ABSTRACTS

OF THE SCIENTIFIC WORKS

for participation in the contest for the academic position of "professor"

(Annotations of the materials under Art. 76 (1) of PRASPU for participation in the contest, including self-assessment of contributions)

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37 scientific publications, 6 textbooks and study aids and 1 monograph were selected for participation in the current competition (see List of scientific works for participation in the competition). All of them were published after occupying the academic position "Docent".

I. Scientific publications:

1. *Stanimir Stoyanov, **Todorka Glushkova**, Veneta Tabakova-Komsalova, Asya Stoyanova-Doycheva, Vanya Ivanova and Lyubka Doukovska (2022), INTEGRATION OF STEM CENTERS IN A VIRTUAL EDUCATION SPACE, Mathematics 2022, 10, 744. https://doi.org/10.3390/math10050744, ISSN 2227-7390, https://www.webofscience.com/wos/woscc/full-record/WOS:000771236700001 (WoS, IF 2022 = 2,258, Q1)*

   This paper presents a distributed education platform based on the reference ViPS architecture that supports shared use of learning materials at the university and in STEM centers in secondary schools. The architecture of the platform, comprising two main components, is also presented. The university's e-learning environment operates as the backend, and the frontend component resides in the School STEM Center. In addition, the implemented prototype of the platform is discussed in the article. Its use is demonstrated by two educational games – one about the rules of the road and the second about identifying plants in a teaching vegetable garden in a school STEM center. The platform is extended with four educational robots that "feel" the changes in the environment and interact with the educational environment during the implementation of the learning scenarios.

2. *Valchev, E., Malinov, P., Glushkova, T., Stoyanov, S.(2022), APPROACH FOR MODELING AND IMPLEMENTATION OF AN INTELLIGENT SYSTEM FOR LIVESTOCK CATTLE ON PASTURES, IFAC-PapersOnLine, Volume 55, Issue 32, 2022, Pages 211-216, ISSN 2405-8963, https://doi.org/10.1016/j.ifacol.2022.11.141, https://www.webofscience.com/wos/woscc/full-record/WOS:000889052400037 (SJR 2021=0.63, SCOPUS, WoS)*

Pasture farming of cattle ensures the production of organic food in an ecologically clean environment. The paper examines one approach to developing an intelligent IoT system for cattle grazing. The infrastructure model and the software architecture of the system are presented. The capabilities of the second prototype version of the VOC Virtual Operations Center are discussed and the results obtained so far from the implementation of the developed prototype are shared. A model is presented to normalize the received sensor data in real time. Various options for solving the problems related to remoteness and difficult accessibility to mountain pastures are discussed. Ideas for future improvements to the system are noted.

3. *Stoyanov S., **Glushkova T.,** Popchev I., Doukovska L. (2022) VIRTUALIZATION OF THINGS IN A SMART AGRICULTURE SPACE. In: Sgurev V., Jotsov V., Kacprzyk J. (eds) Advances in Intelligent Systems Research and Innovation. Studies in Systems, Decision and Control, vol 379. Springer, Cham. ISBN: 978-3-030-78124-8, 349-368, https://doi.org/10.1007/978-3-030-78124-8_16 https://www.scopus.com/authid/detail.uri?authorId=25927045100 (SJR 2021=0.11, Q4, SCOPUS) (Глава от книга, която по допълнителните изисквания на ФМИ се равнява на 1 статия в списание с импакт фактор или на две статии в списание)*

This paper discusses the adaptation of the ViPS Virtual Education Space reference architecture for building smart infrastructure for smart agriculture. The main challenge in the platform is the virtualization of "things" from the physical world, as well as their associated events, temporal and spatial aspects. This article presents two modeling approaches that are used to virtualize physical "things". To represent the spatial aspects of things, we use an Ambient-Oriented Modeling approach and the formal notation for context-aware modeling CCA (Calculus of context-aware modeling). By adapting the interpreter of the specialized CCA- programming language ccaPL, and using of animated simulator are modeled some scenarios for the realization of basic services in the space. The second approach uses intelligent agents with environments represented as artifacts. Both modeling approaches are demonstrated with an irrigation example. The possibilities for a prototype implementation of the space for intelligent agriculture in the Plovdiv region are commented on.

4. *Grancharova-Hristova, M., Moraliyska, N., Glushkova, T., & Rusev, K. (2022). VIRTUALIZATION, PROCESSING, AND STANDARDIZATION OF KNOWLEDGE ABOUT BULGARIAN CULTURAL, HISTORICAL AND NATURAL HERITAGE FOR USE IN SCHOOL EDUCATION. Digital Presentation and Preservation of Cultural and Scientific Heritage, 12, 131–140. https://doi.org/10.55630/dipp.2022.12.10 https://www.webofscience.com/wos/woscc/full-record/WOS:000856020100011 (SCOPUS, WoS)*

The article proposes an approach for the digitization of the cultural-historical and natural heritage of Bulgaria by using the standard for digitization and cataloging of cultural-historical objects (Cataloging Cultural Object - CCO). Furthermore,

the idea of a combined use of a system of ontologies and databases with CCO-standardized digital objects is proposed. The authors' experience of using these data in school education is also shared.

5. *Stoyanov, S., Glushkova, T., Tabakova-Komsalova, V., Ivanova, V., Stoyanova-Doycheva, A., Petrov, A. (2021), INTEGRATED DOMAIN IN SUPPORT OF GAME-BASED LEARNING IN SCHOOL EDUCATION, The Educational Review, USA, 2021, 5(11),pp. 434-446, ISSN Online: 2575-7946, ISSN Print: 2575-7938, DOI : http://dx.doi.org/10.26855/er.2021.11.004, https://www.hillpublisher.com/journals/er/*

   This paper presents a platform known as ViTOS supporting game-based learning in an integrated educational field that includes university education and secondary school STEM center learning. The frontend and backend components of the platform are also described in detail. In addition, a personal assistant is also introduced, which manages the conduct of the games. The use of the platform is demonstrated with two examples from two different fields – smart city and smart agriculture. The games take place for real-world education in a school STEM center and in a university e-learning environment. Ideas for future improvements are also presented.

