

CODING DATA FLOWS METHOD FOR VIRTUAL PROFILED EQUIPMENT IN INTERDISCIPLINARY ENVIRONMENT OF LABORATORY RESEARCHING

In the present research an improved the technique of coding the specification from widespread software complexes for modeling and designing the subject area is proposed, which is optimized with regard to the specialization of data flows of the built scheme of learning experiment with operational access to information resources and computerized means for appraise demonstrated competencies. Stipulated hierarchy of target categories for simulation model of production stages distinguishes of structured rubrics sets, meaningful records of which represent properties and events in visualization the regular objects, guaranteeing stability of experimental scheme due to unified procedures of subject area processing and absence the arhythmization in algorithm of file format serialization. Thus, related instances of complementary objects of ramified technological map or commenting on graphic pattern the generalized simulation model of experimental scheme provide the completion accompanying hypertags of projected specification, which assure the integration of created media platform into academic information space. The adequacy of modeled data structure is confirmed by saving of user settings by API and the correctness of subject area file processing in file system according to accepted signature.

Keywords: virtual laboratory, learning experiment scheme, subject area, data flows, specification, signature, academic information space.

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МЕТОД КОДУВАННЯ ПОТОКІВ ДАНИХ ВІРТУАЛЬНОГО ПРОФІЛЬОВАНОГО УСТАТКУВАННЯ У МІЖДИСЦИПЛІНАРНОМУ СЕРЕДОВИЩІ ЛАБОРАТОРНИХ ДОСЛІДЖЕНЬ

З огляду на перманентне поглиблення впливу інформаційних технологій на індустріальні суб'єкти господарювання розглянуто напрями підвищення якості підготовки кваліфікованих фахівців. Показано позитивний вплив цільового інтегрування інфокомунікативних обчислювальних платформ лабораторних досліджень на успішність здобувачів вищої освіти в умовах віддаленої форми навчання. Проаналізований досвід світових вчених щодо використання комп'ютерних засобів моделювання для закріплення практичних навичок студентів в обраній галузі знань, пов'язаних з викликами сучасної індустрії, свідчить про недостатній обсяг праць відкритого доступу стосовно засобів впровадження міждисциплінарних комп'ютеризованих середовищ навчального експерименту в цифрові крос-університетські інформаційні системи з цільовою адаптацією до потреб авторизованого споживача освітніх послуг. У представленому дослідженні вдосконалено методику кодування специфікації розповсюджених програмних комплексів моделювання та проектування предметної області з огляду на спеціалізацію потоків даних побудованої схеми навчального експерименту з оперативним доступом до інформаційно-методичних ресурсів і комп'ютеризованих засобів оцінювання продемонстрованих компетентностей.

Обумовлена ієрархія цільових категорій імітаційної моделі виробничих етапів виділяє множини структурованих рубрик, змістовні записи яких представляють властивості та події при візуалізації регулярних об'єктів, гарантуючи стабільність схеми експерименту за рахунок уніфікованих процедур опрацювання предметної області та відсутності оптимізації в алгоритмі серіалізації файлового формату. Відтак, пов'язані примірники доповняльних об'єктів розгалуженої технологічної карти чи коментування графічного образу узагальненої імітаційної моделі схеми експерименту надають прикінцевим супровідним гіпертегам проекрованої специфікації освітньо орієнтований контент, що забезпечує інтегрування створюваної медіаплатформи в академічний інформаційний простір.

Ключові слова: віртуальна лабораторія, схема навчального експерименту, предметна область, потоки даних, специфікація, сигнатура, академічний інформаційний простір.

Introduction

The amount growth of information and communication technologies in the manufacturing sector leads to a continuous increase in the requirements for the competencies of hired employees. This state of affairs leads to need for continuous updating of relevant curricula and working out the competency-based educational services. The experience of training engineering specialists with integration of computerized learning experiment environments is now widely used in higher education institutions.

Although the replacement of subject-spatial lessons with material stands of laboratory infrastructure by means of digital infocommunicative toolkit for modeling the subject area does not fully help students to achieve the necessary learning goals with comprehensive mastery of professional motor skills in interaction with real laboratory equipment, however, such environments have become especially relevant with the total introduction of distance learning associated with quarantine measures around the world. Such situation partially solves the problem of developing students' practical skills and providing them with simulation models of varying degrees of adequacy.

