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Chapter 1: Introduction to educational robots

Introduction

Educational Robots is a new technological field and a new challenge for teachers because they have to know what is the best way to transmit that knowledge to students. Private companies, Organizations and educational challenges as **FIRST** for example, help the whole community showing the right way to evolve educational robotics. Now Students has a nice opportunity to begin on robotics with subjects taught on the educational systems or included in **STEM** programs.

What is the source of the knowledge about robotics?

Robotics is a live science/engineering and continuously you are receiving several news about it. That knowledge is generating by universities and research labs around the world. When that knowledge is stable, private companies develop products for industry. Currently in industry replace humans by robots in the following areas Automotive, Food and Logistic Market.

If you surf on You tube you will see many videos about robots working in that areas. In the following example, you will see a set of robots assembling a car in a product line on a factory.

Illustration 1: An automotive production line with robots assembling cars

In parallel, educational systems and STEM programs develop activities to introduce robotics in the mind of students and teachers. With the time, the main problem to not grow this kind of activities are Teachers. In general, Students like robotics, but **how to teach robotics to teachers?**

It is necessary to increase the support and qualifications of teachers to improve the results. If educational system and market doesn't give support for teachers in robotics matters, it is hard that students introduce in this kind of science/engineering. In this sense, this book tries to help teachers and students.

Does exist a 3CPO?

If you observe news, you will notice that it is more frequently to listen and see news about robotics recently. But in many cases, that projects are in a "beta" stage or they are teleoperated by humans.

In rare cases, you will listen news about autonomous robots or robots that you see in movies as 3CPO in Star Wars or Data in Star Trek.
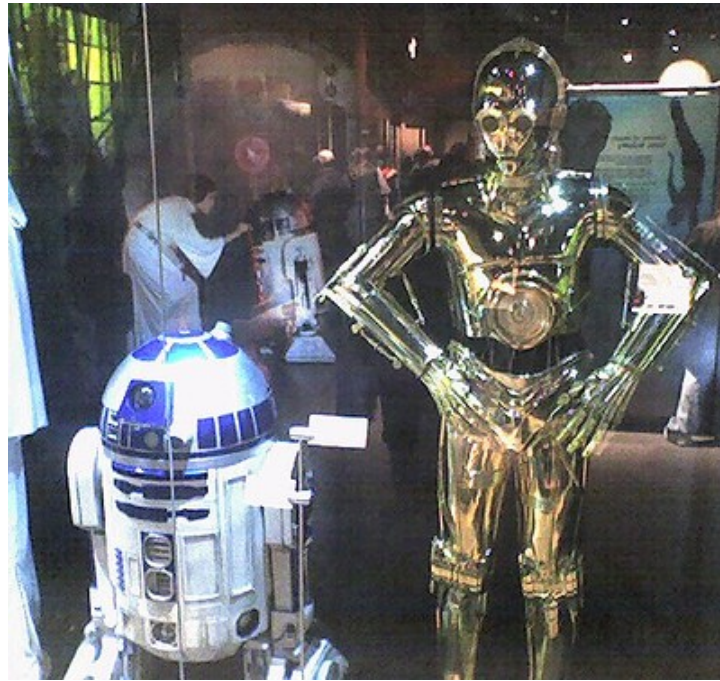
Illustration 2: The robots R2D2 and 3CPO from Star Wars

Why doesn't exist autonomous robots? If you read the following list you will understand some reasons.

1. Robotics is a Experimental Science field
2. Knowledge is complex and multidisciplinary
3. Technology applied to robotics has several dependencies
4. Cost are high in equipment and human resources
5. Human recourses with strong experience is rare
6. It is hard and complex the modeling or real scenarios

Although you read many new articles about robotics on industry which robots work in rutinary tasks or in spacial missions, for example mar rovers, exist another revolution in educational system to introduce robotics in classes. In EEUU, it is very famous the concept STEM in the educational system STEM is Science, Technology, Engineering and Math. With STEM many activities related with robotics are included in several curriculums

What is a robot?

