SqueakNxt: Programming Nxt robots with Etoys

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1. Keywords:

Robotics – Education – Lego Nxt – Etoys – Squeak

2. Description:

The objective of this project is to provide a versatile software platform to control Lego Nxt robots within Squeak and Etoys. It needs to be easy to use and powerful enough for non-trivial projects. Currently, SqueakNxt supports control of servo motors and the four basic types of sensors (light, touch, ultrasonic and sound). The communication is made via Bluetooth under the direct commands protocol.

3. Licence:

This project is being developed under the MIT license.

4. Why teaching Robotics?

Robotics can be a very suitable tool for teaching science to young children because of different reasons:

- The presence of robots in the classroom generates curiosity and children seem to enjoy playing with them.
- Teaching robotics allows the student to build and explore his own representations of different world's phenomena facilitating the acquisition of knowledge about them.
- Robotics is closely linked with diverse scientific disciplines such as logic, mathematics, physics, artificial intelligence, biology, medicine and nanotechnology.
- Most of the robotics activities foster camaraderie and teamwork abilities.

5. Why Lego Nxt?

The Lego robotics kits allow a rapid introduction to robotics. They have been used with great success in lots of countries for the past ten years and they are very versatile. Lots of different robots can be built without any expertise in electronics or mechanics, and the large amount of different sensors allows the development of very interesting projects. The current version, called Nxt, is especially powerful because it provides Bluetooth wireless communication capabilities.

6. The concrete material

The Lego robotics kits combine perfectly with Etoys philosophy, and they add an important aspect not taken in consideration by Etoys: the concrete material. The integration of the virtual world of Etoys with the real world of Robotics helps the students by forcing them to develop the necessary abilities to work with real world materials. Nowadays, it is seen that most of the educational and recreational activities have been digitalized, thus creating a whole generation of kids who use only a part of their senses, have less motor function and are less capable of participating in a concrete world. Adding Robotics to the school curricula should help to solve this problem.

7. SqueakNxt characteristics

SqueakNxt defines a simple model to represent the Lego Nxt robots and an equivalent Etoy interface. This separation allows the user to use SqueakNxt for any other purpose not necessarily related to Etoys nor education.

7.1 Model

A Lego Nxt robot is composed by a main brick which contains the "brain" of the robot and a set of motors and sensors plugged in some ports. So, the model is basically composed by the following few classes[1]:

- LegoNxt – Represents the robot itself and includes the protocol for connecting to a Bluetooth serial port, accessing the motor and sensor ports, accessing the battery level of the robot, playing sound files and tones, and starting/stopping programs.
- Port – Represents a port in which pluggable devices such as motors and sensors can be plugged.
- NxtMotor – Represents a servo motor and includes the protocol for setting the motor power (from 0 to 100), getting the rotation count, and different forms of breaking (i.e. blocking the motor).
- LightSensor – Represents a light sensor and includes the protocol for accessing its value and setting the sensor as active (turning on a little lamp on the sensor's front to sense its own reflection) or inactive (turning the lamp off).
- SwitchSensor – Represents a touch sensor and it does not include any special protocol apart from the needed to access its value.
- SoundSensor – Represents a sound sensor and includes the protocol for accessing its value and setting the sensor as inaudible or audible (measuring all frequencies range or only the audible range).
- UltrasonicSensor – Represents an ultrasonic sensor and it does not include any special protocol apart from the needed to access its value.

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[1] Actually, there are more objects in the system but it is expected that the user should not worry about that and only focus his attention on these few essential objects.

7.1.1 Communication mode

Currently, SqueakNxt only supports communication over a Bluetooth serial port using the direct command protocol provided by Lego. This communication allows controlling the robot in "real time" and making it interact with the computer (something that the official Lego Nxt software currently does not supports). Although some applications[2] benefit from this aspect of the system, this is not enough to make a complete platform to work with Lego Nxt robots. Due to these reasons it was decided to implement a simple translator from a subset of Smalltalk to NBC[3] that will allow executing Smalltalk programs on the Nxt. In order to make it compatible with the direct commands communication mode it was necessary to make the model independent from the communication mode, so all the direct commands protocol was implemented as a collaboration of classes being NxtDirectMode the most important one. This class is responsible of all the communication over a Bluetooth serial port and the LegoNxt simply delegates all the corresponding messages to it.

