MECHATRONICS MINDSTORMING WITH LEGO MINDSTORMS NXT

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Abstract: Students of mechatronic during education will get to know programming different robots and robotarms. The robot such a apparatus which use mechanics, electronics and informatics knowledge, can solve different exercises alone or programmed examples. The LEGO® kits take less place, need less protect because of plastic parts and more cheaper than other use for special example robot. It's teach the studets in form of play for building, using and programming. They can learn easily the controlling, feedback controlling, programming knowledge with the multimedia, and they will be able to use later in individual complicate exercises. The kit contain different sensors, servomotors and can controll with the central control unit. The LEGO® Mindstorms® kits can integrate and expand with Technic family.

1. Introduction

In the ancient times they knew that using different games are more efficiently help for process of teaching-learning. The Mindstorms® products alloying and using knowledge of mechanics, electronics, mathematics and informatics. Their application would be justified already in the technical high schools and the primary school's upper school. In the engineer education on the other hand essential to get acquainted with modern times robots.

It NXT sensors and actuators elements which can be found in the set is that help acquaint developable easliy feedback controlling, controlling, programming knowledge. The set is suitable for individual and group complex tasks equally. LEGO® Mindstorms® conquers increasingly bigger space into the world. Robot constructor and programmer competitions organize for different age groups for ages. [1]

2. The LEGO® Mindstorms®

The LEGO® deal with robots more than twenty years. First serial Mindstorms® was made in 1998. The 9719 Robotics Invention System (RIS) 1.0. contained 727 elements. In the set there were two motors, two touch sensors, one light sensor and an Intelligent Brick RCX unit. The brick is include one of 8 bit Hitachi processor with 16 kbyte ROM, 512 byte inside static memory and 32 kbyte outside static RAM. The RCX can communication with computer (PC, MAC) in infra red gate. That series which is sold in shops can observe three input (temperature-, touch-, light-, rotation sensor) and can control three output (motors, lamp).
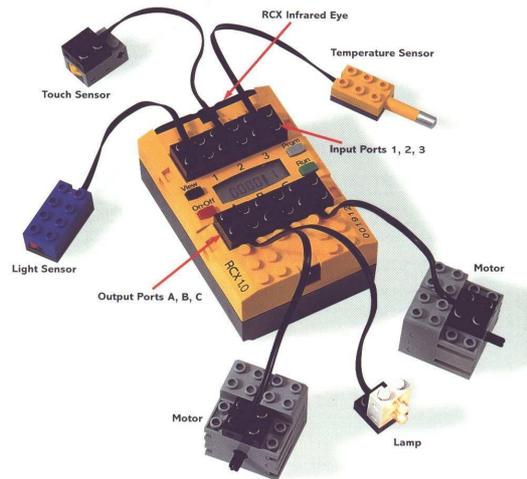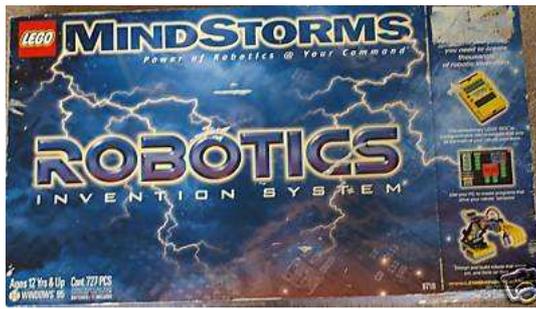
Figure 1. The 9719 RIS 1.0 [2]

The 8527 NXT more modern and more refine version was appeared in August 2006. It's contained 577 elements with three servo motors, touch-, light-, sound-, ultrasonic sensor.

| Servo motor | Touch Sensor | Light Sensor | Sound Sensor | Ultrasonic Sensor |

The product was achived the American „Toy of the Year" category of technical main award and the innovation award at toys exposition of Nümberg in category of „Technical innovation".

