

Human-robot interaction: importance, opportunities, and educational responsibility in this regard

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Abstract—This article describes the actual status of Hungarian education of IT in elementary and high school, highlights the fact that Hungarian education doesn't follow the evolution of IT at a required pace. Authors think that fields of IT which are probably present in everyday life in the near future don't get enough stress. In the article a simple and cost-efficient suggestion is drafted to transfer knowledge related to programing and robotics.

I. INTRODUCTION

In life we are surrounded by technical devices everywhere: in our flats, workplaces, traffic and entertainment. However, mobile phones are the only ones that appear in all spheres of life. The emergence of mobile phones involved considerable changes in the everyday life of adults, while for younger generations they are natural parts of life. Therefore, this is the reason why smartphones started becoming popular with younger generations at first and they are more typical with them than older people. Older and younger generations use them for different reasons. While youngsters much more tend to use the opportunities to listen to music, play games, watch films, surf the Internet send messages immediately and e-mails as well, the day of the latter begins with waking them up using the alarm function of the mobile phone; during the day it reminds them of their obligations, they can collect information about different events; it helps them manage their problems quickly, bridge physical distances rapidly, and their days end when they set the alarm function for the following day. Due to their „smartness” they are / may be utilized in special fields, for example, in the education of IT in elementary and high schools in my opinion because the majority of elementary and high schools students own their smartphones as everyday utensils. In this field of use they would go far beyond their „original” function, they could become teaching aids as the result of the utilization of such advantages that they are rather like small-size computers kept by us during twenty-four hours a day.

II. ANALYSIS OF THE SITUATION, RAISING THE PROBLEM

These days IT is being taught nearly as it was in elementary and high schools at the introduction of the subject. Since

this subject is considered to be new compared to the others therefore the majority of teachers teaching this subject still belongs to the „first generation of IT teachers. Many of them were qualified in postgraduate studies 20-30 years ago, so their methodological skills do not always meet today's expectations. In many cases the recognition / the way of making students recognize the opportunities in the utilization of the knowledge conveyed by the subject is missing. Elementary and high school curriculum can be covered with maximum four topics, the following ones: basic theoretical concepts, use of MS Office package, basics of algorithming and programming with LOGO, use of Internet. These pieces of knowledge are adopted by students passively, they do not need to / do not have any opportunities to develop their individual creativity. As a consequence of this students are unmotivated, they lose their initial interests in IT as a subject and cannot see how knowledge that they can acquire in class can be utilized. The „results” of this manifest itself among the students of institutions of higher education as well. [1]

Teaching, studying and the new field of use of LOGO may be a possible breakout in this situation because children start becoming familiar with LOGO programming language in the third year of primary school in IT lessons or in subject interest groups. Using this language they improve algorithmic way of thinking, algorithmic skills, and they study basic programming. It has been embedded in the education of IT in elementary and high schools as a curriculum that it may appear even in the class 10 of high schools as well. Whats more, a national competition is based on it which is called Logo National Information Technology Competition and is organised in four categories from class 3 to 10, for 2-2 classes together.

Students with more talent and interest (who practise at home as well, and try new things/ideas with the help of it) easily reach the level that they lose their interest in opportunities provided by it, „outgrow” LOGO or they are just simply bored at „drawing”. And you do not have to

wait with it till high school, it often happens in elementary schools as well. However, the teacher has to teach a whole class not only several talented students, they have to help less interested/talented and weaker students reach a certain level.

A device and its operation may be a solution for the problems of both more and less interested students which encourages „better ones” to work further and arouse the interest of unmotivated students having interest in the subject.

III. THE PRESENTATION OF CURRENT POSSIBILITIES AND DEVICES

In order to solve the problems having been detailed so far, new educational devices have been applied (LEGO MINDSTORMS NXT robot kit, interactive whiteboard, Arduino) in the Hungarian educational system but their overall spreading is hindered by more factors (financial problems, teacher's aversion and lack of education, lack of time, lack of students' previous experience, etc.). Although, college experiments and surveys [2], [3], [4] proof that significant results can be achieved in a short time by LEGO's product.

