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METHOD FOR DETERMINING THE BEST MANUFACTURER OF SINGLE-BOARD COMPUTERS

Single-board computers that have central processing unit (CPU), RAM, permanent memory, IO devices on the same board are widely used in industry due to easy adaptation in solving specialized problems. Development trends have led to the appearance of a large number of single-board computers (SBC) on the market. The main issues related to the research and creation of SBC are represented in the works of J. Patterson, A. Tanenbaum, T. Austin, W. Roche, K. Kruglyak, D. Beykun et al. But it is not enough disclosed how to choose the best type from a large SBC set simultaneously by many parameters. Therefore, the development of the method that reduces design time is an urgent task.

The purpose of the work is to determine the best manufacturer of single-board computers from the defined set at the expense of development of object-oriented conventional quality criteria by technical and economic indicators and sign model with geometric interpretation of Venn diagrams.

Formulation of the problem.

To accomplish this goal it is necessary to solve the following problems:

- to create an array of manufacturers of single-board computers;
- to structure existing SBC data by the main technical and economic indicators;
- to determine analytical relationship between indicators and the type of simulation;
- to develop object-oriented conventional quality criteria by SBC technical and economic indicators for various manufacturers;
- to build a sign model of quality criteria relationship in dimensionless coordinates;

– to conduct geometric interpretation of Venn diagrams and determine the best SBC manufacturer.

The solution of the problem.

A set of modern manufacturers of corresponding types of single-board computers and their performance based on heuristic method is determined. Taking into account that HummingBoard company has multiple SBC series, four of them are shown in Table 1 (3-6).

It is known that the main technical and economic indicators include the price (P) and RAM capacity (V). Structured data of SBC manufacturers by these indicators are shown in Table 1.

Table 1

Indicators of the price and RAM capacity for manufacturers of single-board computers

№	Manufacturer	P_{min}	P_{max}	V_{min}	V_{max}
1	Raspberry PI	20	35	256	1024
2	Cubietech	49	125	1024	2048
3	HummingBoard-Edge	102	172	512	2048
4	HummingBoard-Gate	50	150	512	2048
5	HummingBoardPro	85	150	512	2048
6	HummingBoardBase	70	100	512	1024
7	LinkSprite	30	120	512	1024

Generalized mathematical model is synthesized to determine the relationship between technical and economic indicators, which takes the following form:

$$F(P_{min}, P_{max}, V_{min}, V_{max}) = 0, \quad (1)$$

where P_{min} – the minimum computer price of manufacturer;

P_{max} – the maximum computer price of manufacturer;

V_{min} – the minimum computer RAM capacity of manufacturer;

V_{max} – the maximum computer RAM capacity of manufacturer.

Taking into account the lack of analytical relationship (1) between specified indicators a conventional simulation is selected.

Based on the properties of dimensional theory and dimensionless power complexes the following object-oriented conventional quality criteria and their physical interpretation are generated:

$\frac{P_{max} - P_{min}}{P_{max}}$ – the quantity that characterizes the range of SBC price for respective manufacturer, the best criterion value verges towards 1;

$\frac{V_{max} - V_{min}}{V_{max}}$ – the quantity that characterizes the range of SBC RAM capacity for respective manufacturer, the best criterion value verges towards 1.

Herewith, criterion equation takes the following form:

$$\psi\left(\frac{V_{max} - V_{min}}{V_{max}}; \frac{P_{max} - P_{min}}{P_{max}}\right) = 0 \quad (2)$$

.

For optimization procedure in Fig. 1 a sign model of quality criteria relationships, the values of which are given in Table 2, is built.

Table 2

Results of similarity criteria calculations for SBC manufacturers

№	Single-board computer manufacturers	$\frac{P_{max} - P_{min}}{P_{max}}$	$\frac{V_{max} - V_{min}}{V_{max}}$
1	Raspberry PI	0,43	0,75
2	Cubietech	0,61	0,5
3	HummingBoard-Edge	0,41	0,75
4	HummingBoard-Gate	0,67	0,75
5	HummingBoardPro	0,43	0,75
6	HummingBoardBase	0,3	0,5
7	LinkSprite	0,75	0,5

