

Prospects for Introduction of Robotics in Service

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Abstract: *The paper reviews promising robotic devices in service. 6 options for robots use for various purposes were considered, ranging from autonomous drones for food delivery to exoskeleton for installation operators. The aim of this work is to provide an overview of evolution of research in robotics ranging from humanoid robot to modern devices that allow you to preserve human health during heavy physical labor. Trend trends in service robotics are considered because of their common goal to bring robots closer to human social needs.*

Keywords—prospects; implementation; review; robotics; service.

1. INTRODUCTION

The relevance of robotics in service is becoming increasingly important. Service robotics (SR) are automatic devices that perform useful work for people and equipment. At the same time, various research and analysis tools can be used here [1]-[6]

The current stage of science and technology development is characterized by expansion of robots application scope. Robotics is one of industries in world that is currently developing most intensively. Approximately 29 % of world production is partially automated [7], [8]. Manufacturers are increasingly using the work of "smart" machines, saving from 15 % to 90 % on operating costs [7]-[11].

The world leaders are China, the United States, South Korea, Japan and Germany. The governments of these countries in 2015-2022 will allocate about \$ 63 billion for the development of robotics. The most promising areas of the SR are work for industry, drones, logistics systems, medical work, etc. According to IDC forecasts, in 2022, global spending on acquisition of robotics and unmanned aerial vehicles will reach \$ 201.3 billion.

Due to lack of comprehensive analysis of research in field of robotics in service, topic of work is quite relevant.

2. RELATED WORK

In the works [7]-[12] importance of modern robotics in society is noted. The development and prospects of robotics in service are considered in [13], [14].

In [13] presents important technological trends in robotics based on their stage of dissemination and position in knowledge space.

Two cases: two electric commercial vehicles – one golf cart and one car converted into autonomous robot to transport people in cities or to perform specific tasks on websites; and auxiliary vehicle (electric scooter) used by people with

reduced mobility is shown in detail in [14]. The authors presented designs of various components needed to achieve such automation.

The effectiveness of use robotics of in service is provided by works [15]-[18].

The field of activity in which use of modern robot technologies is offered and demanded in order to ensure optimization of internal material flows is presented in detail in [15]. The authors consider robotics-Logistics and digital technological assessment of logistics efficiency and supply chain.

In [16] refers to application of service robotics in construction, which can solve number of problems, including low productivity and labor shortages.

One of most important roles of service robots today is application in field of medicine.

The effectiveness of SR in medicine and health care has repeatedly proved its expediency [17]. The work presents Zeus and Da Vinci systems. Described, service robots that help doctors perform their tasks easier, safer, more accurately and faster. The article provides examples of service robots use in diagnostics, radiation therapy, surgery, remote treatment, rehabilitation, distribution of medicines, patient care and disinfection of premises in medical institutions.

An overview of future trends, as well as impact of artificial intelligence and service robots on tourism and hospitality sector, is presented in [18].

In [19] combines quantitative and qualitative methods for analyzing service robot research from point of view of systematic literature review. The authors analyze hot spots and development of research on service robots. Based on analysis of timeline, authors divide evolution of SR studies into three stages. However, explicit consideration of service robots is still rare, especially in scientific literature.

3. OVERVIEW OF MODERN SERVICE ROBOTICS

This work describes robotics in service: in service sector and in maintenance.

Drones are most popular destination in robotics.

Nuro.ai received \$940 million investment from softbank vision fund, only of four projects actually controlled by drones – autonomous cars, Nuro.ai are engaged in delivery of products from Kroger network in Arizona.

As example from Nuro, consider autonomous car, which is now particularly relevant in context of Covid-19 pandemic, presented in fig. 1 [20].



Figure 1: Autonomous car Nuro R2

Unmanned electric van R2, capable of moving at speed of 40 km / h. In cabin of delivery robot R2 there is no driver's seat and usual controls, only a place for parcels with cargo. The van is controlled remotely by operator [20].

Today, development of online trading and online services is constantly increasing amount of work in warehouse (formation of orders, inventory, control of shipments and receipts, monitoring of goods movement, delivery, etc.). It happens that people are not able to cope with such an increase in work, so replacement of people with robots is unpredictable, DHL experts and not only them came to this conclusion [21]. That is why there is explosive growth in the field of automation and logistics robotics. According to research group ABI Research, which studies promising markets for breakthrough technologies, by 2025 more than 4 million robots can work in global warehouses.

Let's consider as example of application of SR in field of logistics – Kroger Co drone.

U.S. supermarket chain Kroger Co has invested \$440 million in Ocado, British online chain known for using robots rather than humans to process and package orders.

Kroger Co uses drones to deliver purchases and plans to strengthen its U.S. product delivery business through the development of robotic warehouses (fig. 2) [21], [22].



Figure 2: Drone Kroger Co

Kroger Co self-driving vehicle allows up to five pounds of cargo to be delivered to customers' homes or wherever they are, allowing kitchen utensils to be sent directly to park in just 15 minutes.

