14

Hybrid System for Ship-Aided Design Automation

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1. Introduction

In carrying out the most important tasks of a shortage of ship design is the lack of formalized application methods, mathematical models and advanced computer support. Decisions and adopted solutions are often based on knowledge resulting from experience and intuition of designers. Use of information on previously executed projects of similar ships allow expert systems using the Case Based Reasoning method (CBR), which is a relatively new way of solving problems related to databases and knowledge bases.
This facilitates the efficient design of the ship as soon as possible [1]. A similar role has been neural networks, which can be taught on the basis of representative examples, and the results obtained from other sources (eg during the operation of the ship).
To achieve this purpose, a hybrid support system for ship design based on the methodology of CBR with some artificial intelligence tools such as expert system Exsys Developer along with fuzzy logic, relational Access database, and artificial neural network with backward propagation of errors. Hybrid systems forming a new class of artificial intelligence tools have to combine the capabilities of each of the tools used to solve specific problems. In the simplest case of the hybrid system is a combination of classical techniques of expert systems with neural networks [2], which was applied in developed computer-aided design system.
This system is intended to be ship-aided design automation, where most projects are using pre-built similar ships. The scope of the system, in addition to computer-aided design automation, were also aided design of ships at the initial stage, which determines the main parameters of the ship.
In order to find solutions to similar, previously used on ships developed its own algorithm for multiobjective optimization of weighted gains to search a database of similar ships [13]. The proposed algorithm was applied to computer-aided design ship's engine room automation, where the similarity may be of partial for example main propulsion (MP), power plants and individual installations, and the weighted sum of partial similarities is the similarity summary of the whole ship.
Using this algorithm, the selection is made of methods for calculating the similarity presented in the literature, adapted to the design of ships and their own methods, has not been used, based on the use of functions: rectangular, trapezoidal, triangular and Gaussian [13]. Using these methods, similarity analysis was conducted for the selection of ships, power and speed of main engine (ME). This analysis is intended comparison of selected methods and the selection of the best of them for computer-aided design automation engine room in the database application and expert system. Based on the results obtained are searched in a database similar ships, ie ships with the greatest similarity weighted summary. In the case of

unsatisfactory results in the calculation of similarity, as a complementary, provided for a neural network learning algorithm. This algorithm is implemented in the system of Access and can be used for the selected database and its fields of any numeric type.

2. The structure and functions of computer-aided design ship's engine room automation

2.1 Searching for similar ships

System-aided design ship's engine room automation is an application that (improves) streamlines and facilitates greatly the design process automation monitoring and fitness of the ship. The application was developed using expert system Exsys [16] and is planned to work with the database management system Access [6] as a support system for ship design engine room automation, but can also be an independent operating tool, in a somewhat limited scale, only in the database Data Access (without the use of expert system), which lowers the cost of applications.

Searching for similar ships in the system can be realized in two ways:

- The selection of the ship by a similar expert system in conjunction with the application database and verifying the results obtained by a neural network
- looking like a ship through the database application with a possible revision of its design using neural network.

In both cases the results are verified by a neural network using back propagation algorithm. The neural network learned on the basis of design data stored in ships built in the database used to verify the project in case of setting it up on the basis of sub-projects from different ships (eg data on the drive from the ship BXXX, and power plants - BYYY). Structure aided design automation system is shown in Figure 1

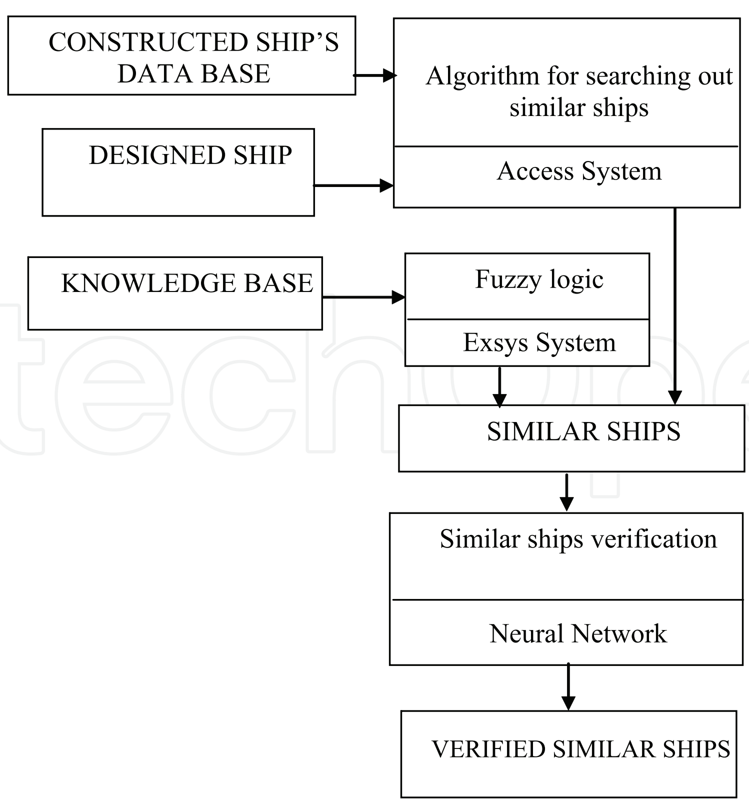

Fig. 1. Schematic design automation system for supporting the ship on the basis of similarity

A database contains data about objects and systems, devices and automation components from catalogs, or used on ships previously built. It can provide detailed information for designer about the elements of the automation systems used on ships constructed, as well as directory information on those systems and components.
Knowledge base system is the automation of selected elements of the project, which are implemented by the expert system based on the domain model (without the use of information on ships built). Based on the domain model can be made also an adaptation of the project, which takes place when the database was not found enough to like or ship found the ship has a relatively low similarity summary and the designer decides not to match an existing project for the design of self based on a knowledge base.

2.2 The hierarchical structure of automation

To achieve effective and transparent (formal) similar ships were searching the classification structure of engine room automation, which is multilayered and includes the following levels:

- the engine room
- systems
- objects
- control and measurement points.