The new NXT contains a 32 bit ARM7 microcontroller with 256 kbytes FLASH and 64 kbytes static RAM. It's even more contains a 8 bit AVR microcontroller with 4 kbytes FLASH and 512 byte static RAM. The RIS family infra red communication was changed over to USB (12 Mbit/s) and Bluetooth v2.0 (Class II) wireless data communication. The equipment has 100x64 pixel graphic display and loudspeaker too.

The 8547 NXT 2.0 was appeared in August 2009. It contains 619 elements with combinated color sensor and touch sensor instead of light-, sound sensor.

| 8527 NXT | 8547 NXT 2.0 |

Figure 2. The NXT sets [3]

Over the NXT sets sensors compass-, accelerometer-, RF-, gyroscope-, temperature-, color-, infrared receiver-, infrared seeker and infrared link sensor are also available. [4]

| Compass Sensor | Accelerometer Sensor | RF ID Sensor | Temperature sensor | Color Sensor |

3. Programming the LEGO® robots

That built robots which was made on the basis of guide or our fantasy without a program only the multitude of constructor elements. It is possible to invest our prepared robots with interesting and exciting characteristics (among programming and physical frameworks).

3.1. RoboLab and NXT software programming surface

LEGO has made graphical programming software for RIS and NXT with help of National Instruments company it together and developed and realised with the LabVIEW software.

It is possible to prepare without bases of programming knowledges the controller programs. It is not necessary to care about many complicated parameters, it's enough to place icons (constructor elements) side by side and join them. Learning the brachs, cycles and delays does not cause a problem, these are in a graphical form in the developer environment. The flowchart is ready with the completion of the program simultaneously, help for us in understanding. The main graphical software runs on Windows and MacOSx operation system. Compared to the traditional programming languages forming strange, the more serious programs already cannot be reviewed. The finished program runs slowly and use much memories!

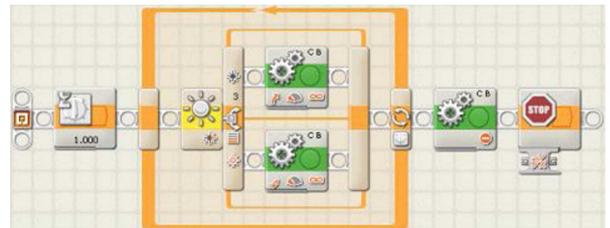*Figure 3. Programming with RoboLab [4]*

Figure 4. Programming with NXT-G [5]

3.2. Other programming languages

The programming of the robots to apply other more complicated softwares too.   Each developer software contain different advantage-disadvantage so everyone can found the most ideal.

The NBC/NXC [6]
Language pair one which can be download free. The two programming languages were being made for skilled programmers. NXC the higher-level one, to C programming language his name shows the similarity of truth and his diference (Not eXactly C). NBC (Next Byte Codes) NXT is equal to the byte code of a unit. The result received code 25 times faster, smaller size, than the NXT-G with software.

NI LabVIEW Toolkit [7]

This an accessory for NI LabVIEW programming language. Graphical surface, but language a much upper level, which it is in a basis supply, can be found. Significantly more opportunity offer. This toolkit expands by related devices with NXT the VI palette (engine, sensors, Bluetooth mailbox, etc.), that is directly can be programmable NXT with LabVIEW.

The leJOS [8]

This is base on Open Source JAVA operation system. Exist two version for RCX and NXT because different hardware. The NXT version is leJOS NXJ. The robot in JAVA related NXT makes the running expanded opportunities of programs. It does not imply independent developer environment. This is plugin for Netbeans and Eclipse software. Language can be download free and support all of the forms of communication Bluetooth. It replaces NXT operating system. Due to this single small Java a virtual machine appears on the robot. The program can be run on Windows, MacOSx and Linux on an operating system.

The RobotC [9]

Mainly for programming of robots, currently only can be run under Windows operating system, a programming language which can be used gratis until one month.