Drone Express allows packages to be delivered to location of customer's smartphone, not just to street address, it just means that customer will be able to order delivery of picnic accessories to park or seasonings for cooking in backyard. Licensed pilots Such robot can deliver to Kroger customers, for example, chicken soup to sick friend or get quick delivery of olive oil if they run out while cooking dinner.

Drone Express will control process from an on-site trailer "with additional off-site monitoring," which could mean flights currently require visual observers.

The use of drones will reduce labor and fuel costs to make e-commerce more profitable, obstacles such as weather, privacy and insurance remain stumbling block.

The next area of our research is use of robots to perform massage. The robot can be configured individually and can have various variants of "final equipment" (fig. 3). Robotic table MR 01 Massage Robotics [23].



a)

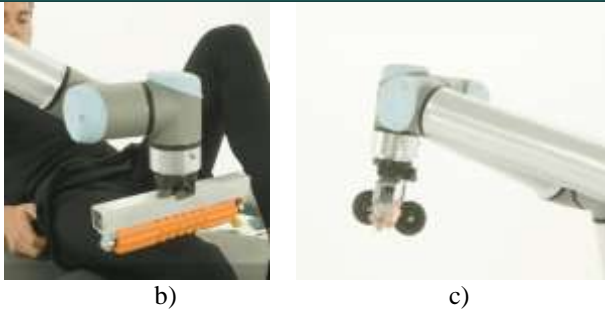


Figure 3: Massage robot

The hands of such robot are activated by voice and can respond to commands – to move left or right, while increasing and decreasing pressure.

There is hand on each side of motorized table. Both can be customized with massage-friendly hands (effectors) that ultimately don't look like hands. In one configuration, robot holds what looks like pair of roller skates (fig. 3, a), while other has kind of wide, soft scraper (fig. 3, b) [23]. The third configuration is two-wheel configuration (fig. 3, c).

Another of trends is universal robot panda from UBTech – robot with height of 1.3 meters and 63 kg can play piano and chess, write and draw pictures, play sports, and as service robot can perform massage to people (fig. 4) [22], [23].



Figure 4: Robot Panda from UBTech

The robot is easy to control with help of refrigerator, coffee maker and stove (fig. 5) [24], [25].

UBTech, global artificial intelligence (AI) and humanoid robotics company founded in 2012, has applied AI technologies to its patented robots, including computer vision for service robots, autonomous navigation and positioning, hand-eye coordination, motion planning and control; and voice technology.

The UBTech panda robot was created using symbolic image of panda and incorporates an original cutting-edge technology based on Work-Humanoid Service Walker [18, 19].

Consider another masterpiece of robotics in service – service sector – robot waiter BellaBot (fig. 5), which was developed by Pudu [26].

BellaBot supports laser SLAM and visual SLAM positioning.

BellaBot has navigation solution to adapt to more scenarios. Both are accurate and easy to use. Both positioning solutions that BellaBot offers provide same wonderful user experience.



Figure 5: Robot-office BellaBot

BellaBot's customer-centric service never changes.

BellaBot inherits outstanding characteristics of previous generation, being endowed with excellent opportunities for human interaction and work. With innovative bionic design language, cute looks, multimodal interaction, and many other new features, BellaBot delivers food to users.

BellaBot uses innovative bionic design. The bionic design is simply perfect from height of machine body to tilt of screen to curved shape.

So, innovation of exoskeletons for installers.

Consider Hilti's Echo exoskeleton.

Hilti is only one that has begun to think about installers and their hard work, and about preserving health of robochis.

As many builders encounter shoulder pain caused by continuous work overhead, which ultimately leads to reduced productivity and financial losses. Most of load falls on shoulders, which can cause joint pain or even injury, so there was solution – exoskeleton Exo-01 (fig. 6) [27], [28].

Structurally – lightweight system that is comfortable for use throughout working day. Such device does not constrain movement of person.

Supported by system of tensioners, which reduces muscle pain and fatigue.

It is possible to adjust length of levers.



Figure 6: Exoskeleton Exo-01

Attaching exoskeleton to chest girth, not just at two points, but completely girth of body.

A huge plus is that, for example, when installer holds heavy working tool at height, raising his hand high, then when adjusting stiffness of levers, it is possible to hold tool for long time without fatigue (fig. 7) [27], [28].



Figure 7: Possibilities of exoskeleton Exo-01

That is, operator becomes frame mobile and is less tired, which is huge advantage.

The peculiarity of such exoskeleton is that higher operator raises his hand, the more Exo-01 makes support.

4. PROSPECTS FOR DEVELOPMENT OF ROBOTICS IN SERVICE

With this research, we contribute to better understanding of highly dynamic field of robotics in service, as well as new designs and future prospects.

Autonomous robotics originated as field of research and development almost forty years ago, but only fifteen years ago, after call of DARPA (Defense Advanced Research Projects

Agency of United States Department of Defense), autonomous mobile systems began to be seen as solution to service problem [14].

Robots are increasingly supporting people both at work and in their personal lives. While use of industrial robots has long tradition in manufacturing industry, service robots are relatively new.

