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Chapter 2: The platform Lego Mindstorms NXT

Introduction

In this chapter you will learn the platform Lego Mindstorms NXT and the Open Source project LeJOS to develop software for robots with Java. In this chapter you will learn other alternatives in the market and other alternatives to develop a NXT Brick.

Lego Mindstorms NXT

Lego Mindstorms is an educational product designed by Lego to build robots. The product has evolved along the time and currently Lego Mindstorms NXT is the third generation of the same product.

History

To now the past and future of this platform, it is necessary to know the history of this product.

1988:
In collaboration between the LEGO Group and Massachusetts Institute of Technology (MIT) begins on development of an "intelligent brick" that will bring LEGO creations to life via computer programming.

Illustration 1: Intelligent Brick

1989:
Dr. Seymour Papert, of Massachusetts Institute of Technology's Development Laboratory of Computer Learning becomes "LEGO Professor of Learning Research."

1998:

LEGO MINDSTORMS and the Robotics Invention System are unveiled to the public at Toy Fairs in Nürnberg, London and New York.

1998:
RoboTour™ '98 launches from the Chicago Museum of Science and Industry, kicking-off a two-month, 30-city odyssey across America in search of learning about and seeing everything robotic.

Illustration 2: Lego Mindstorms RCX

1999:
The Robotics Discovery Set™, a derivative of the Robotics Invention System allowing users to program right on the smart brick instead of through the computer, and the Droid Developer Kit™, a pre-programmed, remote controlled constructible robot kit, are unveiled at the International Toy Fair in New York.

The Robotics Discovery Set, Ultimate Accessory Set, Droid Developer Kit and the Robotics Invention System 1.5 are released in the United States. The Droid Developer Kit and the Robotics Invention System 1.5 are released in Europe and Asia, and The Robotics Discovery Set and the Robotics Invention System 1.5 are launched in the United Kingdom.

2000:
The Robotics Invention System 2.0, Dark Side Developer Kit™ (a preprogrammed, remote controlled constructible robot), Vision Command System™ (a PC camera expansion kit for the RIS) and Exploration Mars™ (themed robot challenges, building instructions and games for the RIS) expansion set are unveiled at the International Toy Fair in New York.

The Robotics Invention System 2.0, Dark Side Developer Kit and Vision Command System are released in the United States.

2001:
SpyBotics, a spy gaming-oriented series of remote controlled and programmable robots, are unveiled at the International Toy Fair in New York.

2006:
The next generation of LEGO MINDSTORMS robotics is unveiled at the International Consumer Electronics Show.

Illustration 3: Lego Mindstorms NXT

2009:
Lego launchs Lego Mindstorms NXT 2.0 with a better commercial kit, but the hardware is the same.

What is a NXT Brick?

The NXT brick is the control unit in the Lego Mindstorm kit. It's an intelligent computer brick that lets a robot come alive and perform different operations.

Any NXT brick has the followin parts:

Actuators:

Motor ports
The NXT brick has three output ports for attaching motors - Ports A, B and C

Illustration 4: NXT Motor

Loudspeaker
Make a program with real sounds and listen to them when you run the program

NXT Display
Your NXT comes with many display features - see the MINDSTORMS NXT Users Guide that comes with your NXT kit for specific information on display icons and options

Sensors:

Sensor ports
The NXT has four input ports for attaching sensors - Ports 1, 2, 3 and 4.

NXT Buttons
Orange button: On/Enter /Run
Light grey arrows: Used for moving left and right in the NXT menu
Dark grey button: Clear/Go back

Communications:

USB port
Connect a USB cable to the USB port and download programs from your computer to the NXT (or upload data from the robot to your computer). You can also use the wireless Bluetooth connection for uploading and downloading.

Bluetooth
NXT Brick has a bluetooth chip embebbed in the board to connect with other bluetooth devices as a Laptop, GPS or a Mobile phone.

Zigbee
NXT brick has the option to communicate your NXT brick using a Sensor from the provider Dexter laboratories, NXTBee

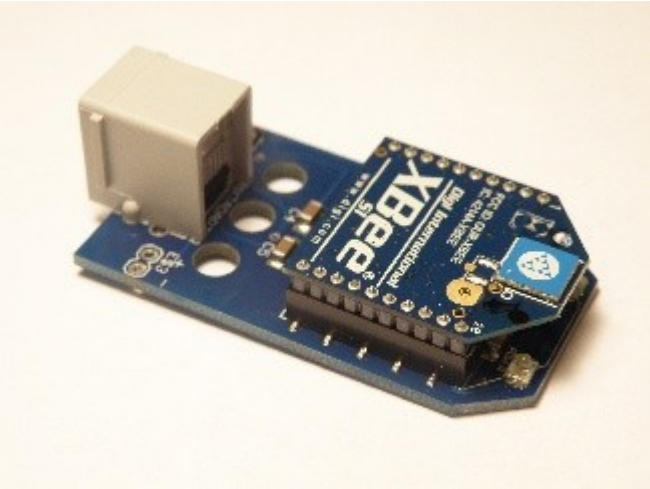

Illustration 5: NXTBee

Technical specifications of NXT Brick

NXT Brick has the following Specification:

- 32-bit ARM7 microcontroller
- 256 Kbytes FLASH, 64 Kbytes RAM
- 8-bit AVR microcontroller
- 4 Kbytes FLASH, 512 Byte RAM
- Bluetooth wireless communication (Bluetooth Class II V2.0 compliant)
- USB full speed port
- 4 input ports, 6-wire cable digital platform (One port includes a IEC 61158 Type 4/EN 50 170 compliant expansion port for future use)
- 3 output ports, 6-wire cable digital platform
- 100 x 64 pixel LCD graphical display
- Loudspeaker - 8 kHz sound quality. Sound channel with 8-bit resolution and 2-16 KHz sample rate.
- Power source: 6 AA batteries

Bricks or TETRIX pieces

When you begin to develop robots with the platform Lego Mindstorms NXT, you usually develop small robots for indoor environments, but if you continue developing projects with this platform it is normal if you develop bigger robots with more weight.

Lego Mindstorm has a product designed to develop strong physical structure, the product is TETRIX.

Illustration 6: TETRIX Kit

With a TETRIX Kit you can develop bigger robots with stronger structures. The kit includes a Servo and DC Motor controller for Lego Mindstorms NXT.

Software platforms for Lego Mindstorms NXT

Introduction

Lego Mindstorms NXT Kit includes NXT-G a graphical programming environment to develop software for the platform. This platform is a real success with newbie users but we don't recommend to use for complex projects.

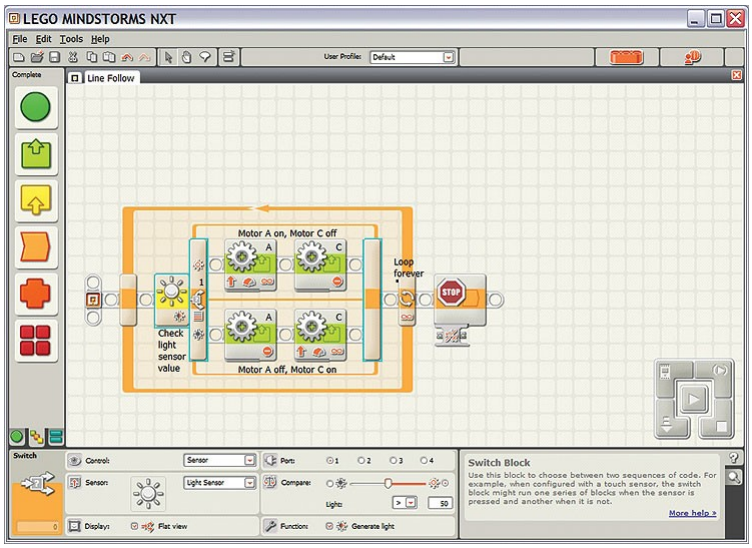

Illustration 7: NXT-G

NXT-G is easy to use to develop simple projects or to develop the programs to solve **FLL** but if you want to develop a project to drive a robot autonosmously with GPS with a conection with a mobile phone, NXT-G is not the best option.

To solve complex project we recommend LeJOS project the way to develop with Java on Lego Mindsotrms NXT.

LeJOS Project

LeJOS is an open source project created to develop a technological infrastructure to develop software into Lego Mindstorm Products using Java technology. LeJOS project offers support for Lego Mindstorms NXT and previous product, Lego Mindstorms RCX.

With LeJOS Project you can develop software for NXT brick using a set of Java or develop a distributed solution which you have some software running in your laptop and other part in your NXT brick.

Others alternatives

LeJOS project is one of the options to develop software for robots which use Lego Mindstorms NXT as hardware platform but exists others alternatives in the market.

Some alternatives:

1. NXT-G
2. RobotC
3. NXTOSek

4. NXC/NBC

Alternatives for Lego Mindstorms NXT

In the market exists others alternatives for Lego Mindstorms NXT kit. The following list has the most active alternatives:

1. Vex
2. Arduino
3. ADK + Android
4. Jstamp

If you study the market in detail, you will notice that the only serios competitor for the product Lego Mindstorms NXT is Arduino.

Arduino platform
Arduino is a great project and it has nice features as:

1. IDE to develop software for Arduino
2. A functional programming language to develop software. Similar to C.
3. The possibility to expand the hardware features with homebrew electronics
4. A good price
5. Large developer community
6. Multi purpose platform

Arduino is good generic platform for guys who like electronics and it can be used in several projects, but Lego Mindstorms NXT is oriented for robotics and software.

Other alternatives

Lego Mindstorms NXT is a nice platform to teach basic course about robotics but in real life exist other alternatives to continue developing with Java. Some alternatives are:

1. JavaClient for Player/Stage/Gazebo
2. Aria library with Java Wrapper for MobileSim

In both cases, it is possible to continue developing software with Java.