6. *Stanimir Stoyanov, Asya Stoyanova-Doycheva, **Todorka Glushkova**, VIRTUAL-PHYSICAL SPACE "BULGARIAN CULTURAL AND HISTORICAL HERITAGE", Cultural and Historical Heritage: Preservation, Presentation, Digitalization, KIN Journal, volume 7, Issue 2, 2021, DOI: doi.org/10.26615/issn.2367-8038.2021_2_005, ISSN: 2367-8038*

   The article presents a virtual-physical space for storing and presenting digitized Bulgarian cultural and historical objects. The space is realized using integrated technology, including means of artificial intelligence, enhanced with modern technologies such as IoT (Internet of Things) and CPSS (Cyber-Physical-Social System). System advantages over conventional approaches to developing such systems are discussed. Objects digitized in accordance with the CCO (Cataloging Cultural Objects) standard are stored in distributed knowledge bases, implemented mainly as ontologies. The space provides users with a personal tour guide that is able to understand and fulfill their wishes and preferences.

7. ***Glushkova, T**., Stoyanov, S., Doukovska, L., Todorov, J., Stoyanov, I. (2021) MODELING OF AN IRRIGATION SYSTEM IN A VIRTUAL PHYSICAL SPACE. Math Biosci Eng. 2021 Aug 16;18(5):6841-6856. doi: 10.3934/mbe.2021340. PMID: 34517560, ISSN 1547-1063 https://www.webofscience.com/wos/woscc/full-record/WOS:000688347400008, (IF=0.63, Q3, WoS)*

   One of the main challenges that smart agriculture is expected to address is the efficient use of water resources. The conservation and efficient use of clean water is a long-term strategy worldwide. Modeling smart farming systems is an important factor because the processes there are very slow and sometimes take

a year or more for a complete crop cycle. At the same time, a large amount of data is usually needed to make informed decisions. This determines the importance of developing appropriate systems through which to simulate, generate, optimize and analyze various possible scenarios and prepare appropriate plans. This paper presents an infrastructure based on the reference ViPS (Virtual Physical Space) architecture adapted for smart agriculture. The space supports an integration of the virtual and physical worlds, where analysis and decision-making takes place in the virtual environment by taking into account the state of the physical objects of interest. Special attention is paid to the possibilities of modeling an irrigation system. An Ambient-Oriented Modeling approach is adopted and the Calculus of Context Ambients formalism is used as the main tool for modeling agricultural processes. In addition, the supporting platform is briefly presented. The active components of the platform are implemented as intelligent agents known as assistants. Users (agricultural operators) are served by personal assistants. The presented modeling system is located on a two-layer system infrastructure in the region of the city of Plovdiv.

8. ***Glushkova, T.**, Stoyanov, S., Ivanova, V., Krasteva, I., AN IDEA FOR CONDUCTING THE EDUCATIONAL PROCESS IN A VIRTUAL-PHYSICAL SPACE, AIP Conference Proceedings 2333, 050006 (2021); ISSN: 0094-243X https://doi.org/10.1063/5.0041727, https://www.webofscience.com/wos/woscc/full-record/WOS:000664205600025 (**SJR=0.19, SCOPUS, WoS)***

The article presents the idea of building e-learning systems as Cyber-Physical-Social Space (CPSS). For this purpose, a classification and analysis of the forms of training is made in order to adapt the reference infrastructure of the Virtual-Physical Space (ViPS) for the field of training. Various aspects of the "trainer-learner" interaction are examined and examples and scenarios are presented. The proposed CPSS-learning space provides opportunities for more complete and effective technological support of learning. Along with the construction of the infrastructure model, various organizational forms for using the educational space are modeled. Various scenarios have been developed and prototyped that take into account the convergence between the physical and virtual worlds and their dynamic and contextual dependence. The article stipulates the need to develop a methodology for implementing the educational process, organized and conducted in a cyber-physical educational space.

9. *Stoyanov S., **Glushkova T.,** Stoyanova-Doycheva A., Krasteva I. (2021) THE VIRTUAL EDUCATION SPACE: CONCEPT, ARCHITECTURE, APPLICATION. INFORMATICS AND EDUCATION. 2021;(9):47-54. ISSN 0234-0453 https://doi.org/10.32517/0234-0453-2021-36-9-47-54*

The e-learning environment known as VES (The Virtual Education Space) has been developed at Plovdiv University for years, with each subsequent version building on the previous one. Initially, a learning system called DeLC (Distributed e-Learning Center) was implemented to support blended and independent learning in the FMI of PU as well as in some secondary schools.

Some problems were identified when working with DeLC, related to the interactions between the virtual and the physical world, where the learning process actually takes place. The team developed a ViPS (Virtual Physical Space) reference architecture based on the concepts of CPSS (Cyber-Physical-Social System) and IoT (Internet of Things). VES is the education adaptation of ViPS. The article reviews the basic concepts, architecture and applications of VES.

VES supports various forms of e-learning: blended learning, self-directed learning, lifelong learning, inclusive and game-based learning (GBL). Because VES is developed as a CPSS ecosystem, users are at the center of attention. This determines the need to develop personal assistants to participate in the processes of the space in the interest of users. Three intelligent agents are modeled in VES: an internal educational agent, an external educational agent, and a career advisor. MATE (Multi-Agent Testing Environment) is a component supported in the ViPS space for teaching and testing students in a game-based manner. MATE is a set of autonomous agents, each with responsibilities in the overall architecture arising from training and testing needs.

10. *Noskova, T., Smyrnova Trybulska, E., Morze, N., Hug, T., **Glushkova, T**., & Gurba, K. (2021). NEW TECHNOLOGIES IN PERSONALISATION OF STEM AND STEAM EDUCATION - INTERNATIONAL CONTEXT. International Journal of Continuing Engineering Education and Life-Long Learning, Vol. 32, Issue 5, Page 591-615, doi:10.1504/ijceell.2022.10037158, ISSN: 1560-4624, https://www.webofscience.com/wos/woscc/full-record/WOS:000860834600004 (WoS, SJR=0.14)*

This article focuses on new technologies in the personalization of STEM and STEAM learning in modern education, as seen by experts from different countries: Austria, Bulgaria, Poland, Russia and Ukraine. The article aims to review the scientific literature and provide opinions, perspectives and reflections presented by scientists and experts from several European universities. The review of the research includes the theoretical basis of the discussed topic, review of national and international research and literature, identification and definition of key concepts, examples of practical achievements and description of current trends in STEM and STEAM education, as well as adaptive learning as micro learning - effective methods for e-learning. Based on this, a number of conclusions are made regarding STEAM education in the conditions of modern development.