The price of LEGO MINDSTORMS NXT [6] basic kit equals about with the amount of minimum wage in Hungary. The purchase of necessary accessories to solve more complex and interesting exercises additional sums of money should be spent. The relatively small number of schools having such kits were able to buy them with the help of tenders or they are foundation schools / private schools based on tuition fees because almost there is no state school which can afford it from its own budget. So the device should be as cheap as possible. Another major problem with the product of LEGO is that both teachers and students should learn to use it and this would demand plenty of time and energy. Therefore many people are unwilling to deal with it at all. Consequently, the device should require only very little human resources. Interactive whiteboards also requiring significant financial investments can be used efficiently in the lower classes of primary school, taking advantage of the students mobility and playfulness. In upper classes and high school there is no time for games because of the quantity and complexity of the curriculum. At the same time these generations require spectacles and interactivity therefore such a device is needed which meets these requirements „more seriously”. Arduino [7], which is an open source physical computing platform, which consists of an I/O chip with a microcontroller and the corresponding development environment, its involvement into education preknowledge in physics, electronics and microcontroller programming are necessary from the students side which they may have earliest in the upper classes of high school.

IV. A GOOD SOLUTION IS NEEDED, A POSSIBLE ALTERNATIVE

Problems having been detailed in our article so far were recognized by the Institute of Mathematics and Information Technology of Eszterházy Károly College a long time ago and it is continuously looking for the solution in more directions in more ways. IT teachers graduating in this educational system are already trained to use the devices (LEGO Mindstorms NXT robot kit, interactive whiteboard, Arduino) in the teaching of IT. [5] On the other side, in the Institute of Mathematics and Information Technology of Eszterházy Károly College a Laboratory of Robotics has been established the aim of which among others is to create robots as teaching aids utilized successfully in the teaching of IT. These two ways are linked together by MA students of IT teaching who take an active part in the work of the Laboratory of Robotics in this field. Having thought over these criteria we finally came to our idea: a robot controllable / programmable with a smartphone and which also „speaks” LOGO language. Similar idea has been tried in other countries [8], [9] but we try to get closer to students with our.

In order to avoid suffering from the „disadvantages” of the devices mentioned above which were used in the education of IT but were also unable to spread fully, our device should be affordable for any school and person Its use should not require the teachers graduated earlier to have any extra qualification and, it should be completely natural for new graduates. It does not require students to have extra knowledge acquired in other fields, so they do not need to do any extra learning either.

The Arduino controlled drawing robot designed by us - with the help of the programs written by children in LOGO language - does the same in physical reality as the turtle virtually on the screen of the computer. The robot can be controlled by the students with the help of their knowledge in (algorithming and) LOGO language acquired in lessons, on an easy-to-handle touchscreen surface developed and optimized for smartphones. The operation of the robot may become independent of school, lesson, desktop computers and the students almost play while learning, and do not notice that they adapt and practise the curriculum of IT as a subject. The disadvantages and deficiencies of the attempts listed above would not be carried by this device: the robot can be manufactured at a low cost, smartphones are used by teachers as well and everyone has some knowledge in LOGO language.

V. THE CONSTRUCTION OF THE ROBOT

The robot is controlled by an Arduino. The movement and positioning of the robot has been performed with 2 NEMA 17 type stepper motors and 2 idler gears by us. In order to realize the „pen” function of the „turtle” two methods were tested. At one of them an electro-magnet and a pen equipped with

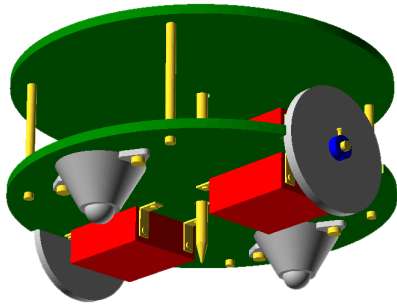


Fig. 1. Model of the robot

a magnet is used. We change the polarity of electromagnet with Arduino depending on whether we would like it to draw (electro-magnet pushes off magnetized pen from itself, so the turtle puts down the pen), meanwhile it is moving forward or not (the electromagnet attracts the magnetized pen to itself, so the turtle lifts its pen). According to an other conception we rotate a threaded rod with a servo motor; a pen is fixed to the rod so in case of a rotation into one direction pen comes down and draws, while into the other direction it is lifted up and does not leave a mark (on the surface). Its power supply is provided by lithium batteries and a charging circuit, so the right charging of the batteries has to be checked, the robot has to work at least for the length of a lesson but rather more under continuous use. The robot receives the instructions through wireless connection, with the help of a bluetooth adapter from the application running on the smartphone. The program running on Arduino is written by us for the robot, there is nothing to do with it later, only when its newer version is issued. That time it has to be updated, so uploads should be made to Arduino which can be performed through some easy steps by anyone. The received information is firstly interpreted then executed by the program running on Arduino. This robot can be built by anyone - a student showing interest or a teacher of a school living on a tight budget. The necessary components are available for everyone and they are payable with little financial investment.