Our program written in this language can be optimized very quickly, close real-time runable speed. Handle local variables and global variables too, and support the basis trigonometric functions. Make 130 times faster code than NXT-G.

4. Mechatronics education with Lego Mindstorms

We can meet all of life area with robots for example manufacturing process, show-business, household made. Very important things to know different modern robots and robotarms the mechatronic engineer students in studying. The robotic use simultaneously artifical intelligence and remote control. It collects sensors information and to consider action, if necessary can criticize over with remote control. The students are study in higher learning different subject from built, kinematic, control of robot. Unfortunatelly students programming knowledge isn't homogeneous therefore we must teach with easly understand and understandable equipment. The LEGO® Mindstorms® NXT is absolutely support.

The wrong programming or command execution more easily understandable through a moving, sound giving robot, than the data announced on the screen. The mistake explorations deriving from the bad reaction of the robot much better are fixed, more knowledge can be acquired under shorter time.

The classic teaching-learning construction of methodological education changes with the usage of these devices. The educators', instructors' role moderates onto the proposition of the problem and a coordinator role. The listeners draw up the workflows, each other alley the works to be done are divided up, they communicate with each other, and the results are summarized jointly, it is presented concerned.

The work made jointly may affect the communicational skills advantageously, since their thoughts, their ideas have to be formulated understandably for the others. The presentation of task is very important part of the process, since each other's strengths and weaknesses are recognised. The lectures formulated verbally, with proper profession essential and ideas, stimulation may be added to the even better problem solving [10].

Figure 5. Made robot from NXT [11]

5. Robot Compeptitions

RCX which appeared in 1998, then NXT was the basis of numerous robot constructor competition, the regulation of competitions existing already earlier was transformed into this special building environment. From among a number competition we present widespread competitions shortly among the primary school and high school students.

FLL, First LEGO League
The competition only announced in USA originally grew into a widespread robot competition mostly in the world. The competition announced for the ones with 10-16 year ages demands serious teamwork, 5-10 students work on a common project together. The teams may get organized freely, is not needed to link a school, indeed to a settlement. The team's leader may be one person who filled his 18th year. The students have to make research work according to granted viewpoints. Their results and proposal solutions found his way out onto the recognised problems have to be presented on the competition in 5 minutes. According to the exact description of the robot task, a robot built by the team individually has to solve around a dozen problem along 2,5 minutes, maybe at what more correctly. The viewpoints of the assessment: teamwork, velocity, implementation, programming. [12]

Robot Sumo
This competition is following the principles of the traditional sumo sport. For the robots prepared by the participants have to fight each other on a battle-field (disk painted onto some cm of tall mat black with a diameter of 1220 mm, the dojo which one 50 mm of wide circular white ring borders). The victorious robot has to push the adversary out from the battle-field. At the time of setting off the robots onto the sumo battle-field it is placed from each other 300 mm far, onto an equal distance from the centre of the battle-field (cca. 150-150 mm far from the centre). The robots can find along a straight, and all may take the road into a contrary direction with the other one. The robots have to search for the adversary actively and no admition to roll the adversary immediately.

The competition consists of more rounds. All rounds last at most three minutes. An attack may not be longer than one minute. The robots have to fit into a 305 x 305 mm square and 0,91 kg! [13]

6. Summary

LEGO® MINDSTORMS® application appears justified in the education of the mechatronic. Recognising this in all more advanced countries deal with the programming of LEGO® robots between frameworks a some kind of level. In our country increasingly in more middle and higher education institution is available in the training of the informatics and the mechatronic because of his price. Countless areas may be conquered in the future and the artificial intelligence, algorithm theory, image processing, formation recognition, communication, game theory may turn into the important devices of researches.

Abroad and in our country increasingly more programming-, building competition are organized motivating the students for achieve a right result. In the competitions and the project tasks the students can be motivated, they learn to collaborate, to communicate with each other on vocational language. The acquired knowledge is applicable excellently in the later employment.

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