A significant percentage of technical students prefer interactive platforms of remote research. Educational versions of such platforms are deployed locally on stationary classroom workstations and mobile student personal gadgets; also authorized access to cloud software is provided through the university information space. Using

the digital content of manuals or guidelines approved in the curriculum of academic discipline, students follow the sequence of standard procedures for construction of subject area, further data assembly and analysis of modeling results. It is obvious that with the development of information technology the share of such infocommunicative media environments in educational process is growing. Therefore, today much attention is paid to the means of improving the pedagogical efficiency of virtual learning laboratories with simulation of profiled equipment in the training of engineering specialists.

Related works

In their publications, world scientists highlight the practical experience and importance of using computer simulation toolkit to consolidate students' practical skills in chosen field of knowledge and ability to solve complex engineering problems related to the challenges of modern industry. In [1, 2] the effectiveness Kolb's empirical teaching method is substantiated, which promotes the increase of cognitive interest and consolidation of competencies acquired by students in comparison with step-by-step practical measures. Herewith, Penn State Berks employees received positive results due to the integrity of the perspective, which includes experience, perception, cognition and behavior. Teachers from the University of Ljubljana shows the correlation of combinations the different styles in laboratory work with desired types of accompanying multimedia materials. The advantages of virtual laboratories over physical ones in terms of unobserved phenomena and the acquisition of theoretical multidisciplinary knowledge are emphasized in [3, 4]. Computer modeling and the experimental method are considered as complementary strategies and teaching means in [5, 6], but with different effects and empirical conclusions.

Another group of researchers is looking for ways to strengthen the links between educational plans and industry. So, in [7] argues the need to implement pre-developed competency profiles in accordance with the production conditions of branch enterprises within the requirements of "Industry 4.0", which leads to narrow specialization of training programs content in the field of engineering knowledge. The originality of project components in educational environments, organized on project-based laboratory principle, significantly increases motivation, opens opportunities for constructive research with the acquisition of flexible and interdisciplinary engineering skills in individual style and pace of learning [7-9]. The general result of this study category is the orientation of project-based learning to students involve in real production problems, helping to improve professional skills through deep learning [10, 11]. Another area of study the stated thematic of designing media platforms of learning experiment is the transformation of CAD-models, their attributes and the obtained experimental data as a list of parameters for the means of production [12, 13] or as input instructions to support of production processes [14, 15].

However, these developments are mostly focused on the pedagogical aspects of the humanization of virtual computer labs or related practical activities for combine different approaches to provide access to finite disparate CAD element analysis. Unfortunately, the available publications do not take into account the technical aspect of over-saturation and redundancy the functionality of these interactive learning means, especially given the problem of digital products accumulation for different academic disciplines. Also, along with the complicated licensing conditions, the toolkit of such software from foreign developers mostly lack implementation of domestic standards, in particular in graphical designation for subject area components. Therefore, the experimental research environments used do not provide flexible means of integrating the subject area into cross-university educational systems with targeted adaptation to needs of authorized consumer of educational services and subsequent access to information and methodological resources and computerized toolkit for appreciate demonstrated competencies. These and other factors have led to the actual need to develop methods for organizing and coding data flows of virtual profiled equipment for designing an interdisciplinary unified laboratory research platform with a sufficient interface where undergraduated students will explicated skills in automated modeling of modern industrial facilities.

Generalized concept of structuring the learning experiment scheme

In accordance with the identified objects of stratified subject area in virtual laboratory [16] there is a need to determine the structured relationships between them to realize the possibility of further saving and editing of researching of experiment complex schemes. Information about the individual parameters of objects in the visualization, modification and subsequent modeling of transients should be provided in computer memory by a set of closed code blocks – a simulation model that will be most adequate to the subject area and suitable for further algorithmic processing.

It is decided to present the stipulated set of code blocks as data flows of computer specification for subject area by hypertags covering the connected fields of parameters of the virtual profiled equipment, forming the all-in-one characteristic of the scheme of leaning experiment. The beginning and end of such data flow is determined by the operating system of end terminal according to proposed sequence of bytes (Fig. 1).