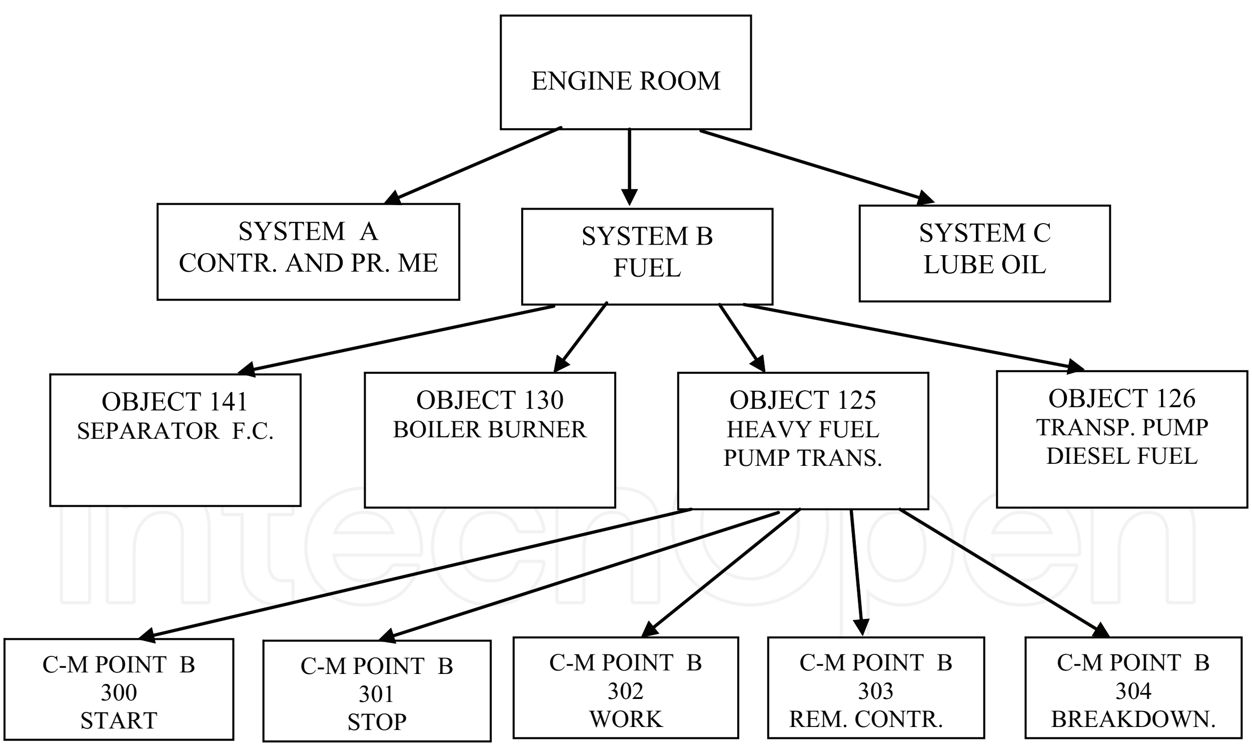

Fig. 2. The structure of design engine room automation on the example of fuel system

For the purposes of computer processing and editing of technical documentation automation adopted a single, numeric encoding systems and facilities installed in a power ships. However, automation components are encoded in accordance with international standards. It was assumed that the selection of automation objects is realized within the marine systems that, for most ships, are as follows:

- system control and protection ME,
- fuel system,
- lube oil system,
- fresh water system,
- a system of sea water,
- compressed air system,
- boilers and steam system,
- bilge system,
- power system,
- ballast system,
- other.

Different levels of this structure (for example, fuel system) are shown in Figure 2.

2.3 Algorithmization searches similar ships

To search for similar ships multiobjective optimization algorithm was used for the selection of automation based on a hierarchy of similarity: the whole engine room, her ships systems and objects designed (proposed) for the individual ships stored in the database. Tasks of this algorithm are as follows:

- Search for similarity between the structures of automation,
- Optimizing cost and scope of automation.

In the first stage of the algorithm is sought in the structure of the ship automation most similar like that described by the structure and number of elements present in the system automation (structure and number of objects, sensors, etc.). By comparing the structure of the automation of other ships built it to be classified in terms of fuzzy as: same, better or worse. Finding the best engine room automation structure is based on the provisions contained in the key project documents such as technical description and comparison of measurement equipment.

In the second stage of the algorithm, based on the existing structure, searches in the directories of the database systems and automation equipment, minimizing costs and maximizing capacity factor (range) of automation for these costs. At this stage, looking for a ship with a high density of automation possible with the relatively small cost - fuzzy optimization criterion.

Optimization method used here is based on a hierarchical optimization successively performed for all criteria.

- Arrange the criteria of importance (f_1) to least important (f_M)
- Find the optimal solution X^1 the primary criterion for f_1 and limitations
- Search for optimal solutions X^i, i = 2.3 ,..., M relative to the other criteria for the introduction of additional restrictions.

Keeping the cost calculation is done using two methods:

- using an estimate - in the initial stages of design based on the technical description and a base price of standard.
- using the exact - in the later stages of the design is based on information from a comparison of measurement and control equipment and bills of materials and details of offers and contracts for the purchase of equipment automation.

Accepted calculation method is based on an estimate of costs based on price information from the pre-built ships that are brought into the so-called. standard prices, ie price per unit for a ship with a standard contract for the equipment. A detailed list of the equipment along with the accepted price is the calculation of the cost of automation, which includes: an integrated alarm system / control / monitoring, maneuvering control panel desktop, remote control system ME, ME diagnostic system, generators, automation systems, pressure transducers, pressure switches, thermostats, level sensors, temperature sensors, etc. The criteria for the optimization algorithm includes:

- computing the minimum price
- the minimum delivery time
- maximum discount
- maximum warranty period
- the priority of the supplier or their lack of automation.

For determining the similarity of the ship used in the classical method of weighted profits. In this method, the coordinates of the vector of profits - the partial similarities are aggregated into a single function of income - a summary by the similarity transformation:

$$pg_{is} = \boldsymbol{ws} * \boldsymbol{ps_{is}}'$$
$$ps_{is} = sum((mo * m\,po_{is})')$$

where: pg_{is} - similar summary automation of the whole ship,
$\boldsymbol{ps_{is}}'$- Column vector of similarities of partial automation systems [w_1 w_2 ...w_{ip}....w_{lp}], $w_{ip} \in$ <0,1>and $\Sigma wg_{ip}[i]=1$,
mo - array of objects weighing individual systems
mpo_{is} - matrix of similarities of objects of individual systems
$_{is}$ - the ID of the ship,
* - the dot product.

The project built the ship automation can be adopted without any change or be subject to adaptation in accordance with the requirements of the designer of automation. Adaptation of the project built ship can be achieved in two ways:

- on the basis of other projects ships built,
- model domain - based.

