

USE OF THE BIOLOID ROBOTIC KIT IN THE TEACHING OF PROGRAMMING

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ABSTRACT:

Teaching Maths and Programming is often done on the theoretical level. Students often find this difficult to understand and they sometimes have no idea at all how the theory they have been taught can be applied in practice. Robots created from the robotic modular construction kit (we use Bioloid manufactured by Robotis) are a great tool for teaching basic programming structures as well as how to integrate hardware and software. Students can see real results of their work - moving robots - which makes teaching attractive for those of them who have not yet done programming before. In the education process, Robots can be successfully used for clarification of terms of higher mathematics, such as integrals or derivatives, and to show how the explained theory can be applied in practice. Furthermore, examples of the possibilities how to work with modular robots at secondary schools significantly increases students' interest in studying technical subjects at universities.

KEYWORDS:

Teaching programming, robot, Bioloid, programming course

INTRODUCTION

When teaching informatics related subjects that are not primarily focused on programming or software engineering, our students' programming skills, as well as their willingness to work and learn new things, varies greatly. Some students have done programming before entering university and are also active during their studies, for example programming web applications. However, at the same time you can find beginner students of IT disciplines who have not come into any contact with programming at all. For this group of students, our one-semester Programming Essentials Course can be a real challenge, both in terms of seeing actual progress, and in terms of their motivation to further their studies. Obviously, it is impossible to become a good programmer after completing thirteen exercises, further education is necessary and the most important thing is practical experience. Lately, we have been noticing a growing tendency towards reluctance to learn programming. This is in contrast to the fact that if there is any demand from the private sector for IT graduates, programmers are the most sought after.

Therefore, the question we need to ask is how to teach the basics of programming in a way that the lessons completed during the semester become the foundation for further deeper study of programming? From practical teaching experience, it is well known that it is not the best idea to teach programming only in relation to the solution of algorithms that are based on higher Mathematics (for example programming algorithms for the calculation of integrals or matrix multiplication ...). For beginners, this creates the unwanted association that programming is equals complicated mathematics, which ultimately leads to an attitude, "I would like to solve something connected with IT, but please no programming." In this way, programming becomes something abstract and hard to understand, and some students end up

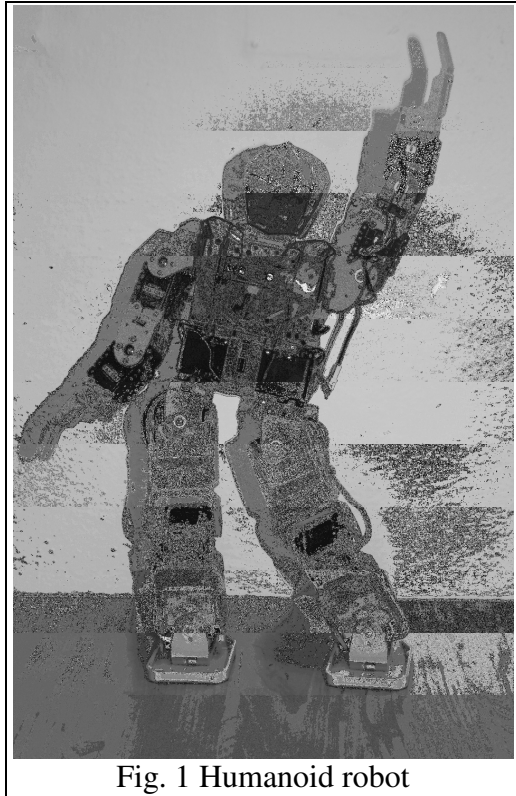


Fig. 1 Humanoid robot

wishing to just "complete the course", with the idea that they will not have to study programming in the future.

For this reason, in the bachelor's courses of programming at Institute of Economics and Control Systems we decided to teach programming using the robotic kit Bioloid from the manufacturer Robotis [2]. What inspired us to take this decision was the success of previous presentations of these robots (some examples are shown in Fig. 1 and Fig. 7) as well as previous experiments where these robots were used to demonstrate how higher mathematics can be applied in practice (for example differential equations of motion applied to the resolution of movement, etc.). As these examples had raised great interest among our students, the next step was to also include the robots in the basic programming course.

BIOLOID KIT DESCRIPTION

The robot kit consists of servomotors, control units and mechanical components for connections [1]. Servomotors are available in several variants, differing in power (and also in mechanical resistance). The robots used in our programming courses consist of servomotors and control units (more detailed parameters can be found in [3]). The control unit is connected to a computer via serial port, either by cable or using ZigBee wireless unit. This makes it possible to send individual orders to the unit, or to download a program compiled with the use of control unit proprietary compiler.

