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A METHOD FOR REDUCING DIMENSIONALITY OF THE SPACE OF ATTRIBUTES OF RECOGNIZABLE OBJECTS

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A new method is suggested for reducing the dimension of the space of pattern attributes, with simultaneous improvement of separability of patterns' classes. The method is based on application of a variant of analog nonlinear decoding of coded continuous messages and permits to diminish dimensionality of the space of attributes by a factor of several hundred. The possibility of raising the signal-to-noise ratio at the analog decoder is confirmed by computer-aided simulation of analog decoding.

Recognition of objects (patterns) involves processing of large amounts of data. The problem becomes simpler if we succeed in imparting a certain structure [1] to these data to diminish as much as possible the dimension of the space of attributes while improving (or retaining) the separability of the classes. The purpose of this work is to find methods for resolving this problem.

Below is suggested a method for handling the problem with the aid of analog decoding used at transmission of messages. As shown by the example included, in this case we may expect some improvement of separability of the classes. The prerequisite of choosing this method of treatment is as follows. Analog decoding falls in the class of nonlinear transformations. It opens the possibility for a greater reduction of dimensionality of the space of attributes [1], a greater increase in the signal-to-interference ratio [2] and, hence, for improvement of separability of the classes [3]. Moreover, owing to analog decoding, the information loss is low [4], and the implementation presents no serious difficulty.

The essence of the method is as follows. We transform step-by-step (the number of steps $s = 1, 2,...$) k_0 attributes x_{q-1i}, $q = 0$, of the object $\vec{X}$ to be recognized, into a reduced (by several times) number $k_s < k_0$ of attributes x_{si}, $i = \overline{1,k_s}$. The procedure is performed by means of analog decoding in such a manner that the input attributes of the first step are attributes x_{qi}, $q = 0$, $i = \overline{1,k_0}$, of the recognizable object $\vec{X}$; the input attributes of the qth step of decoding are the output attributes x_{q-1i}, $i = \overline{1,k_{q-1}}$, of the $(q-1)$th (i.e., preceding) step; the output attributes x_{qi}, $i = \overline{1,k_q}$, $q = s$, of the final sth step of analog decoding are used for calculation of attributes of standard vectors, correlative moments, thresholds for comparison, and for decision-making [1] when using the correlation method of recognition. At the qth step of analog decoding we carry out the following operations: for every input attribute x_i, $i = \overline{1,k}$, and for every checking quantity (representing an analog of the checking symbol in noise-stable coding of discrete messages) we perform the checking

$$x_{k+h} = \left[\left(\sum_{i=1}^{k} x_i g_{ik+h} + 2bq\right) \bmod 2b\right] - b, \qquad (1)$$

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