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CLASSIFICATION SYSTEM OF SHAPING CHARACTERISTICS OF PERSONAL SERVICE ROBOTS

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ABSTRACT

This article discusses the shaping factors in the design of personal service robots. This study develops a classification system of shaping characteristics of personal service robots based on the system of shaping factors of entire design solutions. The systematization of functional, structural, technological, aesthetic, economic factors affecting the shaping of personal service robotics makes possible the selection of the main shaping characteristics and the development of a classifier to create a system for analyzing and scientific description of personal service robots. Relying on classical approaches to the design of a product, the characteristic "Form" uses the properties of the composition of three-dimensional objects related to geometry, volume, and visualization. The structural aspect interrelates structure, configuration, mechanics engineering, electronic engineering and software engineering. The materials aspect involves type, colour, texture, and facture of the materials. The technology aspect refers to functional regarding the production of the service robot products.

1. INTRODUCTION

The development of technologies in the field of robotics engineering and the parallel expansion of the range of tasks in human life requires competent integration of robots into the social sphere by means of design to create a well-rounded artistic image and cultural interface of robots [1].

The engineering aspect is the basis in the design of robotics, issues related to artistic design are solved as a rule in practice and do not always have an intelligent theoretical foundation in the synthesis with engineering [2], [3].

Modern culture sets the role of a designed project through design, which influences people's attitudes through the visual image building of an object and its surrounding environment. The design of the robot or its cultural interface from this fact is an important communication vehicle through which human-machine interaction is established.

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The purpose of this work is to support the relevance of the study of personal service robotics as well as in an attempt to create a classification system of shaping characteristics of this type that can be used in the development of modern design solutions.

A significant variety of fields of applications, characteristics, structures, shapes of robotics leads to the fact that for a specialist first faced the task of designing robots is rather difficult to determine the most relevant types with a strong artistic statement of their cultural interface. To establish the type of robotics that requires more sensitivity to artistic design it is necessary to focus on the classification of robots based on various characteristics and to identify their main technical characteristics.