Adaptation based on other ships built projects takes place when the partial similarity between the different systems of the ship similar (with the greatest similarity of the summary) are smaller than the similarities of the individual systems of other ships.
Adapting model domain - based [3] takes place when the database did not find enough like a ship or ship is found has a relatively low similarity summary and the designer decides not to match an existing project for the design of self. At each stage of development envisaged is the possibility of interference by the designer of automation.

3. Analysis of the similarity of the hierarchical automation engine room

3.1 Basics of calculating the similarity automation

The support system of the ship design automation similarity was related to characteristics of ships built in the engine room. It is assumed that the solutions for the automation are subject to certain features of the engine room in scheduled ship. Due to the large number of ships taken into account the characteristics of similarity is defined, broken down by certain groups of traits. The collection in question features (parameters) of the ships was divided into subsets with respect to the entire ship propulsion, power, and the following marine systems (installation): fuel, lube oil, fresh water, sea water, compressed air, boiler and steam system, bilge, in ballast, and others. The results of calculations of similarities in these subsets are defined as partial similarity. The study of similarity includes some parameters such as:

- general information: type of ship, load, number of refrigerated containers, the number of moving cars, the classification society, class automation
- main propulsion (MP): The number of main engines (ME), type ME, power ME, ME speed, the number of propellers, the type of propellers, the number of transmissions;
- power plant: the number of sets PG1 type, the type of PG1, power PG1, PG1 speed, number of sets PG2 type, the type of PG2, PG2 power, speed PG2, the number of shaft generators,
- the installation of fuel : the number of fuel valves, the number of fuel pumps, the number of centrifuges, the number of filters;
- bilge: number of valves, the number of bilge pumps.

To calculate the similarity of ships in the database application uses some functions of similarity (rectangular, trapezoidal, triangular, Gaussian, with a lower limit), and the expert system - fuzzy logic. The similarity of ships calculated in the database application is forwarded to the system Exsys in tabular form. Along with the similarities and partial summary of the database shall be the values of selected parameters on which the expert system calculates the fuzzy similarities and looks similar ships.
The system Exsys to the database are forwarded to the resulting maximum partial similarity with the corresponding identifiers of ships and ship's maximum aggregate similarity as the sum of the partial similarities. On this basis, the system searches the database of the ship as a ship like that.

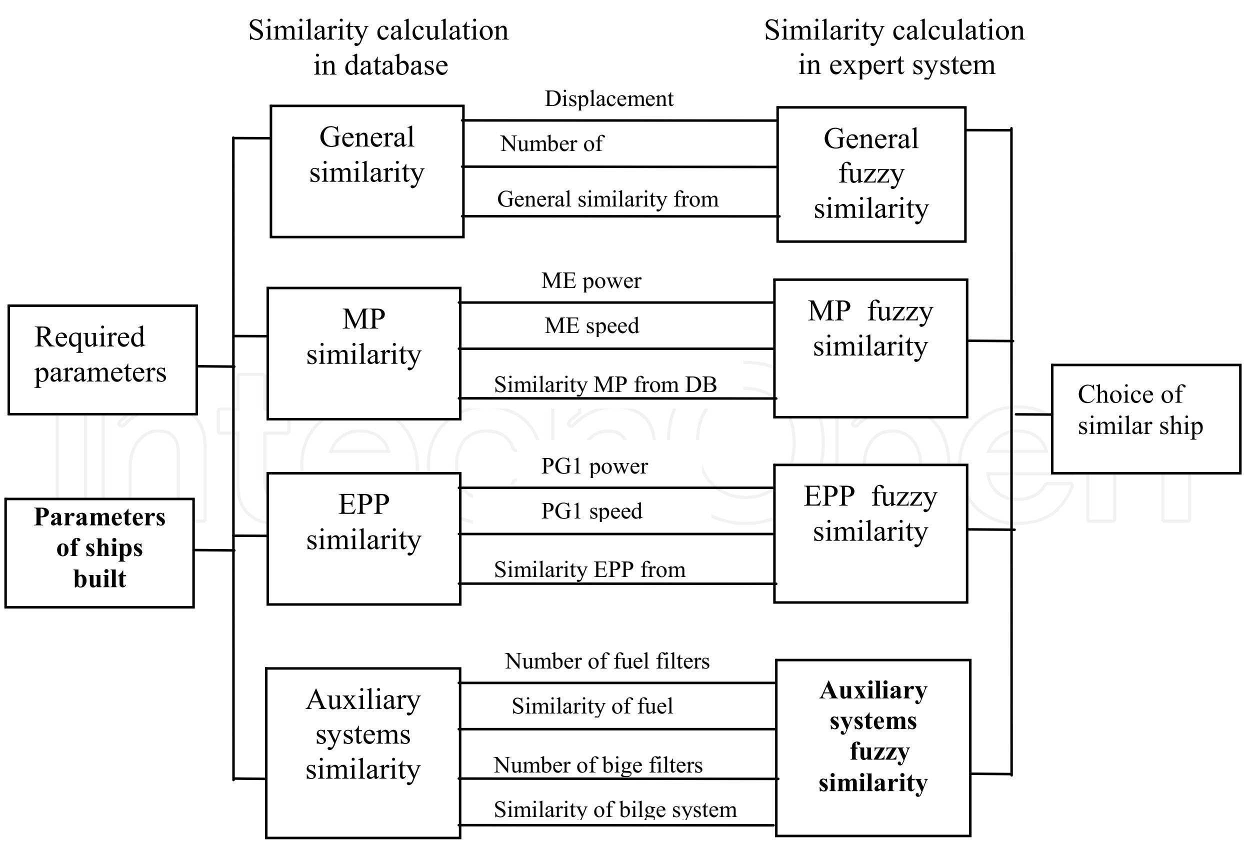

Fig. 3. Block diagram of a search for a similar ship in the database application and expert system

Example of searching for a similar ship is shown in Figure 3, where: MP - main propulsion, ME - the main engine, PG1 - generator of type 1, PG2 - generator of type 2.
The project on the basis of automation projects, other ships can be implemented:

- based on a draft of the ship similar or ship chosen project,
- by including the individual systems (objects) of ships built.

