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Participation in robotics competition as motivation for learning*

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Abstract

Motivation for learning is a central problem in a modern university, since motivation is a source of activity; it performs an urging function and brings sense into education process. This article describes the influence of the robotics competitions on the student's interest in more profound knowledge of control theory and computer science. The meaning of the proposed method is to create such terms of the education process, which provide a struggle between groups of students and such competition involves equal participation for each of them.

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Keywords: robotics, education, competitions, student motivation, robotic kits.

1. Introduction

Motivation for learning is a central problem in a modern university, since motivation is a source of activity, it performs an urging function and brings sense into education process.

Motivation refers to an inner psychological characteristics of personality, shows a person's attitude toward the world and different activities (Bobtsov A. et.al. 2012, Marginson S. 2006, Alon S. 2009). Activity without motive or with a weak one is not carried out at all or highly unstable. The amount of effort that student makes his studies depends on how he feels in a particular situation. Therefore, during the learning process it is important to evolve in students an intensive and inner urge to knowledge for gaining scientific experience and practical skills.

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An element of game and competition is one of the major aspects of motivation. The meaning of the proposed method is to create such terms of the education process, which provide a struggle between groups of students and such competition involves equal participation for each of them. Effective competitions are based on the following principles. Rules should be accessible, invariable and identical for all participants. Updating of the competition results should be regular and accessible. It is also required to comply with equal conditions of competition between the participants.

Nowadays, the development of hardware and software allows us to realize in practice control algorithms developed in theory and verified by computer simulations (Bobtsov A. et.al. 2012). Experimental verification can be carried out at different elemental bases, such as robotic kit Bioloid, developed by the Korean company Robotis (Bazylev D. and Pyrkin A. 2013).

This article describes the influence of the robotics competitions on the student's interest in more profound knowledge of control theory and computer science. Thus, new skills are directly applicable to implementation in robotics practice. Motivation problems in education are described in first chapter. Features and benefits of educational robotic kits are described in second chapter. Third chapter of article is devoted to the implementation of robotic kits in education and description of the results.

2. Problem statement

Using of real robots is necessary since one of the main problems of testing control algorithms developed in theory and verified on working capacity by computer simulation is the implementation of the results in practice (Bobtsov A. et.al. 2012). Relevance of the algorithm synthesis is determined by the need to create intelligent control systems for complex technical objects: space, surface and submarine machinery and apparatus, precision electromechanical systems, injection internal combustion engines, chemical reactors, transport systems, multilink and mobile manipulators, vibrational stands, multiwheel and walking mechanisms.

Designing or upgrading of objects control systems is complicated by several factors: the uniqueness of the object itself, a very large cost and risk of breakage, as well as lack of opportunity to conduct an experiment in interaction with other subsystems under conditions close to reality (Kim, J.-H. et.al. 2009, Balch T. et.al. 2008).

Creating of robotic research complexes, which are prototypes of real technical objects, provides the necessary platform for system development, obtaining new methods and testing intellectual control algorithms based on simple analogies.

Currently, development of hardware and software allows to make an experimental verification of algorithms on different element bases and complexes, such as robotic kit Bioloid, presented on the robotics world market by the Korean company Robotis.

Evolution of robotics leads to expansion of the application areas and complexity of technology. This contributes to the emergence of creative, talented professionals who can create new ideas, implement them and improve control methods for more complex robots.

Therefore, for improving the educational process and the modernization of existing curricula it is necessary to create conditions for scientific creativity of students. Professionally trained specialists that have modern theoretical and applied knowledge will provide re-industrialization of the economy in a period of rapid growth due to in-depth career guidance of labor and the creation of high-tech new products.

Advanced research and development of high-tech industries, scientific discoveries and their commercial implementation and justification of use are fundamental reference points of the modern economy. These trends pose high requirements to level of training of professionals that have to be capable to implement the latest achievements of science and technology in industry. Therefore, mass attraction of the young generation to the engineering and design professions is necessary.

The need to solve the motivation problem is confirmed by the following facts (Luijten-Lub A. et.al. 2005, Verner I.M. and Ahlgren D.J. 2007, Gotel O. et.al. 2009, Lundström, U. 2011):

- A shortage of skilled young people at the industrial enterprises;
- Practically, there are almost no pre-university centers of scientific and technical training and creativity.

