Physical Etoys: Freedom beyond the digital world

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Abstract. The objective of this work is to present Physical Etoys, a free and open-source robotics programming platform for children that can be used for all the challenges that take place at the Robocup Junior.

Keywords: Physical Etoys, robotics, education, constructionism

1 Introduction

Physical Etoys is an extension of Etoys, a media-rich authoring environment and visual programming system made by the very same people who created Smalltalk, and it inherits all its educational potential (Kay, 2007). The purpose of Physical Etoys is to allow kids to program robotic kits in an environment specially designed for them, following Papert's constructionism ideas (Papert, 1993). Within this environment physical objects are represented graphically and the students can directly interact with those entities, instantly seeing the consequences in the real world.

Physical Etoys is free, open source, it works in several operating systems, and it is translated to several languages such as Spanish, English, French, and Portuguese, among others.

2 Characteristics

Among the robotic kits supported by Physical Etoys we find two big referents widely used by the education community: the Lego Mindstorms NXT and the Arduino board. Since version 2.0 Physical Etoys also supports an argentinian robotic kit called DuinoBot, which is used in several schools from Argentina. Moreover, Physical Etoys includes a module system that allows the user to extend it in order to support many different electronic devices such as Microsoft Kinect, Nintendo Wiimote, Orbotix Sphero, among others.

Physical Etoys exposes a graphical user interface in which the real objects used in each kit (including motors, sensors, controllers, and wires) are represented by virtual objects. The user can create scripts by dragging and assembling tiles. These scripts run virtually at the same time, implicitly exposing the student to concurrent programming in an easy way.

Physical Etoys provides two different ways to program: the “Direct” mode and the “Compiled” mode. Both use the same visual programming interface, being the only difference “where” the code is executed.

When programming in “Direct” mode, the scripts are executed on the computer and all the commands are instantly transmitted to the device (via USB cable, or a Bluetooth connection). The “Direct” mode enables us to modify the script and see the changes instantly in the behavior of the robot, simplifying the programming and debugging process (especially for an inexperienced user). By using the communication between the device and the computer this mode lets us see the values of every sensor and every variable at any moment, allowing us to use it as a data logger. However, since there is an intrinsic delay in the communication, some problems that require really fast reaction time (typically presented in autonomous robots) may not be solved by using this programming mode.

On the other hand, the scripts programmed in “Compiled” mode are translated to the C programming language, compiled, and then transferred to the device, in order to execute the code on the microcontroller without maintaining the communication between the robot and the computer. The “Compiled” mode solves the latency problem by avoiding the communication altogether and executing the scripts directly in the microcontroller, letting the robots behave autonomously.

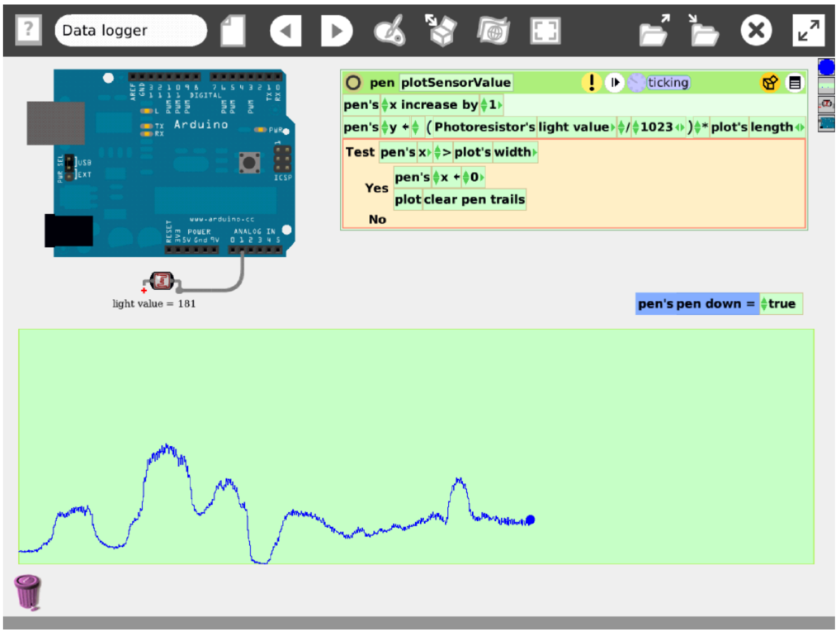

Fig. 1. Example of the “Direct” mode using an Arduino board as a data logger.

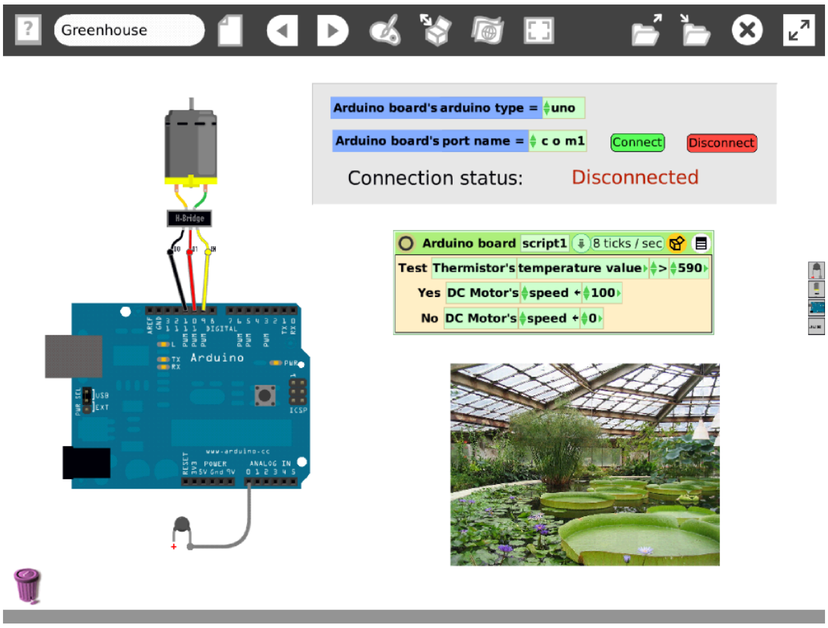

Fig. 2. Example of an Arduino board controlling the temperature of a greenhouse.