Maybe there is the adoption of the entire project before the ship was built (as a base project) or its adaptation projects on the basis of individual systems and (or) objects of other ships stored in the database.
Project base design can also be freely chosen by the designer of the ship built. In each scenario using the base project can then be modified several times based on systems built by other ships built in terms of both technical description and selection of equipment, such as by changing the design of systems (objects) that originate from other ships or may be supplemented and corrected by the addition of new and (or) removal of existing control and measurement points.
The search system or building automation built ship is carried out in two stages: the first stage of the search is looking for entries for the system (object) on all ships stored in the database, in the second stage, records are searched for the system (object) on the selected ship. The result of each stage is displayed on the screen, giving the designer the opportunity to review and compare the equipment of the system (object) to individual ships before the final choice.
Network activities of this process is shown in Figure 4.

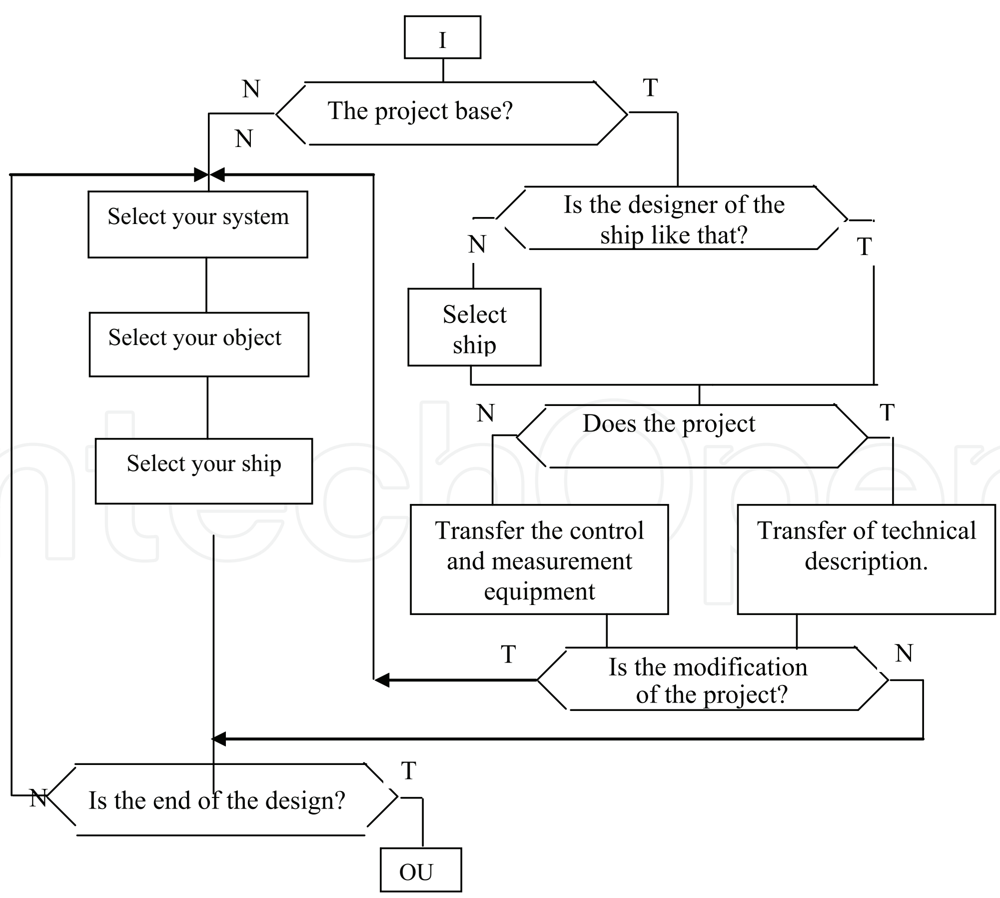

Fig. 4. A network activities of algorithm design engine room automation

3.2 Application of the similarity calculation functions of engine room automation

Functions of similarity is one of the most important element of case based reasoning method. Functions presented in the literature of this type (with a similar use) relate to the similarity collections without analyzing the similarity of the individual components. These functions do not provide such a large room for maneuver for the designer in search of similar ships, as proposed here functions of similarity. The fact that they may play a role similar to that of fuzzy logic improves their usability for two reasons:

- In database applications, ensure the implementation of fuzzy logic operators,
- It gives the possibility of waiving the application of expert system and reduce support automation for simplified variant (without the use of expert system).

The developed system of choice for calculating the similarity function depends on the design task, as well as the expectations of the designer. These functions provide greater flexibility in determining the ranges of values of the parameters input. Their selection should result from the need to include greater or lesser number of similar ships, for example for the similarity analysis of individual systems (installation). The designer may choose a specific function or function can be automatically applied at both the preliminary design, as well as in the selection process of automation.

The designer can specify the value of individual design parameters, as well as deviations and standard percentage points lower and upper, which are converted into real values and the limit of standard parameters. They may be of a symmetric, if their values are the same, or asymmetric, if different. Determining lower or higher ranges of parameters, such as in the design automation of the ship may be comfortable in a situation where the designer to adopt a tolerance for technical parameters is looking for solutions to the most profitable from an economic point of view, namely to the lowest price (with possible discounts and rebates) or shortest time of delivery.

The similarity of the resulting parameter is obtained as a weighted similarity of this parameter. The process of calculating the weighted similarities of each parameter is terminated after taking into account all the input parameters of the ship, and their weighted sum is a partial similarity of the MP. The sum of the similarities of partial similarity is the weighted aggregate of the whole ship, under which ships are searched on.

Based on sample data, the proposed board and the data contained in the database of ships built, as the ship is similar, the ship was named B500. The partial similarity of some ships from the database are contained in Table 1.

Ship	General sim	MP sim	EPP sim	INST sim	Weighted sum sim
B191	0,62	0,74	0,50	0,55	0,60
B222	0,15	0,33	**0,70**	**0,75**	0,48
B369	0,17	0,60	0,48	0,68	0,48
B500	**0,90**	**0,78**	0,55	0,73	**0,74**
B501	0,10	0,25	0,67	0,51	0,38
B683	0,13	0,56	0,68	0,50	0,47
B684	0,13	0,59	0,49	0,61	0,45

Table 1. The partial similarity of some ships

The partial similarity of the ship were calculated similar to the values of weights for each group of parameters, which was adopted by the arbitrary decisions of the designer on the basis of his experience (Table 2).

Kind of similarity	Weight of the parameter	Weighted value of the similarity
GENERAL SIM	0,1	0,09
MP SIM	0,4	0,312
EPP SIM	0,3	0,165
INST SIM	0,2	0,146

Table 2. Partial similarities of the similar ship

Partial similarity of the greatest value from a variety of ships (B500, B222) are shown in Table 3.