Only a few sections and groups that have no general principles of learning, teaching and technical base exist;

- Lack of acquaintance with modern industrial challenges and problems, solved by qualified specialists in

manufacturing plants, generates unawareness of specialty selection when entering higher technical schools, and as a result, produces the lack of interest in finding employment of the studied area;

- Most of manufacturing problems at enterprises are solved using obsolete tools and methods since managers and professionals with significant experience have the lack of knowledge about modern achievements.

To ensure a comprehensive approach for solving the problem designated above modernization of work for different age and composition groups should be held. It is necessary for the following reasons:

- provide information and access for children and youth to advanced achievements in science and technology, provide funds for the development of contemporary and modern knowledge and technology; highlight the opportunities and prospects of building a career in high-tech industries or implementing their own innovative projects in the field of commercial activity;
- provide educational institutions with modern teaching programs for obtaining practical skills and theoretical knowledge, that requires updating logistics, training faculty, establishing links between different research teams;
- carry out programs aimed at enhancing the image of designing and engineering professions, create a scientific and technological elite in the country and its regions.

3. The usefulness of robotic kits

Nowadays there are many robotic kits on the basis of which educational courses can be created (Fig.1): Mechatronics Control Kit, Festo Didactic, Lego Mindstorms, Bioloid, Parallax and etc.

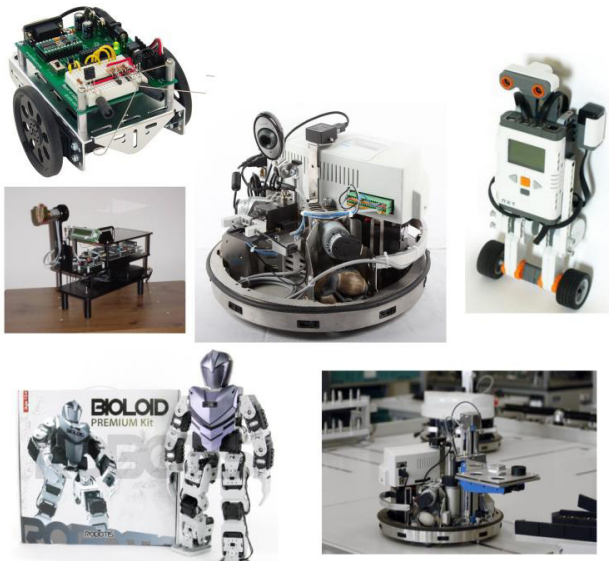

Fig. 1. Examples of robotic kits

Getting physically real results pretty quickly contributes to the formation of learners independence, developing their leadership skills, promotes a positive educational process.

Robotics also provides prestige and growth of interest in the field of engineering and design, which greatly waned recently.

Thus, the use of robotics in education will create a powerful impulse that will contribute to addressing a wide range of tasks:

- growing interest in the development and training of engineering and design directions of preparation and specialties;

- younger generation's development of the analytical type of thinking, ability to technical creativity, pursuit of achieving goals, and resistance to competition;
- to ensure public opinion acceptance of engineering and design specialties' prestige.

One of the best scientific and technical innovation competitions for the development of educational programs in Russia is annual festival "RoboFest". Before "RoboFest" festival (until 2009) there was not any support program for robotics. The main objective of the competition is to restore the prestige of the engineering profession in Russia. In 2013, the festival was attended by about 500 teams from 40 regions that participated in 19 kinds of game.

Today "Robofest" is one of the largest festivals in the world, it is also one of the national finals in international robotic competitions. Winners of "RoboFest 2014" will take part in the international robotics competition in the United States (FTC, FLL), Europe (ElRob) and Asia (ABU ROBOCON).

The main types of competitions:

1. FIRST (North American world robotic competitions).
2. ABU robocon (Asia-Pacific region robotics competitions).
3. Mobile Systems (competition of robots made in accordance with the regulations).
4. Android (android robots competition).
5. Freestyle (demonstration of designs in the categories "sports category", "creative class", "robotic assistants").
6. Hello, robot! (competition for beginners to engage in robotics). In categories: "trajectory", "biathlon", "kegelring", "walking robot."

The advantages of this program are:

- Creation of multi-level studying courses for engineers, based on a competitive model in the field of robotics for different age groups,
- Combining the basic elements of mass sports and international technical activities in a single system, the integration of the festival in international competitions,
- The establishment of branches in accredited colleges and universities,
- Preparation of qualified specialists.

4. Application of competition results and future work

Number of the University students was tasked to create a "dancing robot" for research of the movement and trajectory planning of complex mechatronic objects. To date, planning and stabilization of walking robots movements are very urgent task. These include the stability of robots standing, stable walking, down and up the stairs, moving on inclines and slippery surfaces, etc. Thus, the goal of this project is interest and motivation of students and graduate students to explore and develop their control systems for anthropomorphic robots.

