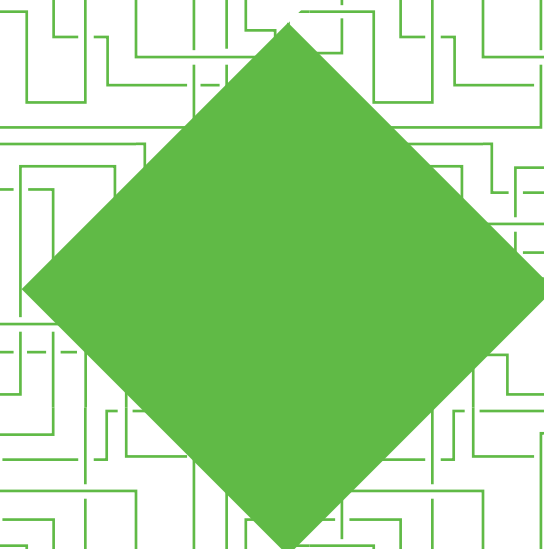


Centre for
Smart Cities and
Infrastructure

ANNUAL REPORT 2021



STRATEGIC PARTNERS





Darius Pupeikis • Head of CSCI

By 2021, the world had learned to live with pandemic conditions, but these were followed by other challenges, energy, and raw materials shortages, intensifying warming and accelerating inflation. Let us acknowledge that the construction sector is a major contributor to these phenomena. Buildings and related processes are responsible for 38% of global CO₂ emissions. Around 75% of the world's raw materials are used for buildings. These figures make one wonder about the importance of the construction sector. Although the construction sector has been accompanied by technological advances over the last decade, it has become clear that progress is too slow. Buildings are becoming technologically

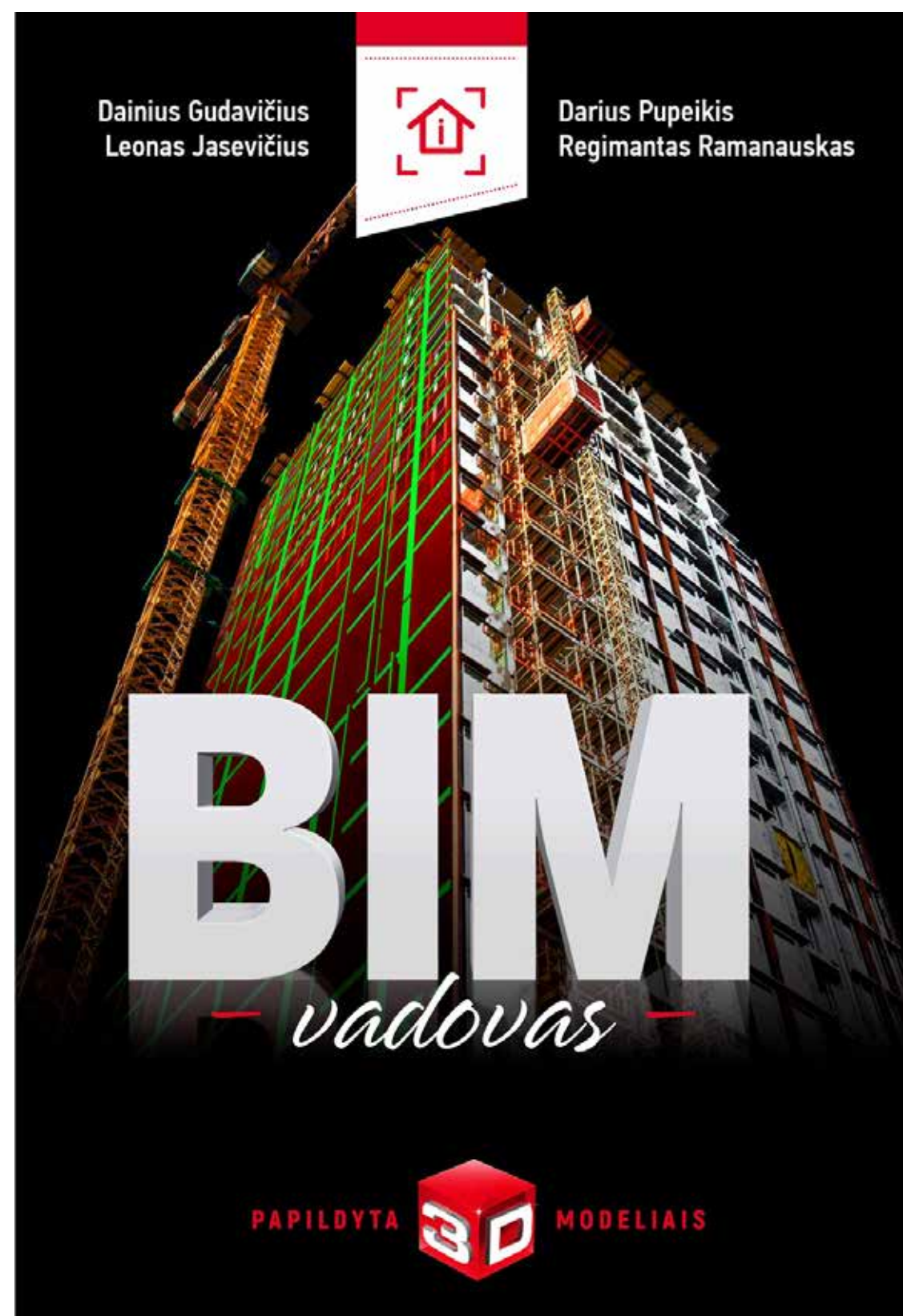
obsolete too quickly and it is important to find effective solutions for their modernisation. Construction time has become a competitive advantage for many market players and the advantage of prefabricated building elements has become more clear than ever. Transformation towards renewable energy and energy efficiency is necessary, as the environment is already demanding new quality buildings that meet the highest sustainability standards.

