Chapter 3

Existing Robotics Technologies for Implementation of Special Education

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ABSTRACT

Collaborative robots (Cobots) are described from the point of view of the cognitive processes underlying the perception and emotional expression of learners based on individual human interacting with non-humanoid robots. The chapter describes a project that is aimed at the development and prototyping of mobile cognitive robotic system designed for service and assistance to people with disabilities. In creating this robot called "AnRI" (anthropomorphic robot intelligent) the experience from building the previous one was used, and it was used in the project Conduct Research into the Adoption of Robotic Technologies in Special Education by Children, Young People, and Pedagogical Specialists. It is described as a device of the robot and realization of cognitive processes to integrate knowledge-related information from sensors, actuators, and multiple sources of information vital to the process of serving people with disabilities.

INTRODUCTION

The first service applications of the mobile robots were very successful and soon the robotic community become aware of the great future of this new branch of robotics – service robotics, stating that their positions promises to be even stronger than those of the industrial ones in the near future. At the beginning of service robotics they were developments mostly of single purpose (specialized) mobile robots able to be used only for specific tasks. Many designers and companies today are changing their design and production strategies in service robotics towards modularization in order to become more flexible and competitive on the market (Bjoern M., 2015).

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As stated in the Cybernetics of Norbert Wiener (Wiener N., 1961), man is a purposeful system, the behavior of which is determined by the set of tasks. The process of successful pursuit and achievement of the set goals, without prejudice to the pre-set restrictions, is determined to a large extent by the learner's desire and interest. The learner's interests are a powerful stimulus in the processes of education, learning the information on the path of pursuing the strategic task (Smith, P., 2007). At the modern stage of human society development, with the introduction of new ultramodern technologies, including robotics, it is possible to challenge the interest of the learners, thereby enlivening the perception of such important information in the process of education. It is possible to use the Service Robots like Assistant Teachers in the process of special education (Kaburlasos, V.G., Dardani, Ch., Dimitrova, M., & Amanatiadis, A. 2018).

Using better and better cheap sensors and sensor systems, robots become easily adaptable to a large variety of industrial processes. The simple mobile robots called in the industry as Automated Guided Vehicles (AGV's) have entered the production systems firmly and have helped the creation of the Flexible Manufacturing Systems (FMS) and later on the Computer Integrated Manufacturing (CIM). Giving to the AGV's some more sensors and intelligent functions, they become the first's service robots operating in warehouses, shops, supermarkets etc. The degree of intelligence of the universal mobile robots, developed for R&D and scientific applications by the world leading universities and laboratories, is growing very fast (GNU ARM, 2015). This is possible with the development of modern microprocessor based control systems, and thanks to the use of sophisticated yet comparatively cheap sensors (like mono and stereo, colour CCD video-systems, laser based sensors and a large variety of other types) and remarkable achievements in the software (Zahariev R., N.Valchkova., 2004).

Data from the US Census Bureau Statistical Brief of 1993 showed that over 34 million Americans had difficulty performing functional activities. Of this number, over 24 million were considered to have severe disabilities. Every year more and more people become disabled in a way which minimizes their use of upper extremities. These can be motor dysfunctions due to accidents, disease, or genetic predispositions (Mitchell R. L., 2012).

The field of Rehabilitation Robotics has emerged in an attempt to increase the quality of life and to assist in the activities of daily living. Rehabilitation Robotics addresses assistive technologies as well as the traditional definition of rehabilitation: increasing or expanding the individual's mental, physical, or sensory capabilities. The primary focus of Rehabilitation Engineering and robotics is to increase the quality of life of individuals through increasing functional independence and decreasing the costs associated with the assistance required by the individual (Scassellati B., H.Admoni, & M.Matarić, 2012).

Robotic aids used in these applications vary from advanced limb orthosis to robotic arms. These devices can help in everyday activities for persons with severe physical disabilities limiting their ability to manipulate objects by reducing their dependency on caregivers (Serpanos, D., 2015).

Often but not always the service robots are mobile. Service robots usually consist of a mobile platform on which one or several arms are attached and controlled in the same mode as the arms of the industrial robots. With this definition manipulating industrial robots could also be regarded as service robots provided they are installed for non manufacturing operations (Liu C., and all 2008).

In overall, people are generally content with the intelligent sensing and performance of robots at work, even become emotionally to them and accept them as partners - they even prefer robots repaired rather than replaced (Prescott T. & Szollosy M.,2017).

