Mendieta: low cost platform for educational robotics

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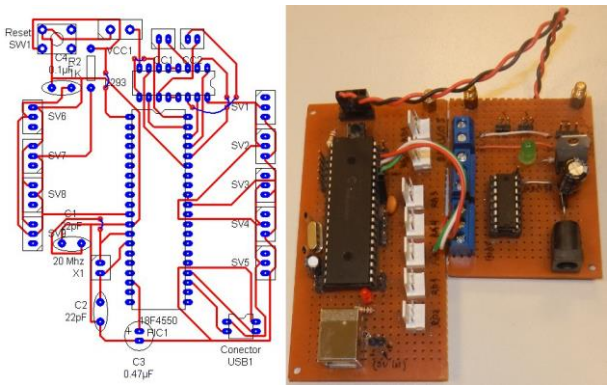
Abstract. In Argentina, the Conectar Igualdad program has distributed 3 million netbooks to students in high schools. This massive integration of technology has enabled the emergence of different projects for the effective use of computers in the classroom. In this paper we present the development of a low cost hub called Mendieta for connecting the netbook to sensors and motors for data acquisition in physics and chemistry experiences and for teaching robotics in the classrooms. We also show the development of the software platform that allows reading sensors and programming the device.

Keywords: Mendieta; educational robotics; Physical Etoys.



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1 Introduction

Thanks to "Conectar Igualdad" program [1], we meet in all high school classrooms with a device that can serve as a processor of data acquisition systems or a robotic device driver. Then, we created a research project with this goal: develop a low-cost hardware platform for elementary and high schools classes for learning robotics. In order to reach this goal, we have established the following specific objectives:

a) Develop a hub for connecting sensors to the USB port of the netbooks used in education.

b) Develop a motor controller with USB port connection.

c) Design the mechanical architecture of a robotic kit.

d) Incorporate the Mendieta Etoy to Physical Etoys for communicating with the hub and the developed motor controller.

e) Develop an image processing system with low processing requirements that can function on the hardware of the netbooks of the Conectar Igualdad program.

2 What have we done

We have developed a hub that allows the connection of motors and sensors to a netbook, effectively transforming it into a device capable of interacting with its surroundings. This hub, which we call "Mendieta", is composed by a single-board microcontroller that plugs in the computer through the USB port and allows the connection of multiple devices such as LEDs, switches, servo motors, photoresistors, among others. It talks to the computer using a communication protocol that allows the user to fully control the board.

The netbooks delivered by the "Conectar Igualdad" program have the following main characteristics: Processor: Intel® Atom™ N455 (512K Cache, 1,66 GHz, 64 bit bus); 2 GB DDR3; 2Mp integrated webcam; integrated microphone; Internal WiFi card; 2 USB ports.

In order to take advantage of the camera that most netbook include we developed the software needed to retrieve information from the images that the camera can provide.

3 Hardware

Since cost and availability in Argentina are our most important requirements we have compared prices of the main components in Buenos Aires stores and we concluded it would be cheaper to base our project on a PIC 18F4550 microcontroller instead of an AVR like Arduino. Mendieta will allow controlling several servomotors and up to 2 DC Motors and one AC Motor thanks to an integrated H-Bridge.

Furthermore, up to 8 analog inputs and 18 input/output pins can be used. It permits to connect directly analog and digital sensors with 3-pin Molex connectors. In order

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to control motors, Mendieta has a L293D integrated circuit with four circuits that can handle medium power loads, specially for little motors with do not surpass 600 mA in each circuit and a voltage between 4,5 V and 36 V. The entry of this direct current to the board is performed by a terminal located at the opposite end to the USB connector. It can come from a transformer connected to the electricity network or from an optional amplification circuit that has four rechargeable AA batteries.

4 Software

The firmware developed for Mendieta allows the full control of the board by implementing a simple communication protocol based on Firmata. All messages are composed by a byte that denotes the message id followed by zero or more bytes that represent arguments, or data that will be used to evaluate this message. To distinguish each type of byte we use its first bit, being 0 for message ids and 1 for arguments. This protocol requires all data to be packed in 7 bits, then it allows a maximum of 127 types of messages. In practice, this has never been a problem because most messages expect a very small amount of arguments, and we never needed more than 20 different messages.

On the computer side, we developed a Physical Etoys [2] external module that implements this communication protocol and allows to fully control Mendieta. We also made a programmable graphical object that allows us to program Mendieta both in a visual environment specially designed for kids or, in the case of advanced users, in text mode using the Smalltalk programming language.

Physical Etoys was also extended with a new capability of image analysis. We called this tool “BlobFollower”. Usually, the algorithms used to do image analysis are very complex both to use and to configure and the student should not have to deal with that problem. To achieve this we decided that the only information to be provided is what color should be tracked, hiding all the complexity of the algorithms and settings from the user. By only giving color detection we are forcing the student to build the logic needed to interpret what does it means.

5 Future work

Mendieta is still a work in progress. The first functional prototype we have built still lacks the possibility of getting the information from the connected sensors. This needs to be incorporated both in the firmware and in the Physical Etoys interface.

6 References

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