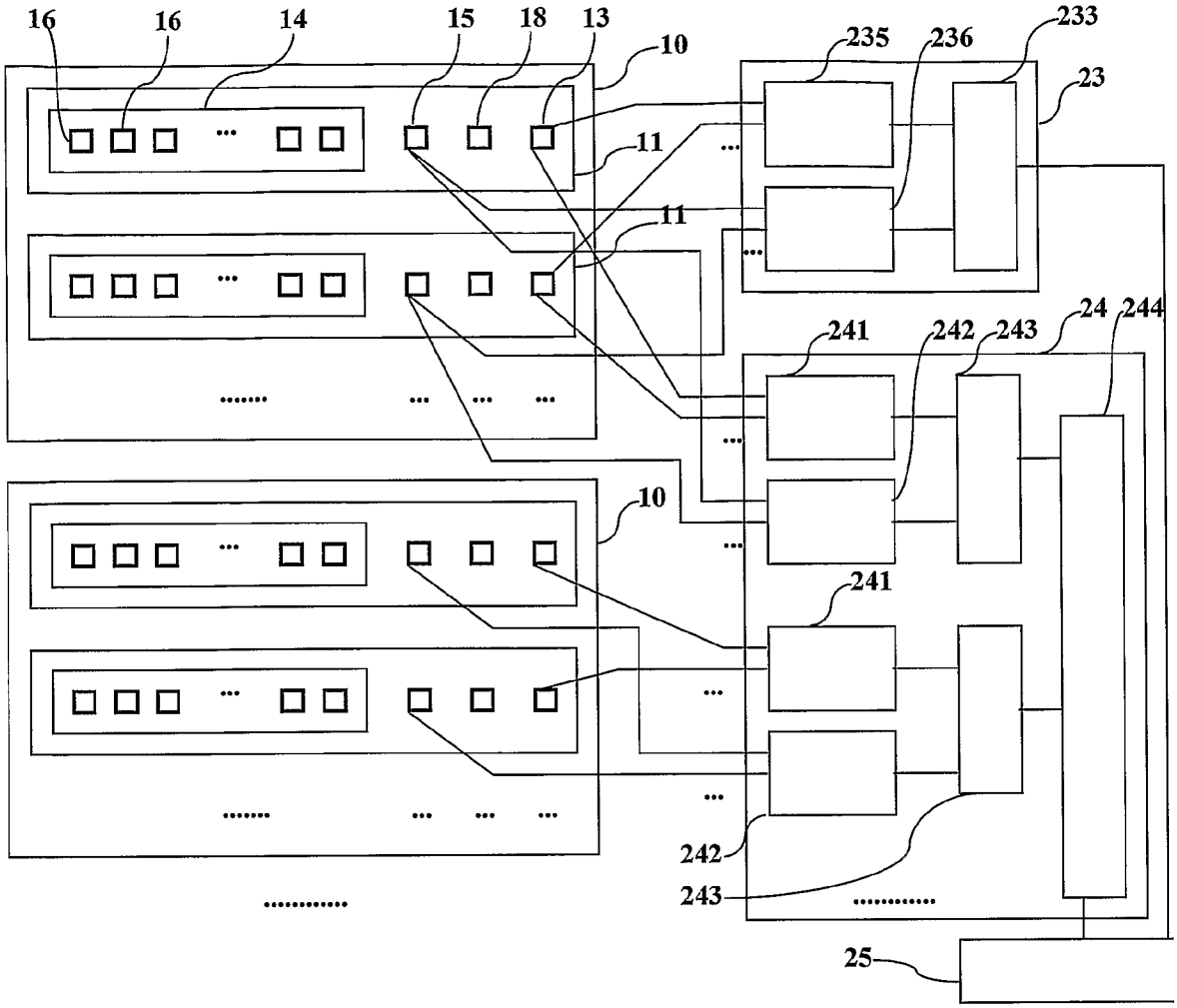
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Fig. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/CZ2009/000054

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06N1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06N G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 98/14950 A (ADVANCED MICRO DEVICES INC [US]) 9 April 1998 (1998-04-09) the whole document	1-4
X	US 4 926 385 A (FUJISHIMA KAZUYASU [JP] ET AL) 15 May 1990 (1990-05-15) the whole document	1-4
X	US 6 105 114 A (OKUNO TOMOHISA [JP]) 15 August 2000 (2000-08-15) the whole document	1-4
X	US 5 214 610 A (HOUSTON THEODORE W [US]) 25 May 1993 (1993-05-25) the whole document	1-4

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 July 2009	10/08/2009

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Fax: (+31–70) 340–3016	Volkmer, Markus

INTERNATIONAL SEARCH REPORT

International application No
PCT/CZ2009/000054

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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