BRIEF HISTORY OF THE FIRST ROBOTS

The word “robot” was invented in 1920 by the Czech writer Karel Chapek who used it for the first time in the science fiction RWR or Rosum’s Universal Robots. In 1954, the world’s first robot IC industrial arm, called the Programmed Transfer Device, was patented by George Devol. In partnership with Joseph Engelberger, in 1959 it was marketed under the name “Unimate”. Then for the first time a robot was successfully installed in a General Motors plant. Joseph F. Engelberger, an American physicist, engineer, and businessman, was responsible for the birth of one the most important and impactful industries, gaining him global recognition as the Godfather of Robotics. It is very fames his remark “I can’t define a robot, but I know one when I see one.” (Engelberger,J.1983).

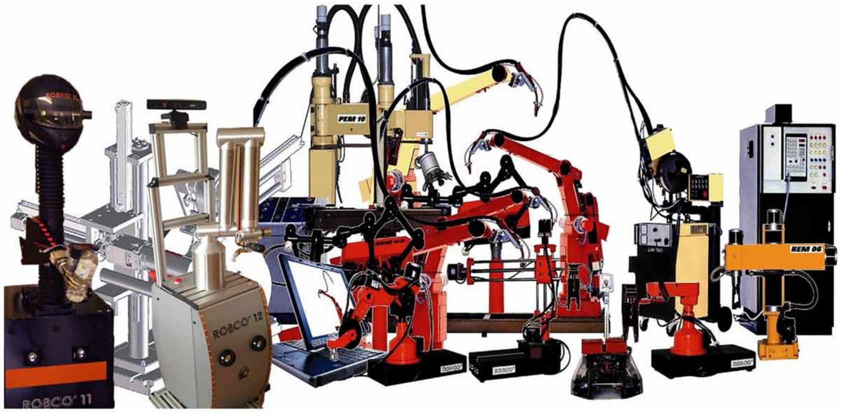
In the period from 1960 to 2000, industrial robots became robotic cells as complete systems that include the robot, controller, and other peripherals, requiring considerable investment and programming knowledge, and became widely known in automation and other industrial sectors. Since 1979 was started work in the field of Robotics at Bulgarian Academy of Sciences (BAS), Institute of Technical Cybernetics and Robotics, which successor is at present Institute of Robotics – BAS (IR-BAS). As an illustration on Figure 1, a historical view of the robots from the Institute of Robotics-BAS is presented.

BRIEF HISTORY OF THE FIRST COLLABORATIVE ROBOTS (COBOTS)

In 1989 Joseph F. Engelberger in the book “Robots in Service” place the Idea for used the robots for human service (Engelberger,J.1989). In 2001-2005, a research team at the University of Southern Denmark compared existing automation solutions to market needs and opened up a new era for industrial robots. In 2005, Universal Robots A/S was founded by three specialists from the University of Southern Denmark’s research team to develop a flexible, collaborative, and light-weight, robust robot with a fast return on investment.

In 2008, Universal Robots launched UR 5 - the world’s first collaborative robot to work well, reliably and safely, side by side with the human. In 2012, the new collaborative robot UR 10 with greater reach and payload makes its world debut. In the years 2012-2016 “Collaborative Robots” are recognized as a

Figure 1. Historical view of the robots of IR-BAS



fully applicable, new class of robots. A major robot maker and robotic technician began to develop and produce robots.

In 2014, TÜV NORD (German Product Validation Organization) certifies the safety system of the 3rd Generation UR Cobbies. In 2015, Universal Robots released UR3 on the world market - the first desktop tabletop robot. In 2016, ISO publishes the long-awaited ISO/TS 15066:2016 specification containing instructions on how to ensure employee safety when handling robotic collaborative systems. With the new third-generation Cobots, robotics has a real opportunity to be used where both flexibility and safety are required ISO 10218-1:2011. The new robots offer up-to-date hardware technology and an improved security system.

ADVANTAGES OF COLLABORATIVE ROBOTS

Collaborative robots are a natural evolutionary branch in robotics. They save a valuable place in factories, making them suitable for implementation even in the most space-related applications (Bjoern M. 2015). At the same time, it is becoming easier for such a robot to be programmed and adapted to a specific task, even to the most specific processes, by not requiring a specially trained programmer. Configuration can be done quickly and easily by anyone via the robot's touch screen (Figure 2).

