A Human Centred Approach to Robotics

Human centred robotics refers to the development of service and support robotics, which aims to address human social needs and production processes. It focuses on the knowledge and structures needed for robots to help, interact and collaborate with humans.

The 2016 '**Digital Skills and Jobs Coalition'**[1] is an alliance which brought together Member States of the European Union, companies, social partners, non-profit organisations and education providers, wishing to take action and tackle the lack of digital skills in Europe. This coalition reinforces the need of all to help meet the high demand for digital skills in Europe which are essential in today's job market and society. Europe is looking for digitally skilled persons to fill jobs in all sectors, with a shortage of professionals to take up to **750,000 Information and Communication Technologies (ICT) professional jobs by 2020**[2]. Yet unemployment among young people of 15-24 years old is at almost 20% in the EU.

Computer science skills are increasingly required in many different fields, not only in ICT jobs. Programming and computational thinking skills are becoming ever more important in our society and working environment. In addition, people with robotics and AI (Artificial Intelligence) skills are needed to meet the human centred robotics demand. Only in the manufacturing sector, the skills gap could rise from 488,000 unoccupied jobs the previous year to 2.4 million open jobs in 2028, based on a report in 2019 by The Manufacturing Institute and Deloitte[3].

Up to now schools have been using ICT to focus only on computer literacy. There is nowadays an ever growing need to teach students the subject of Computer Science and Engineering: teaching them how to code, and how to create their own mechanisms and program them; not just how to work with a computer, but how an electronic system works and how to make it work for you.

"Bridging the Skills Gap: Strategies for the Promotion of Digital, Coding and Robotic Skills for Social Inclusion, Equality and Access (Robot4All)" is an Erasmus+ project which was designed to introduce Robotics and Coding to schools for vocational education and training (VET-schools) as an innovative way to address deficits, social exclusion, prejudice and learning disparities and to also familiarize VET students with the human centred approach to robotics.

The project consortium developed a ***"Complete Tool Kit***" and an ***"Educational Pack"*** for developing, implementing and monitoring various **inclusive** strategies for promoting coding and the human-centred robotics skills in VET schools. The project aimed to bridge the digital gap based on the creation of partnerships and synergies between the schools, stakeholders and the labour market (policy maker, ICT experts, providers and enterprises).

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[1] 'The Digital Skills and Jobs Coalition' (2016) Available at: https://ec.europa.eu/digital-single-market/en/digital-skills-jobs-coalition

[2] 'Commission launches Digital Skills and Jobs Coalition to help Europeans in their career and daily life' (2016) Available at: https://ec.europa.eu/cyprus/news/20161201_2_en

[3] 'Robots.Jobs addresses robotic skills shortage with a national approach' (2019) Available at: https://www.therobotreport.com/robots-jobs-addresses-skills-shortage/

The project ran in a non-working school time being a part of after school and afternoon activities, which allowed to set up ***Robot4All Laboratories*** in school premises thus ensuring access and adequate participation. It created ***synergies*** between VET schools, universities and the business world to bridge the skills-gap between education and the labour market. It introduced the ***Open Badges*** as a methodology to ***validate*** and ***award*** the coding and robotics skills acquired by both VET students and trainers thus achieving transferability, credibility and transparency.

It also established transnational cooperation between partners for the organisation of ***ROBOT4ALL Competitions*** and events, and set the stepping stone for the creation of Key Action 1 mobility courses thus ensuring sustainability and exploitation of products and results.

The ***Direct Target Group*** was VET students in need who learned how to code and assemble a fully functioning robot, whereas an ***Indirect Target Group*** was VET trainers, whose profile was upgraded and strengthened by the experience they received by pilot-testing the material which was created by the consortium.

The Human-Centred robotic approach of the Robot4All project

There is no strict categorization considering the human centred approach to robotics since the field is dynamically changing and new technological developments have been enriching it constantly. MIT and Northwestern University have asserted that the correlation of humans and robots should incorporate ***interaction***, ***physiological integration and autonomy***[4]. The Robot4All project attempted to incorporate these aspects in the curriculum it proposes.