Kind of similarity	Ship	Weighted value of the similarity
GENERAL SIM	B500	0,09
MP SIM	B500	0,312
EPP SIM	B222	0,21
INST SIM	B222	0,15
SUM SIM	B500	0,76

Table 3. The biggest partial similarity

4. Application of selected methods for calculating the similarity

4.1 In the expert system and database application

Detailed analysis of selected methods for calculating the similarity between the ships was limited to the example of MP computer-aided design as an element of partial whole system, from which depends largely on ship engine room automation design.

The primary function of the system is developed to search a database of similar ships, which number may be quite varied and range from one up to several dozen ships. This is based on the applied similarity function, as well as the size and content of the database and assumed design parameters, such as ranges and thresholds of similarity functions. These parameters are determined by the designer before starting the search process similar ships. Next, data are required for the proposed ship. Then begins the process of calculating the similarity between the various parameters, including power and speed of the ME, then the similarity of the functions of the threshold. This process can be launched by the designer at any time and anywhere via the form shown in Figure 5.

MP partial similarity is calculated based on the similarity of number fields ME and non-numerical creating similar comprehensive MP. At this stage the table is created with the data of both source and calculated the similarities in the database application for Exsys (click for Exsys), on the basis of which similarities are calculated fuzzy.

In addition to calculating the similarity of ME in the database using the method of fuzzy logic in the expert Exsys system. This method was used to calculate the similarity between the parameters of the proposed board and the same parameters of individual ships built, as well as the similarity of other parameters of a numerical transferred from the database.

Application of fuzzy logic analysis of several examples (P1-P5) of design capacity and speed of the ME, and the results (weighted) for the calculation of similarity and prediction similar ships Exsys by the system shown in Table 4. In the case of a database of many ships of the same value of similarity in the table was placed first found a similar ship.

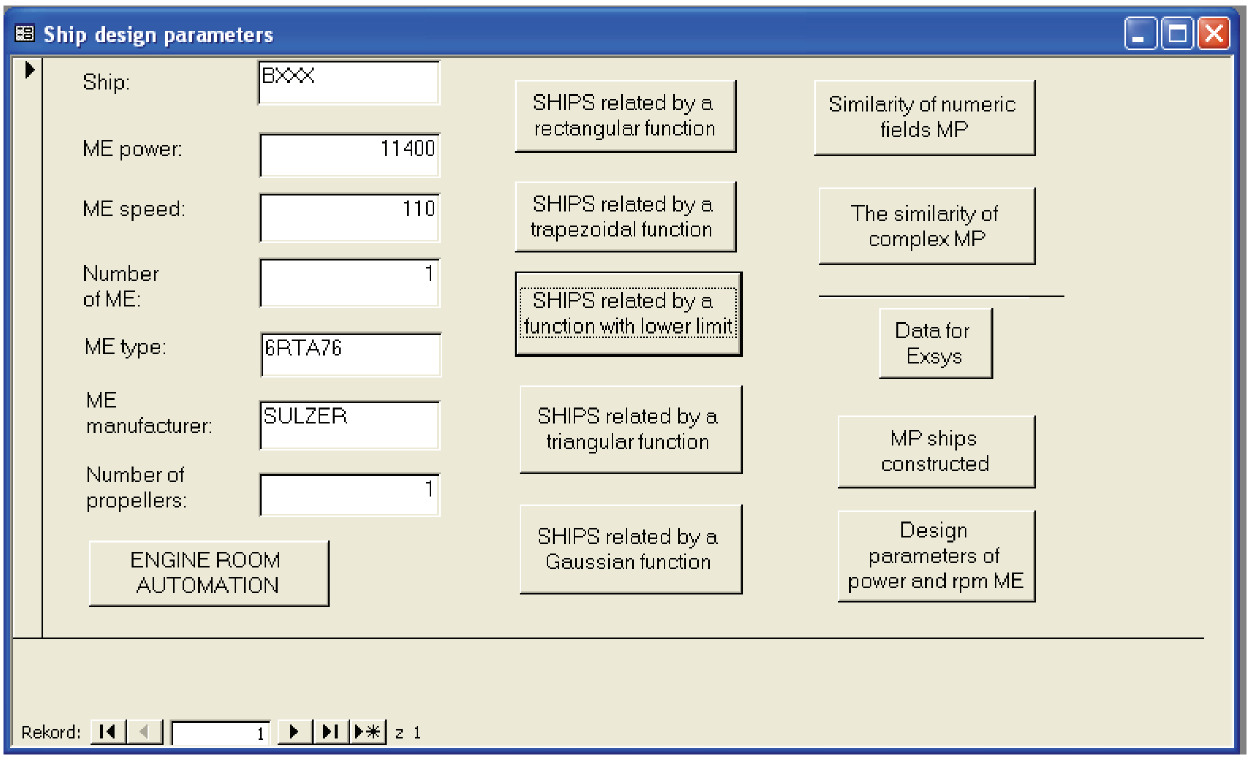

Fig. 5. Menu for calculating the similarity of ships on the example of the control system ME

Exemple	Designed power	Designed speed (rpm)	Number of similar ships	Values of maximal similarity	Similar ship power	Similar ship speed
P1	16200	107	3	0,6286	18160	110
P2	11400	110	20	0,6286	10800	118
P3	6600	150	1	0,8	6650	154
P4	11000	120	38	0,6286	13050	124
P5	17000	500	3	0,45	17400	530

Table 4. The results obtained in the similarity of MP Exsys system

Some examples have been found one (P3) or three (P1, P5) ships with a maximum similarity weighted summary, but sometimes also the number of ships with the same value of similarity is very high, eg in the P4 - 38, and P2 – 20.

For example, P2 analyzed the results concerning the maximum similarities ships Exsys calculated in the system using fuzzy logic, and calculated by using various functions in the database application using the sample (different) value deviations. Results for the three variants of border and standard deviations, respectively: [20.10] [40.20] [40.30] is shown in Table 5.

If the function of the lower bound and fuzzy logic in all three variants are the same values for the number of ships and the maximum value of similarity. For a rectangular function of deviations are negligible. For the triangular function is important to limit slippages value only because, by definition, the value of standard deviation is zero. For the Gaussian function increases in value and standard deviation limits search results more similar ships.