Among the most serious arguments in favor of collaborative robots is safety. These robots have integrated sensors, soft and rounded surfaces and a number of other ways to minimize the risk of impact, breaking down or crushing the user. The most significant distinguishing feature of collaborative robots in terms of safety is the limitation of force in the moving joints (hinges, joints). Additionally, the robot is typically programmed to immediately stop touching a person or shortening the distance to the person to avoid possible collisions and injuries.

Figure 2. Configuration of the collaborative robot

ORIGIN OF SERVICE ROBOTS

Service robots assist human beings, typically by performing a job that is dirty, dull, distant, dangerous or repetitive, including household chores. They typically are autonomous and/or operated by a built-in control system, with manual override options. The term "service robot" does not have a strict technical definition. The International Federation of Robotics (IFR) preliminary definition of service robotics states: "Service robot – a robot which operates semi or fully autonomously to perform services useful to the well-being of humans and equipment excluding manufacturing operations". Service robots may or may not be equipped with an arm structure as the industrial robots (Bjoern M., Th.Reisinger, 2016).

DEFINITION OF "SERVICE ROBOTICS"

In a joint effort started in 1995, the United Nations Economic Commission for Europe (UNECE) and IFR engaged in working out a first service robot definition and classification scheme which has been adopted by the current ISO Technical Committee 184 / Subcommittee 2 resulting in a novel ISO-Standard ISO8373:2012 which became effective in 2012. This International Standard specifies a vocabulary to be used in relation to robots and robotic devices operating in both industrial and non-industrial environments. It provides definitions and explanations of the most commonly used terms, which are grouped into clauses of the main topics of robotics. Its vocabulary definitions relate to industrial as well as to service robotics. Relevant robotics related definitions are (Provisional definition of Service Robots, 2012):

- A robot is an actuated mechanism programmable in two or more axes with a degree of autonomy, moving within its environment, to perform intended tasks. Autonomy in this context means the ability to perform intended tasks based on current state and sensing, without human intervention.
- A service robot is a robot that performs useful tasks for humans or equipment excluding industrial automation application. Note: The classification of a robot into industrial robot or service robot is done according to its intended application.
- A personal service robot or a service robot for personal use is a service robot used for a non-commercial task, usually by lay persons. Examples are domestic servant robot, automated wheelchair, and personal mobility assisting robot.
- A professional service robot or a service robot for professional use is a service robot used for a commercial task, usually operated by a properly trained ◊operator. Examples are cleaning robot for public places, delivery robot in offices or hospitals, fire-fighting robot, rehabilitation robot and surgery robot in hospitals. In this context, an operator is a person designated to start, monitor and stop the intended operation of a ◊robot or a ◊robot system.
- A robot system is a system comprising robot(s), end-effector(s) and any machinery, equipment, devices, or sensors supporting the robot performing its task.

Please note: According to the definition, "a degree of autonomy" is required for service robots ranging from partial autonomy (including human-robot interaction) to full autonomy (without operational human-robot intervention). Therefore, in addition to fully autonomous systems, service robot statistics include systems which may also be based on some degree of human-robot interaction (physical or informational) or even full teleoperation. In this context, human-robot interaction means information and action exchanges between human and robot to perform a task by means of a user interface (Dimitrova, M., N. Vegt, N., & E.Barakova, 2012).

AUTONOMOUS ROBOT

An autonomous robot is a robot that performs behaviors or tasks with a high degree of autonomy. This feature is particularly desirable in fields such as spaceflight, household maintenance and delivering goods and services.

A fully autonomous robot cans (Fasola J, Mataric M. J., 2010):

- Gain information about the environment.
- Work for an extended period without human intervention.
- Move either all or part of itself throughout its operating environment without human assistance.
- Avoid situations that are harmful to people, property, or itself unless those are part of its design specifications.

An autonomous robot may also learn or gain new knowledge like adjusting for new methods of accomplishing its tasks or adapting to changing surroundings.

Like other machines, autonomous robots still require regular maintenance.

The first requirement for complete physical autonomy is the ability for a robot to take care of itself. Many of the battery-powered robots on the market today can find and connect to a charging station, and some toys like Sony's "Aibo" are capable of self-docking to charge their batteries.