The overall trends in the market and in the construction sector only prove that CSCI's activities are heading in the right direction. All these challenges and their solutions require digital data to develop more efficient solutions and new products, adapting to each building individually and assessing the environmental impact.


In 2021, CSCI was characterised by its continued work on EU H2020 projects. We started a new project to create a digital twin of the KTU student campus. One of the main milestones this year was the digitisation of the newly constructing MLAB prototyping laboratory. In the field of studies, we managed to introduce and implement a new non-formal education study programme National Construction Information Classification System, and several Master's thesis projects using reality scanning and artificial intelligence technologies for digitisation of buildings. Last year, the socio-educational project for schools DEC LT celebrated its 3rd season.

New colleagues have joined the CSCI team to strengthen it in the areas of Internet of Things (IoT), programming and building information modelling. On behalf of the whole team, I am delighted with the work we have done. I wish to keep up the momentum, keep improving and innovating for the construction and related industries.

IMPORTANT HIGHLIGHTS:

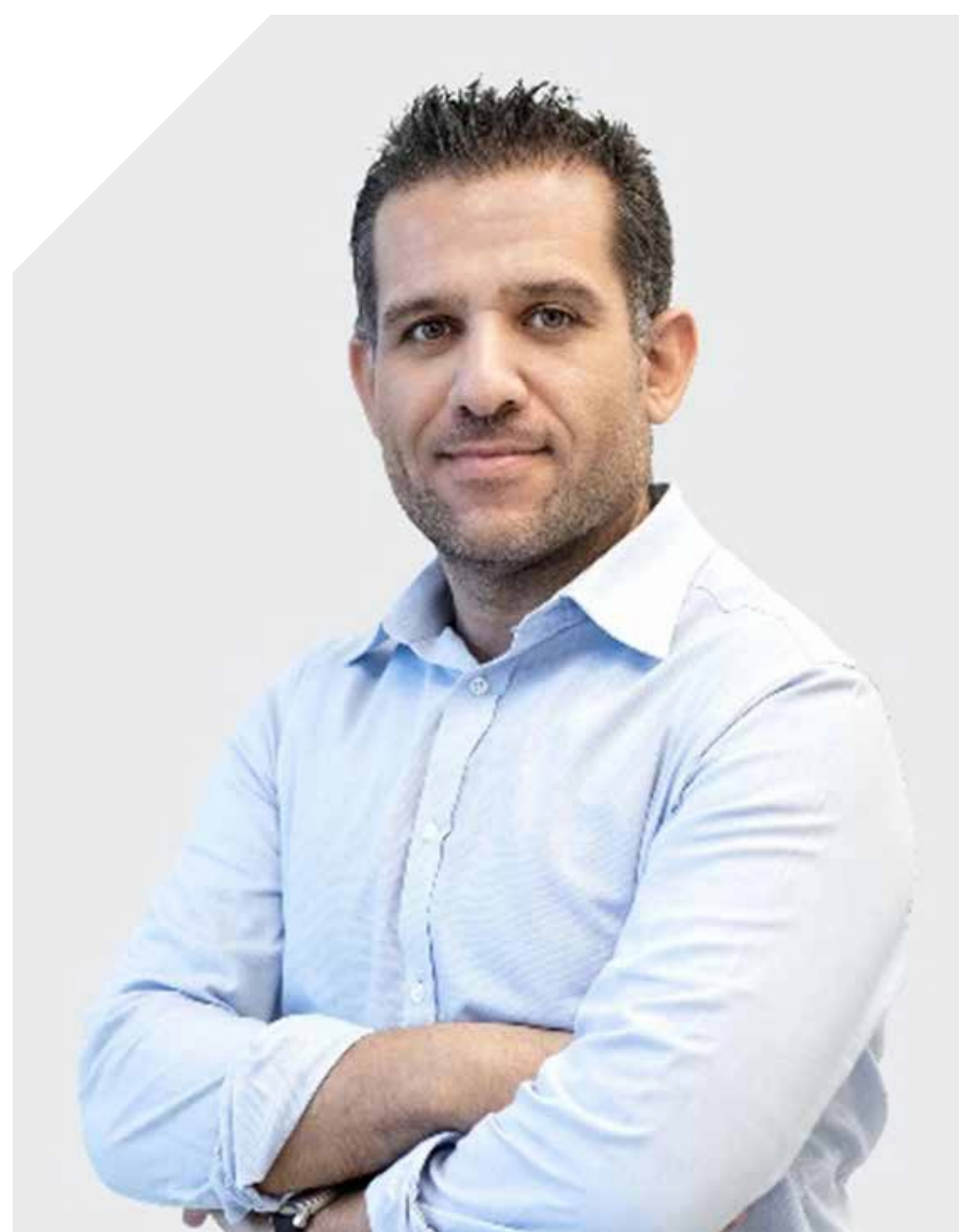


- ◆ Established **Machine Learning Club** within the Faculty and CSCI. The main activities are focused on findings and application of Artificial Intelligence to construction data
- ◆ Established collaboration with SC Kauno energija, JSC Center of Informatics and Communication Technologies and Community “Šilo namai” regarding access of buildings energy data
- ◆ Regular participation in **Construction Classification International Technical Committee** by making policy regarding common standardization of construction information between the Baltic Sea Region and neighbor countries