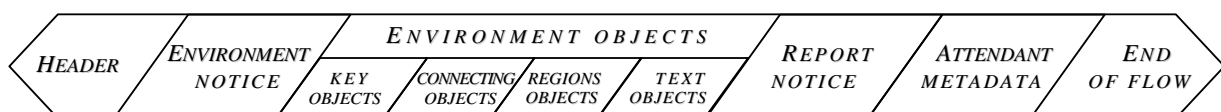


Fig. 1. Structuring the subject area specification

Thus, initial, *HEADER*, hypertag proclaims general the information about file format signature of constructed experiment scheme as *.CХЕ, by which the operating system can initiate the process of starting a computer

environment to working the entire data flows of stored subject area. As an ordered data structure in the file system after the *HEADER* hypertag, the designed specification contains a *ENVIRONMENT NOTICE* hypertag with proclamation of instructions that characterize the experiment scheme and are intended for its visualization: informing the analytical apparatus of media platform the virtual laboratory about location of categories substructures of subject area objects in continuous data flow for their subsequent serialization. Properly, the scheme of constructed experiment, which imitated a subject-spatial laboratory stand, is represented by hierarchical hypertag with a description of the target categories of *ENVIRONMENT OBJECTS*.

In accordance with requirements of organization the laboratory lessons, research results on transients in conducted learning experiment must be documented to accordance with rules established in the educational institution. It is decided to keep such rules, as well as instructions to letter of explanation template in the records of *REPORT NOTICE* hypertag for further automatic generation of reporting documentation with a graphic image of constructed experimental scheme, transient process diagrams, tabular ordered simulation results, etc. Letters of explanation the calculation part of laboratory work after verification are sent to digital academic repository; also, if necessary, printed reports are stored as an object of record to strict reporting keeping in the archives of the educational institution [17].

The *ATTENDANT METADATA* hypertag covers descriptors of methodological resources from faculty funds or academic library collections to provide theoretical information, a list of training exercises, the sequence of planned laboratory work or contextual consultation to current action being performed. Here can also formalize the typical errors and link their codes to topics of reference subsystem the media platform of learning experiment or decision-making to appreciate the competencies acquired by applicants for higher education [16]. The final tag notifies the operating system of the completion of data flow the learning experiment scheme.

Hierarchy of meaningful categories of the learning experiment scheme

The description of the subject area in of a simulation model form, composed of toolkit the application media platform of virtual laboratory, contains a hypertag of *ENVIRONMENT OBJECTS*. The contour route of the learning experiment scheme consists of a sequence of laboratory stand components that imitate physical industrial appliances or production stages combined in one way or another. Such components are regular objects in a computerized environment of experimental research (Fig. 2). When designing the specification of the description of the subject area from individual objects, the methods of their coding attract the main attention, the correctness of their layout in the working field of the media platform will further determine the adequacy of the simulation model in general.

So, *KEY OBJECTS* tag covers sections describing virtual device models, which are accessed when calculating the absolute position displacement by index number of virtual equipment instance. The specification fragment of some current device (Fig. 2, a), belonging to *KEY OBJECTS* category the experimental scheme, in data flows during serialization is uniquely determined by component *class identifier* from target dynamic library, which is responsible for its adequate visualization and in further elaboration afforded a mathematical model. Following stage in presented data flow encoding method involves a series steps to storing the appearance of current key object. Therefore, the instance graphic image in object-oriented environment of virtual laboratory, imitating the properties of parent class, retains the individual characteristics in records of corresponding meaningful section of *instance attributes*. These user-defined characteristics when composing a subject area will be the parameters of the transfer function of the instance, which is determined by the described key object class identifier from the first record of the instance section. The next section that regulates the functionality of object is the *instance location*. In particular, the gateway array record stores instance identifiers of adjacent objects, mostly connectors, which further allows a stable contour to be identified. In particular, the gateway array record stores instance identifiers of adjacent objects, mostly connectors, which further allows a stable contour to be identified.

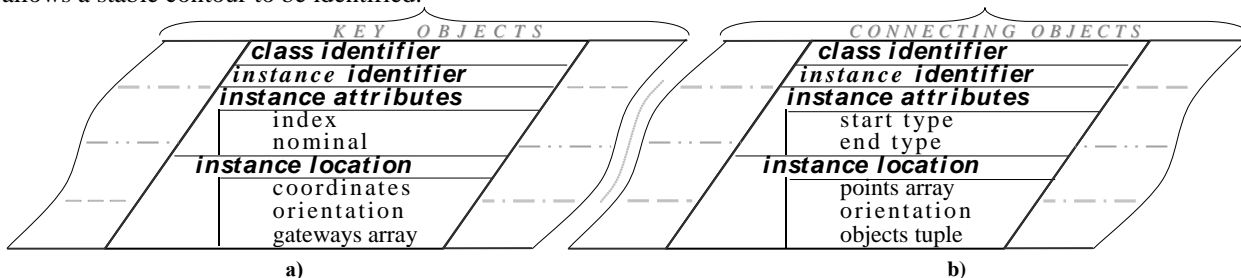


Fig. 2. Specification's meaningful sections of instance the regular objects in experiment scheme