Using the definition from Wikipedia:

"A robot is a mechanical intelligent agent which can perform tasks on its own, or with guidance. In practice a robot is usually an electro-mechanical machine which is guided by computer and electronic programming. Robots can be autonomous or semi-autonomous"

If you read carefully this definition, you could think about some parts about this definition:

"intelligent agent which can perform tasks"
Real robots makes always the same task. In this book, you will learn how to design robots to perform tasks.

"perform tasks on it own, or with guidance"
Good robots execute tasks autonomously without any human presence in the process. To design nice robots it is necessary to design good control loop. In this ebook, you will learn control loop concept in robotics.

"electro-mechanical machine"

To control your robots, it is necessary to know many technical details about platforms that you use. A robot has sensors, actuators, control units and other stuff.

"guided by computer and electronic programming"

In last release of this ebook, we focus on computer programming. Many platforms allow to develop software for embedded platforms but these environments are very limited and at the end it is better to develop software in a PC platform because data processing is better. Now notebooks has a right size to join with your latest creation or teleoperate with your creating using a link with a wireless technology as Bluetooth, Zigbee or Wifi.

Once we have analyzed definition, you know the scope about this ebook and what technologies you will learn.

You will learn some platforms as Lego Mindstorms NXT and Ardrone to develop sofware inside the board, in the case of NXT and using a PC in both case to perform task autonomously or guided.

Types of robots

Exist many classifications about robots but in this ebook we will classify robots using the medium in which they operate (Sand, Air and Water). In this book you will learn how to develop software for all types of robots. For terrestrial robots we will use the platform Lego Mindstorms NXT and for aerial robots ebook will use the product Ar.Drone.

Note:
To understand concepts described in the ebook, ebook's author recommends using Lego Mindstorms NXT in a preliminar stages and later, use Ar.Drone or otrher platforms.

Architecture of a robot

One robot is based on the following parts:

- Sensors
- Actuators
- Communications
- Control system

Sensors

A sensor is a device that responds to a physical stimulus (as distance, light, sound, contact, magnetism, or a particular motion) and transmits a resulting impulse (as for measurement or operating a control)

Interactive robots use sensors to intereact with environment, for example a robot which detect an obstacle in the route.

Illustration 3: An Ultrasonic Sensor from a NXT robot

Actuators

An actuator is a mechanical device for moving or controlling something. Robots use actuators to build grips or mechanical arms. Other kind of actuators are motors. With motors and servos you add motion features inside of your robots

Communications

Robots need to intereact with other systems or humans, so it is necessary to use this kind of technologies. Depends of the usage of your robot and the environment you will use, Wifi, Bluetooth or Zigbee to stablish communications with other systems.

Control system

Every robot has a control system to organize data from sensors and actuators with the goal to perform a task.

How to learn robotics?

Robotics is a hard field because you have to combine many different knowledge because you have to manage hardware and software. In hardware side, you have to be very creative to build robots from zero and you have nice skills on electronics. In the other hand, you have to know how to develop software. In this sense, we prefer to use platforms where user only have to be focused on software as NXT or Ar.Drone. We recommend to learn robotics in team and better if you assist to any subject or activity related to robotics. Learn alone is hard. One way to test your knowledge and skills is participating in some challenges about robotics in your cite as **FIRST** or **RoboCup**.

Platforms & programming languages

Build and develop software is a nice adventure but you need to know all alternatives to understand why this ebook use some platforms and Java. In previous sections in this chapter you read that robotics is a multidisciplinary field so if we can reduce the number of hours dedicated to some area you will invest them in another one, for example the development of a better software. In this sense this book use the platforms Lego Mindstorms NXT and the product Ar.Drone to use them with the same programming languaje, Java.

Less electronics, more software with Java

Using a closed products as Lego Mindstorms NXT or Ar.Drone, users only will use his time in software processes and this is the point of view of ebook's author. In robotics, the main programming languaje is C or C++ because that language has the possibility to develop in low level, but currenlty in many environments drives to manage sensors or actuator are developed so Java is possible.

