Software environment to teach programming of robots

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Abstract

This article discusses the issue of selection of suitable software environment for programming the robots needed for university studies. Educational robots are two types of Lego Mindstorms NTX2 and Lego Mindstorms EV3.

1 Introduction

The practical applications of artificial intelligence robots as more "conquer" the world with their possibilities to be used in many fields of people's lives. The interest on these derives from their opportunities to relieve replacing them when performing routine and / or dangerous activities.

This requires the search for suitable forms and means for organization and conduct of training in universities. Curricula should offer opportunities for acquiring technologies and tools for development and Robots control.

Subject of this report is the choice of suitable software environment in training on robot programming in the course "Artificial Intelligence". There are a lot of of hardware platforms - robots for training and environments for their programming.

Our university has two models of the robot Lego Mindstorms NTX and EVE. Choosing the right software training on "Robots" from the course "Artificial Intelligence" is an important issue for the effective and organized process of teaching. It depends on the interest and successful absorption of knowledge in the field from the training students.

2 Programming environments for robots

The article examines environments for programming the robots that are available and correspond to the objectives of the course "Artificial Intelligence". It's explored a variety of software environments, but limited part on them are subject to the description.

2.1. HARDWARE FEATURES ON THE TRAINING ROBOTS

Before being characterize the software environments for programming the robots need to review their hardware peculiarities.

Table 1 shows the hardware features of robots used in the teaching of "Artificial Intelligence".

TABLE 1 Hardware features of LEGO robots

FEATURES	ROBOTS	
	EV3	NXT
Display	Monochrome LCD 178 x 128 pixels	Monochrome LCD 100 x 64 pixels
CPU	300 MHz Texas Instruments Sitara AM1808 (ARM9 core)	48 MHz AtmelAT91SAM7S256 (ARM7TDMI core)
Memory	64 MB RAM 16 MB Flash microSDHC Slot	64 KB RAM 256 KB Flash
USB ports	YES	NOT
Wi-Fi	Optional dongle via the USB port	NOT
Bluetooth	YES	YES
Link to Apple devices	YES	NOT

Lego Mindstorms NXT 2.0 (Figure 1) is the second of Lego Mindstorms LEGO series from 2009 [4]. The kit comprises a plurality of parts including a new sensor which can detect the colors. Lego Mindstorms EV3 (Figure 2) is a third-generation robots Series LEGO Mindstorms. It is the successor of the second generation robot Lego Mindstorms NXT 2.0 [3]. In the "EV" is the definition of "evolution" series of NXT. "3" refers to the fact that this is the third generation of Lego Brick. EV3 has better performance compared with the previous model NTX 2.0, which can be seen in Table 1.

Robot kits include a multitude of parts [1, 2], through which they can assemble different configurations. Electric motors are available to allow their smooth movement. They possess various sensors that can be programmed for implementing the complex algorithms. These are: Color sensor - the sensor for detecting color 6 different shades: blue, green, red, yellow, white, black; Light sensor - light sensor recognizing light levels. (Included in the first version, but in 2.0, replaced with a color sensor.); Touch sensor - is a button that through which the robot senses touch him; Ultrasonic sensor - ultrasonic sensor for measurement of

distances by ultrasonic waves; Sound sensor - this "hearing" the robot capable of measuring the volume, but cannot record real sounds; Compass sensor - used to detect direction with integrated calibrator to reduce interference from objects with magnetic properties; Accelerometer sensor - serves to monitor the direction of movement of the surface and can be measured force of gravity; RFID - radiosenzor communication between several robots; Rotation sensor - rotation sensor measures the direction of rotation; Bluetooth - used for wireless communication with other devices such as access to written to a computer or other device and program data

FIGURE 1 Lego NTX

FIGURE 2 Lego Mindstorms EV3

2.2 PROGRAMMING SOFTWARE FOR ROBOTS

Have been developed a variety of languages and environments for programming robots. Only a small part of them are the subject of the article and are mainly related to robots series Lego. The opportunities for programming via the control unit of robots called "smart brick" are limited, especially for NTX 2.0. Elementary commands can be created by this block. In complex programs need to be developed on a PC and transferred for execution via the USB port in that block.

The choice of a suitable environment for programming could be done using the generalized characteristics shown in Table 2. The table shows some of the environments in which it is possible to train students for programming of different types of robots, including the series Lego Mindstorms. At the end are shown links to more sources of information for other media included in the exhibition.