- ◆ Darius Pupeikis presented CSCI activities and oral presentation about Digital Twins of Built Environment in conferences “**Gervė 2021**” and “**BIM and technological progress. Possibilities and practical implementation**”
- ◆ CSCI became a member of [Proptech LT](#)
- ◆ DEC LT 2 season final event
- ◆ DEC LT 3 season opening event + 2 new schools
- ◆ First time CSCI course “National Construction Information Classification System” was established and carried out
- ◆ Published “BIM Guide” – the first book about BIM in Lithuanian language by Darius Pupeikis as a co-author
- ◆ CSCI partners participated in internship day for FCEA students
- ◆ Workshop Digital Twin of Built Environment



WORKING ON H2020 PROJECTS

◆ WORKING ON H2020 PROJECTS



Paris A. Fokaides

Chief Researcher

Faculty of Civil Engineering
and Architecture Kaunas
University of Technology

CSCI's participation in the EU-funded research projects is of major importance for the center. Through its involvement in the EU-funded projects, CSCI has an opportunity to collaborate with leading research institutions in the EU and beyond, exchange ideas, as well as promote the activities and excellence of the center. At the same time, through its contribution to these programs, the center returns back to the society in a tangible manner its know-how and experience in the field of digitization of the built environment, as well as smart and sustainable ways of its assessment. The center also has the opportunity to participate in the latest developments, to be informed about the current trends in the field and in general be an active player in the research market of sustainable buildings.

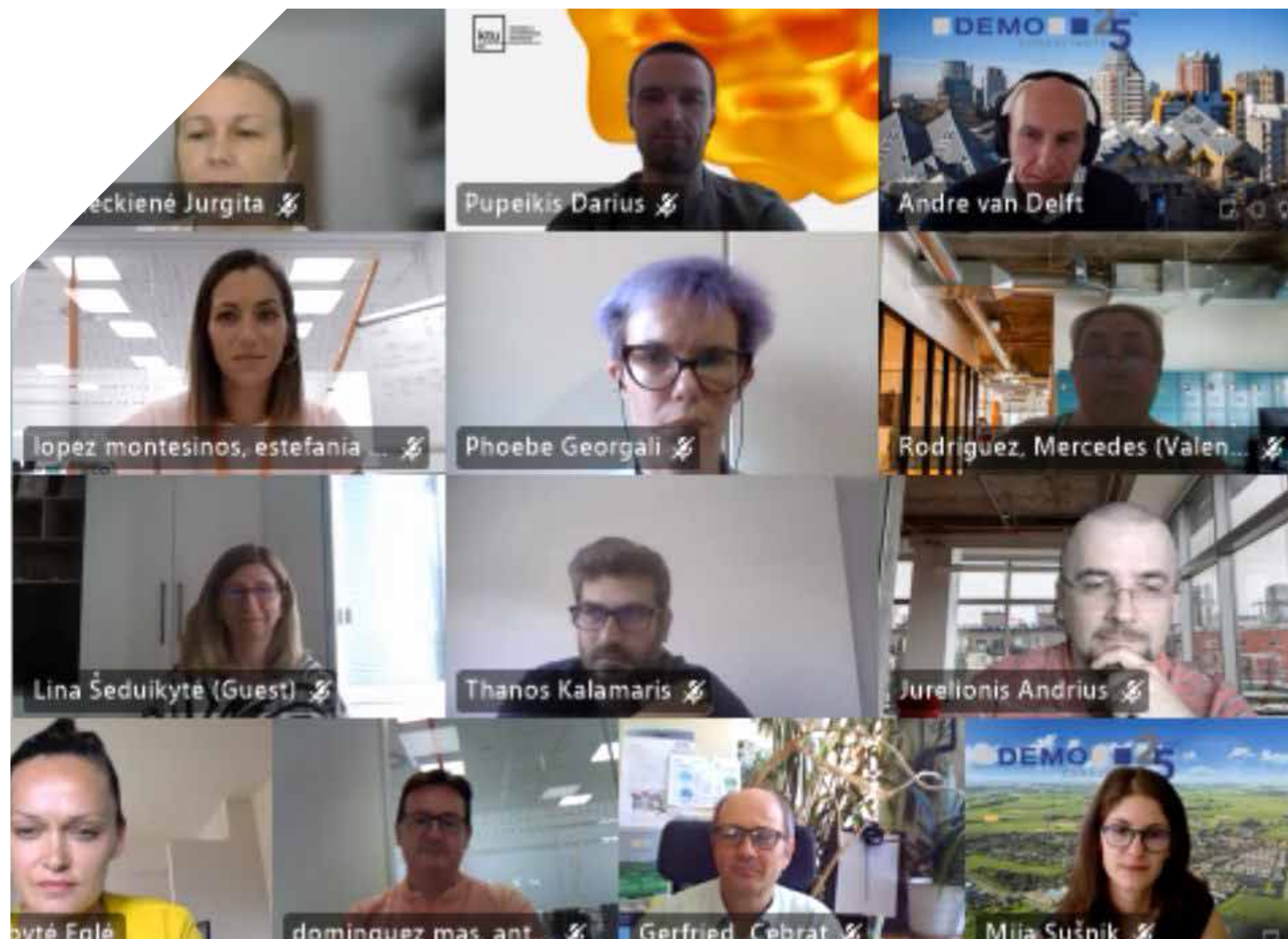
CSCI currently contributes in three EU funded projects, D²EPC, PRECEPT and eUMaP with the aim to provide its expertise in the field of the digitization of the built environment, and its sustainability assessment with smart tools and practices. CSCI's participation in these projects is another proof that the center stands in the forefront of the research and development field, on a European level.