		Trapezoidal function		Gaussian function		Triangular function		Function w… lim…
ΔP_D i ΔP_G %	ΔO_D i ΔO_G %	Number of ships with maximal similarity	Value weighted similarity	Number of ships with maximal similarity	Value weighted similarity	Number of ships with maximal similarity	Value weighted similarity	Number of ships with maximal similarity
20	10	10	0,50	2	0,36	3	0,37	3
40	20	33	0,50	3	0,46	5	0,43	
40	30	54	0,50	6	0,48			

Table 5. The number of ships with the highest value of similarity according to particular functions in the database application and Exsys system

In the case of trapezoidal function with increasing values of deviation limits (lower and upper) and standard deviations of a growing number of ships, the most similar, with a maximum value of similarity is not changed, and for the analyzed case is 0.50. Keystone function in this respect is similar to fuzzy logic.
The number of ships of similar products using fuzzy logic is, in some cases very large, for example in Example P4 fuzzy logic method has been found up to 38 ships with a maximum value of similarity. Such a large number of similar ships is recognized in the membership function, which may involve some ranges of a large number of ships included in the database, while others will be limited to just one or several ships. Is dependent on the contents of a database - the types of ships in it are stored.
Mostly due to the use of fuzzy logic will be found to be a lot of ships with the highest value of similarity to the design ship. This method can therefore be applied to the initial classification of ships in the first stage of their search. Reduction of an excessive number of search ships may provide placement in a database or limit your search to the ships of the same type, for example, only the container [5].

4.2 In the neural network

The similarity of MP ships calculated in the application database and expert system can also be verified using the neural network with back-propagation of error, which was implemented in Visual Basic for Access, and can be used for any number of input and output parameters in the form fields database table [6]. In applications of neural networks is required to have numerous possible training set. Research results presented below are based on a set of hundreds of ships constructed. In studies that sought power dependencies, and then the engine speed from the main input parameters such as load capacity, length and width of the ship, its immersion and speed.
The calculations used a two-layer network with continuous unipolar activation function and the classical backward error propagation algorithm for weight change. The collection ships were divided into two subsets: learning and testing. To a set of testing randomly selected 25% of ships. All parameters of ships before the calculations were normalized to the range [0,1]. In this case, a computational cycle consisted of an introduction to the network input parameters of all the ships in succession from the training set. Completion of the network training followed when the mean square error in the cycle ec received less than the desired value. This error is related to the difference between the actual power of the ME and the power calculated by the network for the same ship.
The developed algorithm with the backward propagation of errors used for the selection of power and speed of the ME, is essential to select the database and table from which the field adopted as parameters for the network, resulting in a recall of relevant data for review.
After determining the number of cycles and the initial error value, as well as learning rates η_1 and correction η_2 is started learning network. The results obtained with the neural network are stored in a separate box "Calculate" the source table.
The values of all parameters of the network learning algorithm are introduced via the form shown in Figure 6.
In the process of network learning, consider the following problems:
1. selection of training set of sufficient size,

2. determination coefficients η_1 as the learning rate and η_2 as a correction factor weights,
3. definition of learning time.

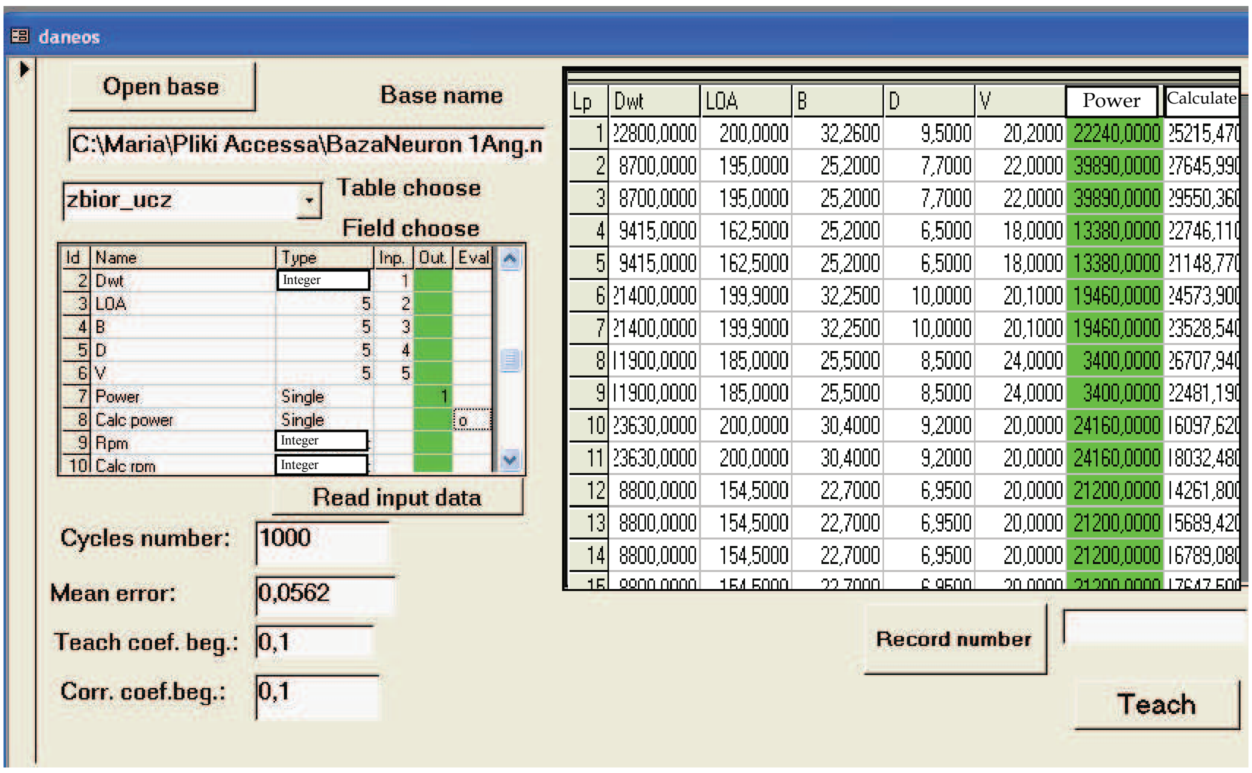

Fig. 6. Form to enter parameters of neural network

It is important to the skilful selection of learning rate η_1 [14], which has a huge impact on the stability and speed the process. η_2 coefficient is multiplied by a back propagated error and is responsible for the speed of learning. Too little value for this parameter makes the learning and convergence of networks is very slow, taking too much of its value the process of searching the optimal weight vector is divergent and the algorithm may become unstable [16]. η_2 coefficient is multiplied by the rate of change of weights in the previous step, "smoothing" too abrupt jumps connection weights. η_2 values should be selected on the basis of a compromise, so that further increases in weight accounted for a small portion of their current values (eg, several percent).
Selected examples of the use of neural network algorithm developed in the selection by the ME, based on size, load and speed of the ship shown in Table 6.
Research on selection of power ME on the basis of other design parameters, mainly the dimensions of the ship was carried out for example the number of cycles in the 100 - 30000, 50000 and even at the values of coefficients η_1 and η_2 equal 0.9 and 0.6 respectively and the values in the range 3 - 0.1 and 1 – 1.
In most cases, adopted the option of reducing the value of learning rates, which resulted in obtaining an average error within the limits: 0.034 - 0.06. In other cases, they applied the same values of coefficients, which contributed to the growth of average error, with a small number of cycles up to a value equal to 0.1. In one case, used to increase the value of coefficients, and the resulting average error does not differ from previous values.

