NXT 001

An Introduction to Robotics

Lesson 1

By Chad Cardwell

Objectives

- Discuss an overview and history of LEGO MINDSTORMS
- Discuss LEGO TECHNIC pieces
- Discuss NXT electronics
    - NXT Brick
    - Input sensors
    - Interactive output motors

Overview and History of LEGO MINDSTORMS

LEGO MINDSTORMS has been around since 1998 when it was first introduced as a robotics set known as the Robotics Invention System (RIS). It incorporated a mixture of LEGO TECHNIC pieces and never-before-seen advanced electronics such as a programmable computing brick, input sensors, and output motors. It became highly successful as an educational tool and has been used by many different schools and universities worldwide. It was improved upon and re-released in 2000 as version 2.0. (Figure 1.1)

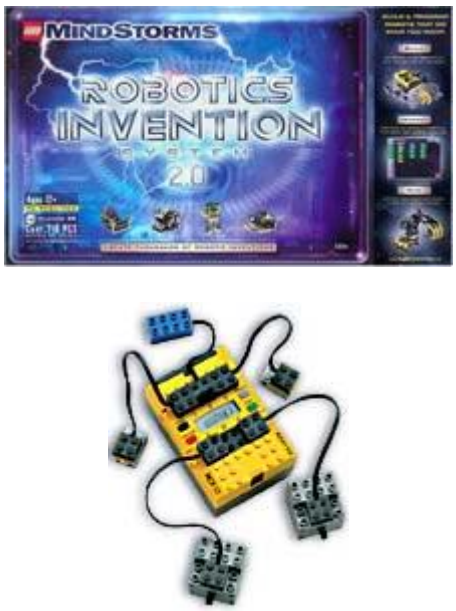
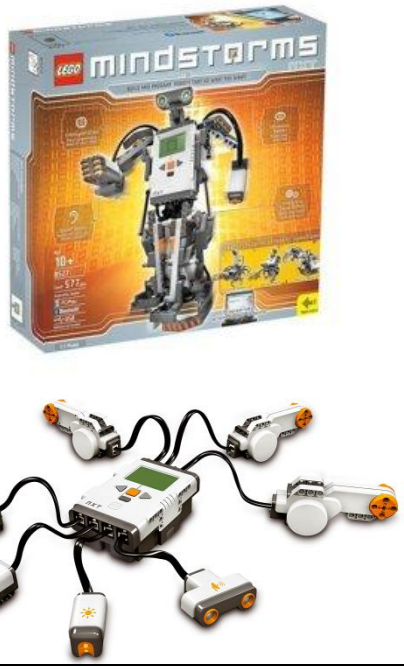
LEGO MINDSTORMS RIS 2.0	LEGO MINDSTORMS NXT
	

Figure 1.1 (Images from: *http://mindstorms.lego.com*)

The newest version of the MINDSTORMS set, known as NXT, was released in 2006. It is a great improvement over its predecessor. Like the RIS, it uses TECHNIC pieces as the building blocks for robots, but it contains completely new electronic devices consisting of a new programmable computing brick, input sensors, output servo motors, and easy-to-use programming software. This software, known as NXT-G, will be the primary focus for the majority of this course.

The NXT set is designed for children ages 10 and up, and it is a great tool for introducing them to science and technology, specifically in the areas of robotics and programming. Pictured above (Figure 1.1) on the right is the retail version of the NXT set. Schools and universities will most likely be working with an educational version of this set, which is displayed below. (Figure 1.2) It differs from the retail version in that it includes a plastic storage case, a rechargeable battery for the NXT brick, and its piece count is slightly modified and reduced. However, educators often combine this set with the Education Resource Set (Figure 1.2), which provides additional standard elements as well as a variety of special elements like a chain drive and tread wheels.

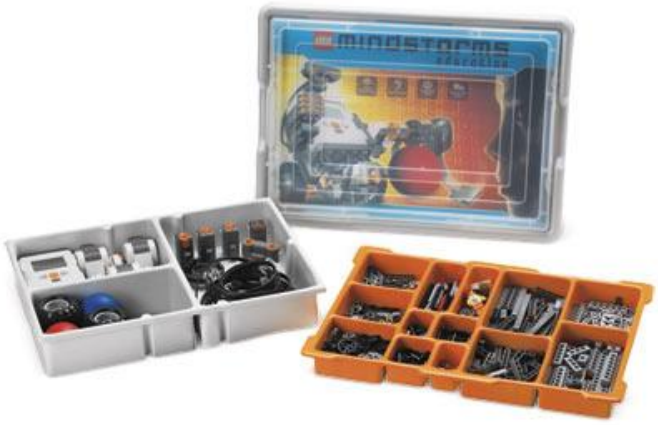
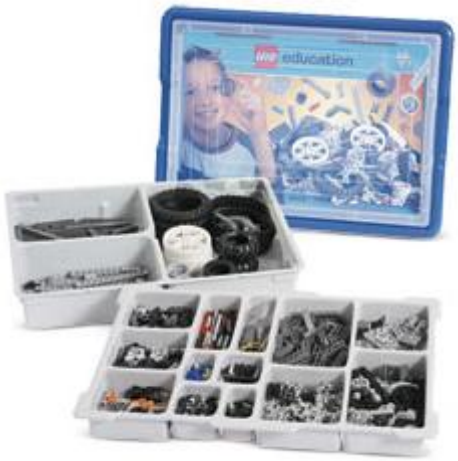
LEGO MINDSTORMS NXT Education Set	Education Resource Set
	