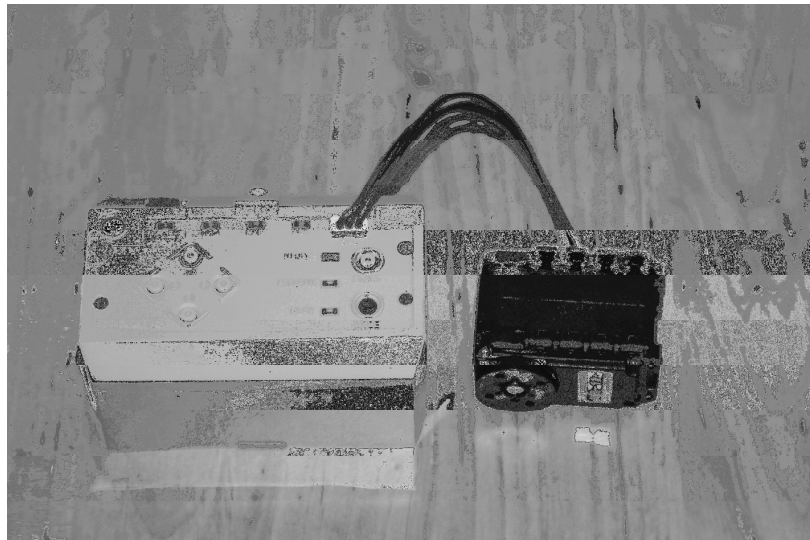


Fig. 2 Control unit CM-5 (left) and servomotor AX-12

The robotic kit being modular, it is possible to build a large number of different robots, e.g. a robotic dog, spider, insect robots, simple vehicles or humanoid robots. As far as programming and configuration options are concerned, the manufacturer supplies their own programming environment, or it is possible to use a processor proprietary compiler in the control unit (in this case, ATmega128). In the latter way, programs can be created in a standard programming

language and downloaded into the control unit via serial port. The program can then be started using either control buttons on the control unit, or remotely using the supplied remote control unit.

USE OF THE BIOLOID KIT IN ESSENTIAL PROGRAMMING COURSE

At the beginning of the essential programming course students are given basic information about the robots, the way they function, and the way how to programme them. The aim is to motivate students to study further. They can see real thing whose functionality is clearly defined, which can be a great help in explaining how knowledge of programming can be used.

The course then continues using proprietary software from the manufacturer (RoboPlus). This tool makes it possible to set the parameters of individual servomotors. Each engine is equipped with various sensors, communication interfaces and a single-chip processor, which provides status information (e.g. servomotors have LED signalization and status bits to determine whether the LED is on). This example can be used to explain the concept of variable and address of the variable (Fig. 3).



Fig. 3 Demonstration of the term “variable“ while setting the servomotor

The next step is to use the software development tool to create simple control algorithms. Here, students learn the basic programming constructs - condition and different types of cycles.

