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Design of humanoid service robot for elderly and disabled care – ROBCO 18

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Abstract: *The need for assistive devices to assist and facilitate the lives of elderly people, as well as for people with problems in the locomotor system, has always existed. With the advancement of the engineering and science and technology sectors, solutions are being developed to successfully facilitate the everyday routine tasks in the domestic environment of disadvantaged people. The dynamics of our times gives different solutions in nature and kind. One answer as a solution to the problem is achieved through the development of servicing robots for adult care. A specific answer to this problem is through the development of the care robot Robco 18. Designed to help those in everyday life, the robot aims, through its variety of functions and design, to deliver what the user requires.*

Keywords: *Robco 18, service robot, service robot, disabled, elderly, adults, locomotor system, industrial design;*

1. Introduction

Successful interaction between the user and the robot takes place primarily based on design, as design is the mediator in the communication between man and robot [1].

The realization of a physical model is preceded by a step related to the creation of the 3D model (Fig.1). In order to make clarifications in the forms, before the physical model implementation phase, using computer generated images, after the analysis of the components constituting the robot, the desired changes and corrections were made. This avoided the possibility of an unwanted result.

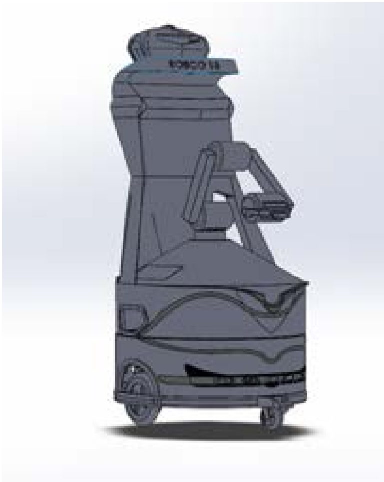
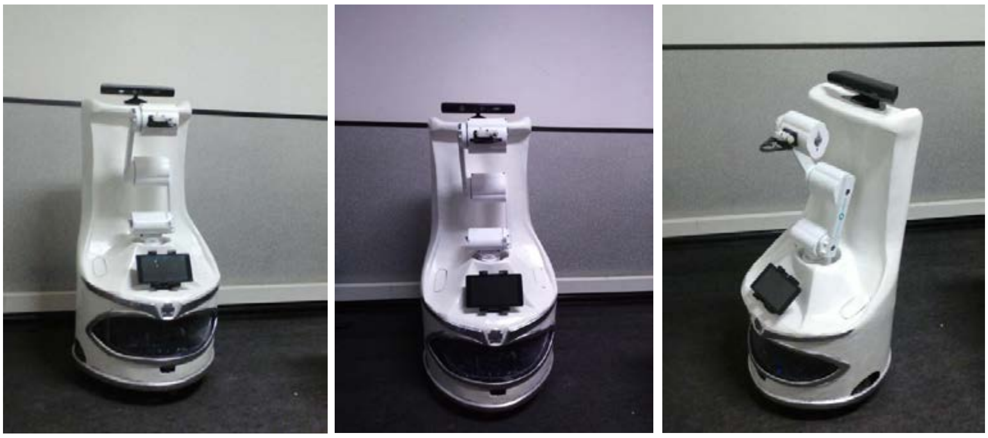


Fig. 1. 3D model

The present design of Robco 18 is the result of a study of various parameters that found that at the current stage of development, the robot's appearance was adequate to allow further research into a real living environment, in which to interact with potential users. In this case, a design was realized, which was subordinated to the parameters considered from the point of view of industrial design, but also to the already constructed and physically realized mechanical part of the robot [2]. The main idea of Robco 18's design is the balance between the living environment for which it is adapted and the people with whom it will interact. That is precisely why design refers to the past - while retaining its innovative and contemporary design. In this way, a better and easier connection is made with the user, who is more easily perceived by him as he makes an analogy with already recognizable objects, which do not represent threatening objects in their own nature, thus establishing a connection that is successful without impeding the user from using and interacting with the machine [3]. Figures 2a, 2b and 2c illustrating three different perspectives of a robot's physical model give a general understanding of the robot's balanced vision.