1. Physical and Social Interaction with Humans

'Physical and Social Interactions of Robots with Humans' - Social (or sociable) robots are designed to interact with people in a natural, interpersonal manner – often to achieve social-emotional goals in various applications such as in the areas of health, education, life quality, communication, collaboration and entertainment. The long-standing objective of creating social robots that are capable and skilled companions for people is quite a challenging and exciting endeavour. A profound understanding of the human mind and behaviour across numerous aspects such as cognitive, affective, physical and social, is necessary in order to create robots which can successfully have a useful role in the everyday lives of people. This approach requires a combination of social robot skills which have to be up-to-date with artificial intelligence, human psychology, neuroscience, anthropology, to name a few.[5]

Figure 1 - The Pepper Robot

Nowadays there is a plethora of Robots which aim in offering social services to humans. One of the most popular is Pepper designed by SoftBank Robotics which is widely used across many industries. The charming humanoid design offers a high level of acceptance by humans and it is used to attract customers in

[4] 'Human Centered Robotics Workshop' (2017) Available at: http://users.eecs.northwestern.edu/~ Centered-Robotics-RSS17.html

[5]Cynthia Breazeal et al (2019) 'Social Robots that Interact with People' Available at: https://link.springer.com/referenceworkentry/10.1007%2F978-3-540-30301-5_59

a shop, to welcome and inform university students about their schedule and where their classroom is located, or even in healthcare by improving awareness of prevention care and to reduce anxiety on diseases and treatments[6].

Asimo is another humanoid robot developed by Honda intended to support someday with important tasks like assisting the elderly or a person confined to a bed or a wheelchair. It reflects one of the main concerns of Japan as the predictions for the aging of the country's population is steadily increasing. Asimo has come a long way since the first version appeared in 2000 and numerous variations have been presented to the public so far. Honda also is considering the android to be able one day to perform some tasks which are dangerous to humans, such as cleaning up toxic waste and putting out fires[7].

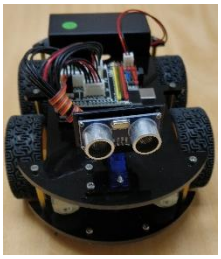

Figure 2 - The Robot4All Robot Car

The Robot4All curriculum offered students the opportunity to assemble a Robot Car which could assist humans by transferring cargo in a predefined path with the help of the sensors which measure the reflected light intensity as well as offer recreation by programming it to participate in social events such as a robotics Sumo competition or even to participate in a robotic football game.

2. Physiological Integration with the Human Body

'Physiological Integration with the Human Body' – From the end of the 20th century medical applications in the form of robotics have been emerged such as remote surgery robots, telemedicine and teleconsultation, rehabilitation, assistance for disabled, deaf and blind and hospital robots. The field of medical robotics is nowadays expanding rapidly and medical robots are being widely used in hospitals.

Additionally, rehabilitation robots take the form of devices ranging from artificial limbs to robots for supporting rehabilitation therapy and for providing personal assistance in hospitals and residential places. An emerging area in the field of rehabilitation robotics is the creation of personalized rehabilitation interventions. One example is the robot-assisted gait training in children with Cerebral Palsy (CP). CP is a set of neural disorders triggered by damage to the brain at birth, during infancy or in an early childhood stage which affects the walking ability of a person. Clinical results of robot-assisted gait training in children with CP which have seen great improvement which would not be treated in the past without the help of medical robotics.

[6] Softbank Robotics, Available at: https://www.softbankrobotics.com/emea/en/pepper
[7] Honda Asimo, Available at: https://asimo.honda.com/asimo-history/

Another example is blind patients which have been subjected to Bionic Eye Surgery where a small electronic device is placed on the patient's retina. Afterwards, the patient wears a camera attached on a pair of glasses, and a portable computer capable of video-processing. Images are recorded through the camera, processed, and transmitted wirelessly to the implant situated in the user's retina. The implant then stimulates the living cells in the retina, and the human brain translates the stimuli as light. Over time, the brain learns to interpret the signals as objects, the environment, and even in some cases, read printed text[8].

Figure 3 - A woman wears a retinal implant to restore some vision to people with a form of blindness

The students which participated in the Robot4All workshops got to work with ultrasonic sensors and recorded the time it takes to for an ultrasonic wave to bounce back from a distant object. This gave an inside on how devices can be created to offer assistance in object recognition and avoidance. The Robot4All car was tested in a wall labyrinth with the task being to find its way out.

Figure 4 - The Robot4All Car stops when it detects an obstacle

3. Autonomy in Dynamic and Uncertain Environments

'Autonomy in Dynamic and Uncertain Environments' - Mobile robots are defined by robotic systems which undertake tasks in different places and harsh environments. Their system is structured based on the setting they operate, and that includes aerial, aquatic or terrestrial environments. Mobile robots are used in a wide range of situations because of difficulties humans face operating in these territories.

An example where such a robot was used was by the Tokyo Electric Power Company (TEPCO) which sent in 2019 a robot into one of the reactors of the Fukushima nuclear power plant, which was devastated by a tsunami in 2011. The robot discovered where the melted fuel was situated, picked it up and placed it back down to decide whether it was solid enough to transfer it away during a second mission. This would not be feasible if humans where to inspect the radioactive fuel, which would have endangered their health.