Next-generation Dynamic Digital EPCs for Enhanced Quality and User Awareness, (D²EPC)

<https://www.d2epc.eu>

The Project D²EPC ambitiously aims to set the grounds for the next generation of dynamic Energy Performance Certificates (EPCs) for buildings. The proposed framework sets its foundations on the smart-readiness level of the buildings and the corresponding data collection infrastructure and management systems. It is fed by operational data and adopts the 'digital twin' concept to advance Building Information Modelling (BIM), calculate a novel set of energy, environmental, financial and human comfort/wellbeing indicators, and through them the EPC classification of the building in question. Under the project vision, the proposed indicators will render dynamic EPCs as a realistic, accurate and comprehensive tool that can lead the transformation of the European building stock into zero-energy buildings and stimulate energy efficient behavioral change of the building residents. The D²EPC framework will be demonstrated in 6 sites, while its 12 partners coming from 7 European countries will collaborate and provide their expertise as well as resources within the 36 months of the project's lifetime.



PARTNERS:

- ◆ CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS, INFORMATION TECHNOLOGIES INSTITUTE · GREECE
- ◆ KAUNAS UNIVERSITY OF TECHNOLOGY · LITHUANIA
- ◆ GEOSYSTEMS HELLAS A.E. · GREECE
- ◆ CLEOPA GMBH · GERMANY
- ◆ SENERCON GMBH · GERMANY
- ◆ ASOCIACION ESPANOLA DE NORMALIZACION · SPAIN
- ◆ DEMO CONSULTANTS BV · NETHERLANDS
- ◆ SGS TECNOS SA · SPAIN
- ◆ HYPERTECH ENERGY LABS · GREECE
- ◆ AUSTRIAN STANDARDS INTERNATIONAL · AUSTRIA
- ◆ FREDERICK RESEARCH CENTER · CYPRUS
- ◆ AUSTRIAN ENERGY AGENCY · AUSTRIA
- ◆ INTELLIGENT SOLUTIONS FOR ZERO AND POSITIVE ENERGY BUILDINGS · GREECE

KTU TEAM:

- ◆ Eglė Klumbytė,
- ◆ Darius Pupeikis,
- ◆ Vytautas Bocullo,
- ◆ Lina Šeduikytė,
- ◆ Jurgita Černeckienė

CSCI TEAM EXPERIENCE



Dr. Eglė Klumbytė
Researcher

Responsible for managing WP2 working package and coordinating the partners, organizing meetings, risk assessment, communication in the project, timely preparation of tasks, reporting to the EU during the presentation and preparation of reports.

What makes it interesting to you?

I love challenges, and this one really helps me improve. Working in a project is interesting in that I can reveal myself in project management activities as I have ten years of this experience in an international company. These activities intertwine with my work as a researcher. I love teamwork, and in this project I am lucky to have the opportunity to work with such competent, responsible colleagues who are always there to help. Although the topic of the project is a new area for me, it is exciting. The very idea of the project allows to combine fundamental knowledge with the latest technologies and to draw knowledge from many partners with different competencies in different fields.

What was the most memorable thing of this project that you discovered or realized?

The most important thing is the people and a good connection with them. Without them, you will not implement even the best ideas! I am very grateful to Paris Fokaides, Andrius Jurelionis and Darius Pupeikis, for the opportunity, knowledge, endless support and trust. For the whole team, because without them we would not have achieved the current results.

Why is this project important for communities?

The project benefits everyone. The employees have an extraordinary opportunity to improve, apply their knowledge, make acquaintances with foreign partners and even discover the abilities of colleagues that we have not noticed before. The improving employee means a stronger faculty and the entire university. The innovation being developed is a new generation of digital dynamic energy performance certification for buildings that benefits not only Lithuanians but also Europeans. The indicators proposed in the project's vision will turn dynamic energy performance certificates into a real, accurate and comprehensive tool that can encourage the European Building Fund to transform into zero-energy buildings and lead to energy-efficient behavioral change in the building's population.

WORKING ON H2020 PROJECTS

PRECEPT



Precept

<https://www.precept-project.eu>

Traditional residential buildings are reactive. They consume high energy, with elevated maintenance costs. In the majority of cases, the Renewable Energy Sources are untapped, while the occupants' well-being most of the time is not a proper one. Finally, their environmental footprint is very poor. PRECEPT vision is to enable the “smooth” and at almost zero operational costs transformation of traditional residential buildings to Pred(scr)ictive, Proactive Smart Residential Buildings.

The overall goal is to make the transformation of the buildings from reactive to proactive more attractive to stakeholders, more reliable, secured and cost-effective, environmentally friendly, and in line with grid needs, thus enabling the acceleration of building proactiveness transformation. PRECEPT's ambition is to deliver the next-generation of Smart Home (enriched with IoT - Internet of Things) industry.



