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AdMoVeo: Created For Teaching Creative Programming

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Abstract: Learning programming requires abstract thinking and modeling. In many cases, especially in programming for embedded systems, students also have to understand certain basics about electronics. Both come together, becoming a challenge. Most of the design students do not have inherent affinity towards programming and electronics. The AdMoVeo robotic platform is designed, purely for teaching the industrial design students basic skills of programming and for motivating and encouraging the design students to explore their creativity with their passions in graphical and behavioral design.
Keywords: AdMoVeo, robotics, playful learning, creative programing

1. Introduction

Industrial design of intelligent products and systems is a contemporary challenge which deserves more attention and better support by methods and tools [1]. Things becomes more complicated when intelligence is distributed over and embedded in the networked devices [2-7]. Like many other design departments, we are facing the challenge of teaching the engineering principles and practices such as computer science and mathematical modeling to design students that are neither mathematicians nor computer scientists [8]. Most of the students in our department do not have an inherent affinity towards programming and electronics. But they do have passion in visual designs and product behaviors. Traditional ways of teaching programming and electronics by lectures combined with exercises had been tried in our department, but the students found that it was hard for them to build the link between the theory and the practice. Design students are often eager to put the just learned knowledge into their practice, if not immediately, as quickly as possible [8, 9]. Any longer delay in delivering the hands-on experience only builds up their frustrations and disappointments. The AdMoVeo robotic platform [10, 11] is designed purely for the purpose of teaching the industrial design students basic skills of programming. Moreover we aim at a platform that motivates and encourages the design students to explore their creativity with their passions in graphical and behavioral design, which in turn gives them spontaneous and intrinsic drive in learning programming.

2. Creative Programming

We started with seeking for a programming language and environment that are relatively easy to get immediate hands-on experience yet sophisticated enough for introducing serious software design concepts and principles to the students. This seemed to be contradictory. For example the Logo programming language simplifies vector graphics coding by introducing using a relative cursor (the "turtle") upon a Cartesian plane and hiding the basic concepts and principles of functional programming. In the university education, these concepts and principles are however important elements for the students to learn. Programing languages such as C, Pascal and Java are used in the universities for the introductory courses for the students in disciplines such as computer science and electrical engineering. But these languages have higher hurdles to overcome and as we mentioned in the introduction they are not suitable for introducing programming to the design students.

We then discovered Processing. Actually it was the students who discovered Processing, after they were taught to use Java and found it to be difficult. The homepage of processing.org, it states that "Processing is an open source programming language and environment for people who want to create images, animations, and interactions. Initially developed to serve as a software sketchbook and to teach fundamentals of computer programming within a visual context, Processing also has evolved into a tool for generating finished professional work." It seems to suit our purposes. However in industrial design, students need to be motived and intrigued with things that have a physical form, especially a physical and dynamic form that is driven by embedded intelligence [12-14].

We were then looking for an "electronics prototyping platform based on flexible, easy-to-use hardware and software" (arduino.cc) that could be easily used with the Processing environment. The Arduino board seems to fit perfectly. However Arduino alone cannot create any dynamic behavior. It has to be connected to sensors and actuators to make it run and sing. Since the electronics was not the main purpose of a programming course, we did not want the students to spend too much of time on it. A robotic platform, driven by an arduino board, called AdMoVeo, is then created.

3. Hardware Design

The design of AdMoVeo (Fig. 1) features a detachable Arduino Diecimila board and two wheels integrated within the round shape of the chassis. The size of the chassis is increased from 10cm to 12cm in diameter, exactly the size of a CD. The chassis and motor mount are made from transparent acryl glass, giving it a see-through look into everything inside. The sensors include two line readers at the bottom, three infrared distance sensors at the sides and in the front with sensibility of 0 to 20cm, two light sensors in the front, two sound sensors at the sides and two optional encoders coupled to wheels. The actuators include two motors driving two wheels, a buzzer and a RGB color LED integrated into the acryl chassis. An XBee module is optional for wireless communication.

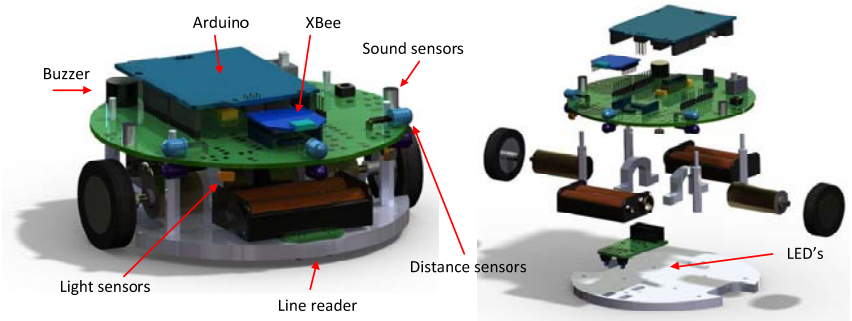


Fig. 1 AdMoVel Hardware design

The Arduino board is designed to be detachable, so that the students can take the Arduino boards with them after the course and further make use of them in their design projects. The hardware is designed to be easily assembled by students themselves. Experience with soldering and wiring the components together gives the student a lot of confidence in handling the electronics. Extra attention was also paid to the layout of the components, so that modifications and extensions can be done easily. For more experienced students, they can detach the preconfigured sensors and actuators, and connect different ones for their applications, without paying too much of efforts.