Self-maintenance is based on "proprioception", or sensing one's own internal status. In the battery charging example, the robot can tell proprioceptively that its batteries are low and it then seeks the charger. Another common proprioceptive sensor is for heat monitoring. Increased proprioception will be required for robots to work autonomously near people and in harsh environments. Common proprioceptive sensors include thermal, optical, and haptic sensing, as well as the "Hall's effect" (electric).

COLLABORATIVE FUNCTIONS

According to the international standard ISO 10218-1:2011, "Robots and Robotic Devices - Safety Requirements for Industrial Robots", Part 1 Part 2, there are four types of Collaborative Functions:

- Safe braking. This collaborative function is mainly used when the robot works mostly on its own, but it is possible for the user to enter its workspace. When the user enters the secure, virtually restricted work zone, the robot immediately stops, not shutting down, but stays in the standby mode.
- Direction of manual operations. This collaborative application is used to guide the hand when working with robotic tools or to train the robot on the desired trajectories in pick-and-place and other similar operations.

The technology allows the robot to engage in collaborative activities through additional force-sensing devices by means of force, compression, torque and torque sensors, and so on.

- Speed monitoring and redefined work area. In this type of collaborative applications, the robot's working environment is monitored by lasers or a machine vision system that track the user's position in space.

The robot operates only within the scope of the predefined work area. When the user enters this zone, the robot reacts with a significant decrease in its speed of operation, and when a person enters a predefined smaller perimeter around the robot, it stops completely. Typically, to resume work in Safe Shutdown and Safe Mode modes, the robot waits for a feedback (command or signal) from the operator.

Work areas and safety zones are classified so that the robot reproduces different responses to the human situation in space.

- Power and power limitation. Collectible robots with power and power limitation function are considered to be the safest as they can work side by side with no additional devices or restraint systems.

The robot is programmed to "recognize" unusual (too big) efforts and to stop instantaneously in the presence of such. This type of robot is designed to "distract" the force in the event of a collision with a person on a larger area, and therefore have rounded shapes. In addition, this type of robots has no display cables and other moving parts.

A large number of collaborative robots are certified by the relevant authorities in accordance with industrial safety standards for human and robot collaboration. In this respect, the Technical Specification ISO/TS 15066:2016 "Robots and Robotic Devices - Collaborative Robots" defines the maximum force and energy that can be applied to a person without causing him physical harm.

ISO/TS 15066:2016 specifies safety requirements for collaborative industrial robot systems and the work environment, and supplements the requirements and guidance on collaborative industrial robot operation given in ISO 10218-1 and ISO 10218-2. ISO/TS 15066:2016 apply to industrial robot systems as described in ISO 10218-1 and ISO 10218-2. It does not apply to non-industrial robots, although the safety principles presented can be useful to other areas of robotics.

This Technical Specification provides guidance for collaborative robot operation where a robot system and people share the same workspace. In such operations, the integrity of the safety-related control system is of major importance, particularly when process parameters such as speed and force are being controlled. It is applicable to human-robot collaboration with both conventional industrial robots and collaborative robots with power constraints.

DEVELOPMENT OF SENSOR TECHNOLOGIES FOR COLLABORATIVE ROBOTS

Sensor devices are keys to integrating robots into industrial machinery and equipment. Mass presence sensors, including capacitive and inductive proximity sensors and distance sensors, ultrasonic and photoelectric sensors, are widely used.

Generally, all robots incorporate feedback devices - encoders, resolvers and electromechanical angular or revolution measuring devices. Additionally, depending on the particular purpose, the collaborative robots are equipped with three categories of sensor technology - Snap Sensors and other End-of-Arm

Tooling devices (EOAT); preventive sensors (to prevent damage to the robots themselves) and safety sensors that take care of the security of people near robots on the move.

- **EOAT Sensors:** Typically photoelectric sensors, proximity sensors or video sensors that detect when an object is caught by the grippers or other robot tools associated with system logic. If the griper sensor is not active, the robot programming will instruct the robot to take another trajectory or to alert the operator that something is wrong.

This type of reporting has two distinct aspects - registering an object's presence in the gripper in order to safely continue the sequence of operations as well as qualitatively assessing an object when it enters the robot's workspace, verifying and deciding whether to be captured by tools and manipulation with it to continue.

- **Prevention Sensors:** Prevention sensors are usually analog sensors. They are used to detect small deviations in the robot's work by analogue measurements, which he is not able to account for as errors. Such are, for example, attempts to assemble two parts that do not fit in assembly operations.