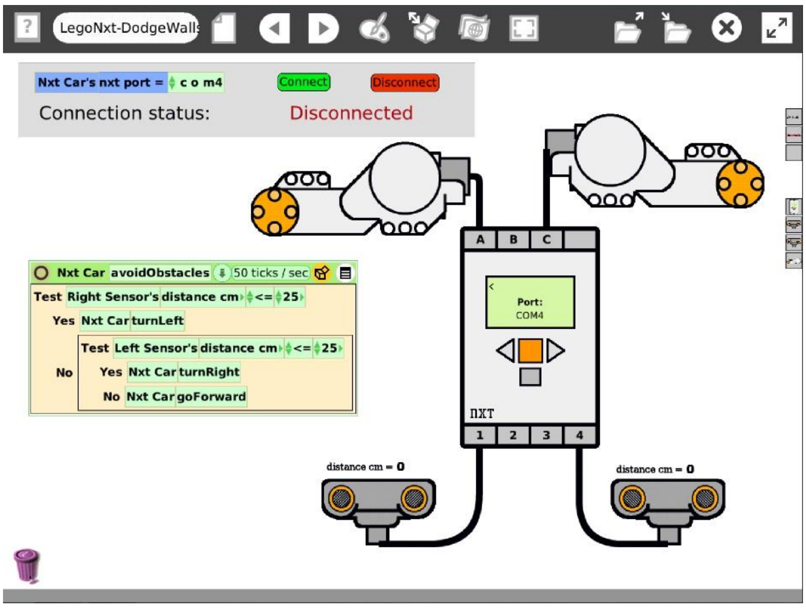

Fig. 3. Example of a simple autonomous robot built with Lego Mindstorms NXT that avoids colliding with walls.

As a programming platform, Physical Etoys meets the requirements for use in international events such as Robocup Junior (in all its challenges), and in local events such as Roboliga[1], which takes place in Argentina.

Robocup Junior, in particular, does not allow any kind of communication with the robots during game play (unless the communication between two robots is via bluetooth or via ZigBee). Some visual programming platforms for children (such as S4A[2]) need an open communication channel with the robot in order to work. Physical Etoys used to suffer from that same limitation but since the inclusion of the "Compiled" mode, it can transfer its programs to the robot's microcontroller in order to execute them in an autonomous way, thus complying with Robocup Junior rules.

3 Physical Etoys in the world

Since its first version Physical Etoys has been adopted, extended and used to teach robotics by several educative communities around the world.

In France, the educative organization Planète Sciences has integrated Physical Etoys with SqueakBot (a similar programming language based on Etoys) and it has been used to introduce children to robotics in workshops as well as in the official curricula, which includes educational robotics as a mandatory subject.

Citilab, a spanish institute for the formation and the spreading of the Information and Communications Technology in Barcelona, has been using Physical Etoys and Scratch (another tile-based programming language) to teach robotics to young children. Also, the Linux distribution for education named Guadalinex now includes Physical Etoys as one of its default programs.

In USA, Physical Etoys has been used in several experiences with children. The University of North Carolina Wilmington organized a programming camp where children developed, among other things, small robots to participate in sumo competitions.

In Colombia, Indonesia, Brazil and Portugal, Physical Etoys has been used to create some projects with kids.

In Uruguay and Chile, Physical Etoys has been used to dictate several lectures and workshops.

In Argentina, some government programs inspired by One Laptop Per Child (OLPC) have shown interest in Physical Etoys. The most important one, called "Conectar Igualdad", which involves all the public high schools in Argentina, has included Physical Etoys as one of its default applications. In La Rioja (an argentinian state), students from elementary schools use Physical Etoys on laptops from the OLPC program and DuinoBot kits. Finally, the program called "SarmientoBA", which involves all the public elementary schools from Buenos Aires, use Physical Etoys with both Arduino, Lego Mindstorms Nxt, and DuinoBot kits.

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[1] Roboliga - http://www.roboliga.edu.ar/

[2] Scratch for Arduino - http://seaside.citilab.eu/scratch/arduino

4 Conclusion and Future work

Physical Etoys has gone a long way from its first version. However, a lot of work needs to be done. One of the most important challenges for the future releases of Physical Etoys is the improvement of Sugar support (the user interface for the OLPC laptops). Even though students from La Rioja already use a Sugar-based version of Physical Etoys, its support is currently restricted to this experience and not general enough for the rest of the OLPC users.

Another challenge would be to support the Raspberry PI computer, which has gained a lot of popularity in recent times. We already have started experimenting with it with promising results.

The next challenge would be to include the microphone and camera of the netbooks as sensors to our project. In the case of the camera, we have already developed a working prototype that follows blobs of color on an image.

And finally, we will propose a simple physical structure with motors and sensors, which allow locating the netbook on it for using as an autonomous robot.

We hope to overcome these challenges and improve Physical Etoys to the point of making it the robotic programming platform of choice for all educational experiences around the world.

5 References

1. Kay, A. Children Learning by Doing: Squeak Etoys on the OLPC XO. VPRI, Research Note RN-2007-006-a.

2. Papert, Seymour. *Mindstorms: children, computers, and powerful ideas*. 2º ed. New York: Basic Books, 1993.