Develop Educational Robots with Java Step by Step

Version 0.9

Juan Antonio Breña Moral

6-Oct-11

Table of Contents

History

This section show the evolution of this project

- **0.1 (12/01/2008)**
  Initial Release
- **0.2 (18/2/2008)**
  Add FAQ Section
- **0.3 (09/03/2008)**
  Add support for SVN using torotise
- **0.4 (23/6/2008)**
  Add project about RC Car
- **0.5 (20/3/2009)**
  Refactor the book
- **0.6 (10/04/2009)**
  Add support for RS485
- **0.7 (16/08/2009)**
  Add support for Linux environments
- **0.8 (30/12/2009)**
  Change the title
  Add BlueJ support
- **0.9 (26/7/2011)**
  Refactor the whole book

Preface

Introduction

The line of products Lego Mindstorms are an excellent hardware platform to learn concepts about **Robotics** and others fields as Engineering, IT Technology and Electronics. With the time, this platform has reached a huge popularity in many educational segments as High School and University and now it is considered the facto standard to teach this fields in a interactive way.

This platform has his own software to operate using a visual programming language, NXT-G which is really useful to understand basics concepts about robot programming and it is a right way to get results quickly but in my personal opinion, this approach is not really useful to solve complex problems and others alternatives are better for this purpose. In this point, one alternative is **LeJOS project** an Open Source project created to develop a Java virtual machine and a API designed to develop your own software for robots using the programming languaje **Java**. This ebook covers Java and LeJOS project to develop software for robots.

Since 2008, I have been working in this educational project to help Mindstorms Community to solve many doubts about how to use the product Lego Mindstorms NXT and how to use Java in your projects. I remember when I bought my first Lego Mindstorms kit with the brick RCX inside and I didn't have many ideas about how to create my first projects and Internet didn't have many solutions. In that days, build software for robots was very hard. Now exist several sources of information and alternatives and this is the new challenge for newbie: What is the best alternative to learn?

In last 2 years, users has more alternatives in the market to develop robots as Arduino, Bioloid & ArDrone but in my personal opinion, I continue recommending Lego Mindstorms NXT as the first way to explore robotics at secondary school, university bachelors, and postgraduate programs / Phd.

In next 10 years, **Robotics** will become in one of the most helpfully technology for the society. Currently, robotics field is not in a mature phase and it needs new ideas to evolve but this goal is not easy because robotics is a complex science and it has several research lineas as as Localization, Computer vision & Neural Networks for example.

This ebook is a project to spread the knowledge about Java programming for robots using the platform Lego Mindstorms NXT as the main platform and the API from leJOS project to develop software for robots. This ebook is live and every 3-6 months, I will try to update with new ideas and techniques from the projects and the readers.

Enjoy, Learn, *Contact with me* to improve the eBook and share ideas.

Juan Antonio Breña Moral.
www.juanantonio.info
@juanantoniobm

Audience

The ebook has been written to be read by the following kind of users:

- Lego Mindstorms users
- LeJOS Developers
- Java Developers
- Teachers who teach robotics courses
- Students in Secondary School
- Students in University
- Students in Postgraduate/PhD programs
- Scientific
- Engineers
- Robotics hobbyist
- Electronics hobbyist

Organization

The ebook has been organized in the following chapters:

Chapter 1: Introduction to educational robots
This chapter will show the reader the state of art in educative robotics.

Lego mindstorms NXT

Chapter 2: Lego Mindstorms NXT
This chapter explains the platform Lego Mindstors NXT. The chapter explains the origins, history and other stuff about this platform.

Chapter 3: LeJOS project
This chapter explains the LeJOS Project, API, Tools, Project structure and how to begin to develop with Java and LeJOS API using Eclipse.

Chapter 4: Learn Java to develop Robots with Java
This chapter explains basic concepts about Java for robotics. This chapter is not a Java course but connect Java knowledge with robotics.

Chapter 5: Sensors
This chapter explains how to use sensors from NXT Kit or sensors from NXT providers as Mindsensors, Hitechnic, CANCAN and others.