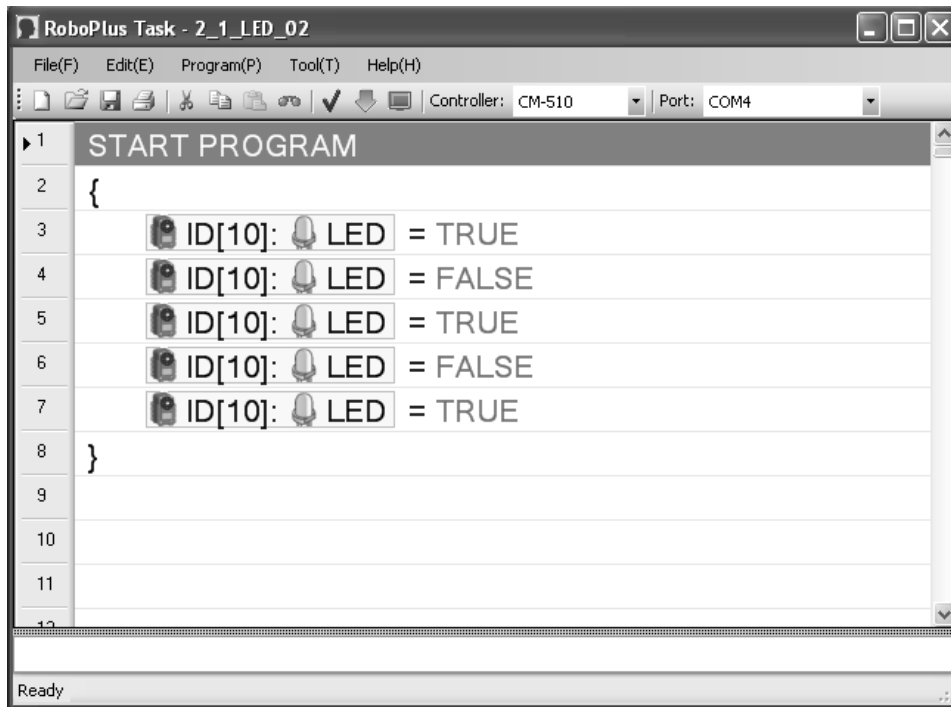


Fig. 4 Demonstration of the use of variables in turning on the LED on the unit

The controlled device – servomotor – has a certain degree of inertia. When control commands are sent to the device too quickly, they are not completed (the servomotor has its time constant). This can be used to demonstrate how to use a timer and construct loops with condition.