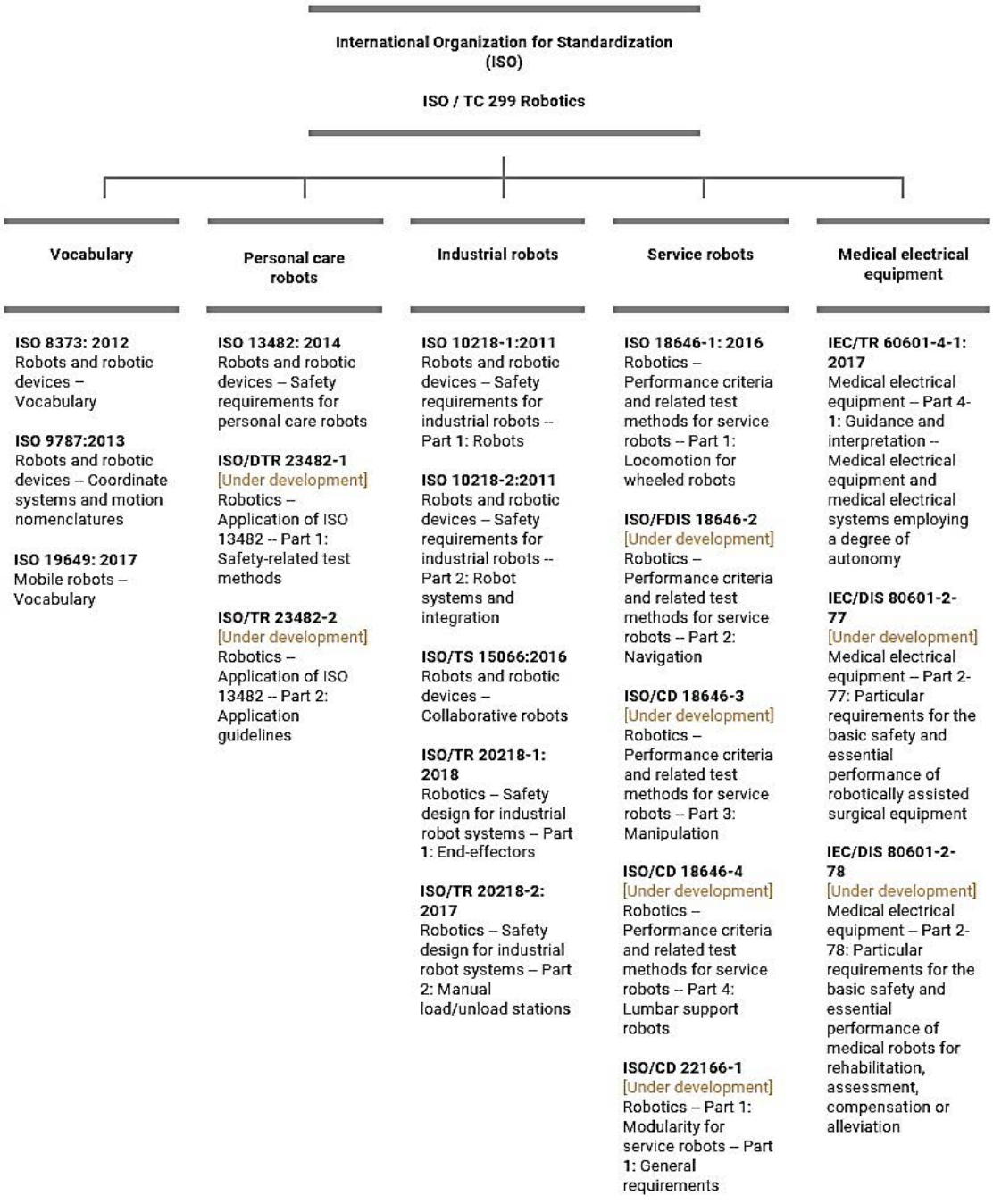

Figure 1: The main standards for robotics of the International Organization for Standardization

2. ISO STANDARD FOR ROBOTS

International standards ISO is a generally accepted evaluation system, which today is used as a reference basis for standardization. The ISO / TC 299 Committee for Robotics of the International Organization for Standardization identifies certain groups of standards in the field of robotics, which should be guided by manufacturers and consumers (Figure 1) [4].

According to the international standard ISO 8373: 2012 “Robots and robotic devices. Terms and definitions” the term “robot” means “a drive mechanism programmed in two or more axes, having a certain degree of autonomy, moving inside its operating environment and performing tasks for its intended purpose”, which includes the control system and control interface [5].

The international standard ISO 8373: 2012 “Robots and robotic devices, terms and definitions” divide robots into industrial and service in accordance with their intended use and defines these terms [5].

3. CLASSIFICATION OF SERVICE ROBOTS

3.1 INDUSTRIAL ROBOTS VS SERVICE ROBOTS

“Industrial robot” is “an automatically controlled, reprogrammable, multipurpose manipulator programmed in three or more axes. It can either be fixed in a correct location or it can have transport possibility to perform industrial automation tasks” [5].

The definition of “a robot that performs useful work for people and equipment, excluding industrial automation tasks” corresponds to the term “service robot” [5].

The relationship of the field of application, functions, and visual image and user requirements for the characteristics of the robot is the basis of its cultural interface. Getting the balance between the functional and social roles that the robot has underlain its competent design. As a result, service robotics is involved more in the social sphere, requires a special approach in designing its artistic aspect.

3.2 PERSONAL SERVICE ROBOTICS

The international standard ISO 8373: 2012 and the data of the International Federation of Robotics divide service robotics depending on their field of application into personal service robots and professional service robots (Figure 2) [5], [6].

According to ISO 8373: 2012, a “professional service robot” is “a service robot used for commercial work”. A “personal service robot” is “a service robot for personal use”, i.e. a robot used for non-professional non-commercial work [5].

Robots as a connecting link between people and modern technologies can serve to enhance the social interaction of a person with high-tech devices [7], which allows increasing the proportion of robots for personal use [8]. Accordingly, the cultural interface of personal service robotics has to meet the value settings and requirements related to the aesthetic expressiveness of the object.