PARTNERS:

- ◆ WATT AND VOLT A.E. • GREECE
- ◆ CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS • GREECE
- ◆ KAUNAS UNIVERSITY OF TECHNOLOGY • LITHUANIA
- ◆ FREDERICK RESEARCH CENTER • CYPRUS
- ◆ CLEOPA GMBH • GERMANY
- ◆ NUROMEDIA • GERMANY
- ◆ ODIN SOLUTIONS S.L. • SPAIN
- ◆ DEMO CONSULTANTS B.V. THE • NETHERLANDS
- ◆ AUSTRIAN STANDARDS INTERNATIONAL • AUSTRIA
- ◆ LC INNOCONSULT INTERNATIONAL • HUNGARY
- ◆ STATE HIGHER EDUCATIONAL INSTITUTION PRYDNIPROVSKA STATE • UKRAINE
- ◆ CONTECHT GMBH • GERMANY
- ◆ PRIVATE CONSTRUCTION AND ASSEMBLY ENTERPRISE • UKRAINE
- ◆ MY ENERGIA ONER S.L. • SPAIN
- ◆ POLITECNICO DI MILANO • ITALY

KTU TEAM:

- ◆ Rasa Apanavičienė,
- ◆ Lina Morkūnaitė,
- ◆ Darius Pupeikis,
- ◆ Paulius Spūdys,
- ◆ Eglė Klumbytė,
- ◆ Andrius Jurelionis

CSCI TEAM EXPERIENCE



Dr. Rasa Apanavičienė

Main responsibility for coordinating the activities of the project's 2nd work package "BIM & DIGITAL TWIN TECHNOLOGIES".

What did you learn in 2021 while working on this project?

The package consists of 6 tasks led by representatives of different institutions and each task is performed by partners. Due to COVID-19, the project was carried out remotely. I realized that it takes some time and a series of meetings and discussions before researchers from different countries start to get to know and understand each other, think in the same terms, and work as a team in the same direction.

What makes it interesting to you?

This is primarily a challenge in scientific terms, as the project is an “innovation action” with an interdisciplinary context and not only a scientific part of the project related to product/service development using BIM, Digital Twin, IoT and Machine Learning technologies, but also a business model after a project must be prepared.

Why is this project important for Europeans?

The ultimate goal of the project is to create a residential building management platform that would "turn" ordinary residential houses into proactive smart homes. This would save energy during the operation of buildings, improve indoor climate comfort and residents' satisfaction with the rising quality of life, predict future failures of various household appliances and thus optimize their maintenance, "prepare" in advance for future changes in building operation, taking into account projected changes in electricity supply networks.



eUMaP - Development of utilities management platform for the case of quarantine and lockdown

The project eUMaP aims to develop an open platform through which local and public authorities will be able to better plan and manage the demand and supply of building utilities, including energy, water, waste and telecommunication in crisis, quarantine and lockdown situations such as during COVID-19. Staff exchanges between the nine collaborating partners will develop and pilot a platform in four European cities that can be of a great value to prepare for the future crises. The platform is based on the rational of earth observation, and the recording of the required network information in open BIM platforms of four European cities (Rome, Thessaloniki, Kaunas, Nicosia). The platform will be piloted in study areas with the aim of optimise it and delivering it as an open platform upon completion of the program.



PARTNERS:

- ◆ ALMA SISTEMI SRL • ITALY
- ◆ FREDERICK UNIVERSITY FU • CYPRUS
- ◆ ARISTOTELIO PANEPISTIMIO THESSALONIKIS • GREECE
- ◆ CONSORZIO NAZIONALE INTERUNIVERSITARIO PER I TRASPORTI E LA LOGISTICA • ITALY
- ◆ GEOSYSTEMS HELLAS IT KAI EFARMOGESGEOPLIROFORIAKON SYSTIMATON ANONIMIETAIREIA • GREECE
- ◆ CLEOPA GMBH • GERMANY
- ◆ UAB CAVERION LIETUVA • LITHUANIA
- ◆ SPACE SYSTEMS SOLUTIONS • CYPRUS

KTU TEAM:

- ◆ Darius Pupeikis,
- ◆ Lina Morkūnaitė,
- ◆ Paulius Spūdys,
- ◆ Marius Ivaškevičius,
- ◆ Kęstutis Zaleckis

CSCI TEAM EXPERIENCE



Lina Morkūnaite
PhD Student

Responsible for the coordination and development of Integration of Digital Technology Monitoring and Management into eUMaP.

What did you learn in 2021 while working on this project?

We became acquainted with international partners, shared our experience, discussed the possibilities of developing the eUMaP platform using the latest technologies in civil engineering, such as BIM, Digital Twin, etc. The project is captivated by the fact that the partners have scientific and practical experience in quite different fields, which inspires them to discover new and interdisciplinary applications in the conservative construction and building industry.

What makes it interesting to you?

The project provides excellent opportunities for young researchers to gain international experience. It is also necessary to work with the latest technologies and discover new ways to apply them. At the same time, such experience serves in the preparation of a doctoral dissertation.

What was the most memorable of this project that you discovered or realized?

The project employs professionals from areas such as GIS (geoinformation technology), IoT (Internet of Things), BIM (Building Information Modelling), engineering systems management and utility service organizations (heat, electricity, water management, telecommunications), providing excellent opportunities to gain new experiences. At the same time, I realized that the specifics of working with international partners are slightly different than those of local projects. Coordinating work and integrating individual tasks poses new challenges for working remotely and involving partners in different fields.

Why is this project important?