11. *Doychev, E., Stoyanova-Doycheva, A., Stoyanov, S., **Glushkova, T.,** Ivanova, V., AN IOT VIRTUAL ELEARNING SPACE, Book chapter in Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 2020, 12330 LNCS, pp. 148–169, ISSN: 03029743, DOI: 10.1007/978-3-662-62245-2_10, (SCOPUS, SJR 2020 = 0,249, Q4) https://www.scopus.com/authid/detail.uri?authorId=25927045100, https://link.springer.com/chapter/10.1007/978-3-662-62245-2_10 – (Глава от книга, която по допълнителните изисквания на ФМИ се равнява на 1 статия в списание с импакт фактор или на две статии в списание)*

The main goal of the article is to present a Virtual e-Learning Space (VeLS), implemented as an Internet of Things (IoT) ecosystem. DeLC suffers from the shortcomings of widely used e-learning systems that ignore the physical world in which they operate. Taking into account the temporal and spatial characteristics of the physical world and the events that take place in it is especially important to support users with disabilities (in our case, students with disabilities). Effective support of the learning process is multifaceted and dependent on actions and events that take place in different places and at different times, e.g. attending lectures and seminars, self-study, exams, and consultations. However, the analysis of the results of the learning process must take into account all the different aspects and must be able to make a connection between them. Adapting approaches from closely related CPSS and IoT concepts, we propose transforming DeLC into a new infrastructure known as the Virtual e-Learning Space (VeLS), where users, time, location, autonomy, and contextual awareness come first. A reference architecture of VeLS has been proposed in order to be applied in other IoT applications. In the reference architecture, the virtualization of "things" is supported by three formal tools - AmbiNet, TNet and ENet, which are discussed in the article.

12. *Stoyanova-Doycheva, A., Ivanova, V., **Glushkova**, **T**., Stoyanov, S., Radeva, I. DYNAMIC GENERATION OF CULTURAL ROUTES IN A TOURIST GUIDE, International Journal of Computing, Vol 19, Issue 1, 2020, pp. 39-48, ISSN 1727-6209 (Print), ISSN 2312-5381 (Online), http://www.computingonline.net/computing/article/view/1691/891 , https://www.scopus.com/authid/detail.uri?authorId=25927045100, (SCOPUS, SJR 2020 = 0,184)*

This article presents an adaptation of ViPS for tourism and in particular the generation of tourist routes, considering the wishes and intentions of tourists, as well as various circumstances such as location, time, and more. The environment is called a "Tourist guide" and its architecture consists of several intelligent agents which work with an ontological network and ambient network as a knowledge base to generate tourist routes. The ontologies present the cultural and historical sites of Bulgaria according to the CCO standard, and the ambients present the physical properties (location, working hours, etc.) of these sites. In addition, dynamic route generation is demonstrated by modeling an environmentally oriented approach.

13. *Stoyanov, S., **Glushkova, T**., Stoyanova-Doycheva, A., Todorov, J., Toskova, A., A GENERIC ARCHITECTURE FOR CYBER-PHYSICAL-SOCIAL SPACE APPLICATIONS, Book chapter In: Jardim-Goncalves R., Sgurev V., Jotsov V., Kacprzyk J. (eds), 2020 Studies in Computational Intelligence, Vol. 864, pp.319-343, ISSN: 1860949X, https://doi.org/10.1007/978-3-030-38704-4_14, https://www.scopus.com/record/display.uri?eid=2-s2.0-85086093215&origin=resultslist&sort=plf-f – (Глава от книга, която по допълнителните изисквания на ФМИ се равнява на 1 статия в списание с импакт фактор или на две статии в списание) (SCOPUS, SJR = 0,185)*

The article presents the architecture of the Virtual Physical Space (ViPS). The purpose of the architecture is to adapt to the implementation of various cyber-physical-social applications. The main components of the architecture are presented – an Event Engine, personal assistants, an ambient model (AmbiNeT), and the interpreter AjTempura of interval temporal logic used in TNet. Each of the components is discussed in the article and its application in the ViPS architecture is presented. The adaptation of ViPS for an application called Tourist Guide has been demonstrated. The Tourist Guide (TG) is implemented as a personal assistant that aims to assist tourists in their tourist routes. An extension of TG has been proposed to recognize folklore elements (embroideries) using neural networks.

14. *Stoyanova-Doycheva, A., **Glushkova, T**., Ivanova, V., Doukovska, L., Stoyanov, S., A MULTI-AGENT ENVIRONMENT ACTING AS A PERSONAL TOURIST GUIDE, Book chapter in Studies in Computational Intelligence, Vol.862, pp. 593-611, 2020, ISSN: 1860949X, https://doi.org/10.1007/978-3-030-35445-9 , https://www.scopus.com/authid/detail.uri?authorId=25927045100 – (Глава от книга, която по допълнителните изисквания на ФМИ се равнява на 1 статия в списание с импакт фактор или на две статии в списание) (SCOPUS, SJR 2020 = 0,185)*

The article presents a tourist guide, which is implemented as a multi-agent system. Its architecture consists of several operational assistants. The Questioner Generation Assistant (QGA) is responsible for user surveys. Its main task is to create a user account that contains the main cultural and historical objects, for which the user wants to receive information. The Knowledge Generation Assistant (KGA) is responsible for extracting information about cultural and historical sites from the knowledge base. The Calculus of a Context-aware Ambient Assistant (CCAA) generates a final route by filling in the main route with additional information such as location and status of exposures (or individual objects), working hours, and others. The last assistant is the Tourist Guide Assistant (TGA). It works in the Front-end component and performs the following main functions: serves as the tourist's GUI, determines the tourist's location, and manages the life cycle of the system. The knowledge base of the tourist guide, which is a network of ontologies (OntoNet), structured according to the CCO standard, is briefly presented. The operation of the system is demonstrated by an example using CCA to represent the route.

