Greta 2.0 Anthropomorphic Robotic Platform for Training and Research

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Abstract. Android-type robots have always attracted the human mind, being the most expressive result of his desire for creativity. Currently, research and development in the field of artificial intelligence is ahead of its application on real humanoid robots. Meanwhile, many research groups of students and postgraduates are inspired by the idea of applying their developments to a physical model. Due to the complexity of manufacturing an Android-type robot, such projects usually fade away at the level of implementing mechanics and adapting the original idea to the limitations that have arisen in the process of working on mechanics. The article describes an anthropomorphic robot based on the experience of creating the "Greta" robot. Examples of training tasks are shown.

Keywords: Robotics, Education, Cyber-Physical Systems, Anthropomorphic Robots, Control Training, Multi-Agent Systems.

1 Introduction

The purpose of this work is to study the possibilities of introducing a universal electronic-mechanical platform for creating robots and project activities in the field of cyber-physical systems and artificial intelligence into the educational process.

1.1 History/Background

In 2012, students of Physics and Mathematics Lyceum #239, under the guidance of a group of teachers and specialists from scientific organizations, created a robot of the Android type "Greta" [1], which had one main function: the hand clapping game (Fig.1). Because of a reasonable decision to minimize the requirements for the robot's mechanics and electronics, results were achieved in the field of software control of manipulators using capacitive touch sensors and computer vision elements.

2 First Stage

2.1 Tasks

The following tasks were set:

- creating manipulator hands that can interact with human hands through the touch of electromagnetic sensors,
- implementation of computer vision elements for recognizing human hands,
- implementation of speech interface elements,
- creating a positive appearance that is attractive even for a child,
- different game modes: teacher, student, partner.

Fig. 1. The robot Greta, 2012.

The Greta robot won gold medals at the WRO world robot Olympiad in Malaysia [2] and the international RobotChallenge competition in Austria [3]. This was not the only achievement of schoolchildren, and the robot "Greta" repeatedly pleased children and adults at exhibitions and festivals.

2.2 Results

Results of the First Stage:

- **t**he set goals were achieved with minimal means,
- implemented the necessary control algorithms,
- the system is optimized for Autonomous operation without an operator,
- the Greta robot has worked together for about 2 months at various exhibitions and festivals,
- there is a need to continue at a qualitatively new level,
- realized the need for a production base.

2.3 Analogues

The success of the first version of the project inspired its creators to search for new solutions. There were already a number of anthropomorphic robots for various purposes in the world. Large corporations and universities create the most impressive models, so it makes sense to consider budget projects as analogues that should be based on the experience of creating them. For the AR601M Android robot produced in Russia, a control algorithm has been developed since 2014 [4], and the function of upright walking has not yet been implemented, although according to official data, the annual total budget of the project was tens of millions of dollars. RUB [5]. Due to the objective complexity of this task, it was decided in the new version of the robot "Greta 2.0" to implement a moving system using a simpler Omni-platform and focus on the interaction of the robot's manipulators with human hands. As an illustration of the training system of the Russian manufacturer, it is worth paying attention to the RL "Mechatronics of anthropomorphic robotic systems" [6], produced in the SPA "Android Technics". The introduction of robots in the educational process is also carried out at the level of industrial robots [7, 8].

Spontaneous movements of robot manipulators, similar to human hands, are presented in the development of Japanese laboratories, which was called Alter [9]. Neural network algorithms based on data received from multiple sensors control the robot’s movements. It does not seem appropriate in itself, but it serves as a step towards empathizing with robots and using machine learning to shape their behavior.

3 Second Stage

In 2017, the Greta project was joined by a commercial company [10] founded by specialists of the creative mechanics production Studio "Life machines" [11], and the development of the next version of the robot called "Greta 2.0" was started, which should become a full-fledged educational platform for project groups of schoolchildren and students (Fig. 2).

The developers were assigned the following tasks:

- maintaining and improving the functionality of manipulator hand movement and contact with human hands,
- moving around the room on the Omni platform,
- ability to modify manipulators for actions with objects,
- functional elements of the universal promo robot,
- using computer vision and machine learning to recognize human hands and other objects,
- voice interface.