4. Software Design

The open source Arduino board comes with a programming environment and language, which is very close to Processing. However, the Arduino language is based on C++, and we did not want to get the students into the complication and the confusion. We designed the software to separate the concern and to focus the students only on Processing. The software design is based on a layered structure of composition and inheritance (Fig. 2). It has mainly two major parts – the firmware IDuino running in the Arduino microcontroller of the AdMoVeo robot, and the Java API library for programming and controlling AdMoVeo in the Processing programming environment.

The firmware IDuino is an implementation of Firmata (see firmata.org), a generic protocol for communicating with microcontrollers from a host computer. At the host computer side, the Arduino object acts as a proxy to the firmware, hiding the communication details and providing transparent access to the digital and analog I/O pins of the Arduino board. The AdMoVeo class further wraps up the Arduino I/O details, providing transparent access to the sensors and actuators of the physical robot. Once the IDuino firmware is uploaded to the robot, the students only need to program the robot from the computer using the Processing language without leaving the Processing programming environment and touching any pieces of the Wiring code inside the Arduino microcontroller. Programming examples can be found in [10] and on the website of wiki.id.tue.nl/creapro.

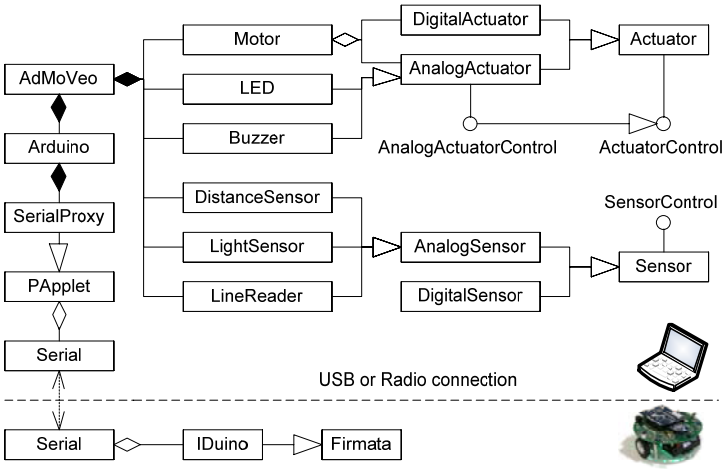


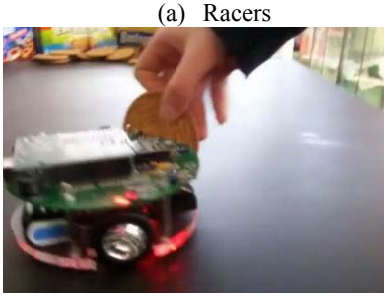
Fig. 2 Software Architecture

5. Examples of programmed AdMoVeo

The AdMoVeo has been used for teaching Creative Programing in our department since 2008, for about 400 students. We were supersized by how well they could learn and by the creativity they had put in creating the behaviors for the robot. There were racer cars (Fig. 3a) using the light sensors to follow the lines on the floor; there were maze solvers using distance sensors to find the way out (Fig. 3b); there were cookie finders and Barbie chasers using the distance sensors to follow an object (Fig. 3c&d); there were also robots that were created to work with other systems, such as a music selector that detected the CD covers and sent the information to a music player(Fig. 3e), and a robot that could be controlled using Phidgets (Fig. 3f). More of these examples can be found on YouTube by searching for "AdMoVeo" and "Creative Programming".

(a) Racers

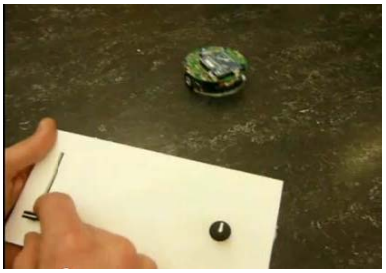
(b) Robo-maze



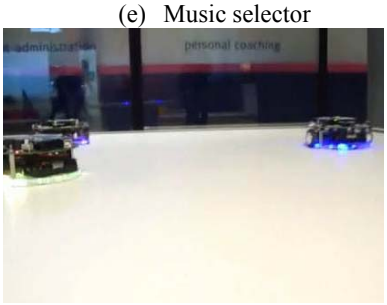
(c) Cookie

(d) After Barbie

(e) Music selector



(f) Phidget-admoveo



(g) AdMoVeo in Dutch Design Week

(h) De Food Robots by Knol-ontwerp

Fig. 3 AdMoVeo examples

AdMoVeo attracted the attention from designers and media. They were demonstrated in the exhibitions of the Dutch Design Week 2009 (Fig. 3g). The designers from Knol-ontwerp (www.knol-ontwerp.nl) used AdMoVeo to serve food in their techno-food exhibitions (Fig. 3h). Tom's Guide introduced AdMoVeo as one of these "Build Your Own Gadgets" for teaching "design students to bypass the complexities of hardware and circuit design and to instead focus on the programming aspect" [15].

AdMoVeo also attracted attention from the more or less technology-minded. It is used in the department of electric engineering at our university for the students to experiment with technologies used in automotive path-finding. They were also used in one of the primary schools in Eindhoven (Basisschool De Bijenkorf) for teaching children about robotics.

6. Concluding remarks

The AdMoVeo robotic platform is designed purely for the purpose of teaching the industrial design students basic skills of programming. Moreover we aim at a platform that motivates and encourages the design students to explore their creativity with their passions in graphical and behavioral design, which in turn gives them spontaneous and intrinsic drive in learning programming. In the design of AdMoVeo, the transparency provided by the software structure enables the student focusing on the programming aspects, and at the same time quickly being engaged in hands-on experience with embedded behaviors; the separation of the Arduino board from the robotic platform invites the students further apply and further develop the learned knowledge in their design projects.

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