VI. THE APPLICATION RUNNING ON SMARTPHONE

Android is the mobile operational system which is the most widespread with the users of the target group, therefore we primarily „aimed at” this platform to develop [10] the application. Several criteria and requests have been drawn in connection with the application, additionally, new ideas, suggestions and even repairs are also welcome with pleasure. The most important requirements towards the application are the following:

- should be downloaded free of charge, open source,
- its interface should be easy-to-handle, transparent
- its use should not require any extra learning,
- two kinds of user modes should be differentiated: beginner and advanced. In beginner mode the robot is

controlled by touching, while in advanced mode similarly to the computer-based realization there should be an opportunity to write a program code

- there should be a previously defined, simple shapes drawing function where by giving the name and basic parameters of the shape it would be more simple and faster to improve, for example: square(100). It should not be specified with a program code, of course, rather by entering a shape name selectable from a list, by specifying a value adjustable with a slide with regard to beginners and achieving results as quickly as possible.

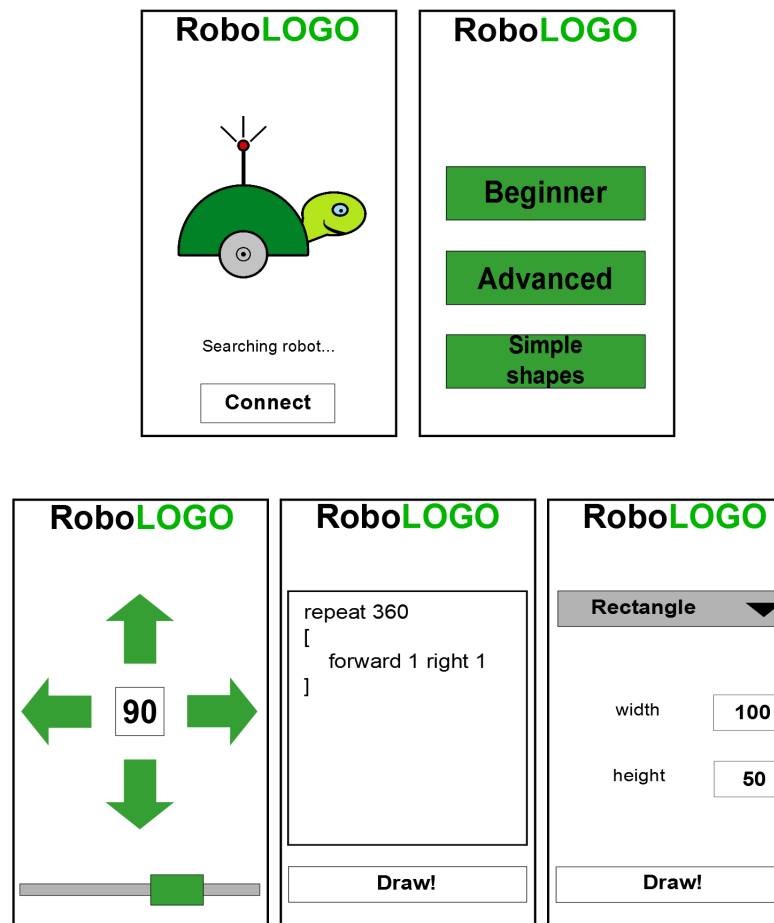


Fig. 2. RoboLOGO Android application design

VII. CONCLUSION

There are several attempts to solve the problems of Hungarian education of IT in elementary and high school. We would like to join these attempts, to connect the curriculum of IT as a subject with student's most often used device, a drawing robot controllable/programmable with a smartphone was developed by us.

VIII. FUTURE WORK

We are planning the following developments in the near future:

- Windows desktop OS client written in C# .NET/WPF with „simulator” like Imagine LOGO or Comenius LOGO, but much more modern and powerful and later a cross-platform one
- Windows Phone client
- Work out a proper pen color changing method/mechanism

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