15. *Krasteva I. K., **Glushkova T. A**., Stoyanov S. N., MODELING AND DEVELOPMENT OF A MULTI-AGENT SPACE FOR THE SECONDARY SCHOOL. Informatics and education. 2020; vol. 4, pp. 53-62, ISSN 0234-0453, https://doi.org/10.32517/0234-0453-2020-35-4-53-62*

One of the main principles of the Fourth Industrial Revolution is the need for lifelong learning. This defines the growing role of intelligent education systems to provide the necessary learning resources and services to users at any time and in any place. This paper presents the modeling and development of an intelligent multi-agent learning environment for secondary school, developed by

a team of the DeLC Laboratory at Plovdiv University, Bulgaria. Learners are placed in the focus of the learning environment through personal assistants who support working with the learning space and ensure the implementation of user-adapted functionalities and services.

16. *Stoyanov, S., **Glushkova, T.,** AN APPROACH TO E-LEARNING IN THE VIRTUAL EDUCATION SPACE, CEUR Workshop Proceedings, vol. 2770, pp.55-64, Code 165695, ISSN 1613-0073, 2020, https://www.scopus.com/authid/detail.uri?authorId=25927045100, (**SCOPUS)***

The article presents some aspects of the development of the Virtual Educational Space (VES). The main challenge is the integration of the virtual and physical world in both directions – from the physical world to the virtual and vice versa. The first direction from the physical to the virtual world concerns the virtualization of physical objects ("things"). The direction from the virtual to the physical world aims to bring the intelligence embedded in the system as close as possible to the physical world. At the same time, special attention is paid to the support of different groups of users. The Virtual Education Space (VES) is an adaptation of the reference ViPS architecture in education. The article examines some aspects of the development of VES and its possibilities for adaptation and application for different forms of education. E-learning in space is demonstrated through examples from school learning.

17. *Stoyanov, S., Stoyanova-Doycheva, A., **Glushkova, T.,** Doychev, E., Todorov, J. A REFERENCE ARCHITECTURE OF INTERNET OF THINGS ECOSYSTEM, Vol 7 No 1 (2018): Computer Sciences and Communications, ISSN: 1314-7846, https://csc.bfu.bg/index.php/CSC/issue/view/19*

Summarizing the experience of the team from the DeLC Laboratory of Plovdiv University in the construction of the Virtual Educational Space (VES), this article presents a reference architecture called Virtual Physical Space (ViPS). ViPS is being developed as Cyber-Physical-Social-Space. The aim is to make the reference architecture adaptable for different IoT ecosystems in different fields such as smart cities, smart environment, agriculture and smart medicine. The article presents the first version of the common reference architecture of ViPS and its main components.

18. ***Glushkova, T**., Stoyanov, S., AMBIENT-ORIENTED MODELING OF INTELLIGENT CONTEXT-AWARE SYSTEMS, сп. Vol 7 No 1 (2018): Computer Sciences and Communications, ISSN-1314-7846, 53-61, https://csc.bfu.bg/index.php/CSC/article/view/207*

The paper presents an approach for modeling intelligent IoT context-aware systems. Ambient-Oriented Modeling AOM enables process tracking in considered processes and scenarios, taking into account dynamic changes in the environment. The main concepts and characteristics of the approach are discussed. The formal semantics of CCA (Calculus of context-aware ambients) supporting the approach is described. The application of CCA in modeling tourism-related smart city services is demonstrated.

19. *Stoyanova-Doycheva, A., Madanska, S., Grancharova-Hristova, M., **Glushkova, T**., Cholakov, G. (2022). DEVELOPMENT OF ONTOLOGIES IN DIFFERENT DOMAINS FOR A TEST GENERATION ENVIRONMENT. 8th International Conference on Higher Education Advances (HEAd'22), 925-933. http://dx.doi.org/10.4995/HEAd22.2022.14205 https://www.webofscience.com/wos/woscc/full-record/WOS:000883579200109 (SCOPUS, WoS)*

The purpose of the paper is to present an approach to creating and using ontologies for automatic test question generation. The test generation environment was created as part of the Virtual Educational Space (VES). The ontologies presented in the article are in different subject areas and can be useful to students and students in their exams or in the process of self-preparation. The ontologies are in the fields of botany, biology, literature, history of Bulgaria and the architecture of the Renaissance houses. The article presents examples of automatically generating questions for each of these areas.

20. ***Glushkova, T**., Stoyanov, D., VIRTUALIZATION AND MODELING OF SERVICES IN A SCHOOL EDUCATIONAL PLATFORM, Proceeding book from 5th International African Conference on current studies, ed. Dr. Sheeba S. A., Samira K.O., February 2-5, 2022, Cairo, Egypt, ISBN: 978-625-7464-76-5, pp. 263-270*

Cyber-Physical and Social Systems (CPSS) represent a convergence between the physical and virtual worlds where social interactions between users are essential. In recent years, a team from Plovdiv University has been developing a reference architectural framework for virtual-physical space (ViPS) that can be adapted to different domains. The adaptation of ViPS for school education is the BLISS platform. The main task of BLISS is to provide educational services to diverse groups of students that consider the state of the virtual and physical world. BLISS is being developed as a multi-agent system in which the user's personal assistant plays a central role. Due to the complexity of the BLISS educational space, pre-modelling, testing and verification of different scenarios is key. The paper presents an approach to modeling and virtualizing "things" by using the formal semantics of the Calculus of Context-aware Ambients (CCA). Environments model physical or virtual objects along with their spatial and temporal characteristics. A specialized programming language ccaPL and its interpreter are used to test and verify the basic scenarios related to services for students with motor and visual disabilities.