In such cases, the sensor sensing system detects more effort than is typically required by the load sensors and instructs the robot to stop trying to perform the processes. This type of reading prevents breakage or other damage to the clamps and other robot tools and systems.

- **Safety Sensors:** The sensor systems for industrial robots have undergone significant development over the years. Among the most advanced technology to provide staff safety today are 3D scanners and video sensors. Usually, they are positioned next to the robot perimeter of the operating area and programmed to register the entry of a person into predefined range of the system. This technology is suitable for ensuring robot safety, which is triggered automatically.
- **Proximity Sensors:** Proximity sensors have the main function to register the presence or absence of an object (device, product, component, tool) at a certain stage of the robotic processes necessary for the safe performance of the desired subsequent operations. Installed mainly of buckles or the relevant enforcement tools (end effectors) on top of the robotic arm/hand, this type of sensors take into account whether they were engaged with the right object, and whether it was engaged in a correct way. For this purpose different solutions exist - from simple discrete sensors that only turn on and off to more sophisticated sensors that send information to the controller about the constant spatial position and size of the object via analog or serial digital outputs.
- **Precision Sensors:** By reducing the gauges of the objects with which the industrial robots handle, as well as the working cells themselves, they require ever higher accuracy and precision in their work. As a result, miniature sensors are becoming more and more sophisticated in automated production.

In addition to obvious advantages, such as extremely small dimensions and weight, this category of sensors also ensures much higher accuracy of reading. The term "precision readout" is used to define the ability of miniature sensors to provide more stable reading points even at temperature fluctuations. Sensors of this type are also more repetitive, with shorter hysteresis windows, the difference between switching and switching points, and a better ability to detect the presence of very small objects, often "invisible" for larger sensors. Precision miniature sensors provide robots with spatial information about the positioning of the object being handled. Through technologies such as laser distance sensors and machine vision systems, robots can precisely handle the desired product or component, as well as avoid collisions with workers or different objects in the work area.

- **Machine Vision Systems:** Machine Vision Systems in the last years has been developing very much. They are a separate category of sensors with very rich capabilities. Due to their wide-range functionality, they can be used to perform all of the above-mentioned types of robot sensor systems. The problem is that the robot is run in real-time mode and sometimes does not reach the machine's time to perform the task. Therefore, the combination with other types of sensors is very successful in identifying certain obstacles or objects with which the robot will interact. By using the Sensors Fusion processes, the tasks of the Video System are minimized by alleviating its activity and utilizing the information from other more profiled sensors in order to make a successful decision for the realization of certain actions of the robot in real time mode.

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By using Artificial Intelligence elements such as "Detecting" and "Identifying" objects from the robot's workspace using predefined "Knowledge" in the Environmental Database, the Video System is greatly facilitated and so it is possible used in the process of managing the robot in real-time mode. When making a successful decision in the management process, the resulting is recorded in the Database for future use in a similar situation so could "Self Learning Procedure".

Indisputable benefits from the collaborative robots are:

- **Fast Installation:** Collectable robots can be installed by untrained staff and put into service only within a few hours.
- **Easy Programming:** The innovative collaborative robot technology enables anyone without pre-training or experience to program the system quickly and seamlessly with intuitive tools and logical steps through an easy-to-use software programming wizard.
- **Improved Safety:** Collaborative robots, on the other hand, can work side by side with no safety equipment and no need for large space to install.
- **Flexible Adaptation:** to multiple applications. The collaborative robots are lightweight, small-sized, save space and are suitable for deployment in different areas of the technological lines and can be easily moved. Capable of repeatedly using recurrent operations, they require minimal reset time and effort.

Technavio, ABB, Kuka, Rethink Robotics, Universal Robotics, Adept Technology, Fanuc, Yaskawa Motoman and some others are the biggest suppliers of robot products and solutions. ABB has announced the acquisition of the German company Gomtec, which will expand its portfolio of collaborative robots. Collaboration with Gomtec will extend our range of collaborative automation technologies, which already includes the first YuMi industrial two-handed robot developed specifically for small-part assembly applications.