TABLE 1 Environments for programming robots

Software environment	Characteristic						
	Platform	**Interface**	**Integration**	**Training**	**Convenience of use**	**Price**	**Additional information**
actor-lab	Mac OS / MS Windows	graphic	unknown	easy	excellent	free	
NXT-G	Mac OS / MS Windows	graphic	unknown	easy	excellent	Included in the kit	Provides a kit
LabVIEW Toolkit	Mac OS / MS Windows / UNIX	graphic	National Instruments LabVIEW visual programming language (G code)	hard	excellent	There are no data	
Lego::NXT	Mac OS / MS Windows	graphic	unknown	easy	excellent	Included in the kit	API offers between Perl and NXT
ROBOTC	MS Windows	graphic text	language C	medium hard	medium	1 year license - $49	Includes built-in debugger, code templates mat. / Triglyceride. Built-in functions and sample programs.
RoboMind	Mac OS / MS Windows /	Text editor and	The software of Lego	easy	excellent	1 account - 10 € (offline) and 5 €	Using simple scripting

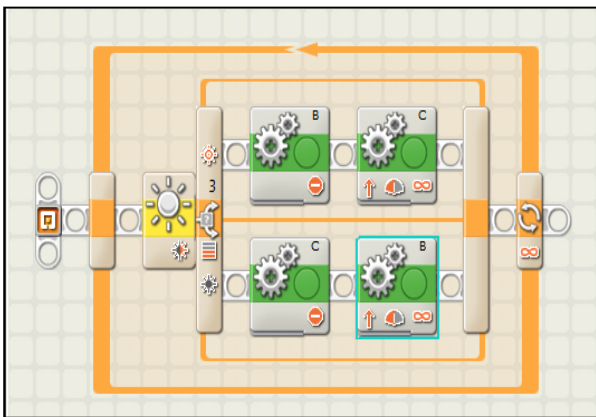|							
	LINUX	graphics in general IDE	Mindstorms NTX and EV3			(online students)	language similar to C / C ++ and JavaScript
MATLAB and Simulink	Mac OS / MS Windows / LINUX	Text and graphics	Variety of options	a moderate hard	excellent	a paid	Many control facilities over USB ports robots
Microsoft Robotics Developer Studio (Microsoft RDS, MRDS)	MS Windows	Graphical interface, web interface and language for 3D simulation	Visual programming language for Microsoft Visual Programming Language, a link to the C # and more. .NET Languages.	medium hard	excellent	he paid version and a free academic	Environment controls and simulation of robots for academic, amateur or professional development.

FIGURE 3 Program NXT-G

```
define SpeedSlow 50
#define SpeedFast 100
int SV;
task main() {
int Threshold1=600;
long t;
// It will set the sensor
SetSensorType(IN_3, IN_TYPE_LIGHT_ACTIVE);
SetSensorMode(IN_3, IN_MODE_RAW);
while (true) {
// Reads the value of the light sensor
SV = SensorRaw(IN_3);
// Check whether we are on the black line
if (SV < Threshold1) {
//Looming on the motor A to move quickly and motor B to
move slowly, causing rotation of the robot..
OnFwd(OUT_A, SpeedFast);
OnFwd(OUT_B, SpeedSlow);
}
else {
//Set of motor B to move quickly and motor A to move slowly,
causing rotation of the robot.
OnFwd(OUT_A, SpeedSlow);
OnFwd(OUT_B, SpeedFast);
}
}
return
```

FIGURE 4 Program to pursue a line through

The programming can be shown by a classic task in which the robot is to soak line [5, 7].

Figure 3 shows the implementation of the programming language - NXT-G, and the next Figure 4 decision of NXC. The workflow can be described with the following steps:

1. The robot rotates in one direction while the light sensor does not detect the black line.

2. The robot begins to rotate in the other direction until the light sensor no longer detects the black line.

Colored in yellow block checks the value of the light sensor and performs two green blocks. Green blocks drive motor (movement), either stop them or place. Language Not eXactly C - NXC requires some experience with programming and is quite powerful (Figure 4).