'Atlas', a humanoid robot by Boston Dynamics is described by the expressive ability to undertake complex dynamic interactions involving the whole body and environment to plan movements. It is capable of search and rescue missions and can perform several human activities such as run, leap and do somersaults as well as lift heavy equipment.

[8] Dr. Mark S. Siegel (2015) 'Bionic eye is an incredible breakthrough', Available at: https://yourislandnews.com/bionic-eye-is-an-incredible-breakthrough-but-not-right-for-everyone/

Ocean One is a bimanual underwater humanoid robot which has been developed to closely mimic the abilities of a human diver and to work with a team at sea level and explore the depths of the ocean, providing cognitive capabilities and expertise.

Even planet Mars is currently home to four autonomous rover robots with a fifth mission landing in 2021[9]. The Sojourner rover was the first to land back in 1997 followed by Spirit and Opportunity in 2004 and Curiosity in 2012. Their aim is to search for evidence of habitability, organic materials such as carbon and water on the planet and set the stepping stone for humankind to colonize the planet.

Figure 5 - The Robot4All cars ready to race!

In the Robot4All project students created their own rover robot. Students created areas where the robot could explore and areas where the robot had to navigate autonomously with the code the students wrote. Students also programmed the robot to accept instructions remotely (similarly to the robots mentioned above) with the help of a Bluetooth receiver add on.

They also organized a racing competition with their robots turning the lab rooms in an obstacle race.

Robotics in Education

Robotics is an effective, fascinating and motivating way to introduce students to coding which integrates all STEM (Science - Technology – Engineering – Mathematics) fields. At the same time, it promotes other employability skills such as: problem solving, group work, leadership, creativity and initiative.

There is a plethora of options available for schools and educators to choose from starting from the primary school stage. Lego is an important player in the field with kits such as the **Lego Boost** and **Lego We Do** platforms where students can assemble robotic contraptions the same way as they would use any Lego piece. Another option is the **Edison Robot** which has been endorsed by the Australian education system and is also Lego compatible. Students can construct a variety of different robotic mechanisms and control them with companion applications from smartphones and tablets.

Figure 6 - The robotex competition in the biggest robotics competition in Cyprus organised by the Cyprus Computer Society

One of the most popular robotic kits suitable

[9] Nasa (2020) 'The Mars Rovers', Available at: https://spaceplace.nasa.gov/mars-rovers/en/

for Secondary schools is the **Lego Mindstorms EV3** platform and the most recent one the **Lego Spike Prime**, were students can be introduced to coding through Block Based and Scratch based Coding and can then advance to modern programming languages such as Python.

Another popular solution is the option the Robot4All project chose to utilize which is the A**rduino platform**. Arduino is an open source platform where the schematics of the hardware are available to anyone wishing to produce a microcontroller device which as a result has a minimal cost for the schools wishing to participate and follow the Robot4All curriculum.

The coding language utilized in the Arduino IDE (Integrated Development Environment) is a version of **C++ programming language** which is widely used in the field of teaching and research due to the fact that it is a high-level, general-purpose programming language adequate for the successful teaching of all basic coding concepts (procedural and object-oriented).

The Robot4All consortium prepared and pilot-tested the material created, which included the complete toolkit and educational material needed to support VET teacher's through a targeted VET teachers' training course and a set of teaching material and resources appropriate for the target group of VET students.

As an added value to the project an innovative **Open Badge** validation system was created for the coding skills to be made visible, transparent and accessible through the students and VET trainers. It includes a dynamic and interactive **portal/platform** which will serve different purposes such as managing and monitoring the Robotics programme, communication, and as an **Assessment Tool** for monitoring, recording and validating the acquisition of the digital, coding and robotics skills using the Open Badges ecosystem. Through this platform students could present their work to their trainers and gain an Open Badge which they could showcase in their portfolio.

The Robot4All Complete Toolkit and Educational Pack can be found at: www.robot4all.eu

And the Course Portal is also freely available at: www.academy.robot4all.eu

The consortium consisted by eight partners: the VET-school 2 EK Peraia from Athens - Greece, the IT Educational and Research Centre Emphasys Centre and the Cyprus Computer Society from Nicosia - Cyprus, the IT Service Centre Civic from Edinburgh - UK, the Non-governmental organisation CDIMM from Baia Mare - Romania, the Non-governmental organisation Women in Digital Initiatives WIDE from Luxembourg and the VET-school IES Maria Moliner from Segovia -Spain. The project was coordinated by the Leibniz University of Hanover - Germany.

The Robot4All project strived to empower students with the skills needed in the 21st century and offered development opportunities to VET students and trainers in the European Union in the field of Human Centred Robotics and Coding. The study of robotics offers a great opportunity for further development across all sectors which will hopefully serve humanity into progression and prosperity.