For the *CONNECTING OBJECTS* category, the data flow encoding method for meaningful sections also starts visualization by specific instance defined attributes from *class identifier* (Fig. 2, b). However, according to the target purpose of this category, the *instance attributes* section stores records about the display features of the endpoints of the connecting segment. Properly, the array of remaining reference points of the connecting object instance is stored in corresponding record of next section of specification by descriptor of *instance location*. Given the representation

of working area according to discrete model of square tessellation, such intermediate points are initially calculated by the Lee algorithm. Later, after operator interence, the instance of polygonal connecting object may change its shape, so there is a need to save discrete elements the tiling model as feature of connector tracing as a separate record that has a standard volume. The last record of described section contains a tuple of length in two ordered pairs, respectively, to describe the two extreme points. Here, to determine the adjacent key object, the instance identifier and its gateway number are specified (Fig. 2 a).

Therefore, the presented method of coding the meaningful sections of regular objects in learning experiment scheme assumes their identical in target purpose (but not in content), which makes it possible to unify the procedures of processing the subject area and avoid arhythmization in the format serialization algorithm by interactive media platform. In general, the graphic image of virtual laboratory stand is almost ready, but object-oriented model of experiment scheme requires setting localized trajectories of ramified technological map, within which the transients of the current subject area will be studied.

Each such trajectory, sequentially set by user in the direction of technological map route, is stored in meaningful of corresponding subtag among other trajectories within the tag *REGIONS OBJECTS* (Fig. 3, a). The last semantic section of each trajectory contains a mathematical model prepared by operator, according to which the procedural modules of plotter or tabulator will reflect the adequate transition process of studied production stage.

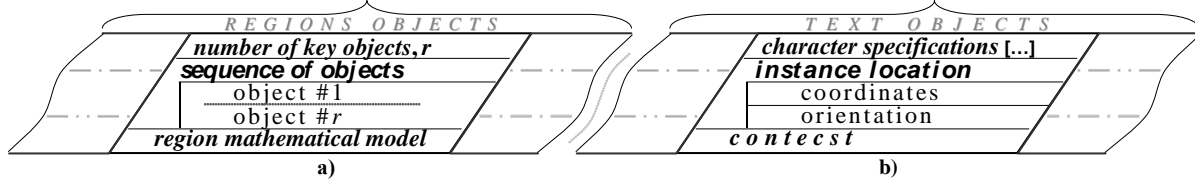


Fig. 3. Meaningful sections of complementary structures in the experiment scheme

To prompt commenting on details of maked experiment, standard text objects from system graphics device interface are used, the properties of which are stored in appropriate meaningful sections, generally covered by *TEXT OBJECTS* tag. So, each subtag here contains a parametric description of typical attributes to display the entered context in the Unicode standard and features of its location (Fig. 2, b). Because text blocks are system components of end terminal, in designed infocommunication environment of virtual laboratory for them there no component class is provided. Therefore, together with the *REGIONS OBJECTS* tag, which was previously described, *TEXT OBJECTS* comment storage containers are considered as complementary structures of the experiment scheme, in contrast to previously explored regular objects of virtual profiled equipment (Fig.2) with a well-grown classes hierarchy [16, 18].

Verification results

It was claimed, after completing the subject area layout, the prepared format specification enters the procedural module of soft plotter to transients visualize for built models or in tabulator module, where the simulation results are properly organized. Thus, in addition to operating the internal coding system of multimedia platform, which allows to saving a full data file of subject area (Fig. 4, a), the developed format should be based on syntax of current operating system for unambiguous association with the software suite environment (Fig. 4, b). The system registry supports such a correspondence between file extension and application together with parameters of the infocommunication platform integration into the academic information space. Therefore, the main problem of format subsequent decoding is the serialization of several levels at hierarchy (Fig. 2, 3). When reading the format, analytical apparatus of media platform finds the necessary logical data block, using agreements and definitions of separated objects, which are stipulated in specification. In general, defining feature of this approach at employment the developed method of coding data flow is coverage number of user means, guaranteeing access to interactive environment of learning experiment, automated parameterization of end terminal and profile support, adapting to needs of students with varying degrees of prior training.