21. *Rusev, K., **Glushkova, T.** (2022), DEVELOPMENT OF A COMPONENT FOR CONTEXT-AWARE MODELING IN VIRTUAL-PHYSICAL SPACE, Proceedings of the International Scientific Conference "INFORMATICS, MATHEMATICS, EDUCATION AND THEIR APPLICATIONS", IMEA'2022, 23-25 November 2022, Pamporovo, Bulgaria, 195-203, Plovdiv University Press, ISBN 978-619-7663-33-4, https://imea2022.fmi-plovdiv.org/section-b-informatics/*

The paper presents an approach to develop a prototype of a CCA Ambient-oriented modeling Component in the Virtual-Physical Space. The results of the first prototype version of this Component are presented, in which the spatial aspects of "things" are modeled as a priority. A simple demo example is considered, through which the capabilities and functionalities of the Component are presented, and directions for future development and improvement are commented.

22. ***Glushkova, T.,*** *Stoyanova-Doycheva, A. (2022). AN APPROACH TO MODELING OF SMART AGRICULTURAL SERVICES AND SCENARIOS, 2022 IEEE 11th International Conference on Intelligent Systems (IS), Warsaw, Poland, 2022,* ***ISBN:****978-1-6654-5656-2, pp. 98-106, doi: 10.1109/IS57118.2022.10019723.* *(****IEEE -*** *https://ieeexplore.ieee.org/abstract/document/10019723* ***, Scopus****)*

Creating a smart space that meets Cyber-Physical and Social Space (CPSS) requirements involves modeling scenarios and services where the physical and virtual worlds interact for the benefit of their users. These scenarios are often very complex, which defines the need for upfront modeling, testing, and verification. This report presents a modeling approach for a CPSS-based platform to support the development of an intelligent agricultural environment called ZEMELA. The possibility of using several formal modeling systems, which consider a different aspect of process development and have their own testing and verification system, is discussed. A model is being developed for monitoring the development and management of winter wheat cultivation processes. The need to create an integrated modeling component that provides a comprehensive view of the modeled processes and scenarios is justified.

23. *Stoyanov, S.,* ***Glushkova, T.****, PERSONALIZED LIFELONG LEARNING IN THE VIRTUAL EDUCATIONAL SPACE, Proceedings of International conference "Информатизация Образования и Методика Электронного Обучения: Цифровые Технологии в Образованиии", Noskov, M. editor, issue 2, pp. 400-406, 24-25.09.2021, Krasnoyarsk, Russia. http://conf.sfu-kras.ru/DTE-2021/proceedings*

This article presents one approach to personalizing lifelong learning. The considered approach is implemented in a platform known as Virtual Educational Space (VES). VES works as a Cyber-Physical and Social System in which active components are implemented as intelligent agents. The SCORM 2004 standard specification is used for development of training resources in VES, and testing is carried out using the QTI 2.0 specification. The personalization of learning materials, services, the learning process and the assessment of students in both the university and the school is carried out through the use of specialized Personal Assistants - PA. The personalization of school learning is also carried out through the use of some specific services such as the development of an embedded multi-agent game learning system designed for students with specific educational needs.

24. ***Glushkova, T.,*** *& Tabakova-Komsalova, V. (2021). AN APPROACH FOR DEVELOPMENT AND APPLICATION OF CPSS- EDUCATIONAL*

ENVIRONMENTS IN BULGARIAN SCHOOL. Proceedings of CBU in Natural Sciences and ICT, 2, 20-26. https://doi.org/10.12955/pns.v2.148

Modern realities and the global Covid-19 pandemic pose new challenges to education. It is a fact that classical learning supported by modern ICT technologies provides an effective learning process, but the Covid-19 realities have forced a rapid transition to remote absentee learning. The use of computer-based learning systems and cloud platforms has its advantages, but also problems related to the low level of personalization of the learning process and the adaptability of learning content to the specific characteristics of each student. Cyber-Physical and Social Systems (CPSS) largely solve the problems of integrating processes and interactions in the virtual world with the dynamically changing conditions of the physical world. This gives reason to focus on the creation of CPSS educational platforms for the secondary school. Following this approach, we created a prototype CPSS educational space called BLISS. The paper presents some results from the test application of this platform in a school educational space. It is concluded that if we put the learner with his/her characteristics, goals and interests at the center of the learning environment and present him/her through his/her personal assistant, we could significantly increase the interactivity of the learning process and the adaptability of the learning content offered.

25. ***Глушкова, Т.**, Русев, К., Тодоров, Й., Стоянов, С., ПРОСТРАНСТВЕНИТЕ АСПЕКТИ ПРИ МОДЕЛИРАНЕТО НА ИНТЕЛИГЕНТЕН ГРАД ЛОВЕЧ, Сборник научни доклади от Национална научна конференция TechCo'21, 2-4.07.21, Ловеч, https://www.tugab.bg/images/documents/Techko-Lovech-2021.pdf, ISSN 2535-079X, 116-122.*

The Internet of Things (IoT) and Cyber-Physical and Social Spaces (CPSS) are related concepts that ensure the provision of appropriate services to users related to their needs, desires, goals and personal characteristics. The article examines various aspects of Lovech as a small smart city. Attention is focused on the spatial aspects of "things" and their representation and modeling through the mathematical notation CCA (Calculus Context-aware Ambients). Specific baseline scenarios involving different domains in the modeled smart city are considered. A prototype of a custom designed visual CCA-Editor for modeling is presented.

26. ***Glushkova, T.**, Stoyanov, S. Rusev, K. Krasteva I. and N. Moraliyska. AMBIENT-ORIENTED CCA MODELING IN AGRICULTURE, 2021 International Conference Automatics and Informatics (ICAI), 2021, pp. 310-313, ISBN 978-166542661-9, doi: 10.1109/ICAI52893.2021.9639591, (SCOPUS - https://www.scopus.com/record/display.uri?eid=2-s2.0-85123858984&origin=resultslist&sort=plf-f)*

Because of their complexity, the processes in cyber-physical and social systems preliminary modeling and verification. When developing a smart farming system, it is necessary to consider the spatial aspects of smart IoT. The article motivates the use of Ambient-Oriented CCA-modelling. Some baseline scenarios related

to irrigation in a smart agriculture system are considered. The special tool developed is presented - a visual CCA editor, through which the considered scenarios are modeled and verified.

