KNOWLEDGE-BASED APPROACH TO ADAPTIVE SELECTION OF EQUIPMENT FOR TEACHING ROBOTICS

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Abstract

Innovations and progress in teaching, introduction of new academic disciplines in the curricula, changes in the paradigm of school education in Ukraine, the search for innovative tools, techniques and teaching methods, especially teaching STEAM create a good basis for teaching robotics.
However, the organization of classes in robotics requires the creation of a special educational ecosystem, which important element is the technical base (equipment). It is not a secret, that administrative staff who sometimes even do not have required experience in technology are often engaged in the procurement of equipment and its selection. The current study was conducted to solve this problem, as well as to create a universal recommendation for creating an appropriate ecosystem for teaching robotics
As part of the study, the task was to develop a prototype of an expert decision-making system for selecting of an appropriate equipment and zoning of a classroom (ICR) for conducting classes in robotics. Knowledge-oriented approach was used to create the prototype.
Keywords: *knowledge-based approach, robotics, adaptive selection, teaching robotics*.

Introduction

The state of art in educational system development is associated with the expansion of interdisciplinary relations, integrated learning, the predominance of practice-oriented didactic tasks, and development of students' creativity. These directions are particularly relevant in the framework of the reforms being implemented in the Ukrainian educational system due to the "New Ukrainian School" philosophy (Ministry of Science and Education of Ukraine, 2019). In accordance with this philosophy, the goal has been set to make school comfortable and child-friendly, to adapt the learning process to modern living conditions. One of the tools which is going to be used is teaching robotics.

Among the main principles of the reform are the following: the formation of practical skills and competencies instead of abstract knowledge; use of modern teaching technologies; comfortable and interesting learning ecosystem.

It is also planned to fundamentally change the learning process itself, to pay special attention to such changes: gamification of the teaching process; increase of practical tasks; the introduction of integrated lessons; teamwork; collaborative learning; creating of a p2p-friendly atmosphere of mutual assistance

After analysing these approaches and making a comparison with the basic aims of school robotics (Eguchi, 2014; Scaradozzi, Sorbi, Pedale, Valzano, & Vergine, 2015) it was suggested to implement robotics into school curriculum, as an important tool for creating conditions for reforming the whole national educational system. Simultaneously with the introduction of such a toolkit, it is necessary to teach the upcoming teachers how to use robotics systems for educational purposes.

The necessity in creating of a methodical system of training for different categories of students — from elementary school students to students of pedagogical HEIs, upcoming teachers of IT is obvious.

At the South Ukrainian National Pedagogical University named after K. D. Ushynsky such investigation is carried out in two directions. The first direction is the bachelor degree program “Secondary education. Informatics" where robotics is introduced. In the framework of this program special courses of technical, programming and methodical training of the upcoming IT-teachers for introducing the elements of robotics into the teaching process in secondary school have been developed.

The second direction is carried out in the framework of extracurricular classes conducted for students of Odessa region, who are introduced to the basics of robotics and programming at the Department of Applied Mathematics and Informatics.

It is obvious that the process of introducing educational robotics is gradually and steadily approaching the development of generalized recommendations for the creation of teaching materials and technologies which allow teachers of any subject to use robots during their classes for the own didactical needs. And one of the serious issues that needs to be solved in each particular school or university is the problem of choosing the necessary and reasonable configuration of equipment according to the goals, capabilities and specifics of each educational institution.

In the current article, the issue of improving the approach to the formation of the equipment configuration, as part of an integrated methodological system, is considered.

Research Methodology

General Background

The task of choosing the best hardware configuration, due to the lack of clear ideas about the sought-after capabilities and necessary functions of robotic systems implemented in training, is poorly formalized. Furthermore, the state of art in application of robotics in the teaching depicts that there is no clear unambiguous algorithm for such selection. However, this kind of task is going to be adopted to the multitude of heterogeneous requirements of a particular educational institution, among which there is a group of non-formalized ones. All this leads to the conclusion of using the knowledge-based technologies to solve the current task.

Transferring recommendations of experts into the form of production rules allows automatically receive a recommendation regarding the most appropriate configuration option with taking into account the entire spectrum of heterogeneous and multidimensional requirements for a specific robotic laboratory — from didactical to economical ones.