Output parameters	Number of cycles	Number of input parameters	The values of coefficients		Learning time [min]	Average error
			η_1	η_2		
Power of ME	1000	5	0,9	0,6	1	0,06
	10000	5	0,9	0,6	7	0,04
	30000	5	0,9	0,6	13	0,037
	50000	5	0,9	0,6	20	0,034
	1000	5	0,1	0,1	0.5	0,1
	2000	5	1	0,1	1	0,05
	4000	5	0,1	0,1	2	0,05

Table 6. The results of neural network algorithm developed

Results of neural network for the number of cycles = 30000 are shown in Figure 7.

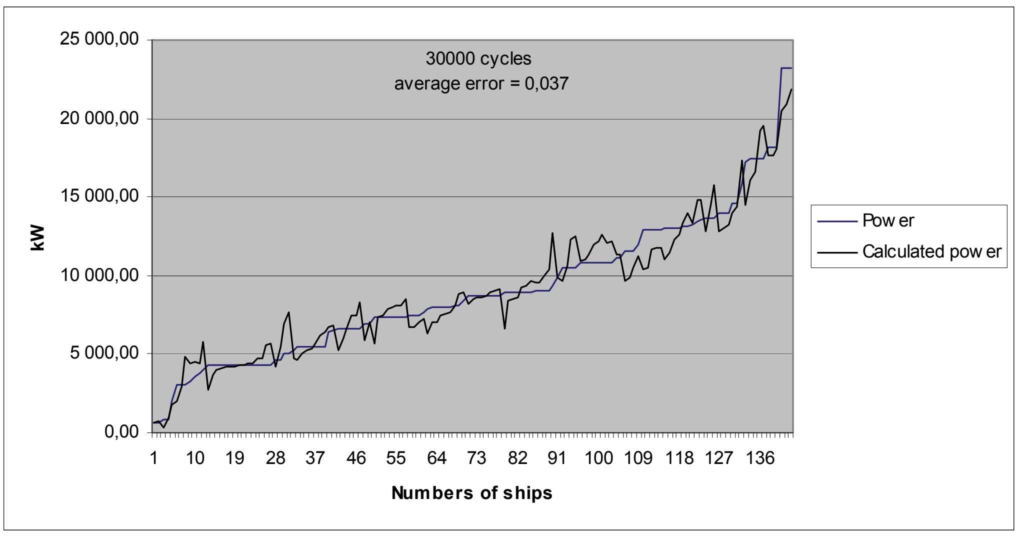

Fig. 7. Results of neural network for the number of cycles equal to 30,000

For comparison of these results was a test for the selection of neural network by ME, performed on a set of ships with a capacity of ME >13,000 kW and < 25,000 kW, as shown in Figure 8.

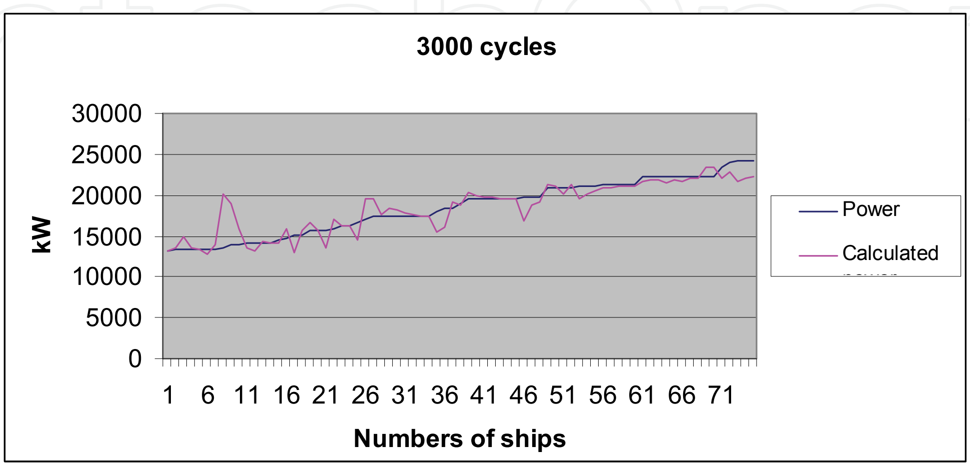

Fig. 8. The results of network training for a selected set of ships

The results of developed methods for calculating the similarity to support preliminary design of the ships used for the selection of main engine power, are summarized in Table 7. When searched the database under the ME value of ships for various functions for calculating the similarity is identical to the draft national (case 2, 3, 4, 6) - Tab. 7. results obtained with neural networks are worse. There is therefore no need to verification by the network, which is applicable in case you did not find enough similar vessels using the methods of calculating the similarity in the database application (cases 1 and 5) - Tab. 7. Then there is the process of verifying these results using neural network.

ME power design ship	ME Power of a similar ship				
	with the lower bound method	with the Gaussian function method	with the function of the trapezoidal method	with a triangular function	neural network
4350	4350	4350	4350	4350	2503
5500	5500	5500	5500	5500	5043
7400	7400	7400	7400	7400	7250
8043	4800	8048	8048	8048	6537
11100	13050	13050	12960	13050	11191
12000	10800	10800	10800	10800	11153
13050	13050	13050	12960	13050	12900
13700	13700	13700	13700	12960	13500

Table 7. Values of main engine power of ships like those obtained by using various functions

Comparison of sample results obtained on ships built in - the power values of the largest ships ME similarity in table 7 presents a chart (Figure 9).