27. *__Glushkova, T.__, Stoyanov, S., Sgurev, V., Doukovska, L. and A. Dukovski, APPLICATION OF METHOD FOR CONSTRUCTING A COMPLEX HIERARCHICAL LOGIC IN INTELLIGENT AGRICULTURE CONTEXT, 2021 International Conference Automatics and Informatics (ICAI), 2021, pp. 301-304, doi: 10.1109/ICAI52893.2021.9639757, (SCOPUS - https://www.scopus.com/record/display.uri?eid=2-s2.0-85123859388&origin=resultslist*

The paper examines the possibility of using complex logic to create clearer decision-making models in an intelligent farming system. The possibilities for developing a suitable module for development and modeling of smart agriculture scenarios and processes have been explored. It is believed that the creation of an interpreter of complex hierarchical logic will greatly facilitate modeling and decision-making. The paper presents one way to interpret complex logic using the logic programming language Prolog and its inference engine. The results are illustrated with an example of creating an irrigation plan.

28. *Krasteva, I., __Glushkova, T.,__ Stoyanova-Doycheva, A., Moralivska, N., Doukovska, L., Radeva, I. BLOCKCHAIN-BASED APPROACH TO SUPPLY CHAIN MODELING IN A SMART FARMING SYSTEM, 2021 Big Data, Knowledge and Control Systems Engineering (BdKCSE), 28-29 Oct. 2021, DOI: 10.1109/BdKCSE53180.2021.9627309, Electronic ISBN:978-1-6654-1042-7, PoD ISBN:978-1-6654-1043-4, IEEE: https://ieeexplore.ieee.org/document/9627309, Code 175443, (SCOPUS - https://www.scopus.com/record/display.uri?eid=2-s2.0-85124019726&origin=resultslist)*

Blockchain is a technology that, integrated into smart systems, can solve many of the tasks and challenges in smart farming, such as monitoring and tracking the supply chain, financial management, identifying critical data, including those derived from the IoT, and more. The report presents a model for the development of a supply chain based on blockchain technologies, which includes as separate channels the BG Gene Bank, curators, producer farmers, food producers, trade network of stores, logistics and transport, financial and insurance institutions, distributors, government regulators, etc.

29. *Valchev, E., Malinov, P., __Glushkova, T.__, Nikolov, V., Doukovska L. and V. Monov, MODELING OF A SYSTEM FOR INTELLIGENT ANIMAL HUSBANDRY, 2021 Big Data, Knowledge and Control Systems Engineering (BdKCSE), 2021, doi: 10.1109/BdKCSE53180.2021.9627312, ISBN:978-1-6654-1043-4. Code 175443 (SCOPUS - https://www.scopus.com/record/display.uri?eid=2-s2.0-85124035798&origin=resultslist)*

Modern realities and the rapid development of digital technologies in the era of the Fourth Industrial Revolution bring to the fore the task of developing intelligent systems for precision agriculture and animal husbandry. Grazing

livestock has proven to be extremely important in obtaining biologically pure food products in an ecologically clean environment. The report examines the possibilities for developing an intelligent space for grazing cows, presents the main directions of work on the implementation of such a system and shares the results obtained so far from the implementation of the developed prototypes.

30. ***Glushkova, T.,*** *Rusev, K., Stoyanov, S. AMBIENT-ORIENTED MODELING IN VIRTUAL-PHYSICAL SPACE WITH INTEGRATED DOMAINS, Proceedings of Anniversary International Scientific Conference Research and Education In Mathematics, Informatics and their Applications REMIA'2021, October 22-24, 2021, Plovdiv, Bulgaria, 99-108, ISBN: 978-619-202-711-7, https://remia2021.fmi-plovdiv.org/wp-content/uploads/2021/10/3_2_2_RT_Section-B_Glushkova_Rusev_Stoyanov_99_108.pdf*

The paper discusses a modeling approach in Virtual Physical Space with complex services based on integrated domains. The approach is particularly suitable for supporting the process of developing CPSS applications that provide comprehensive services to their users, which are implemented through the interaction of objects from different domains – smart city, tourism, education, healthcare, etc. The application of the modeling approach to a specific example scenario is demonstrated through a specially developed prototype of CCA (Calculus of Context-aware Ambients) visual Editor working on integrated domains.

31. ***Glushkova, T.,*** *Stoyanov, S., Popchev I., Doukovska, L., AMBIENT-ORIENTED MODELLING IN AN INTELLIGENT AGRICULTURE INFRASTRUCTURE, 2020 IEEE 10th International Conference on Intelligent Systems (IS), Varna, Bulgaria, 2020, pp. 612-618, ISBN 978-172815456-5, https://doi.org/10.1109/IS48319.2020.9199952,* ***SCOPUS:*** *https://www.scopus.com/record/display.uri?eid=2-s2.0-85092747836&origin=resultslist*

The article discusses the process of adapting the reference architecture of the ViPS Virtual-Physical Space during the construction of an intelligent infrastructure for agriculture in the Plovdiv region, called "Agriculture 2.0 - Plovdiv". The main challenge is the virtualization of "things" from the physical world, as well as their associated events, temporal and spatial aspects. The Ambient-orientated approach is used to represent the spatial aspects of things. By adapting the Ambient-orientated ccaPL - interpreter and the animated simulator, some scenarios implementing basic services in the space are modeled. The infrastructure is being developed and tested together with two agricultural institutes in the Plovdiv region - the first deals with cereals and the second with vegetable crops.

32. *Krasteva, I.,* ***Glushkova, T****., Moraliyska, N., Velcheva, N., A BLOCKCHAIN-BASED MODEL OF GENBANK STORE SYSTEM, 2020 IEEE 10th International*

Conference on Intelligent Systems (IS), Varna, Bulgaria, 2020, pp. 606-611, https://doi.org/10.1109/IS48319.2020.9200133, ***ISBN*** *978-172815456-5,* ***SCOPUS:*** *https://www.scopus.com/record/display.uri?eid=2-s2.0-85092735435&origin=resultslist*

One of the main tasks in the development of the platform is the digitization of the Bulgarian Gene Bank and the creation of a web portal providing information and services to various groups of users. The storage and use of genetic samples and the collections of the Gene Bank requires a high level of security, integrity and confidence. This determines the need to use blockchain technologies in the process of creating, verifying and using data for genetic samples and collections. The report presents a blockchain-based model for the development of the GenBank Store module as part of the "Agriculture 2.0 Plovdiv" system.