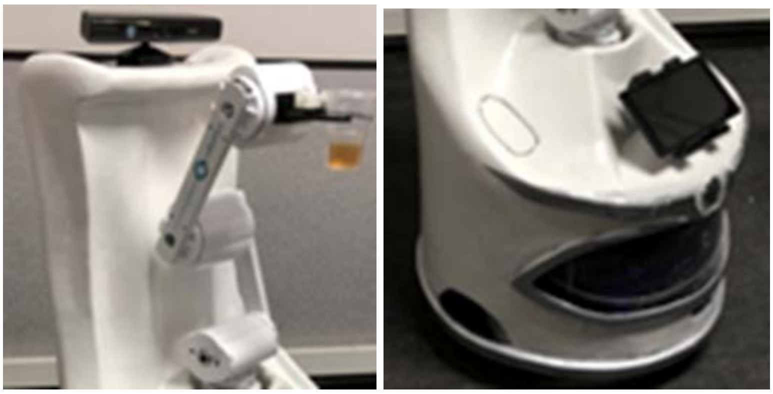


a *b* *c*

Fig. 2. Different perspectives of a robot's physical model

2. Construction

The design of the robot can be considered as a lower cylindrical profile including a plexiglass window and sensor openings (Fig. 3a) and a top y-shaped profile carrying the 3D camera (3b).



a *b*

Fig. 3. The design of the robot

The overall vision of the robot, though built of different in character and multiple components, aims to present the robot as an integral one, which is well balanced optically in terms of its components and details [4]. The idea is to achieve optimized traffic and communication the execution of functions and interaction with other objects of the living environment such as the beverage cup shown in Fig. 4 to be provided to the user.

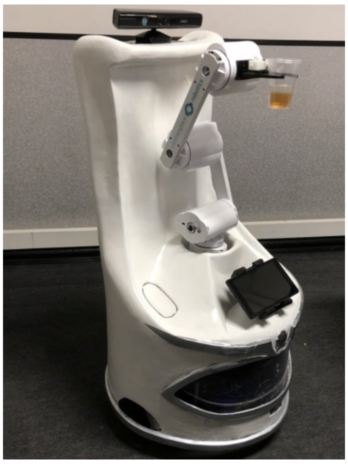


Fig. 4. Execution of functions and interaction

The design is compliant with ergonomic norms. The lower part being at a sufficiently high ground level so it cannot be hung (rub against the floor), with a stop sensor attached to it, which protects and covers areas, which are not covered by the other sensors, which in turn are located in the lower and central part of the cylindrical profile forming the robot. Their correct functioning (sensors) is realized based on holes that are aligned with the rest of the robot's body in an optical whole, thus observing the logical connections of the individual sections and details from the point of view of the industrial design [5]. The front linkage of the cylindrical profile associated with the stop sensor also plays an important role in interacting with the potential user and at the same time fully encompassing the robot, thereby protecting the mechanical parts within it from unwanted damage from external objects in the home environment. In turn, the front lower face that interacts with the user is open for surveillance through a Plexiglas through which the adult can see the mechanical and electronic part of the robot. This removes another psychological barrier in the interaction based on the contrasting pair of known-unknown [6] (yet-familiar-unknown), which raises doubts as to how far we can handle the robot successfully, as the design, while doing a partial reference to forms analogous to given familiar objects, his vision is sufficiently modern. This creates a barrier that is necessary and needs to be overcome, and this is achieved by showing what is inside the robot. Thus, at a non-verbal level, a message is sent through the design, namely, "Here you see me. I hide nothing from you. You know me. I am here to help. "

The design successfully incorporates ergonomic factors for maximum user-friendly use, with minimal effort for the user to get the robot charge. Robot itself as height and size is consistent with the basic ergonomic standardization of sizes of basic household items in the living environment (doors, kitchen tables, chairs etc.) thereby successfully interact with them to help needy person. The height of which is based on hand - manipulator (placed third platform, building the cylindrical profile) allows adequate to interact and handled in this way with people standing or sitting, as well as low or high placed objects in the surrounding life environment. The conventional L-shaped platform on which is placed 3D camera (Kinect) is consistent with the robotic arm in a way that allows full lifting arm height thus generating the possibility of optimal use of the manipulator.