Research Sample

The current investigation and development was based on using CLIPS. CLIPS is an expert system tool originally developed by the Software Technology Branch (STB), NASA/Lyndon B. Johnson Space Center. CLIPS is designed to facilitate the development of software to model human knowledge or expertise. There are three ways to represent knowledge in CLIPS: rules, which are primarily intended for heuristic knowledge based on experience; defunctions and generic functions, which are primarily intended for procedural knowledge; object-oriented programming, also primarily intended for procedural knowledge. The five generally accepted features of object-oriented programming are supported: classes, message-handlers, abstraction, encapsulation, inheritance, and polymorphism. Rules may pattern match on objects and facts. (Giarratano*, 2018*)

Various knowledge extraction methods were used to form a knowledge base: textual (analysis of methodical literature, technical documentation of various equipment, legislation base), active and passive communication methods (questionnaire, interview, brainstorming, lectures, dialogue).

In general, the rules used in the core of the prototype expert system are production rules depicted in the “IF THEN” pattern.

Research Instrument and Procedure

The prototype’s knowledge base consists of a set of predefined facts and rules (so-called *deffacts* and *defrules*). The prototype has a text-based interface. Communication with the user passes in a mode of dialogue, which is based on yes-no questions. After the user has answered the questions, new facts are added to the knowledge base, the presence of which activates a set of rules responsible for the inference engine.

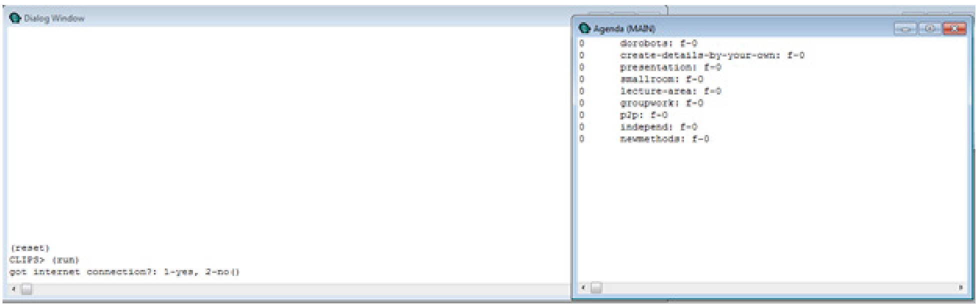

Figure 1. Dialog window and Agenda window.

It should be noted that during the development of the prototype, a conflict situation leading to the activation of several rules in the inference engine occurred. The recommendations proposed by the prototype based on conflicting rules are mutually exclusive. To solve this problem, a conflict resolution strategy was used, and several rules were added to the inference engine to extract from the knowledge base the list facts which could lead to conflicts.

Data Analysis

As a result of the development a prototype of the expert system was obtained, which is designed to make recommendations on the selection of equipment and the zoning of the ICR for conducting classes in robotics. Currently, work is underway to expand the knowledge base of this prototype and validate the rules in order to prevent the conflicts.

Research Results

To demonstrate the results of the work, we offer to get acquainted with the recommendations of the prototype, which were obtained during the trial work of the expert system (Table 1).

Table 1. Recommendations based on user's answers.

<table>
<tr><th>Questions</th><th>Answers</th><th>Recommendations</th></tr>
<tr><td>Got Internet Access?</td><td>Yes</td><td rowspan="5">Lecture area should be created
Server station Is highly recommended
Need projector and smartboard
Soldering stations are recommended
Need CNC
Need PCs</td></tr>
<tr><td>Going to create parts by tour own?</td><td>Yes</td></tr>
<tr><td>Got a small room for ICR?</td><td>No</td></tr>
<tr><td>Going to organise a teamwork?</td><td>Yes</td></tr>
<tr><td>Going to use Peer-Assessment, Brainstorming, etc.?</td><td>Yes</td></tr>
</table>

The results obtained by the user, of course, are advisory in nature and are not a direct indication to action.

Conclusions and Implications

Thus, at this stage of the study, it can be concluded that the use of a knowledge-based adaptive approach to the rational selection of equipment for teaching a robotics classroom at school and its implementation as an expert system is relevant and in demand, as it provides an opportunity to get recommendations on equipping the robotics ICR to the non-expert user (school principal, city / regional / country authorities).

The use of knowledge-based approach and its implementation in the prototype of the expert system make it possible to obtain the necessary recommendations in a short time. At the same time, the likelihood of erroneous recommendations is extremely low due to the use of conflict resolution strategies.

Further development and research is the question of creating a valid and relevant knowledge base, filling it with rules that do not cause conflicts, supporting the work of this knowledge base and updating it in view of the rapid development of technologies and the appearance on the market of new devices and components which can be used in teaching robotics.

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