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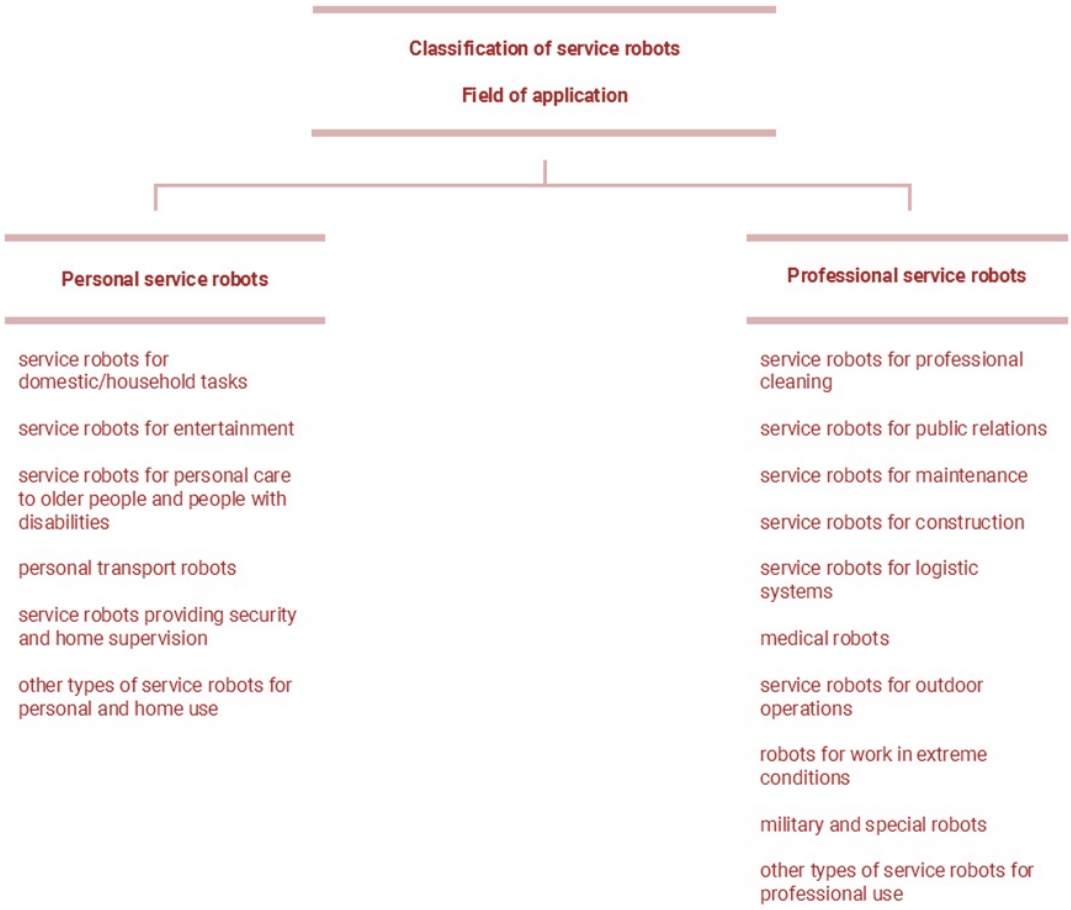

Figure 2: Classification of service robots by fields of application

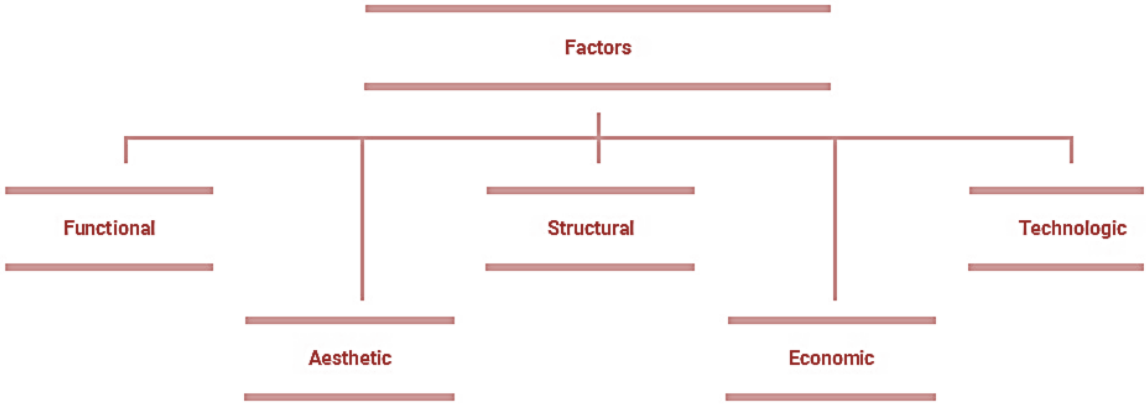

Figure 3: Shaping factors of personal service robotics.