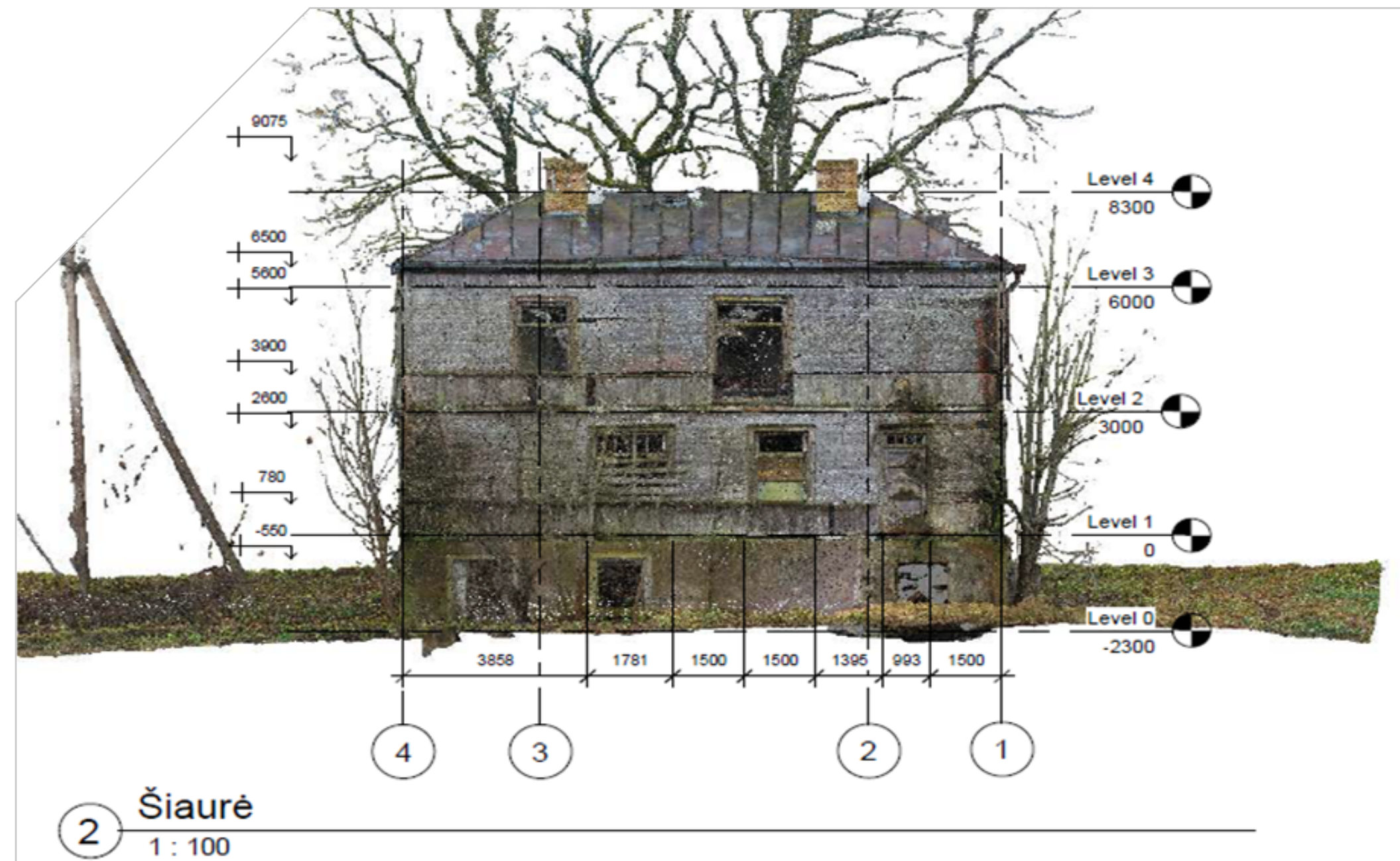
This is a great opportunity for the faculty, and at the same time for the university, to represent itself and Lithuania to the international community. To show that such a small country as Lithuania has enough potential to meet the highest standards of the market and developed countries. This is a great opportunity for the university to be recognized by the highest level of the international scientific community.



WORKING ON NATIONAL-BASED PROJECTS

WORKING ON NATIONAL-BASED PROJECTS

Heritage



Architectural Measurement of Abandoned Heritage objects using UAV photogrammetry

The main aim of this project is to provide detailed measurements and accurate 3D models of selected abandoned real heritage objects, created with unmanned aerial vehicle (UAV) photogrammetry for preparing the documentation of heritage objects. In the first stage, two sites were selected for measuring: church fragments in Kaunas, Radvilėnų pl. 1A; customs building in Suvainiškis, Paupio g. 4. Multiple photos were taken on these sites to create accurate 3D models using ContextCapture Master – software produced by our partners Bentley Systems.

PARTNERS:

- ◆ DEPARTMENT OF CULTURAL HERITAGE UNDER THE MINISTRY OF CULTURE OF THE REPUBLIC OF LITHUANIA

KTU TEAM:

- ◆ Vytautas Bocullo
- ◆ Vilma Karvelytė Balberienė
- ◆ Vilma Kriaučiūnaitė-Neklejonovienė
- ◆ Aušra Andriukaitienė
- ◆ Darius Pupeikis



◆ WORKING ON NATIONAL-BASED PROJECTS

◆ Heritage



Dr. Vytautas Bocullo

Responsible for 3D models production and preparation of drawings with necessary dimensions.

“During the project we communicated closely with specialists of heritage department to have better understanding what features are important and should be presented in 3D model and drawings. It expanded our view on real cultural heritage and application of UAV photogrammetry. This project expanded KTU Faculty of Civil Engineering and Architecture partnership with DCH. Personally, I was always interested in architectural heritage, and I was happy about the opportunity to work in this field. I am now looking forward to continue working on the future sites.”