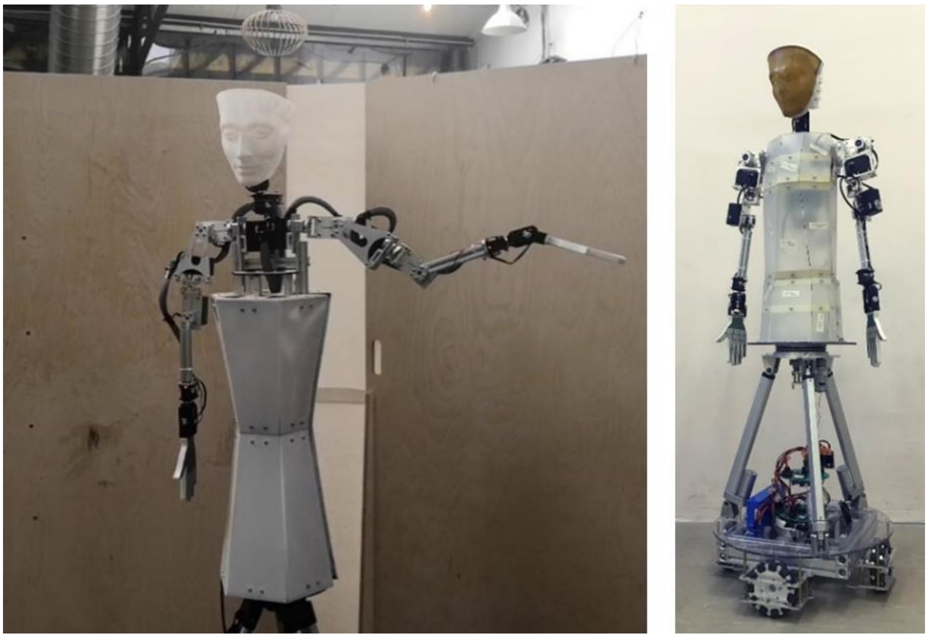

Fig. 2. Greta 2.0 robot in development, 2019.

Within a few iterations, a ready-to-use launch platform was created, providing opportunities for the development of all tasks. Currently roboblather has a number of advantages compared with the previous version of "Greta":

- consists of a small set of standardized parts,

- involves modular Assembly on nodes, as well as rapid change of shells, parts, and tools,
- provides quick replacement of modules with improved ones,
- equipped with a modular mobile platform on Omni-wheels with height adjustment,
- added additional sensors and indications for non-verbal communication (for example, increased the number of contact pads on the palm, built-in led matrix in the face),
- the modules are hand made on the basis of digital servos with feedback on position, speed, current and load.

Now, the Greta 2.0 robot platform consists of two independent parts powered by batteries.

- Torso: two reinforced arm modules (6 degrees of freedom per arm), a head module (2 degrees of freedom); the torso sensor is represented by capacitive palms, web cameras, and a 3D sensor.
- Mobile platform: the pelvis module on a support bearing (1 degree of freedom), three linear actuators for adjusting heights, four motors with Omni-wheels and encoders; the sensor system is represented by a gyroscope-accelerometer in the pelvic part, ultrasonic rangefinders, in the future it is planned to install a laser scanner.

The roboplatform based on high behavioral and design resource. In the future, it will be possible to create multi-variant designs for a wide range of tasks on the basis of easily replaceable modules, connectors and motors with a feedback system.

4 Conclusion

Thus, a universal technical platform has been created that allows connecting various teams and teams that want to contribute to the development of robotics. It is also expected that this platform will be compatible with multiple electronic components, as well as with open resources on the Internet. On the example of a robot platform, training in programming complex kinematic structures with nonlinear behavior, a control system for navigation in a room, and the use of neural networks for self-learning a robot when interacting with a person and the environment is assumed. The roboplatform is universal from the point of view of management, suitable for learning programming at different levels of complexity, since it can be controlled both with AVR microcontrollers and with TRIK robotic controllers [12, 13], as well as with single-board computers like Raspberry Pi or nettops, which are mounted inside the Greta case.

Based on the presented features, the Greta 2 robot can be classified as a socially interactive robot that can solve problems related to social interaction [15].

5 Examples

Examples of training tasks that can be solved using the Greta 2.0 robot.

- Development of a system for determining the position of human hands from images of palms using a multi-layer neural network.

- Study of the possibility of using a neural network to develop a system for determining the optimal trajectories of movements of the Android robot's limbs that repeat the movements of human hands.
- Development of a behavior model for an Android robot playing hand clapping game with a human using a neural network.
- Development of a system for synchronizing the movements of an Android robot that comes into tactile contact with a human, and research on the possibility of using a neural network to determine points of contact.
- Creating multi-agent robotic systems.

The considered robot platform has a high starting potential for inclusion in the work of educational and scientific groups. The Greta 2.0 robot can be successfully used for training in the areas of mechatronics and robotics, industrial cyber-physical systems, etc.

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