4. SHAPING FACTORS

There are quite a number of factors affecting the process of shaping. Figure 3 shows the main factors influencing the process of shaping the appearance of personal service robots [9].

4.1 SHAPING FACTORS ANALYSIS

The foundation for the analysis and identification of characteristics that affect the process of creating the morphology of service personal robots is based on the application of this classification of shaping factors [10].

Modern methods of mathematical statistics make it possible to process any information retrieval.

Cluster and factor analyzes are meant to classify variables into homogeneous groups (segments, clusters) [11], which makes it possible to isolate the necessary shaping characteristics and break them into types.

4.1.1 FACTOR ANALYSIS

Factor analysis is carried out in order to identify latent characters (factors) among the group and is made on the basis of the analysis of factors affecting the process of shaping of personal service robotics (Figure 3) [12].

In the process of factor analysis of the shaping factors that influence the design of robotics, four main groups are distinguished, which characterize the existing objects according to the main features:

- 1. Analysis of geometry and modeling of the object's body;
- 2. Modeling of the structure parameters of the object;
- 3. Analysis of the characteristics of the elements of the object;
- 4. Standardization and unification of the object [12].

4.1.2 CLUSTER ANALYSIS

Cluster analysis is used to build classifications on a functional basis. This analysis makes it possible to determine the size of clusters containing characters of typical objects with a known number of clusters. In accordance with the characters, clusters are given the names of shaping characteristics such as “Form”, “Structure”, “Material” and “Technology”. Certain types of characteristics relevant to each of the selected clusters are identified subsequent to the results of cluster analysis, [12].

Conducted factor and cluster analyzes allow not only to identify the main shaping characteristics but to classify them to create a complete description of the morphology of the designed project, which makes it possible to build a classification system of shaping characteristics of personal service robotics.

4.2 CLASSIFICATION SYSTEM OF SHAPING CHARACTERISTICS OF PERSONAL SERVICE ROBOTS

The classification system is made in the form of a pie chart (Figure 4), divided into sectors, the size of which is proportional to the values of the shaping characteristics "Form", "Structure", "Material", "Technology". In the sectors, there are presented values of types. Each characteristic has its own set of revealing types. Their various combination allows achieving the variability of the forms of existing and developed personal service robotics objects [13]. All parameters are united by the general form-building characteristic “Style”, as the main aesthetic aspect in the design of personal service robotics.

4.2.1 FORM ASPECT OF SERVICE ROBOTS

Characteristic "Form" contains three types – the type of geometry, volume, and visualization of the form. This division grows up from the visual perception of forms based on the typical volume properties used in composition.