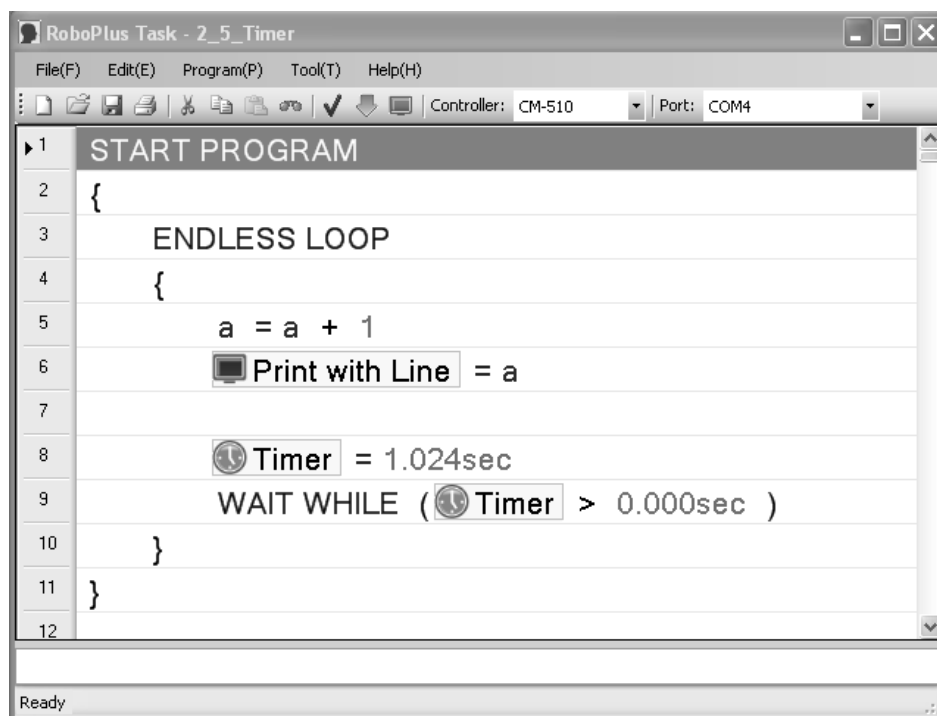


Fig. 5 Loop with timer

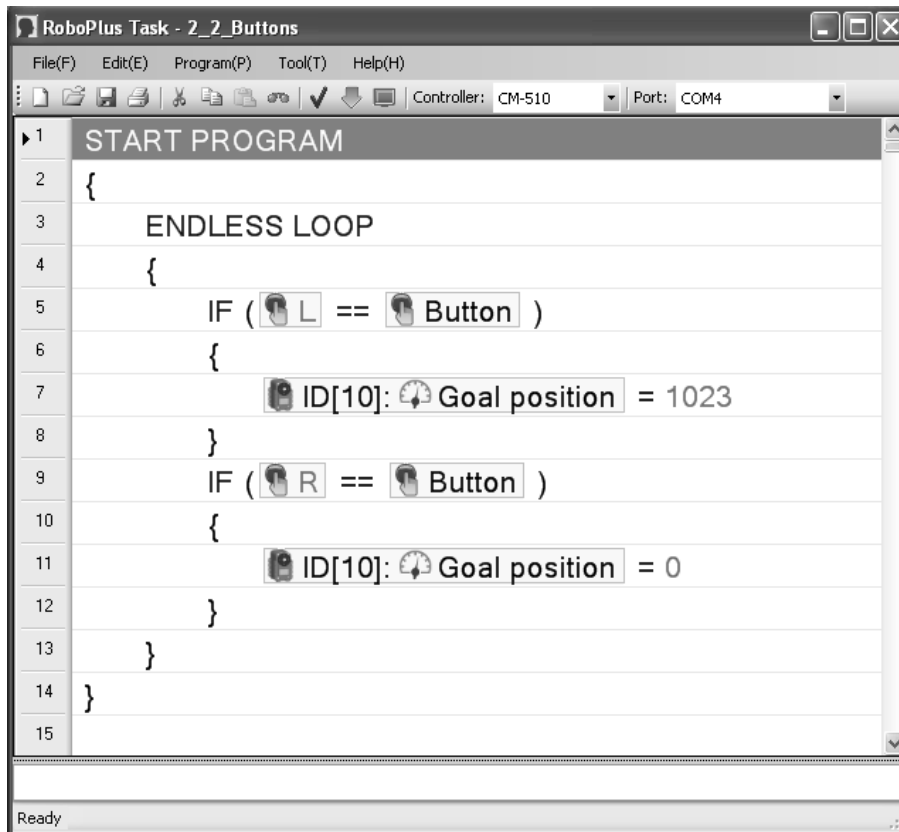


Fig. 6 Programming loop example – reaction to pressing a button on the control unit

The above mentioned examples make it clear that beginner students will mainly focus on learning the principles of programming structures. At this point, thanks to the simplicity of the programming environment there is no need for them to deal with all those complicated abstract elements of classical programming languages. Students are able to see immediate results on real objects. They also familiarize themselves with the way software can be linked with controlling hardware.

ADVANCED PRORGAMMING COURSES

The robotic kit is used again in the following part of the course (more advanced programming), but this time greater emphasis is put on standard programming, i.e. C language. Created programs are compiled and loaded onto the control unit via serial port. Communication with the unit via serial port is also implemented in the form of sending control commands in ASCII form. In this case, the control unit can function as a full duplex terminal (commands can be listed simultaneously, just like in the case of terminals).

When using this robotic construction kit in the advanced course, students are familiarized with controlling robots via serial port – connected by cable, wireless connect by ZigBee or Bluetooth. The programming language used is C #, and students also become familiar with GUI programming - creating a simple Win-32 application that enables them to control individual engines (servomotors). They focus on how to put their assembled robot in motion. In this way, several areas are touched upon, including connecting software and hardware, programming a serial line, as well as principles of GUI application with Win32 interface.

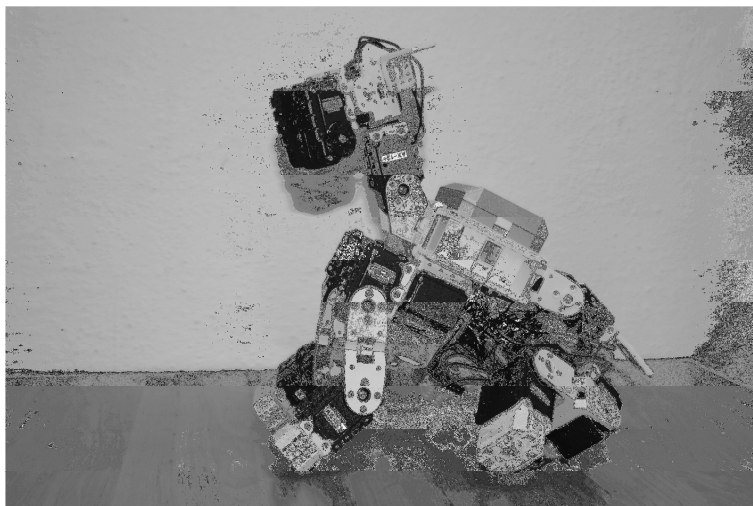


Fig. 7 Robot dog

CONCLUSION

Robot Kit is a great tool to facilitate modular design of different types of robots and been successfully used in teaching programming, especially in terms of increasing students' interest and motivation. Due to all the positive results in teaching programming essentials, it is planned to extend the use of this robotic kit to other subjects, especially Mathematics. At this moment we are working on example robotics problems, demonstrating how abstract constructions of higher Mathematics can be applied in practice.

LITERATURE

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