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Q-processors for real-time image processing

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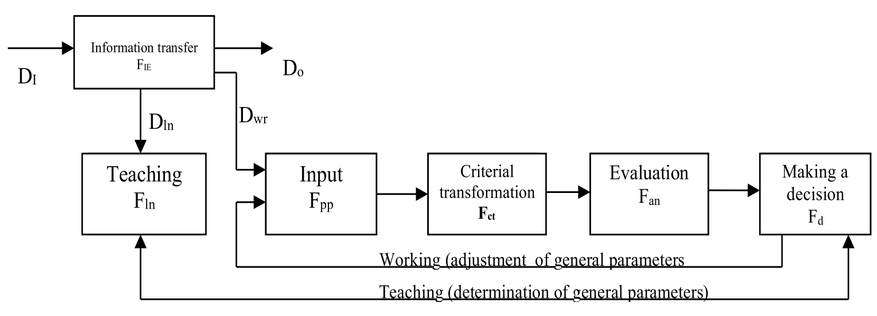
The paper considers increase of processors performance for solution of image recognition and images analysis (IRIA) problems is very actual for applied mathematics and related branches of science and technology, where the progress is achieved by real-time scale (RTS). The paper presents the main developments of the authors in a such vital and immortal for functioning of Q-processors problems as organization, comparative analysis of QQ-transformation (QQT) structure an neurolike structure, completeness and sufficient of Q-characteristics decomposition, algorithms of image restoration from the set of its Q-characteristics, noise-immunity and information content of QQT, result of comparative mathematical modeling, etc. Which are suggested in a number of papers, however, the analysis, performed in our paper, of certain problems dealing with methodology of generalized Q-transformation. Extreme simplicity of hardware realization provides achievement of maximum possible parallelism of data processing at minimum values of energy consumption and dimension – weight characteristics

Problems to be overcome are aggravated by various essences of information problems, being solved at each period of information updating, and by the lack of the theory synthesis of optimal method of corresponding **image recognition and images analysis** (IRIA) problem solution and algorithm of its realization if contradictory criterial conditions are available.

Diversity of the essence of information transformations to each step of information updating is due to the fact that typical IRIA problem in general case includes the execution of a number of necessary, successively performed steps (Fig); the generalized transformation of information, described by F(i) operator being carried out at each it i step.

METHODOLOGY



Stages of decision of task of image recognition and images analysis: D_I , D_{ln} , D_{wr}, D_o - input, teaching, working and output information

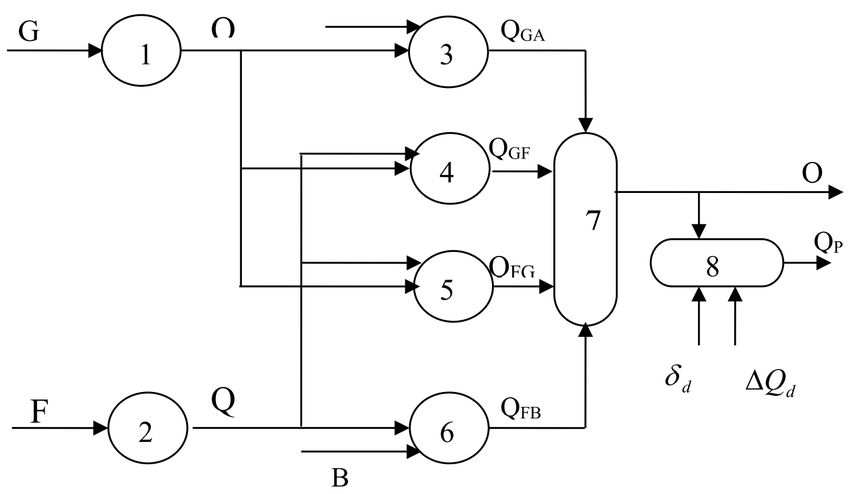
From the above, it is necessary to elaborate complex approach to improve the performance of IRIA problems solution. That is why, the attempts of partial solutions of the discussed problem aimed at maximum simplification should be made:

- IRIA method and algorithm of its realization;
- Element base used;
- Architecture of IRIA system.

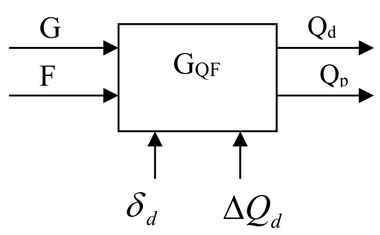
To prove this statement we can mention some directions, the possibilities of which turned out to be less efficient than expected:

- Coherent – optical processing of images based on controlled optic transparants;
- Digital processing of images in homogeneous computational environments;
- Rank algorithms of digital processing of images;
- Methods and means of cellular – automatic logic;
- Digital correlators using non – standard criterial functions of subtractive or correlation types.

