TALKOO: Introducing a rapid way to do physical computing at school

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Abstract

Introducing physical computing into regular school classes are challenged by constraints of schedules and curricula structures, which do not allow for time-consuming electronics prototyping. We present a novel approach to prototyping with physical computing components with the Arduino-based TALKOO kit: It comprises hardware modules, a visual IDE, and prototyping material. Sensor and actuator modules are pluggable and do not require soldering and prior knowledge in electronics. The components have the ability to “talk” back to the visual IDE and to a learning analytics system. A new approach for visual programming maps physical modules onto virtual representations on screen making programming more intuitive. The TALKOO kit expands the field of application of physical computing for children in regular school contexts.

Author Keywords

Education; digital fabrication; physical computing; visual programming.

ACM Classification Keywords

K.3.2 Computer and Information Science Education.
D.1.7 Visual Programming.

Description of the product or project being demonstrated

TALKOO is an educational platform that combines physical prototyping with a visual programming interface to allow learners to rapidly prototype ideas. TALKOO is part of the PELARS project that consists of a special purpose-built learning environment with multiple sensors to collect data during hands-on learning activities. The PELARS project students are high school students and university students in design and engineering. The learning environment is a designed workshop table connected to a freestanding wall with a built-in display. The learning analytics system (LAS) collects data from a computer vision system with facial and object tracking (fiducial markers), log files from the programming of physical prototyping platform kits. There is a mobile system that allows the learners to document their work in a form of annotation of different phases during the activities.

For the demonstration, we will show the TALKOO system that designed to recognize automatically physical blocks (new Arduino based boards) connected to it. Those blocks are reprogrammable sensors and actuators. When recognized, the visual programming interface will enable users to map directly and control the relationships between the blocks (see figure 1). The main concept behind the TALKOO kit is to allow beginners to get started with building electronics avoiding any possible errors produced by incorrect wiring a certain electronic configuration. At the same time, advanced users can take advantage of the kit when trying to prototype interactive systems quickly.

The kit is made of a series of smart modules that can be plugged to one another in any order (figure 2). When connected to a special module—called hub—responsible of connecting the prototype to a computer, the modules become available on a GUI on that computer screen. This GUI has been conceived as a visual programming environment where the virtual representation of the modules—we call them blocks when on the screen—will let users establish virtual connections between blocks

Importance of your submission to the digital fabrication / makers / hands-on learning communities.

Physical computing kits have been used in educational contexts for a long time to learn about STEM and to engage in the making of interactive projects [2][9]. However, hardware components such as the regular Arduino board [1] require wiring of components. Working with electronics and programming requires extensive guidance by skilled tutors especially when working with novel users. Teachers need to have a solid background in electronics and programming to be able to work with those boards. Further, they are challenged by current structures, schedules, and curricula at school. To better establish physical computing into the school settings the process (hardware and software) needs to be manageable by teachers without much previous knowledge in programming and physical computing. More importantly, children to build projects in short time frames without having to struggle with bad connections and circuits.