3. Formation and silhouette integrity

The forms are organic and spillover, resulting in a robot's integrity, a complete overall appearance that collects individual elements and connects them logically and legally. The back of the robot has been cleared, giving enough visibility to the user to see what the robot is doing, thus removing another psychological barrier - a surprise when the robot turns to the user to interact with it. The looping of the shapes made by the robot allows the elements of the device that are visible manipulator, tablet, Kinect to be included in the integrity of the robot by not disturbing the optical balance and the harmonic whole. However, vice versa contributing to its well-balanced vision to predispose the user to actively interact with the robot without prejudice and fear of physical contact. The whole of this result is generated on the basis that the design is as closed and protects the fine mechanical and electronic parts, as it is open - thanks to which it shows the user its machine essence and eliminates the fear and the fears, thus successfully interacting with it.

The open design unequivocally shows the essence of the robot - it is a servicing machine, which aims to help without harm in any way but rather to be even a silent companion assistant. The hand of the robot is involved in the overall figure through the flowing nature of the overall shape. In the same way, the connection with the head in which the 3D camera is located and the lid for feeding the robot directly to the net in the rear lower part is realized. The association of the robot figure with objects that surround us is part of the successful realization of continuity, whose task is to design the role of mediator in solving the interaction between the user and the robot. Another reason for choosing round, flowing, and organic shapes is that they are not aggressive in nature that puts a psychological barrier between a user and a machine, and a purely functional character in the event of a robot falling, thus, due to its rounded forms, removes the possibility of injuries to the user or other robot-surrounding objects.

Purely psychological design with round, organic shapes has an important role to play, namely to make the user at the subconscious level understand the message coming from the vision, namely - "Touch me. I am safe. I am here to help. I am cute "(based on a psychological sample that states that circular shapes and diminished ones are perceived by the brain as sweet). The upper part of the head of the robot is rounded and narrowed to dimensions almost identical to those of the 3D camera (Kinect), thus helping the user to be sufficiently visible in a situation where the robot has its back. The dimensions thus achieved are sufficient to protect the kinetic in the robot roll situation, and from a psychological point of view contributes to the perception of robot integrity as a sweet, round machine that helps us. Due to the flow and logical interconnection of the individual sections that build up the volume of the elements contained in the robot, in the form of a mechanical part, the handles as elements that are used to convey the robot are hidden in integrity. But they are also made in a way that makes it easy lifting as they are positioned under the lids involved in the overall vision of the robot and thus do not disturb the harmonized optical balance.

4. Solutions and methods of operation

The joint trajectory action is a node that provides an action interface for tracking trajectory execution. It passes trajectory goals to the controller, and reports success when they have finished executing. The joint trajectory action can also enforce constraints on the trajectory, and abort trajectory execution when the constraints are violated. The robot follows the planned trajectory in simulation.

Thanks to the fact that the outer design of the robot is made of a single solid body, its reparability is fast and adequate. This builds on facilitating further incorporation of additional mechanisms and replacing existing ones with others. The body itself is made of polyester resin with fibers to ensure sufficient strength, firmness and elasticity of the body, resulting in its physical properties being adequate for working in a real living environment without the risk of fractures or admission of external objects inside the mechanisms of the robot. Another important factor in the design of the lower part of the Plexiglas robot is the possibility of adequate operation of the 360 degree laser sensor, which covers the area necessary for the robot to function properly. The limbic with the humanoid robot depicted on it has an essential function in the common vision. It encompasses the humanoid depicted figure that at a subconscious level brings a sense of protection (because the figure is clearly distinguishable and the user can make a subconscious analogue with himself and relate to it as a subconscious level assimilates the bond - who keeps him and takes care of him). In addition, the humanoid figure also reflects a large part of the research team's logo, giving the overall design a complete look of a ready-to-use product. The conical shaped flowing form, in which the robotized hand is placed, is also successfully coupled with another external element. That element is a part of the integrity of the robot with which the user interacts, namely the command tablet, which is placed in an arch formed by the fusion of the conical shaped flowing form of the lining that encompasses the depicted humanoid figure. Thus making the link a humanoid figure-tablet indicating the direct link of the user with that part of the robot.