STRUCTURAL REALIZATION OF PQS METHOD OF IMAGES



Structural diagram of realization of generalized comparison of indicators, by the totality of specialized converting macrostructures I-8



The generalized converting structure

Generalized Q-transformation, generated in accordance with initial assumption Q-transformation is carried out by means cyclic recursion $F_Q^{(i)}$ of the similar transformation, including preprocessing of $F_{p(Qt)}^{(i)}$ and basic transformation $F_{Qt}^{(i)}$

$$F_Q \leftarrow \overset{0}{\underset{i}{\vee}} F_Q^{(i)} \qquad F_Q \leftarrow \overset{0}{\underset{i}{\vee}} F_Q^{(i)}$$

$$Q_p = \begin{cases} 1, \text{ if } R_p(Q_d, \delta_d, \Delta Q_d) \text{ done} \\ 0 - \text{otherwise} \end{cases}$$

$$F_Q^{(i)} \leftarrow F_{Qt}^{(i)} \circ F_{p(Qt)}^{(i)}$$

$$F_{p(Qt)}^{(i)} \leftarrow F_{\kappa c}^{(i)} \circ [\overset{*}{\vee}(F_+, F_-)]^{(i)} \circ F_c^{(i)}$$

The formal definition of generalized Q-transformation is characterized by great generality, as it includes a variety of different types of preprocessing varying by content and sequence of transformation performed. Operators and in general case are defined as operators of m-type transformation:

for m= 2:

$$F_{(c)2/1}(u_1, u_2) = u_1, \quad F_{(c)2/2}(u_1, u_2) = u_2$$

$$F_{(+)}(u_1, u_2) = (u_1 + u_2)/2$$

...

for any m:

$$F_{(c)m/n\cdot1}(u_1, u_2, \ldots u_n, u_{n+1}, \ldots u_m) = (u_1, \ldots, u_n)$$

$$F_{(c)m/n\cdot2}(u_1, u_2, \ldots u_n, u_{n+1}, \ldots u_m) = (u_2, \ldots, u_n)$$

...

$$F_{(+)}(u_1, .., u_m) = \sum_{i=1}^{m} u_i / m$$

The following variants of K-comparison are of great practical importance:

1) K-preparation (OK-preparation)

$$F_{(KC)}(u) = \begin{cases} \overset{+}{u} = \begin{cases} 1 \; when \; u \geq q_u \\ 0 \; else \end{cases} \\ \overset{0}{u} = \begin{cases} 1 \; when \; q_l < u < q_u \\ 0 \;\; else \end{cases} \\ \overset{-}{u} = \begin{cases} 1 \; when \; u \leq q_l \\ 0 \;\; else \end{cases} \end{cases}$$

2) sign K-preparation (S-K-preparation)

$$F_{(KC)}(u) = \begin{cases} 1 & when \; u \geq q_u \\ 0 & when \; q_l < u < q_u \\ -1 & when \; u \leq q_l \end{cases}$$

K-preparation leads to formation of specially biased positive, negative and zero K-preparations of U={u} field where as S-K preparation provides the formation of specially adjacent preparations. Given types of preparations are often used at the stage of image preprocessing for further simplification of their correlative comparison

Given type of preprocessing is intended for solution of problems dialing rapid analysis and search of reference images [Ri] in the field of current image [Ci] of larger size, but with low accuracy of coordinates. Partial Q-summation (PQS), generalized operator equation of the latter. If contains the following stages:

- Division of image field into fragments, the division is determined by the order (number of fragments) λt, where λ and t – division factors of this field horizontally and vertically, correspondingly. Preliminary digitalization of the image is desirable but not obligatory;
- Summation of pulses of each fragment and assignment to each of obtained PQ-sums the coordinates of corresponding fragment centre. It is obvious, that normalization of these sums by means of its division by the area of corresponding fragment is desirable.

CONLUSIONS

The paper presents the main developments of the authors in a such vital and immortal for functioning of Q-processors problems as organization, comparative analysis of QQ-transformation (QQT) structure an neurolike structure, completeness and sufficient of Q-characteristics decomposition, algorithms of image restoration from the set of its Q-characteristics, noise-immunity and information content of QQT, result of comparative mathematical modeling, etc. Which are suggested in a number of papers, however, the analysis, performed in our paper, of certain problems dealing with methodology of generalized Q-transformation, allows to make some conclusions.

1. Methodology of generalized Q-transformation is a new direction of the synthesis of methods of parallel processing of information needed for solution of image recognition and images analysis problems in a new functional-operational basis, maximally approached to naturally realized operational basis of physical transforming structures with regular systolic architecture.

2. Extreme simplicity of hardware realization provides achievement of maximum possible parallelism of data processing at minimum values of energy consumption and dimension – weight characteristics.