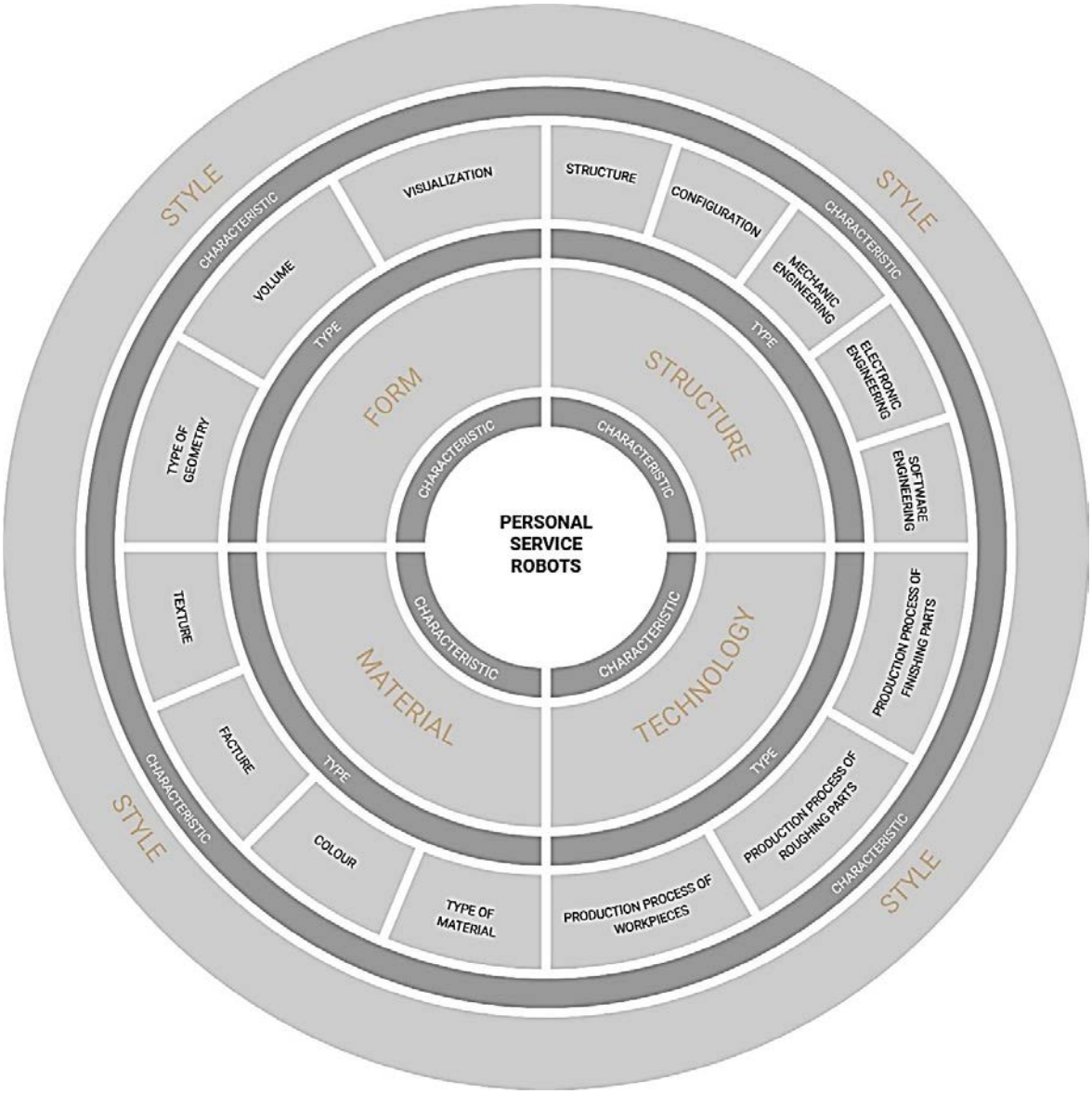

Figure 4 – the Classification system of shaping characteristics of personal service robots

4.2.1.1 Geometric characters of service robots

The typing of forms according to the geometric character is based on the approach to the organization of the forms of objects of the organic and inorganic world [14]. The foundation of this approach is the analysis of the history of material culture, which assumes that the styles of shaping depend on the types of geometry of objects that form well-rounded images with distinctive, characteristic only for the features [15].

4.2.1.2 Aesthetic aspects of service robots

The factor of visualization of the form in the aesthetic respect reflects the properties of the form as an independent unit and part of the object and three-dimensional environment. For robotics, where functional processes are quite complex and multifaceted, the choice of the main theme in search of the form profile, identification the most essential features and disclosure the main function of the object is the most difficult and essential point in the process of creating an expressive form. The visualization of the form of the robot includes such components as a visual image (sign) and its value (meaning), which generate an emotional response and aesthetic evaluation in the process of perception as a marker of expediency [16]. Each form corresponds to certain most characteristic images-signs and the inherent in the very nature socio-cultural semantic meaning.