JavaClient for Player/Stage/Gazebo
JavaClient is a Open Source project developed to develop Java Software for the Simulator 2D & 3D Player/Stage/Gazebo. The simulator Stage is 2D and Gazebo is 3D.

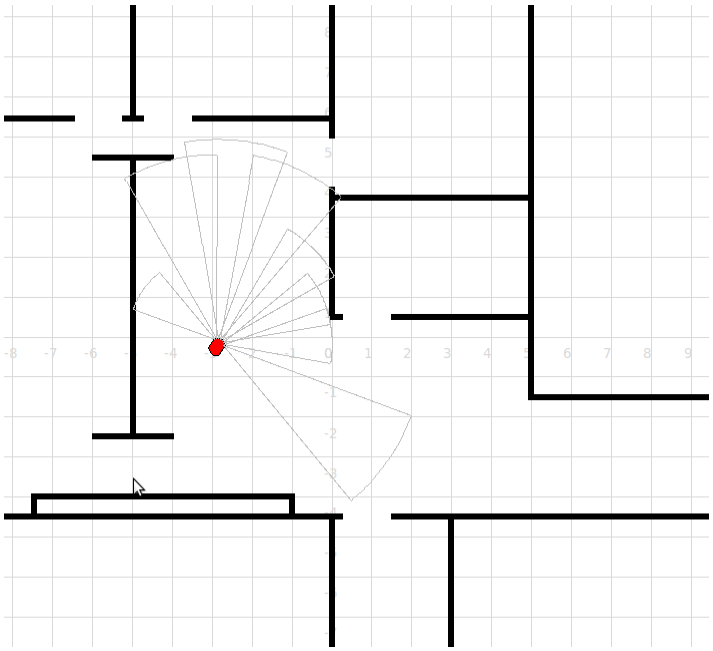

Illustration 8: Player/Stage with JavaClient

Aria library with Java Wrapper for MobileSim

MobileSim is a 2D Simulator from Mobile Robots Inc. This simulator can be developed by Java using the Wrapper from the libraries Aria, ArNetworking & ARNL

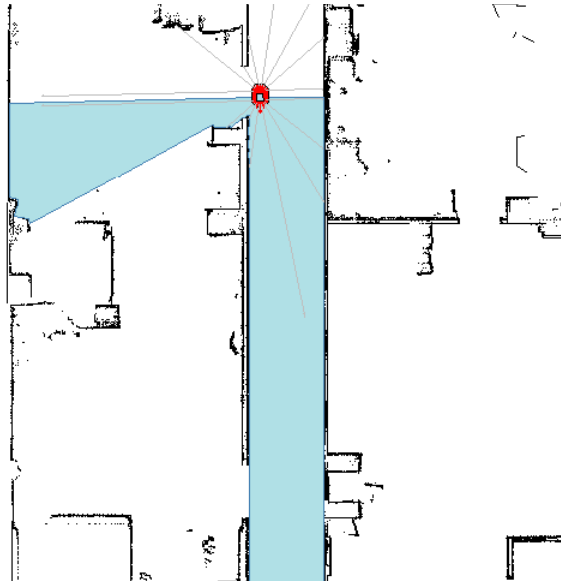

Illustration 9: Aria and MobileSim with Java

Summary

In this chapter I tried to show the following concepts:

- Lego Mindstorms NXT is a platform to learn basic concepts about robotics and artificial intelligence.
- LeJOS project is a platform to develop software for Lego Mindstorms NXT using Java.
- LeJOS project has excellent documentation about the leJOS packages.
- LeJOS project can be used in any project which uses a NXT brick.
- LeJOS project is the unique platform for Lego Mindstorms NXT which is able to manage software in a PC and NXT with the same programming language.

Every hour with leJOS is a hour with Java. If you learn Java so you can learn OOP techniques and you could develop software for Servers, Desktop, Mobile phones and new devices which include a Java Virtual Machine.

Exercises

If you read the chapter and you want to contine with this ebook, do the following tasks:

1. Install Ubuntu on a laptop, notebook or computer
2. Get a Bluetooth dongle and conect with your ubuntu system
3. Install Java in your Ubuntu system
4. Install latest LeJOS release
5. Download and install Eclipse
6. Install LeJOS plugin for Eclipse

Note:

Use annexes.pdf to install Ubuntu, Java, LeJOS and Eclipse

Improve this chapter with your opinion

Send your thought to bren [at] juanantonio [dot] info to improve the ebook

Interesting links

If you want to read more about concepts and ideas covered in this chapter, the following list or URLs will help you in this sense.

http://dexterindustries.com/NXTBee_Pro.html
http://www.tiobe.com/index.php/content/paperinfo/tpci/index.html
http://www.teamhassenplug.org/NXT/NXTSoftware.html