Fig. 2. Competition participants

Robots competition inside the University for motivation was announced, the winners of which will go to represent University at the international competitions in China. Students were divided into teams consisting of four

people. The team captain was selected from undergraduates, the rest of the team were bachelors. The winners were selected by the following criteria: originality, the interaction between robots, the complexity of movements, synchronous execution of movements by group of robots. This competition is allowed to involve a large number of students and teach them the basics of circuit design, electronics, engineering, mechanics and programming of robots. After the tournament the winner team has begun preparations for international competitions.

Competitions were held in the following nominations:

- Athletics: sprint, marathon, steeplechase, running on stairs, weightlifting.
- Ball: Penalties, basketball, golf, soccer3vs3.
- Fight boxing, fencing.
- Gymnastics: horizontal bar, rotation, beams balancing.
- Dancing: single, double and collective dance.
- Work: garbage collection, pushing of strollers.
- Creative performance.

Criteria for evaluation of participants for each discipline were different (speed, accuracy, entertainment, etc.). For participation in the tournament team had studied some additional skills: working with artificial vision, interaction with various sensory systems (accelerometers, gyroscopes, rangefinders etc.). Also a number of additional electronic devices, expanding the capabilities of the kit was developed, and library of functions that let you control them via standard controller protocol and synchronize with other devices was written.

As a result of participation in competitions of humanoid robots in China, which is attended by more than seventy universities from around the world, robots of our student team won gold in the category of "couple dance", silver in the category "collective dance" and a bronze medal in boxing.

For today members of the team help junior students in the development and programming of robots, share acquired experience, help them to solve complex problems. Such a "connection between the generations" allows to obtain a deep level of practical skills and knowledge. Often help of senior students to younger is more effective than a consultation with teachers. This is due to the lack of psychological barriers between students which generates more open communication and a deep level of engagement in the process of knowledge transfer. Experience of responsibilities segregation and interaction during the project also helps to build teams capable to solve more complex problems and researches. Master students, that were the team captains, got experience in project management, the formation of technical tasks, responsibilities segregation and integration of all team members results. It should be noted experience of technological modernization of finished robotic platforms which allows students to implement their ideas, develop technical creativity and create products and systems that are not limited by basic configuration of elements. Such experience may be especially useful in professional activities in various industries.

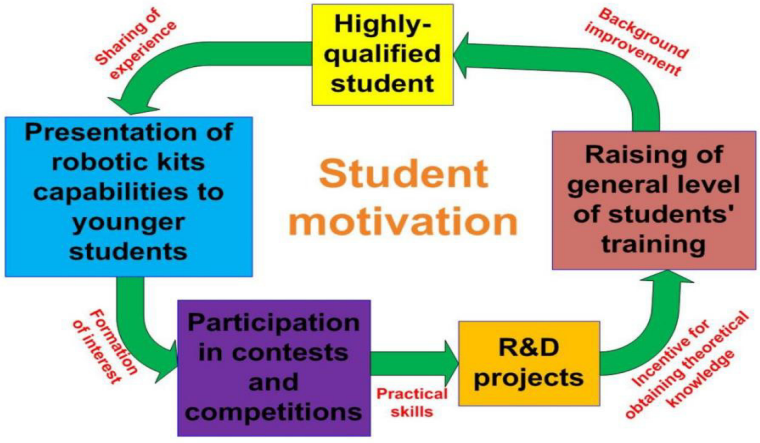

Fig. 3 – Implementation of competitions in education

In the future we plan to introduce some restrictions on participants in university competition. Only students who have successfully passed all the necessary subjects during the course will be admitted to participate in university competition. Thus, students will receive an additional stimulation to the successful passage of the bachelor and master's degrees. As a result, the competitions will increase interest and motivation not only to the subjects necessary for the development and control of robots, but also to other disciplines within the studying course, even if they are not necessary for a competitive activity, as a result will be improved quality of education in the university. As mentioned above, motivation is one of the key factors for successful preparation of highly qualified professionals with extensive knowledge, both in classical and in the most advanced fields of science and technology.

5. Conclusion

To create levers and mechanisms of learning motivation it is necessary to develop a system of competitions, rankings and challenges in robotics, which will correspond to the highest level of international competitions. System, providing competition between the participants, creates the foundation for education leadership qualities, as well as allows controlling the quality of teaching and the system as a whole.

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