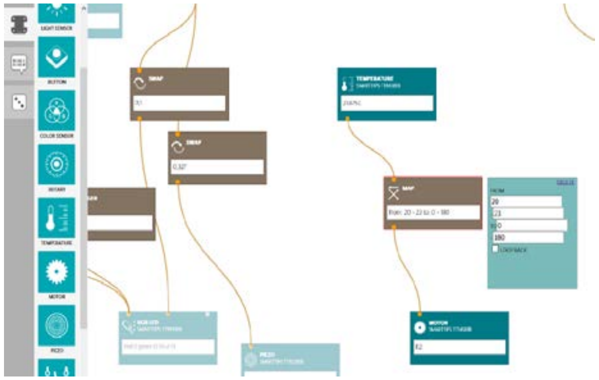

Figure 1: Visual IDE with module blocks representing an

Research has shown that visual programming languages (VPLs) [4][9] for platforms such as Arduino have come up to make programming these devices more accessible for children and novices [5][9]. They translate block-commands into C-code following the same procedural programming paradigm. Booth and Stumpf [3] argue that (adult) learners using VPL have an easier time adapting code from other projects and have a more positive experience than learners using traditional text-based interfaces. Further, programming microcontrollers (especially in the beginning) is an activity of dealing with incoming (input) sensor signals, maybe doing some operations on their values and outputting them to actuators. Especially for beginners, this interplay between inputs and outputs makes tinkering with microcontrollers rewarding and appealing. From this perspective, it makes sense to think about new programming opportunities for (visual) IDEs for physical computing that reflect the structures of hardware and computing operations in program code.

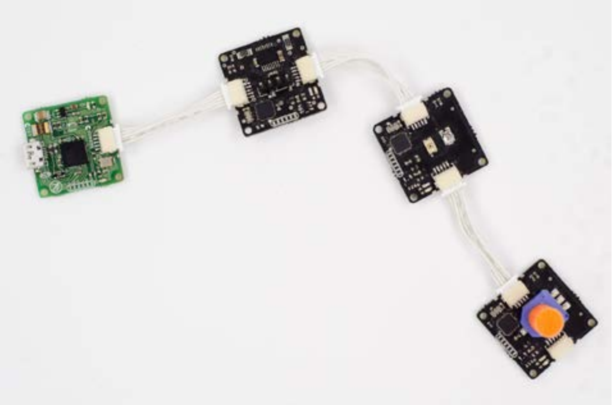

Figure 2: Connected modules: hub, motor controller, light sensor, potentiometer. *Credit: Arduino Verkstad AB, photographer: Mike Ericsson, 2015 CC-SA-BY-NC.*

Therefore, we see an opportunity to provide the means for the rapid prototyping with both hardware and software that TALKOO provides. Learners can easily connect different sensors and actuators and program them without having to learn about in-depth about electronics or textual programming. TALKOO provides an easy entrance to physical computing allowing an inclusive approach for novices and rapid prototyping for experienced users.

Logistical details e.g. power and space needs

An ideal situation for demonstrations allows us to have a round table that several groups of pairs can work on and one or two mentors can help the visitors use TALKOO and sees some of the results of the PELARS project with videos on the screen and or posters on a wall. Power for 3 laptops, a large table preferably round and at standing height, but lower heights and rectangular shape with chairs will work also. Figure 3 below shows the PELARS system in action.

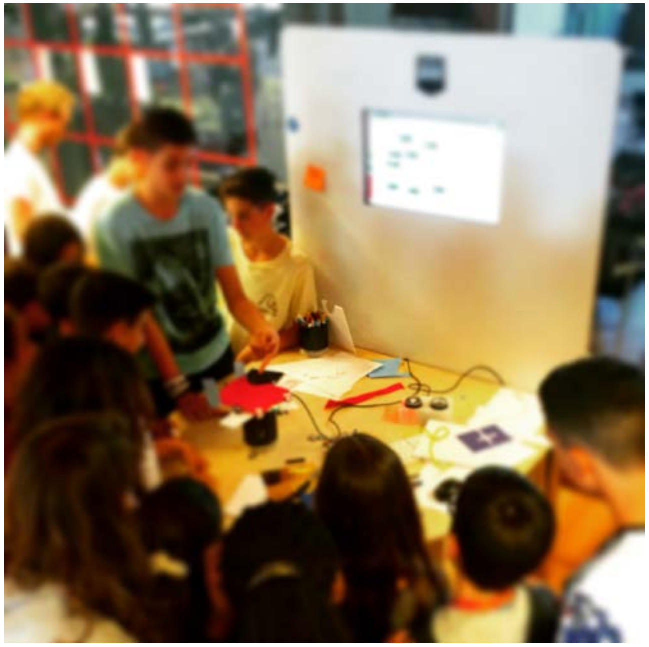

Figure 3:TALKOO and PELARS in action

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