As already mentioned, the structured code model of experiment scheme, which was previously prepared by means of target toolkit in virtual laboratory [16], is initiated by operating system under the signature *.CXE. For junior students with limited design skills, it is very convenient to open a file with a training simulator stand (Fig. 4, a), pre-layout by the teacher. Next, the components of this virtual stand are used to study the course of transients in an environment with a sufficient interface, where the relevant controls do not distract from the substantive part of laboratory lesson, and not needing currently missing professional competencies [12]. Senior course students use the designed environment in layout of original learning experiments, in particular in teamwork [17, 18], while maintaining the composed simulation model of subject area.

Further access to constructed ramified contour of experiment scheme with actualization of used components nomenclature in respectively with developed method of encoding data flows of virtual profiled equipment in contrast to common software packages specifications is assured by instructions of the first organizational *ENVIRONMENT NOTICE* hypertag in structure of the presented specification (Fig. 1). Support and deployment of stored environment configuration on end terminal of academic space according to instructional prescript of the specification is provided by the flexible system service application programming interface (Fig. 4, b) with prompt readjustment for applicants

for higher education, taking into account their competencies and requirements of educational and professional program.

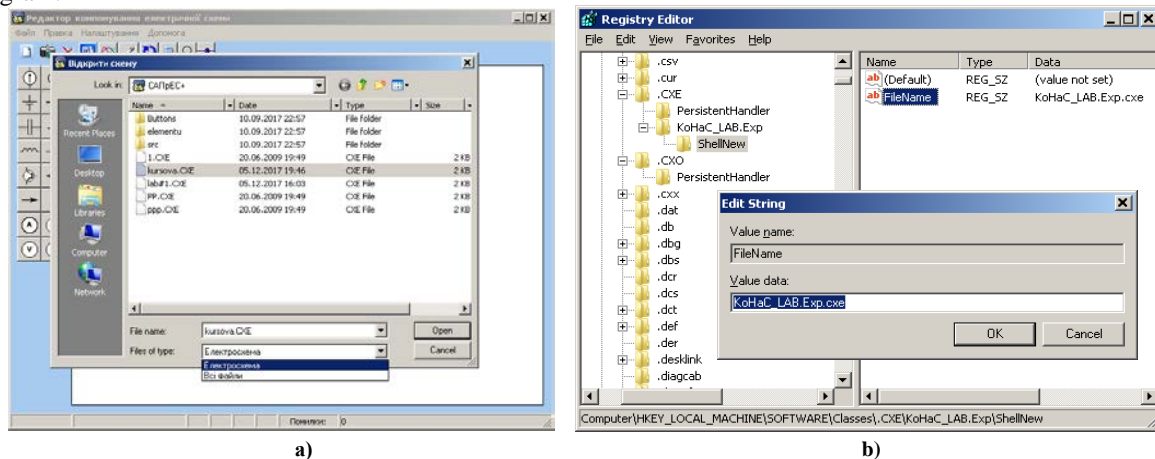


Fig. 4. Support the specification by operating system of end terminal in academic information space

Conclusion and future researching

The presented method of coding data flows of virtual profiled equipment in interdisciplinary environment of laboratory research fully provides formalization the constructed experiment scheme with stored of properties and events for regular objects of subject area in media platform of learning experiment. The format specification generated by the analytical apparatus is registered in the operating system and is suitable for maintaining the composed simulation model, providing sufficient information for the subsequent modeling of transients in the study of professionally-oriented disciplines. Laboratory experiments in the infocommunicative space, conducted with the help of computerized workplaces, increase the pedagogical efficiency of practical lessons and industrial training, showing to students the stable relationship between the discipline meaningful, their learning abilities and future professional career, thus contributing to promoting of problem-based learning.

Further investigation in presented subject-matter of designing experimental research environments within the educational space will relate to deployment of teampad for students scientific creativity with close integration of academic knowledge base and media resources. Received results also provide powerful pedagogical toolkit for finding solutions to formalize common user's errors with subsequent binding of their codes to headings of help subsystem in media platform of educational experiment, or to instructions array for decision-making regarding evaluation the competencies acquired by students and the automatic accumulation of mistakes. Another direction of project progress is the development of softmeans to transforming the presented data structure of subject area from virtual laboratory into the formats of common systems for modeling and design work.

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