Microsoft releases free tool Robotics Developer Studio (RDS) [6] for programming and modeling the behavior of robots. RDS supports some of the most popular robotic platforms, including iRobot Create, LEGO Mindstorms, EV3, Coro Wareand Parallax. The product, which contains a visual programming interface and three-dimensional simulator is intended for amateurs and for researchers and developers.Previously, there were three versions of the product - Free with limited functionality, commercial and educational institutions. 2007 RDS is downloaded half a million times. Assessment of the corporation, the package is used by 60,000 active users and the free version is called to increase this number. Microsoft Robotics Developer Studio (MRDS) [6] provides integrated .NET (Microsoft .NET Framework is a platform that provides a programming model, a set of classes and execution environment written especially for her program code) environment for developing, designing, implementing and debugging applications and robotics. MRDS makes work with software problems present in robotics as coordination, monitoring, configuration, deployment and reuse. There are high on Visual Programming Language (VPL), which uses a programming model based control of the flow of data in a graphical environment. VPL is suitable for programming at the same time in parallel or distributed processing scenarios.
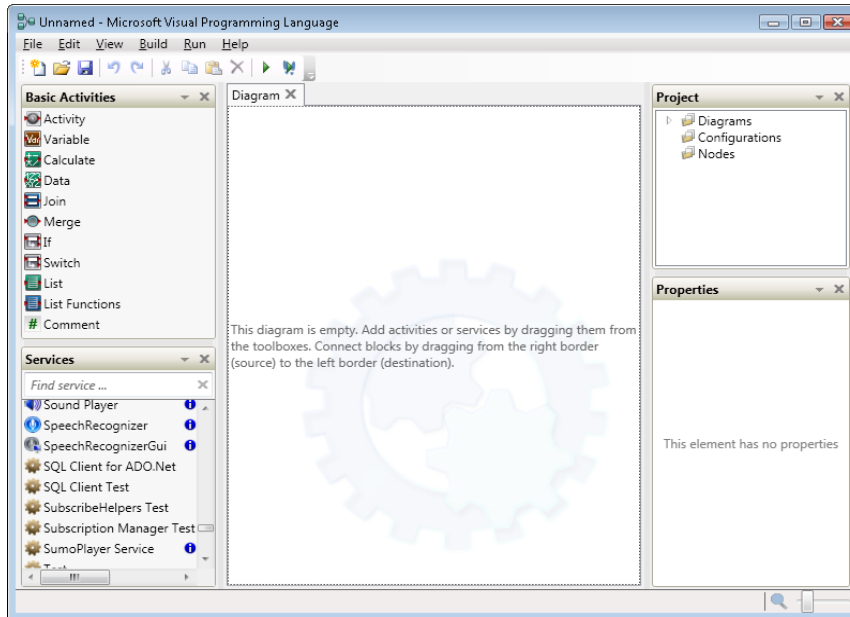
FIGURE 5 View of the main window of VPL

Window of VPL (Figure 5) shows the menu bar and toolbar commands and access to the central part of the scheme, and several tabs, including toolbars that display a list of built-in data and services available (pre-written code which performs functions) that can be used in the project; the current contents of the project (diagrams and configuration files), and a section to edit the properties of selected items. When developing applications using drag-n-drop elements.
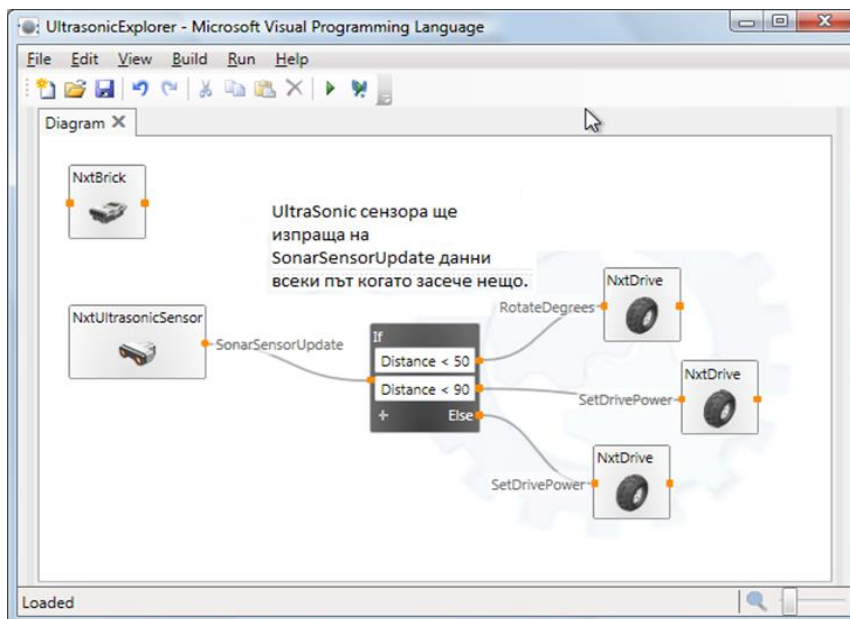

FIGURE 6 Sample program implementation of VPL

It is possible to add a new activity by double-clicking the item from the menu. Retention mouse over any item in the toolbar will display information related to a given element. If the element also includes an icon "I" (information), i.e. provides additional information.

Robots series LEGO MINDSTORMS, using Bluetooth and USB communication between PC and NXT. Robots can build different configurations. MRDS supports both existing hardware and in simulation with great ease to program the included Microsoft Visual Language. Figure 6 shows an example fragment of program implementation.

3 Conclusion

Of the the analysis it can be confirmed that the environment NTX-G is suitable for introduction to the programming of robots in the course "Artificial Intelligence". It has built-in intelligent block of the series robots Lego. Very helpful tool for further study of the programming of robots is Microsoft Robotics Developer Studio (MRDS). Along with the ability

to easily learn and use, friendly interface, MRDS has much greater opportunities for integration with the .NET platform and languages: C / C ++, C # and more. This would give students the hands of a powerful tool for modeling and programming of a serious and significant practical projects. This environment can be successfully used not only for series LEGO® MINDSTORMS® NXT robots and EV3, but also with many other models.

References

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