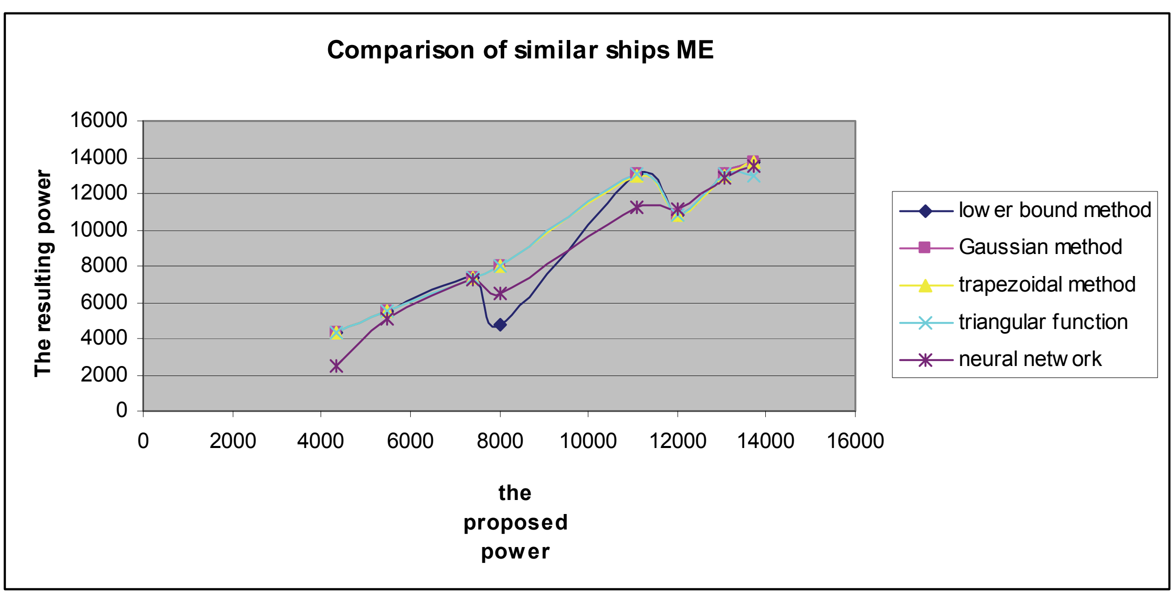

Fig. 9. Graphical comparison of ME under similar ships built according to different methods of calculating the similarity

From the presented examples show that various methods of calculation obtained similar values under the most similar ships are not always close to the power set of the proposed ship. This follows from the fact that similar ships are searched on the basis of similarities summary of all input parameters. An important role is played to determine the appropriate weight values of parameters, as well as test the limits of the ranges and their deviations. Similarity analysis was based on different types of ships built. We analyzed the results in the selection by the ME derived from the neural network. Differences similarities obtained using the various functions may be due the following reasons:

- highly diversified structure of the test set of ships in the database (different types, dimensions, purpose),
- too small a collection of ships in the database, which affects the results obtained with neural network.

5. Summary

The design engine room automation is often used similar design features of ships, since it constitutes the final design phase, in which there is a need to consider a wide range of information by the designer of automation in a relatively short time. Hence, the developed computer-aided design system, engine room automation was considered purposeful use of the CBR methodology, based on the similarity of the cases we present in detail the example of computer-aided design of the main propulsion.
Design automation system developed in the engine room can be implemented in various forms:

- Based on the partial similarities: general, main propulsion, power stations, selected installations (fuel and bilge) and the similarity of the entire ship as a weighted sum of partial similarities are searched in a database similar ships. Searching is done using the methods of calculating the similarity in the application database and fuzzy logic, which was used to calculate the similarity of the selected parameters of the ship, as well as partial similarities computed in the database.
- In the absence of similar arrangements in ships constructed for the possibility of self-design by a designer using the model elements of subject, which can serve both to adaptation and self-realization of the project by the designer of a similar ship.
- Multi-criteria optimization for the selection of automation based on a hierarchy of similarity: the whole power, its systems and objects, in case you find other similar ships, or arbitrary decision of the designer.

The developed hybrid system allows you to convert knowledge into formal rules, contributing to significant improvements in the efficiency of the design process engine room automation. Along with the application of the database is a tool to assist in the design process much automation in the most labor-intensive activities, it allows even the number of times (from several weeks to several days) to shorten the process of selecting the elements of automatic control and measurement points in the statement of apparatus, which has been confirmed by Experts in the practical implementation of this project document on the example chosen ship built. The application was created using Access database management system in collaboration with Exsys expert system, it also performs a complementary role for the expert system, providing the designer with the details and elements of the automation systems used on ships constructed, as well as directory information about these systems.

Usefulness and effectiveness of the search algorithm developed similar ships was confirmed in the developed computer-aided design system, engine room automation, which provides for the implementation of the multilevel structure of the automation.
Used, the system developed, the methodology for determining similarity of ships for the purpose of design provides a better measure of similarity, giving the designer a choice of similarity function according to the requirements and nature of the analyzed parameter. These features, functioning as a filter, help to increase flexibility in design automation, where often the technical parameters are accepted more or less tolerant because of the economic criteria of the project, as applied multi objective optimization algorithm, in case you find other similar ships on the basis of parameters general fitness, looking for a ship with a high density of automation possible with a relatively small cost of using a fuzzy criterion of optimization.

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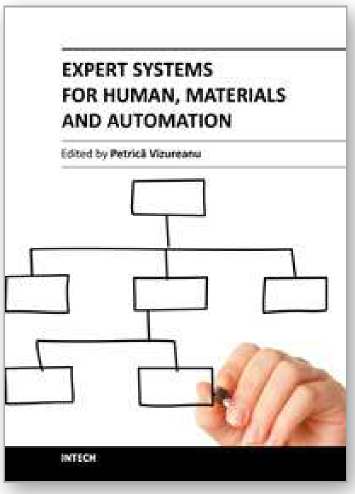

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The ability to create intelligent machines has intrigued humans since ancient times, and today with the advent of the computer and 50 years of research into AI programming techniques, the dream of smart machines is becoming a reality. The concept of human-computer interfaces has been undergoing changes over the years. In carrying out the most important tasks is the lack of formalized application methods, mathematical models and advanced computer support. The evolution of biological systems to adapt to their environment has fascinated and challenged scientists to increase their level of understanding of the functional characteristics of such systems. This book has 19 chapters and explain that the expert systems are products of the artificial intelligence, branch of computer science that seeks to develop intelligent programs for human, materials and automation.