Java is the option to show how to develop software for robots due to the following features:

1. Is the most popular programming languaje
2. It is a multi purpose
3. It has parallel programming features with Threads and Concurrency API
4. It has multi processor features
5. It is a Object-oriented
6. It is a safe programming language

Hardware Platforms

What is Lego Mindstorms NXT?

Lego Mindstorms NXT is a programmable robotics kit released by Lego in July 2006, replacing the first-generation LEGO Mindstorms kit. The kit consists of 577 pieces, including: 3 servo motors, 4 sensors (ultrasonic, sound, touch, and light), 7 connection cables, a USB interface cable, and the NXT

Intelligent Brick. The Intelligent Brick is the "brain" of a Mindstorms machine. It lets the robot autonomously perform different operations. The kit also includes NXT-G, a graphical programming environment that enables the creation and downloading of programs to the NXT. The software also has instructions for 4 robots.

What is Ar.Drone?

The Parrot AR.Drone is a RC quadricopter with cameras attached to it built by Parrot.

Programming Languages

What is Java?

Java is a programming language originally developed by James Gosling at Sun Microsystems (which is now a subsidiary of Oracle Corporation) and released in 1995 as a core component of Sun Microsystems' Java platform. The language derives much of its syntax from C and C++ but has a simpler object model and fewer low-level facilities. Java applications are typically compiled to bytecode (class file) that can run on any Java Virtual Machine (JVM) regardless of computer architecture. Java is a general-purpose, concurrent, class-based, object-oriented language that is specifically designed to have as few implementation dependencies as possible.

Other alternatives to develop robots

Other alternatives in the market are:

1. Programming Languages
    1. C
    2. C++
    3. Python
2. Platforms
    1. General
        1. Arduino
        2. Android-ADK
    2. Humanoids
        1. Bioloid
        2. NAO
    3. Mobile robots
        1. Pioneer

Research areas in robotics

Robotics is field of science in constant evolution so exist many possibilities to research. The following list show main areas of research in robotics:

1. Human Computer Interaction
    1. Speech and Natural Language
    2. Brain-Machine Interfaces
2. Navigation
    1. Local navigation
    2. Global navigation
3. Artificial Intelligence
    1. Machine Learning
4. Multi agent Systems
5. Swarm robots

The ebook and projects inside cover the following areas:

1. Navigation
    1. Local navigation
    2. Global navigation

Note:
If you know more areas of internet, contact with the author of this ebook to update.

Summary

In this chapter, you should get the idea about educational robots and the concept about that in the world doesn't exist robots like 3CPO but engineers everyday are building more complex robots and with this ebook you will begin developing in a right way with solid platforms as Lego Mindstorms NXT or Ar.Drone with software developed with Java without problems related with electronics. Java is not the unique programming language to develop software for robots but it is the most complete and more versatile.

Exercises

The following exercises allow readers to check knowledge learnt in this chapter

1. Is it possible to develop a humanoid with Lego Mindstorms NXT?
2. Find 3 usages of Java for not robotics projects
3. What is UML? ¿How to use UML in robotics?
4. Do you know Humanoid robots in the market?
5. If you could deploy a robot, where do you use it?
6. Do you consider that robot is useful for risky places? What is a risky task for you?

7. Do you think that real robots are similar than sci-fi robots? What is differences? What features are similar?
8. Do you have many opportunities in your city to learn robotics? How to change this situation?
9. Describe your robot project in architecture terms (Sensor, Actuators, Communications and contro systems)

Send your answers to bren [at] juanantonio [dot] info to improve the ebook. Best answer will be published.

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://en.wikipedia.org/wiki/Robot
http://en.wikipedia.org/wiki/Java_%28programming_language%29
http://en.wikipedia.org/wiki/Parrot_AR.Drone
http://mindstorms.lego.com
http://en.wikipedia.org/wiki/Lego_Mindstorms#Lego_Mindstorms_NXT
http://myflex.org/books/java4kids/java4kids.htm
http://www.tiobe.com/index.php/content/paperinfo/tpci/index.html
http://www.readwriteweb.com/archives/robots_for_everyone_getting_kids_interested_in_pro.php