

## VIRTUAL ROBOTIC LABORATORIES ROBOT C IN THE INFORMATICS TEACHERS TRAINING

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**Abstract:** The paper deals with the virtual robotic laboratories experience in the training of future informatics teachers in the full-time and part-time studies. The students get familiar with program language C++ and they use the robotic system Lego Mindstorm and VRL Robot C. However, the number of the available systems is the limited factor. The students have to be divided into the groups. It is very time consuming in order to fix the new knowledge and abilities. The usage of the virtual robotic laboratory seems to be a good option in order to solve the insufficient number of the hardware tools within the education.

**Key words:** Robot Virtual World, Robot C, Lego

### 1 Introduction

The virtual world of the Internet has many advantages, which can be used in education, such as an unlimited dissemination of information, speed and an access to services at anytime and anywhere. Extending the learning objectives about the digital dimension of the proper use of ICT increase the effectiveness of teaching [4]. In order to facilitate the continued and effective integration of digital technology and increasing the quality of learning processes we can explore and observe potential ways to promote and encourage innovation. In preparing future teachers of computer science it is important to implement new knowledge, methods and forms within the teaching of programming languages in such a manner that the teaching is made attractive and interconnected with application outcomes. One of the ways how to make the teaching of programming languages attractive is the use of educational robotic kits. The interconnection of SW and HW in the form of educational kits stimulates students and motivates them to be more active. The motivation in such a form of education is based on the method in which the students, according to their own proposals, use kits to create a device (robot, vehicle, etc.) and by means of SW they program certain features, procedures, behaviour or actions to be performed by the device. Such an interconnection of SW and HW means shows the students how the knowledge of a programming language can be applied in practice (in the fields such as automation and process control). The price of educational robotic kits is the factor that determines their number in schools. The solution can be the use of virtual laboratories that can simulate a HW device and environment.

### 2 Virtual laboratories in education

The virtual laboratories (VL) are interactive environments for creating and conducting simulated experiments. Experiment is the means of knowledge and also a specific form of practice. An important advantage of the virtual laboratories in teaching is a reinforcement of a role of visualization. The visualization can often provide a simple and effective approach to the discovering of the results, to the problem-solving and discovering of the structure of a model itself, whereby students get new information. The visualization of relations and causalities within a single model allows us to derive new results in other fields and areas of science through models, which are isomorphic with the existing model.

The other aspect of visualization stems from the importance of exploitation of various teaching styles within the teaching process. The actual trends of the study of models can be

realized through the educational software. These systems help to easily discover the universal coincidences and rules followed by the model, what is often realized at the expense of decrease in the common algebraic thinking. However, they allow to dynamically changing parameters of the model, thus making it faster and easier for the students to find dependences while adopting new knowledge [2].

Musa et al. [3] showed that the computer animation and visualization can bring forward the following points:

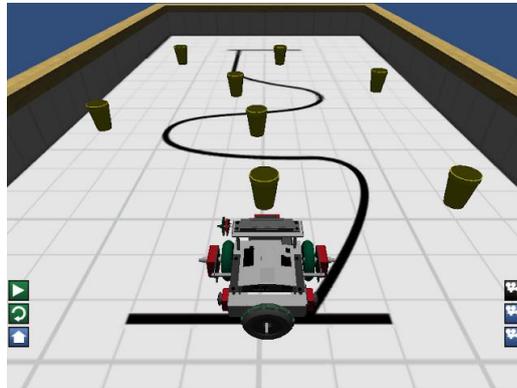
- can be considered as one of the main tools available for teachers to use to promote effective learning nowadays,
- an effective approach while looking for the results, solving the problems and discovering the very structure of the model,
- a visualization of relations in the model allows an inference of new results in other areas and fields of science subjects at school,
- a support of digital competences and basic competences in science and technology.

A technology-enriched environment would greatly enhance students' motivation and develops positive attitude towards the course. Subsequently, the academic achievement would be enhanced. According Gunčaga et al. [1], several studies emphasized the vital role of VL in developing academic achievement, providing awareness of scientific concepts, and modifying misconceptions. Virtual laboratory can facilitate a range of different learning processes: solution of (complex) problems, discovery of new content and new assessment of already known information by means of discovery learning; construction of general principles from experimental work and comparison of individual phenomena (inductive learning). Among the others there are two fundamental aspects concerning the virtual laboratories that must be taken into account the quality of the education by VL, and the realism of the environment created by the VL [5]. The quality assessment of the VL involves several factors and it can be considered an index of its effectiveness as education tool. To this aim in the design phase it is necessary to specify a set of requirements and factors to be taken into account to achieve the desired quality level. According Grimaldi [5] the interest is usually devoted to the graphical environment, the software supervisor that should point out operating errors, the comparison of the results with the correct ones obtained in the same operating conditions, and the accessibility to the higher skill levels on the basis of expertise acquired at the lower ones.