Chapter 6: Actuators
This chapter explains how to use actuators. This chapter includes NXT Motors, PF Motors, Servos, DC

Motors and RCX Legacy Motors.

Chapter 7: Communications
This chapter explains how to use Bluetooth, USB, RS485 & I2C Protocols.

Chapter 8: Local Navigation
This chapter explains how to use latest local navigation API in LeJOS and advanced features as Montecarlo localization.

Chapter 9: Global Navigation
This chapter explains how to use GPS to create autonomous robots in outdoor scenarios

Chapter 10: How to expands the possibilities of your NXT brick?
This chapter discuss how to expands your NXT brick adding more features using other technologies as Arduino and Mobile phones with Android

Java Programming

Chapter 11: Manage your brick from your PC
This chapter explain the way to manage your robot using a PC.

Chapter 12: Human-Machine Interaction
This chapter will show how to control your robot using a Joystick, Gamepad or a Kinect device.

Chapter 13: ROS for Java
This chapter shows how to use your brick with ROS Platform

Parrot AR.Drone

Chapter 14: Introduction
This chapter will show the platform **Ar.drone** and the **Java** project: **javadrone**

Changes in relation to previous releases

In this release exist many changes in relation to previous release due to:

1. **Modular format.**
   Now, you download the ebook in a zip file which includes the whole book organized in small PDF documents. For maintenance purposes, it is better to update chapters with small sizes that maintain big documents. With this change, ebook is modular and students and teachers can print chapters easily

2. **Focus on Ubuntu.**
   When I started studying my Master for PhD in robotics, I learnt more advantages on Ubuntu

than Windows so this release, leave Windows support. Anyway, I will add in some part of the ebook some legacy comments about Windows.

3. **Java for Robotics in PC side.**
   In last years, I have thought about the possibility to use notebooks in LeJOS projects and other projects about robotics which include a PC in the architecture. In previous releases I focused in Java for embedded environments, for example NXT bricks, but now I think that it is compatible to use NXT bricks with a Notebook in the same physical platform.

4. **Java way.**
   In this new release, I will put focus in the educational way to learn Java and how to apply Object Oriented Programming in robotics projects. I think that it is very important to teach Java in a right way to do robust projects.

5. **Integration with other projects.**
   In this release, we will learn how to integrate with other platforms as ROS, Arduino, Android or Ar-Drone with Java

Comments & Questions

Please, I would like to receive your feedback about the ebook to improve it. With last release, I have received more than 3000 downloads and every week I receive many mails about comments, doubts and proposals around the world. Please send me your feedback to improve this project.

Acknowledgments

This Project has been possible with the help and support of my family and friends as Antonio Tejero, Bruno Piñeiro, Isaac Olmos, Marina Perez, Eva Perez, Michael Petichaki & Eftychia Petichaki. I have to congratulate to Lawrie Griffiths, Brian Bagnall, Roger Glassey & Andy Shaw because in the past, he gave the opportunity to join to the leJOS developer team and I learn so much with them.

Finally I have to give many thanks for my readers in special, Yu Yang, Deepak Patik, Koldo & Nikolaos Mavridis and my students.

Sorry If I forgot some name.

Ebook requirements

This ebook needs the following requirements to use correctly

1. Lego Mindstorms NXT Kit
2. Ubuntu 10.04 LTS

About the author

Juan Antonio Breña Moral has collaborated in leJOS Research team since 2006. He works in Europe leading Banking, Marketing, Engineering and IT projects for middle and large customers in several markets. Currently, he teaches NXT courses and research in Robotics and Artificial Intelligence in Spain. His research areas are: Mobile Robots

Further information:
www.juanantonio.info
www.roboticaenlaescuela.es
https://twitter.com/juanantoniobm

Collaborators

Miguel Ruiz Nogués is currently studying Industrial and Operations Engineering at Universidad Pontificia de Comillas (ICAI), in Madrid. His first robotics contact was during his last year of Technical IT Engineering. He submitted a Robot with the ability to guide blind people through a supermarket (the document containing all the information is "Theoretical and Practical Study of Robotics Focused on Society", as part of his final project.