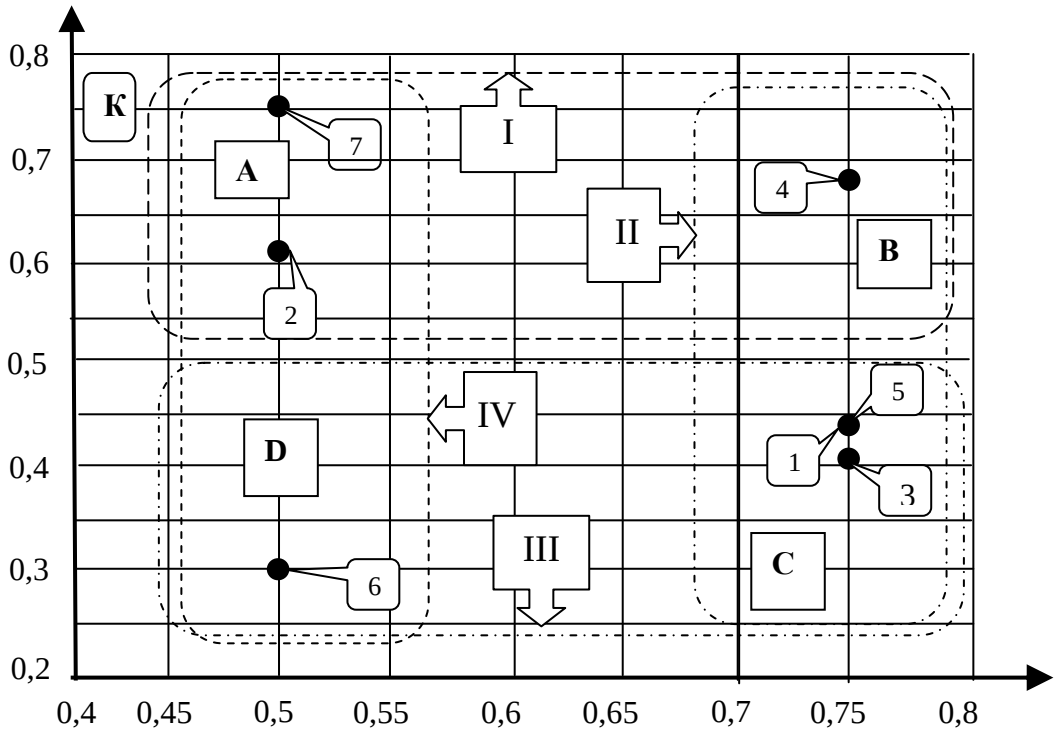

Fig. 1. Sign model of quality criteria relationships for SBC manufacturers in dimensionless coordinates

Note: numbers 1, 2, 3, 4, 5, 6, 7 correspond to sequence numbers of manufacturers of single-board computers in Table 2.

Sign model (Fig. 1) represents the universal set K based on algebra of sets that is divided into four subsets $K = \{I, II, III, IV\}$ for visualization. Herewith, subsets *I*, *III* share the ordinate and *II*, *IV* – the abscissa.

As a result of algebra of sets operations the intersections of these subsets *A*, *B*, *C*, *D*, the visualization of which facilitates the rapid determination of the best manufacturers, are generated.

$$A \subseteq (I \cap IV);$$
$$B \subseteq (I \cap II);$$
$$C \subseteq (II \cap III);$$
$$D \subseteq (III \cap IV).$$

In addition, this helps to automate the process of optimization and to recommend the direction to improve the appropriate SBC manufacturer. This accelerates the process of designing of single-board computers.

Indeed, geometrical interpretation of the following subsets shows that:

- **A** intersection subset has a small range of RAM, but a large price range;

- **B** intersection subset has large ranges both in price and memory;

- **C** intersection subset has a large range of RAM capacity, but a small price range;
- **D** intersection subset has a small range both in price and RAM capacity.

Hence, HummingBoard-Gate is the best company.

Conclusions:

The method of determining of the best SBC manufacturer is developed. The algorithm of this method includes:

1. Creation of an array of manufacturers of single-board computers.
2. Structuring of existing SBC data according to the main technical and economic indicators.
3. Determination of the absence of analytical relationship between indicators and thus the choice of conventional simulation.
4. Development of object-oriented conventional quality criteria according to technical and economic indicators for various SBC manufacturers.
5. Building of a sign model of quality criteria relationship in dimensionless coordinates.
6. Conduction of geometric interpretation of Venn diagrams with the substantiation of the best SBC manufacturer.

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