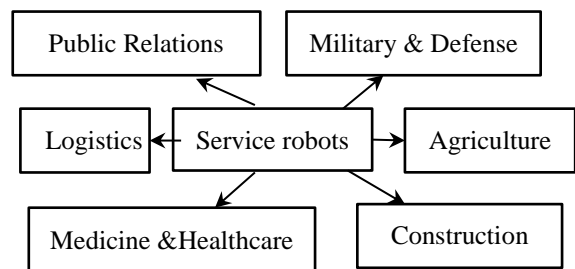
SR is constantly taking over new domains ("automation extension").

Not always, but often SR are mobile. Some of them are fully automatic or even autonomous [13].

To begin with, we will highlight key areas of application of SR (fig. 8).

Currently, use of service robots in public scenes is still in period of expansion. Areas that have been implemented include warehousing, logistics and distribution, hotel services, banks, government, e-commerce businesses, etc., but there are still many areas that are not involved.

Figure 8: Areas of application of SR

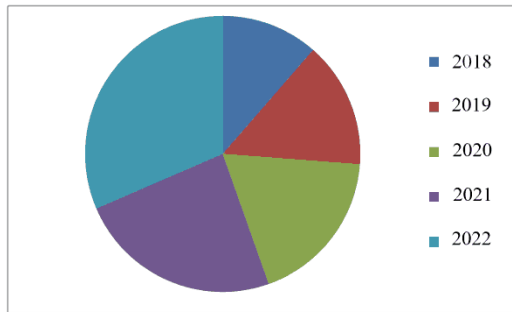


Under Public Relations in work is meant personal and household use, which are produced for mass market, mainly relate to spheres of household robots. This includes robots for vacuuming and floor cleaning, lawn mowing robots or entertainment robots.

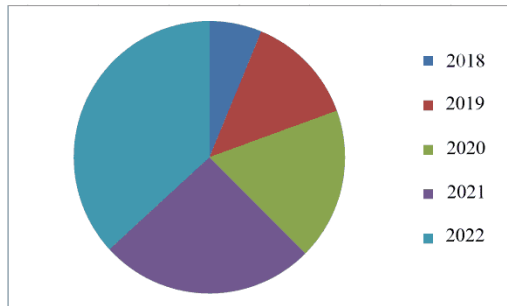
Competitors identified in this market include, among others: Aethon Inc. (USA); Aethon, Inc. (USA); Gecko International Corporation (USA); Hanoor Robotics Corp. (Korea); Honda Motors Co., Ltd. (Japan); Husqvarna AB (Sweden); Iberobotics S.L. (Spain); Intuitive Surgical, Inc. (USA); iRobot Corporation (USA); KUKA Aktiengesellschaft (Germany); LG Electronics, Inc. (South Korea); RedZone Robotics (USA); RoboBuilder Co., Ltd. (South Korea); ROBOSOFT (France); SeaRobotics Corporation (USA); SeaRobotics Corporation (USA); Toyota Motor Corporation (Japan); Yujin Robot Co., Ltd. (South Korea); WowWee Group Limited (Hong Kong); Zucchetti Group (Italy); KEENON Robotics Co., Ltd. [29].

On basis of conducted studies [29]-[33], consider most requested areas of application of SR: medicine (fig. 9, a), logistics (fig. 9, b) and agriculture (here robots for dairy

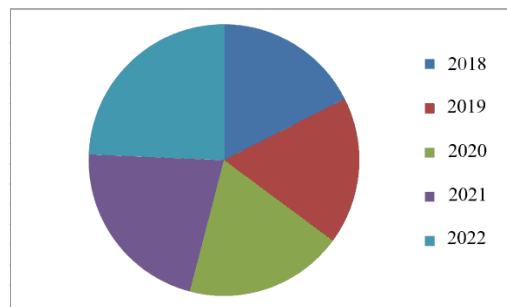
industry, animal husbandry and other field applications) (fig. 9, c).



a)



b)



c)

a) Medicine; b) Logistic; c) Agriculture

Figure 9: Sales of service robots

Robots in logistics – used in non-production environments, such as logistics centers, hospitals or warehouses, as well as for transporting parts inside factories.

Medical robotics is starting from diagnosis of pain to exoskeletons. Simple tasks include delivering drugs, food, or mail to medical facilities, and complex tasks involve robotic systems used in operating rooms, or even performing operations using suitable robotic systems.

Agriculture robotics – from harvesting to dairy industry.

5. CONCLUSION

The paper reviews promising robotic devices in service; 6 options for use of robots for various purposes were considered, ranging from autonomous drones for food delivery to exoskeleton for installation operators. The aim of this work is to provide overview of evolution of research in robotics ranging from humanoid robot to modern devices that allow you to preserve human health during heavy physical labor.

Trend trends in service robotics are considered because of their common goal to bring robots closer to human social needs.

The analyzed capabilities of modern robots clearly that automation, used for any work, increases its efficiency. This directly applies to service, where technologies of future increase speed and quality of service.

Systems allow operators to quickly solve work tasks in ways that may be difficult to imagine even decade ago.

The capabilities of automation modules have expanded beyond core functions such as guest registration, inventory maintenance, financial accounting and cleaning, covering almost every aspect of hotel operations. Modern automation systems for restaurants, bars and different centers have become easier to integrate with various extraneous technologies.

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