### **3 Programming Language C and Virtual Laboratory**

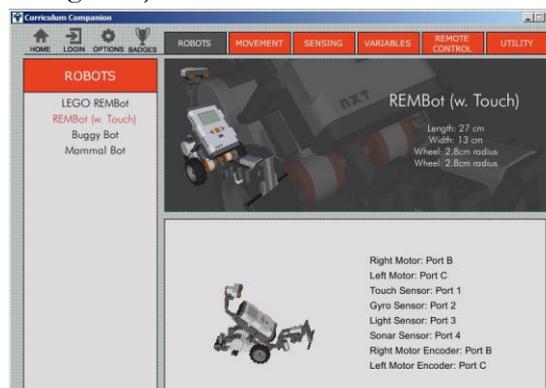
Devices around us, such as microwave ovens, coffee machines, washing machines, security systems, etc., contain circuits that control their functioning – microcontrollers. For their operation they use input information from sensors and actuators. The control of the functioning of a device is a sequence of steps carried out on the basis of a program. For programming such devices (microcontrollers) it is recommended that the structure of a programming language is as similar to the programming language used in the development of SW applications in the PC platforms as possible. The aforesaid suggests that the language C is suitable for programming microcontrollers. It, however, has to contain libraries for programming sensors and a compiler that will convert the program into the language of a given type of microcontroller. In the teaching of programming microcontrollers we use the programming language ROBOTC. This language is for writing and debugging programs and at software level it offers a comprehensive compiler (real-time debugger). The language ROBOTC supports programming several types of microcontrollers that are used in Lego kits, such as NXT, EV3, VEX. It also supports the

platforms Arduino Uno, Mega 1280 and Mega 2560. The program ROBOTC is a multiplatform solution that allows the teaching of the programming language C as well as the possibility to develop professional applications. ROBOTC is a licensed program and it can be used as a time-limited trial version. It includes a robotic virtual laboratory (RVW, Robot Virtual Word). RVW can be separately tried on the website.



**Figure 1:** Virtual environment [6].

The virtual laboratory is intended to substitute a real environment and robot for its simulation (virtual) model in the computer. We use this alternative when it is not possible to provide a sufficient number of HW kits in the classroom. In the teaching of programming we use the Robot Virtual World - laboratory (RVW) in such a manner that each student works independently. RVW includes a 3D environment in which it is possible to program the motion and interaction between the 3D model of a robot and obstacles as if we had a real robot (see Figure 1).



**Figure 2:** Virtual robot Lego Minsdtorm – Base [7]

The virtual model of a robot is identical to the real robot called BASE. This robot can be constructed from the NXT or EV3 Lego kits (see Figure 2 Virtual robot). In the virtual laboratory the visualisation of the motion and interactions of the robot with its environment take place according to the control programs developed by the students. The programs are developed in the programming language ROBOTC. The visualisation of the motion takes place in the 3D environment. The proper functioning of the robot, mutual interactions between the robot and its environment can be observed from different angles.

The physical characteristics of the 3D model of the robot in RVW are designed as if it were a real device.

### Conclusion

In the teaching of computer science we see the benefit of educational robotic Lego kits in the enhancement of the attractiveness of the teaching of a programming language through games. The use of kits offers teachers a variety of teaching forms, e.g. project, problem, or cooperative teaching, the use of video instructions and tutorials. The inclusion of the programme ROBOTC and the virtual laboratory RVW into the teaching of programming, together with Lego kits, provides a comprehensive support for the teaching of programming microcontrollers in the language C. Further, we see the benefit of the use of RVW in the preparation of future computer science teachers within extramural and extension study programmes in the possibility of using blended learning form. Introductory lessons are based on the active use of the HW and SW means of Lego kits at the department of computer science. Subsequently, the students continue in the individual study of the programming language C with the use of RVW. They can consult their individual partial solutions as well as the final result of programming with the teacher offline. In addition, the students can use various discussion forums on the ROBOTC website or directly on the virtual laboratory (RVW) website. The benefit of this form of learning is the enhancement of independence, creativity and the development of individual projects using only a virtual laboratory. The resulting program created and tested in the virtual laboratory can be subsequently implemented into a real robot model. We see a great advantage and importance for the teaching of programming in the combination of Lego kits and virtual laboratory. In this case teaching no longer depends on the number of HW means (kits) and the form of teaching can be changed from group to individual.

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