The communication was originally implemented using the SerialPort class, but in order to increase the performance a virtual machine plugin was developed. This has the advantage of keeping the sensor's process outside the bounds of the Squeak execution threads, thus making it more efficient.

7.2   Etoys interface

Since the Etoys interface must be as much intuitive as possible, it was decided that each object of the above-mentioned model should have a graphical representation in order to maintain the equivalence between the real entities and the virtual objects. In addition, each Morph has special viewer categories that make it possible to control the robot or access the sensor values.

Apart from that, the usage of the objects was designed to be as much similar as possible to the usage of the real objects. For instance, to plug a motor or a sensor to the robot the user needs to get one from the object catalog and drop it on the corresponding port of the LegoNxt. The wire that plugs the objects has also a graphical representation made using Ned Konz's Connectors.
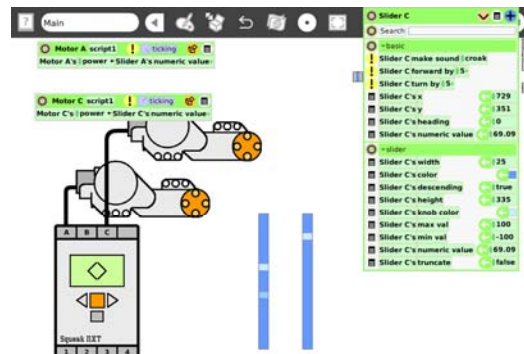
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[2] Robot soccer can be a good example.
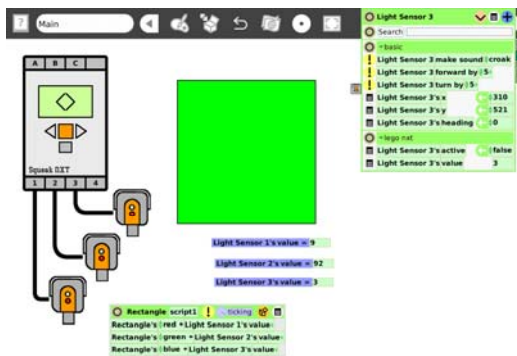[3] NBC is a simple language with an assembly language syntax that is used to program Lego Nxt robots.
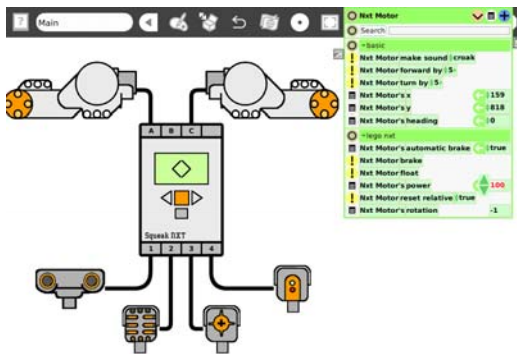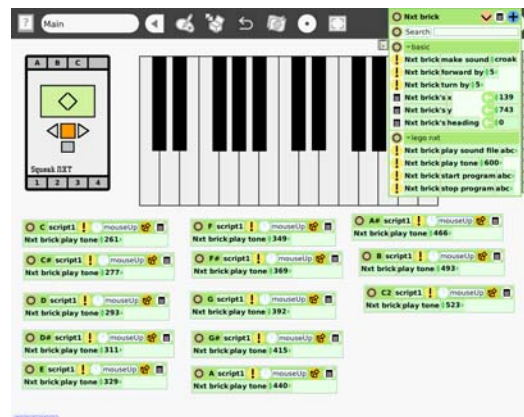
8. Snapshots

A nxt robot with two motors and four different sensors

A simple etoy project that controls two motors using sliders

An etoy project that uses the value of three light sensors to change the color of a rectangle

An etoy project that plays different notes on the nxt using the drawing of a keyboard