4.2.2 STRUCTURE ASPECT OF SERVICE ROBOTS

Characteristics "Structure" is divided into five types - structure, configuration, mechanics engineering, electronic engineering, and software engineering. The most advanced classification of the structure was proposed by a group of Moscow researchers, who lay the foundation for it primarily the typical differences of structures in the relationship between their elements – the manner of aggregation, the mode of interaction and the method of connecting, manner of fastening units, assembly units and parts [17]. Therefore, it can be distinguished groups corresponding to these typical configurations in the structure of the robot. The manner of mutual aggregation of the elements of the structure allows for the conclusion about their configuration [18]. In addition, the structure of the robot consists of information, control, and executive systems. The information system (electronics) collects data about the state of the environment. The control system (programming) creates control algorithms for operating devices using the data collected by the information system and the programs that process it. The executive system (kinematics) implements control signals [19].

4.2.3 MATERIAL ASPECT OF SERVICE ROBOTS

Characteristic "Material" contains four types - the type, colour, texture, and facture of the material. From the point of view of the functional purpose and the field of application of the robots, it is necessary to know the type of the material used, since the capability of the robot with the basic technical requirements depends on their choice [20]. The colour, texture, and facture of the material are equally important from the aesthetic point of view. The effect of texture and facture is primarily used to highlight the natural qualities of the material, to reveal its aesthetic identity. The texture and facture of the surfaces should be selected with due regard to the size of the designed project and the volume of the space which it will function in. Colour can also be used as an active tool of composition. The form is perceived clearly if the flecks and shadows on its surface match to the real compositional interconnection of elements, parts of the object. The lack of shadows (shadowless lighting) deprives a rounded shape of volume, therefore, if the lighting conditions of the object will be only the same, the shape should be changed or corrected by attracting such tools as colour, surface facture, etc. [17].

4.2.4 RELEVANT TECHNOLOGY OF SERVICE ROBOTS

Characteristic "Technology" is divided into three types - production process of workpieces, roughing and finishing parts. A correct choice of the production technology of the object allows achieving the required geometry of the forms, well-balanced configuration breakdown, high quality of the surface and structure of the finished part, increasing the reliability and durability of the service life. The choice of production technology in today's market directly depends on the project budget and technological capabilities of manufacturers.

Production of workpieces is an integral initial phase of any production, forming the first technological degree of processing. Workpieces are made in such a way that their shape and size most closely match the parameters of the finished object [21].

The process is divided into roughing and finishing for high accuracy and grade of finish. The possibility of separating the process into roughing and finishing provides conditions for attaining high accuracy of the workpiece in one cycle without any additional techniques and operations and also

allows to allocate less precise equipment for the roughing process and to keep the equipment entrained in precision process [20].

The characteristic “Style” is the component that assembles the elements of the designed project into a unique visual image, allowing speaking to the fact that the object as a finished design product. The definition of “art form” is applicable to the design product, if it is referred to as such an art and compositional solution, which is made under the influence of cultural patterns, style trends and on the basis of creative consideration of certain laws of compositional harmony. In this sense, the form is not determined rigidly by structure and function, does not blindly follow them, but has considerable autonomy and is a source of aesthetic perception [22].

Most of the objects of robotics define their shapes through the influence of production factors that are connected with the general level of technology, design techniques inherent to this era, materials available to production and its technological capabilities. The modern sphere of industrial production serves as a ground for the formation of style, feeding art with its ideas. However, a reverse process is also possible: art has been and will be the source of style for technology [18].

5. CONCLUSION

The conducted analytical review of various sources suggests to delineate the boundaries of the field of study and make a conclusion about the possible consideration of personal service robotics as an object of design. This work develops the classification system of shaping characteristics of personal service robots. The systematization of functional, structural, technological, aesthetic, economic factors affecting the shaping of personal service robotics makes possible the selection of the main shaping characteristics and the development of a classifier to create a system for analyzing and scientific description of personal service robots.

Each of the considered characteristics contributes to the development of the morphology of robotics, relying on classical approaches to the design of a product. Thus, the characteristic "Form" uses the properties of the composition of three-dimensional objects, "Structure" - typical configurations of industrial objects and interrelations of their elements, "Material" and "Technology" - functional approaches to the production of a one-off and small-quantity product.

6. AVAILABILITY OF DATA AND MATERIAL

This study information is already available in this article.

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