33. *Stoyanov, S.,* ***Glushkova, T****. and I. Popchev. A HEALTH-ROUTE-SEARCH MODEL, 2020 International Conference Automatics and Informatics (ICAI), Varna, Bulgaria, 2020, ISBN 978-172819308-3, https://doi.org/10.1109/ICAI50593.2020.9311388,* ***SCOPUS:*** *https://www.scopus.com/record/display.uri?eid=2-s2.0-85100082353&origin=resultslist*

With the development and implementation of Cyber-Physical and Social Systems, the concept of a smart city is expected to solve many of the problems of modern cities, including air pollution. This article presents the first version of a model known as the healthy route search model. The Health-route-search model is used to implement an electronic service that will suggest possible routes that only pass through areas with clean air. Such routes would be preferred by the population of a city and in particular by people with various lung diseases.

34. *Stoyanov, S.,* ***Glushkova, T.,*** *Stoyanova-Doycheva, A., Doychev, E., AMBINET MODELING OF SPATIAL ASPECTS OF THINGS, 34th International Conference on Information Technologies, InfoTech 2020 - Proceedings, 2020, ISBN: 978-172816914-9, DOI: 10.1109/InfoTech49733.2020.9210987, (SCOPUS: https://www.scopus.com/record/display.uri?eid=2-s2.0-85093964872&origin=resultslist)*

The reference architecture for the Virtual Physical Space (ViPS) is considered, which can be adapted to different applications similar to CPSS. ViPS supports the virtualization of physical "things", taking into account factors such as events, time, space, and location. This article discusses the ViPS AmbiNet component responsible for modeling the spatial aspects of "things" implemented in accordance with the formalism of the Context-Aware Ambient Calculus (CCA), the modeling language, and supporting tools.

35. *Stoyanova-Doycheva, A.,* ***Glushkova, T.****, Doychev E. and N. Moraliyska, A RE-ENGINEERING APPROACH FOR EXTENSION OF THE TOURIST GUIDE KNOWLEDGE BASE, 2020 5th International Conference on Cloud Computing and Artificial Intelligence: Technologies and Applications (CloudTech),*

Marrakesh, Morocco, 2020, pp. 124-131, doi: 10.1109/CloudTech49835.2020.9365875, ISBN:978-1-7281-6176-1, (SCOPUS, WoS - https://www.webofscience.com/wos/woscc/full-record/WOS:000674949000020)

The article presents an approach to expand the knowledge base of the Tourist Guide with the rich information on Bulgarian cultural, historical and natural sites available in the existing databases created under the BECC project. To accomplish this task, the adapted Tourist Guide architecture, which was created as a Virtual-Physical Space (ViPS) reference architecture, is presented, and the process of restructuring the components in this architecture is described. In order to use the existing databases in the BECC project, a model is proposed for the restructuring of information based on standards for the representation of cultural and historical sites such as UNESCO and CCO (Cataloging Cultural Objects).

36. *Stoyanov, S., **Glushkova**, T., Stoyanova-Doycheva, A., Doychev, E., Ivanova, V. (2019) CYBER-PHYSICAL-SOCIAL SYSTEMS AND APPLICATIONS- PART1, LAP LAMBERT Academic Publishing, 2019, ISBN: 978-620-0-31825-1, 101 pages, https://www.lap-publishing.com/catalog/details/store/es/book/978-620-0-31825-1/cyber-physical-social-systems-and-applications?search=978-620-0-31825-1*

This book is an attempt to summarize the research and practical experience of the authors in building distributed systems with intelligent agents as active components. Fifteen years ago, in support of e-learning at the Faculty of Mathematics and Informatics at the University of Plovdiv, the development of DeLC (the Distributed e-Learning Center) began. DeLC is a distributed environment that aims to support the provision of contextual and electronic content-based educational services. The DeLC architecture can be considered as a graph consisting of individual nodes; each of them models a real educational unit that offers a full or partial educational cycle.

DeLC has been used in the real educational process for years. Although DeLC was a successful project for the application of information and communication technologies in education, one of its main shortcomings is the lack of close and natural integration of its virtual environment with the physical world, where the real learning process takes place. The book discusses the transition of DeLC to the Virtual Educational Space (VES) and the transition of this Virtual Education Space to the Cyber-Physical Social Space, which we call the Virtual Physical Space (ViPS). The proposed ViPS reference architecture is adapted for intelligent agriculture.

37. ***T. Glushkova**, A. Stoyanova-Doycheva, V. Ivanova, CYBER-PHYSICAL SOCIAL SYSTEMS AND APPLICATIONS- PART2. APPLICATIONS, Publisher: LAP LAMBERT Academic Publishing (2019-12-23), ISBN: 978-620-0-49831-1, 164 pages, https://www.lap-publishing.com/catalog/details/store/gb/book/978-620-0-49831-1/cyber-physical-social-systems-and-applications?search=978-620-0-49831-1*

The book is a continuation of the book "Cyber-Physical-Social Systems and Applications-Part1" (presented in the list under number 37). The main goal of the authors is to present the adaptation of the created reference architecture of ViPS for different areas. The first adaptation is its application in the field of e-learning, and the second one is the implementation of a smart tourist guide. The tourist guide generates tourist routes for the users, taking into account the characteristics of the tourist sites from the physical world and the preferences of the tourists. The architecture of the intelligent tourist guide is completely adapted to the architecture of ViPS.

II. Monograph:

38. ***Glushkova, T.*** *(2023), Modelling in cyber-physical systems, University Publishing House of Plovdiv University "Paisiy Hilendarski",164 pp., ISBN 978-619-7663-49-5, 2023*

In recent years, the DeLC Laboratory team at Plovdiv University "Paisiy Hilendarski" has been developing a conceptual model of a reference architecture of a Cyber-Physical and Social System, called Virtual Physical Space (ViPS). At its core, ViPS is a multi-agent system in which different types of autonomous agent and intelligent components "pick up" changes in the environment and react according to their knowledge, beliefs and goals. The conceptualization and phased prototyping of this space is a complex task requiring the efforts of all team members. Adapting the reference architecture to different domains requires a preliminary process of modeling the individual processes, states, base scenarios and services. For greater clarity, the author briefly presents some basic concepts related to the Virtual-Physical Space, its characteristics and features, which are defined by the team. The approaches used in modeling some basic scenarios and processes in this space, developed, implemented and tested by author, are considered in more depth.