Figure 1.2 (Images from: *http://www.lego.com/education*)

TECHNIC Pieces

TECHNIC pieces are more complicated than traditional LEGO blocks in that they incorporate items such as building beams, cross-axles, gears, connectors, and much more. These advanced pieces allow for a high degree of flexibility when designing robots and working with them is not that hard once you get the hang of it.

For more information about LEGO TECHNIC pieces, complete the short online lesson entitled **TECHNIC 101** at the following URL: http://technic.lego.com/technicdesignschool/

NXT Electronics

In addition to the TECHNIC pieces described above, the NXT set is primarily known for its unique and powerful electronics. These components are what really make it a robotics set.

NXT Brick

First, there is the NXT brick, which is the brain of any NXT robot. It's a small 32-bit computing device complete with four inputs ports for sensors and three output ports for servo motors. It has four user input buttons, an LCD display screen, a USB port for downloading files and programs, 256 Kbytes of built-in memory for storing files and programs, and an internal loudspeaker for audio output. The NXT Brick can also connect via Bluetooth. This allows it to wirelessly download programs from the computer or communicate with other Bluetooth devices, such as other nearby NXT Bricks or cell phones. It requires six AA batteries or an optional rechargeable battery pack to function.

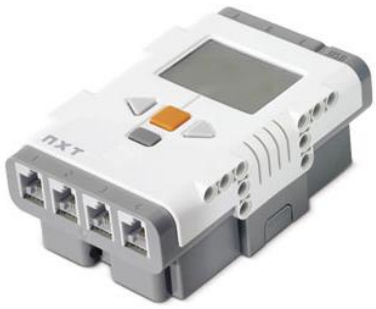


Figure 1.3 – NXT Brick

Input Sensors

The following four input sensors allow an NXT robot to essentially become aware of its surroundings by enabling it to detect tough, sight, sound, and light.

Touch Sensor

As one of the more basic sensors, the touch sensor is essentially a push button device. It can distinguish between states of being pressed, released, or bumped (pressed and then released). It is commonly used for detecting if the robot has run into a wall or for allowing user input with a push button. With a cross-hole built into the button, TECHNIC cross-axles can be connected to the sensor to extend or increase its area of contact.

Figure 1.4 – Touch Sensor

Ultrasonic Sensor

As a more advanced sensor, the ultrasonic sensor allows an NXT robot to detect when it is near something. It does so by emitting and receiving ultrasonic sound waves to simulate sight. By measuring how long it takes the sound waves to return to the sensor, it can calculate its distance from an object in either centimeters or inches.

Figure 1.5 – Ultrasonic Sensor

Sound Sensor

Used to detect sound to simulate hearing, the sound sensor acts as a simple microphone that can measure sound intensity in both dB (decibels) and dBA (decibel adjusted – sounds we can hear). It can also recognize sound patterns and tones. A common use is to make a robot that performs an action when it hears a loud enough noise such as clapping or a voice command.

Figure 1.6 – Sound Sensor

Light Sensor

As the final of the four sensors provided in the NXT set, the light sensor does just what you'd expect – it detects light! It can do so in two different modes of operation. The first mode measures the ambient lighting of the room, and the second mode activates a red LED and measures how much of its light is reflected back onto the sensor. Both modes are useful in certain situations. For example, by detecting ambient light, a robot may perform an action when a room light is turned on. Alternatively, by detecting reflected light, a robot can distinguish between light and dark surfaces.

Figure 1.7 – Light Sensor in ambient mode (left) and reflected mode (right)

Output Servo Motors

One thing we often associate with robots is that they are mobile or at least have moving parts. With the NXT set, this is made possible through the use of interactive output servo motors. These motors provide the user with a multitude of different configuration options. They can be configured to rotate in either direction at a user specified speed/power, and they can do so for a set amount of time, rotations, or degrees. This is made possible because they each have a built-in rotation sensor, which is a major improvement over the older RIS motors. They can also be synchronized to rotate together and allow for easy robot movement and steering.

Figure 1.8 – Servo Motor