Iceland
Liechtenstein
Norway

**Active
citizens fund**



GENIUS LOCI: Urbanization and Civil Society – Šančiai case

<https://sanciubendruomene.lt/en/genius-loci/>

Project mission is to activate the participation of target groups not involved in decision-making in civic activities and self-government, to increase the number of users of digital media that promote public participation in civic activities. Project team aims to solve the problem of unsustainable urbanization in Kaunas Šančiai district that violates the interests of the local population and to create conditions for more active participation of citizens in democratic processes. To strengthen and enable active citizenship.

PARTNERS:

- ◆ COMMUNITY OF LOWER ŠANČIAI • LITHUANIA
- ◆ VELLENEŠ FELLESGORGANISASJON MUNICIPALITY • NORWAY
- ◆ BODØ MUNICIPALITY • NORWAY

KTU TEAM:

- ◆ Laura Jankauskaitė-Jurevičienė,
- ◆ Jurga Vitkuvienė,
- ◆ Kęstutis Zaleckis





Prof. Kęstutis Zaleckis

Responsible for Creating a memory map, present map and the future map.

What are these maps?

The purpose of the Šančiai memory map is to accumulate personal and collective values of memory and, by sharing them with others, to create the history of Šančiai based not only on the policies of official institutions, but also on the memories, experiences, legends, family photos, etc. of each of us. We hope that this map will become a fulcrum for creating a vision for the future of Šančiai and a means to get to know the area better.

The purpose of the current map is to gather information about what and where in Šančiai you had an experience. Which places are important to you and why, and which would you like to change? This map will become an important point of resistance in creating the urban vision of Šančiai. The city is not just open spaces and buildings, it is also a community that shares, modifies, adapts and gives social meaning to public spaces. Alexander Ståhle has developed a sociotope mapping method that allows the social purposes and meanings of a city's public spaces to be objectively determined based on people's experiences. This map involves the community in the planning

◆ WORKING ON NATIONAL-BASED PROJECTS ◆ Šančiai

process and reflects the social needs of these people. The map of the future, based on simulated space syntax models, the impact of new constructions, new functions, new public spaces, infrastructure changes on Šančiai will be analysed. The map of the future and the possible alternatives for the development of Šančiai modelled in it will become a decision support tool for the community to discuss what changes could take place in Šančiai and how they will affect the current use of space. The map will be based on one or another revitalization activities of a specific place, for example, meaningful / activation of historical places in the collective consciousness through artistic activities or installations; active formation of the image of the territory by choosing the most visible or, conversely, hidden but desired places to be “discovered”; site selection and activation of a community “traveling” or stationary center as a TLU (Temporary land use) activity; initiating heritage conservation and restoration programs; initiatives to increase the well-being of the territory by selecting strategically important points, etc.

What did you do in 2021 while working on this project?

The work that we have done since the beginning of the project is the creation of maps of the past and present, certain experiments in mathematical modeling. Personally, I find it very interesting to compare the data collected by people with spatial syntax models and to discover the connection between mathematical simulation calculations and real, ongoing processes in Šančiai, which will predict the impact of one or another decision on life in this part of the city.

What makes it interesting to you?

The project is interesting in that, on one hand, based on the active involvement of the society in the creation of maps, it allows to rediscover what the familiar part of the city looks like and to better understand / see the importance of the

community to the city identity. On the other hand, the project is an interesting synthesis / synergy created by the productive involvement of the community in the urban development process and the possibility of using mathematical simulation models primarily in collaboration with the community rather than professional urban planners.

What was the most memorable of this project that you discovered or realized?

It is impossible to understand the city or its part (Šančiai) without knowing the people living in it - they and the spatial structure of the city form an inseparable entity.

How important do you think this project is for the faculty, the university or the Lithuanian / European society as a whole?

The project is important in few aspects. First, it tests methods for the productive involvement of the community in the urban planning process, using digital maps not only as a means of gathering information, but also as a means of strengthening the community and knowing the place. Second, simulation mathematical models of urban development will be actively used in the project, the use of which in Lithuania unfortunately has only taken the first steps. Third, for the first time in Lithuania, the project has applied such methodologies as mapping of sociotopes, not so much for professionals as for the community itself.