The main contributions of the author are mainly related to: creation of a conceptual model of the AmbiNet module of the Analytical subspace of ViPS; modeling the spatial aspects of virtualized objects through the formal semantics of CCA and related modeling of the processes in the cyber-physical space and the states of individual objects in it.

III. Textbooks and study aids:

39. *Румяна Папанчева,* ***Тодорка Глушкова****, Компютърно моделиране за 4 клас, изд. Изкуства, 55 стр., ISSN: 9786197243642, 2019, https://www.book.store.bg/p288358/kompiutyrno-modelirane-za-4-klas.html*

The Computer Modeling textbook for the 4th grade has been approved by the Ministry of Education and Science. The topics cover the entire curriculum. The authors chose the Scratch block programming environment. It is used in compulsory training classes by students in Bulgarian schools. The textbook was realized with "Izkustva" publishing house. The text book is in Bulgarian.

40. *Гъров, К., Папанчева, Р., Анева С., **Глушкова Т**., Стоицов Г., Тодорова Е., Велчева И., Данаилов Д., Компютърно моделиране и информационни технологии 5 клас, изд. Изкуства-Клет, ISBN:978-619-7669-02-2, https://bguchebnik.com/uchebnici-i-pomagala/5-klas/kompyutarno-modelirane-i-informatsionni-tehnologii/kompyutarno-modelirane-i-informatsionni-tehnologii-za-5-klas.html*

    This textbook is intended for compulsory training of 5th grade students in Bulgarian schools. The topics fully correspond to the curriculum of "Computer Modeling and Information Technology" and is approved by the Ministry of Education and Science. Students will be trained on it from the fall of 2022. In its computer modeling part, the authors propose the implementation of the topics in the Scratch block programming environment. The textbook was produced by "Klet-Izkustva" publishing house. The textbook is in Bulgarian.

41. *Гъров, К., Папанчева, Р., Анева С., **Глушкова Т**., Стоицов Г., Тодорова Е., Велчева И., Данаилов Д., Компютърно моделиране и информационни технологии 6 клас, изд. Изкуства-Клет, ISBN:978-619-7669-03-9, https://bguchebnik.com/uchebnici-i-pomagala/6-klas/kompyutarno-modelirane-i-informatsionni-tehnologii/kompyutarno-modelirane-i-informatsionni-tehnologii-za-6-klas-87826.html*

    The textbook on Computer Modeling and Information Technology for the 6th grade is also approved by the Ministry of Education and Science and is intended for the lessons in compulsory school preparation. In the computer modeling part, the scripting language Python and the online programming environment Trinket are selected. A smooth transition from block to script programming is offered by demonstrating how to solve the same problems with both block and script programming approaches. With this textbook, students will be taught from the fall of 2022. The textbook was produced by "Klet-Izkustva" publishing house. The textbook is in Bulgarian.

42. *Станимир Стоянов, **Тодорка Глушкова**, Йордан Тодоров (2019), Изкуствен интелект. Решаване на проблеми посредством търсене, изд. Изкуства, ISBN: 9786197243871 https://www.ozone.bg/product/izkustven-intelekt-2020-2021/*

    The educational aid "Artificial intelligence. Solving problems through search" is intended for training school students in elective and optional study disciplines, as well as in elective modules in professional and profiled training. It can be used in STEM interest clubs as well as teaching university students. Includes "classical" artificial intelligence topics related to search problem solving algorithms. Many practical examples and tasks are provided. The teaching aid was implemented by "Izkustva" publishing house and has been in use since the fall of 2019. It is written in Bulgarian.

43. *Стоянов, С., **Глушкова, Т**., Папанчева, Р. (2021), Изкуствен интелект. Представяне на знанията чрез логика. Логическо програмиране, Изкуства, 2021, 96 стр. ISBN: 978-619-7243-97-0, https://goodboox.bg/index.php?route=product/product&product_id=875*

The educational aid "Artificial intelligence. Representing knowledge through logic. Logic Programming' aims to support students' learning related to the basic concepts of 'classical' artificial intelligence. Intended for training school students in elective, optional and extracurricular subjects, as well as in elective modules in professional and profiled training. It can also be used in university student training. Includes "classical" artificial intelligence topics related to knowledge representation through logic and logic programming in Prolog. Many practical examples and tasks are offered to demonstrate the introduced knowledge. The study aid was developed on the basis of a curriculum approved by the Ministry of Education and Science and was produced by "Izkustva" publishing house. It is used in training from the fall of 2021. It is written in Bulgarian.

44. *Табакова-Комсалова, В., Глушкова Т., Стоянов, С., Ръководство по Изкуствен интелект, Университетско издателство „П. Хилендарски“, 2022, ISBN: 978-619-202-749-0, 142 стр.*

This study aid was developed in accordance with the requirements and the AI curriculum at the Faculty of Mathematics and Informatics of Plovdiv University "Paisiy Hilendarski". It examines the main approaches to the presentation and processing of knowledge necessary for the development of intelligent systems in all spheres of the modern world - education, intelligent agriculture, transport, healthcare, etc. The content of this manual is dedicated to the topic "Representing and processing knowledge through logic rules and logic programming". Along with the issues related to problem solving through search, this topic has been explored since the dawn of artificial intelligence and is established as fundamental to the discipline. After some hiatus, the logic programming language Prolog is making a resurgence. The subject matter in this guide is an essential part of the core of so-called "classical artificial intelligence".

This study guide has been developed in accordance with the requirements of the approved study programs for the "Bachelor" degree of the Faculty of Mathematics and Informatics at Plovdiv University "Paisiy Hilendarski" for the mandatory disciplines "Artificial Intelligence" and "Intelligent Systems", respectively for "Informatics" majors and "Software Engineering". The guide can also be used for electives in the field of Artificial Intelligence. It is written in Bulgarian.

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