- **Sensing the Environment:** Exteroception is sensing things from the environment. Autonomous robots must have a range of environmental sensors to perform their task and stay out of trouble. Common exteroceptive sensors include the electromagnetic spectrum, sound, touch, chemical (smell, odour), temperature, range to various objects, and altitude.
- **Task Performance:** The next step in autonomous behavior is to actually perform a physical task. A new area showing commercial promise is the area of domestic robots. While the level of intelligence is not high in these systems, they navigate over wide areas and pilot in tight situations around homes using contact and non-contact sensors. Both of these robots use proprietary algorithms to increase coverage over simple random bounce. The next level of autonomous task performance requires a robot to perform conditional tasks. For instance, security robots can be programmed to detect intruders and respond in a particular way depending upon where the intruder is.

AUTONOMOUS NAVIGATION

For a robots which are used behaviors and need with a place (localization) requires it to know where it is possible to be able to navigate "point-to-point". Such navigation began with wire-guidance in the 1970-s and progressed in the early 2000-s to "beacon-based" triangulation. Current commercial robots autonomously navigate based on sensing natural features. The first commercial robots to achieve this were Pyxus' HelpMate Hospital Robot and the Cyber Motion Guard Robot, both designed by robotics pioneers in the 1980-s. These robots originally used manually created CAD floor plans, sonar sensing and wall-following variations to navigate buildings. The next generation, such as Mobile Robots' Patrol Bot and Autonomous Wheelchair, both introduced in 2004, have the ability to create their own laser-based maps of a building and to navigate open areas as well as corridors. Their control system changes its path on the fly if something blocks the way.

At first, autonomous navigation was based on planar sensors, such as laser range-finders, that can only sense at one level. The most advanced systems now fuse information from various sensors for both localization (position) and navigation. Systems such as "Motivity" can rely on different sensors in different areas, depending upon which provides the most reliable data at the time, and can re-map a building autonomously (Zahariev R., N.Valchkova., 2009).

Rather than climb stairs, which requires highly specialized hardware, most indoor robots navigate areas, which are accessible for people with special needs like controlling elevators, and electronic doors. With such electronic access-control interfaces, robots can now freely navigate indoors. Autonomously climbing stairs and opening doors manually are topics of research at the current time. As these indoor techniques continue to develop, vacuuming robots will gain the ability to clean a specific user-specified room or a whole floor. Security robots will be able to cooperatively surround intruders and cut off exits. These advances also bring concomitant protections: robots' internal maps typically permit "forbidden areas" to be defined to prevent robots from autonomously entering certain regions (Valchkova N., R. Zahariev, 2016).

During the final NASA Sample Return Robot Centennial Challenge in 2016, a rover, named Cataglyphis, successfully demonstrated fully autonomous navigation, decision-making, and sample detection, retrieval, and return capabilities (Hall R. L.,N. Loura, 2016). The rover relied on a fusion of measurements from inertial sensors, wheel encoders, "Lidar", and Video camera for navigation and mapping, instead of using GPS or magnetometers. During the 2 hour challenge, Cataglyphis traversed over 2.6 km and returned five different samples to its starting position.

SERVICE MOBILE ROBOTS FOR HELP OF PEOPLE WITH SPECIAL NEEDS

The creation of Cognitive Mobile Service Robots for help of disabled people aims explicitly at fostering the scientific, innovation and patenting excellence of a leading Bulgarian institute – the Institute of Robotics of the Bulgarian Academy of Sciences (IR-BAS) in its striving for European and World Recognition in the area of research, being unique for the Region and acting as a Center of Innovation in: Innovative solutions of advanced system engineering and robotics for supporting independent living.

There is an emerging need worldwide for „Personal Robots“, following the development of personal computers and personal devices like tablets, iPad, touch screen GSMs, etc. It is widely accepted that Service Robots can significantly contribute to better human working conditions, improved quality, profitability and availability of services (Serholt S., 2018). Some visions depict these robots as companions for household tasks like fetch-and-carry-services, maintenance, cleaning, entertainment, elderly care and even care for disabled persons, which on its own right – is no longer a matter of fiction in view of the recent advances in robotics of Honda, Sony, European robotics and many others (Smith,P. 2007).

Present day systems engineering and robotics research aims at implementing cost oriented innovative approaches to build smart, robust, reliable and understandable robotic devices and technological systems serving better the needs of people and creating conditions for a better quality of life for the future generations (Valchkova N., R. Zahariev,2016). These systems have to be projective – not replicating the existing solutions - implementing excellence and innovation based scientific thinking in the socio-economical context of the current world crisis. This is crucially important for countries from the region of South East Europe – where short-cut technologies have to be newly designed and made cost-oriented in order to converge faster to the standards of the European Union and be competitive on the international market (Angelov G., R. Zahariev, 2017) (Figure 3).