5. Colour rendering of the robot

In the stages of realization of this model was experimental with the color variation. The first option was chosen white as the color white symbolizes purity and innocence- qualities that the design is intended to convey to the user i.e. the innocence and purity of the robot interacting with him to help him. Subsequent analysis carried out based on conducted primary research (survey by research and consulting) color decision was changed by reaching performance in metallic gray. Due to its neutral character, the gray color interacts well with other colors and helps to express them. Thus, the main components for interaction with the user - the tablet and the handler - are displayed. Gray color strengthens and accentuates the machine's essence without overloading the visual perceptions. This solution gives moderation and elegance to the robot, emphasizes the seriousness of the developed product and the responsible task it has towards the users (fig.5).

Fig.5: Real model of Robco 18, gray metallic color

It should be noted that color conversion varies due to the fact that the color of the user must be different not only for the robot to be perceived more easily, but because of the psychophysiological effect of the colors, which must be related to the age of the user and his physical disabilities. Therefore, a particular color will be chosen for the user, aiming specifically at psychophysiological impact.

6. Conclusion

The design of Robco 18 is successful and will be confirmed as a vision based on further research in a real living environment. Confirming the hypothesis put forward here, based on research, and thus strengthened in the experiments with people to be described and considered that Robco 18 is a robot who seamlessly and easily removes the psychological barrier between human and machine. Moreover, handles adequately and positively the tasks assigned to help the elderly people and those with problems in the locomotor system in their everyday lives.

Acknowledgments

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References

[1] K. Kosuge and Y. Hirata, "Human-Robot Interaction," *2004 IEEE International Conference on Robotics and Biomimetics*, Shenyang, 2004, pp. 8-11.

[2] R. R. Murphy, T. Nomura, A. Billard and J. L. Burke, "Human–Robot Interaction," in *IEEE Robotics & Automation Magazine*, vol. 17, no. 2, pp. 85-89, June 2010.

[3] Erika Rogers, “Human-Robot Interaction”, Published in *Berkshire Encyclopedia of Human-Computer Interaction*, January 1, 2004, pages 328-332.

[4] Fong T., Thorpe C., Baur C. (2003) Collaboration, Dialogue, Human-Robot Interaction. In: Jarvis R.A., Zelinsky A. (eds) Robotics Research. Springer Tracts in Advanced Robotics, vol 6. Springer, Berlin, Heidelberg

[5] Kerstin Dautenhahn, “Socially intelligent robots: dimensions of human–robot interaction”, Phil. Trans. R. Soc. B 2007 362 679-704; DOI: 10.1098/rstb.2006.2004. Published 29 April 2007

[6] Ronald C. Arkin, Masahiro Fujita, Tsuyoshi Takagi, Rika Hasegawa, An ethological and emotional basis for human–robot interaction, Robotics and Autonomous Systems, Volume 42, Issues 3–4, 2003, Pages 191-201, ISSN 0921-8890

Дизайн гуманоидного сервисного робота для пожилых людей и инвалидов - ROBCO 18

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Аннотация: *Необходимость вспомогательных устройств для оказания помощи и облегчения жизнь пожилых людей, а также для людей с проблемами в опорно-двигательной системе, всегда существовала. С развитием инженерных и научно-технических секторов разрабатываются решения для успешного облегчения повседневных рутинных задач во внутренней среде находящихся в неблагоприятном положении людей. Динамика нашего времени дает разные решения по своему характеру и виду. Один из ответов для решении проблема достигается за счет разработки сервисных роботов для ухода за взрослыми. Конкретный ответ на эту проблему заключается в разработке робота Robco 18. Разработанный, чтобы помочь людьми в повседневной жизни, робот ставит своей задачей своим функциям и дизайном, обеспечить то, что требует пользователь.*

Ключевые слова: *Robco 18, сервисный робот, сервисный робот, инвалиды, пожилые люди, взрослые, локомоторная система, промышленный дизайн;*