DESCRIPTION OF THE ROBOTS “ANRI-0” AND “ANRI-1”

The Robots from series AnRI (Anthropomorphic Robot with Intelligence) was developed based on the Robots from the family “ROBCO” at the Institute of Robotics – Bulgarian Academy of Sciences. (Chivarov N., Penkov Sv., Angelov G., at all, 2012), (Chivarov N,, Paunski Y., at all, 2012). The Robots “AnRI-1” and “AnRI-0” (Figure 4 and Figure 5) are on the base of mobile platforms with four wheels, of which two are driven and two are independent “free” wheels. In the Robot “AnRI-1” the wheels are located in the form of a cross. The driven wheels are at two sides of the platform and the “free” wheels are at the rear and front sides.

With the help of this location of the wheels it is possible to realize the Robots movements around the vertical axis at geometrical centre of construction in the left and right sides. At the hub of the driven wheels are built electric motors, DC powered by a rechargeable battery. The robot is equipped with a manipulator of anthropomorphic type, situated on the platform with three regional and three local degrees of mobility and gripper with separate drive and with three fingers. The same construction has the Robot

Figure 3. Experience of IR-BAS - Mobile service robots "AnRI" for help of people with special needs

"AnRI-0" with the difference is of situation of the wells, which are in the form of "triangle". At the two tops of the triangle are located the driven wheels and at the third top is the "free" wheel.

After experiments with Mobile service robot "AnRI-0", serving people with special needs, it was observed phenomena "The uncanny valley", defined bay Professor Mori (Japan) in 1970 (Mori, M. 1970/2012). This is negative reaction in behavior of the serving people provoke from the anthropoid image of the robot. To avoid this phenomena Mobile service robot "AnRI -1" was constructively formed without anthropoid had.

The drive of the robots is realized, based on "servo" controllers with feedback from incremental sensors, located in each degree of mobility of the manipulator. Regional levels are equipped with electromagnetic brakes and drive wheels of the platform are equipped with worm gearboxes that do not allow movement back using their braking effect.

The Control System of the robot is hierarchical, distributed, microprocessor type (Trevor Martin, 2016) and includes different levels, different devices and systems and corresponding software modules. (Angelov G., R. Zahariev, 2017) The connection between all devices on the management takes place via the serial interface RS 232. The total control module is based on 32 bit microprocessor embedded in the CPU module (Paunski Y., R.Zahariev, 2017).

Figure 4. Service Robot“AnRI-1”

Figure 5. Service Robot “AnRI-0”

PLANNING TRAJECTORY OF THE ROBOTS USING THE FUSION OF THE SENSORS INFORMATION

The Sensors Informational System of the robot converts various values (most often physical) into an information signal (most commonly electrical) that gives an idea of the quantity and quality of the measured parameters.

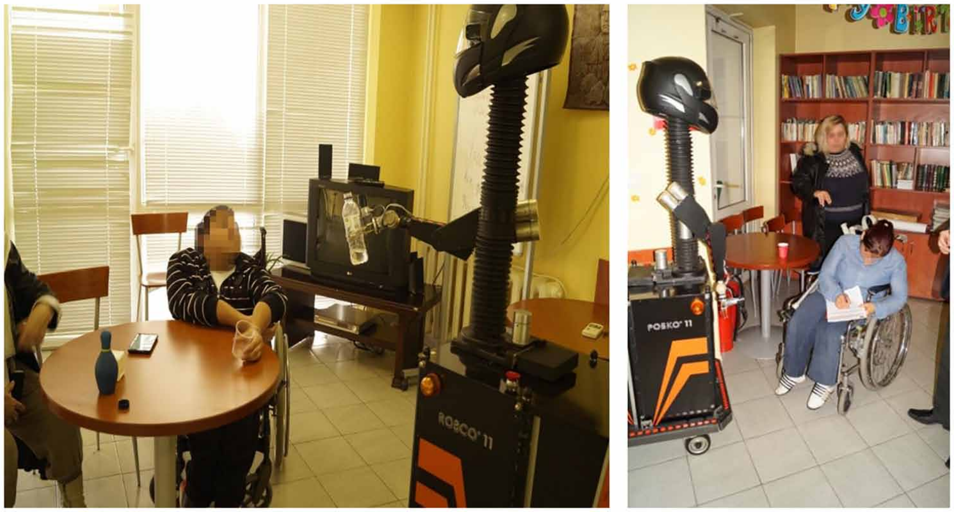
The mobile service robot is subject to specific requirements for the sensor information system, dictated, in particular, by the following features of the robot:

- Heterogeneity of the system: it must combine elements that function in different ways, communicate on different protocols and fulfill different purposes.
- Heteroarchism, heterogeneity of the organization of the system: some of the elements are centralized and hierarchically organized, while others are distributed with a high degree of autonomy:
- Work in conditions of uncertainty: since dynamics of change leads to reaching the limits of knowledge, it is often necessary for the system to use probabilistic or fuzzy methods.
- Working in real-time mode: all changes to the structure and functions of the system must be embedded within real-time mode (Adam Dunkels and all, 2002).

The coherence between the sensors and the mechanical units for which they are to provide information is not unambiguous. For example, one sensor is connected to a mechanical link (robot encoder), in other cases several sensors measure the same magnitude (radar, optical sensor, infrared sensor), in the third case the same sensor gives information about several mechanical components (Video sensor and multiple point tracking in space), and so on.

It is important to note the dynamics of the configuration, which requires a rapid change in the overall functioning of the Sensor System under the influence of the mobile robot coordination unit (Figure 6).

Figure 6. Experimental use of robot "AnRI-0" by people with special needs



This ambiguity and dynamics of the sensor flow implies the need to integrate information, merging, sorting, filtering and completing the data needed to meet the current goal.

The dynamics of changing the environment requires the integration of information from new sensors connected in a new way to new mechanical units, new algorithms and approaches (Joseph Yiu, 2013). In practice, there is a large arsenal of approaches and methods for integrating information into the mobile service robot. The question of strategy and tactics of the particular implementation is what combination of such methods will be applied. (Dimitrova, M., & Wagatsuma, H. 015). The sensor subsystem merges the signals from all the sensors and, after processing, outputs information about the situation in which the robot is at all times.

CONCLUSION

The main challenge of the Project is to make personal robots affordable to people – which is to be achieved by implementing innovations in all aspects of functioning of the robotic device – materials, sensors, cognitive, communication, actuators, energy consumption, etc. In the extremely complicated process of education, an essential point is the definition of clear work and tactical goals (Shamsuddin, S., and all. 2015). With a certain clarity, the teacher should be aware of the goals set and be able to create an interest and desire in learners to absorb information based on key elements. These elements are also keywords that make it easier for learners to perceive the matter and create the prerequisite for higher learning efficiency.

According to M. Minsky's Theory of Framework for Representing Knowledge, (Minsky M., 1974) the information can be organized by the robot in separate frames, each subsequent frame inserted in the previous one clarifying and specifying it and thus progressing to a deep penetration of the problem. The information displayed in this way by a robot will cause interest in learners, which will be a powerful stimulus in the role of absorbing matter on the way to reaching the goals.

The innovations in their concerted design will bring cost efficiency in order to make the product complying with the market demand. That is why the main purpose of the project of conducting research into the adoption of Robotic Technologies in Special Education by children, young people and pedagogical specialists in the Implementation of the EC-funded program "Marie Curie" Project H2020-MSCA-RISE-2017, ID No 77720 "CybSPEED: "Cyber-Physical Systems for Pedagogical Rehabilitation in Special Education", was to examine to what extent the developed robots contribute to ensuring a dignified and independent life for (with a focus on young) people with special needs (CybSPEED, 2017).

On the basis of the studied necessary robots behavioral models, the hardware part should be further developed, which can provide the necessary basis for further development of the program platform in order to better meet the service needs of the same users. In this respect, advances in modern technologies are developing and increasing the capabilities of the used equipment for robots control in "real time" mode. Here, not only the rapid development of digital technology has led to an unprecedented rise in communication tools in society.(Barakova, E. and all. 2015). There is already a new technical revolution with the possibilities for developing analog technology. In this way, extremely fast processes for collection of analogue information from the environment are obtained, without having to transfer it in digital form in order to process it properly and then to decide on the implementation of a given task.

These two processes of development of the hardware and the software part of the robot should go in parallel and iteratively with the development of one part implying a jump in the development of the other part, which in turn puts its own possibilities and requirements that catalyze the development of the other part.

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