MLAB Digital Twin

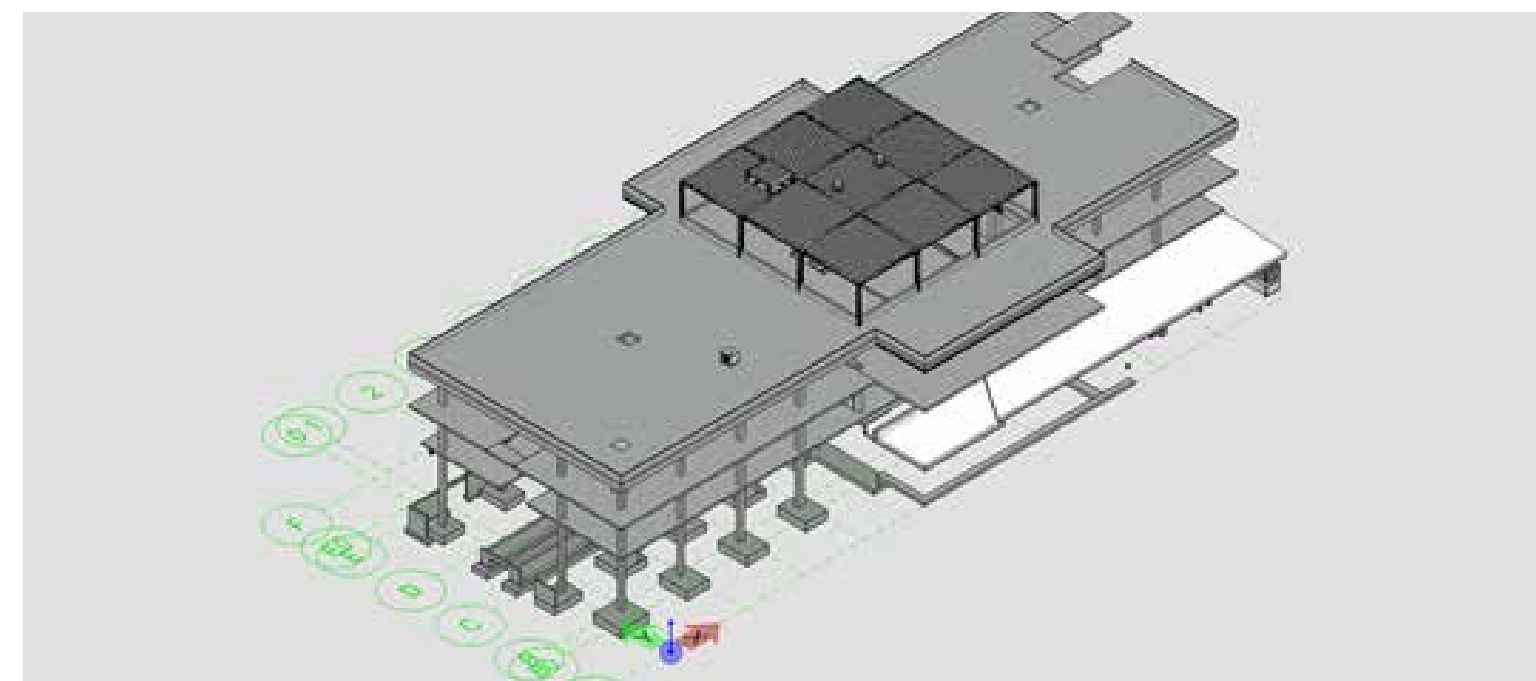
Its goal is to create a digital twin for the MLAB prototyping laboratory at KTU Campus by capturing reality at different stages of the construction process. To develop semantically and 3D geometrically rich "As-Built" BIM model and to convey building's architecture, structures and MEP systems are the essential tasks as well. Digital twins are one of the latest areas of construction, involving not only the digitization of a building during design, but also the monitoring of the required parameters during operation. The MLAB digital twin project generates photogrammetric models of the building at various stages of construction, develops its BIM model with key information from all existing elements, and installs real-time sensors to measure microclimate (and other) parameters that transmit information in real time. Combining all three elements on the Bentley iTwin platform results in a "live" digital twin of a real building.

◆ WORKING ON NATIONAL-BASED PROJECTS

◆ MLAB Digital Twin

PARTNERS: KTU TEAM:

- ◆ GRAŽINA JANULYTĖ-BERNOTIENĖ'S ARCHITECTURE STUDY · LITHUANIA
- ◆ Justas Kardoka,
- ◆ Lina Morkūnaitė,
- ◆ Rytis Venčaitis,
- ◆ Vytautas Bocullo,
- ◆ Ignacio Villalon Fornes



◆ WORKING ON NATIONAL-BASED PROJECTS

◆ MLAB Digital Twin



**Dr. Ignacio Villalon
Fornes**

Responsible for coordinating the project and developing the BIM model.

What did you learn in 2021 while working on this project?

Over the years, I learned to work with Bentley OpenBuildings software, and to develop the key parts of the MLAB building's BIM model, such as architecture, structures, HVAC, water supply and sewerage systems. There was also an opportunity to get acquainted with various technologies of digitization of the existing building, such as Lidar and photogrammetry. It was also necessary to combine the photogrammetry model (3D model generated by photographing a building under construction by a UAV) with the existing BIM model, and thus compare the correspondence between the "As-Built" and "As-Design" building's representations.

What makes it interesting for you?

The main curiosity is innovation, because the topic of digital twins is very new in Lithuania and in the world. It's fun to contribute to the technology of the future. Other thing is our close connections between all parts of project. Since the building under construction (MLAB) is a project of our university, the adjustments were very straightforward. At any time, it was possible to visit the construction site, consult with the supervisor about changes to the project, visit the building with a drone.

How important do you think this project is for the faculty, the university or the Lithuanian / European society as a whole?

This digital twin is like a "pilot" project within a university, during which digital twin technologies are being mastered by our specialists. As these technologies continue to spread, we will be able to contribute by advising others and providing our know-how. In addition, the MLAB digital twin project fits in perfectly with the vision of KTU University's Smart Campus.

E-modernisation

Assessing the possibilities of sustainable modernization and energy supply of the city block using the digital twin (E-Modernization)

The aim of project is to create a digital twin for the urbanized district and assess the potential for modernization and energy supply. The modernization twin concept is used in the modernization project - the developed method quickly evaluates the calculated geometrical parameters of buildings, combining their physical characteristics with a 3D model of the terrain, created by applying the photogrammetry of unmanned aircraft. The digital twin allows for a much more accurate assessment of the energy supply potential of the entire quarter, including the development of RES-based technologies.

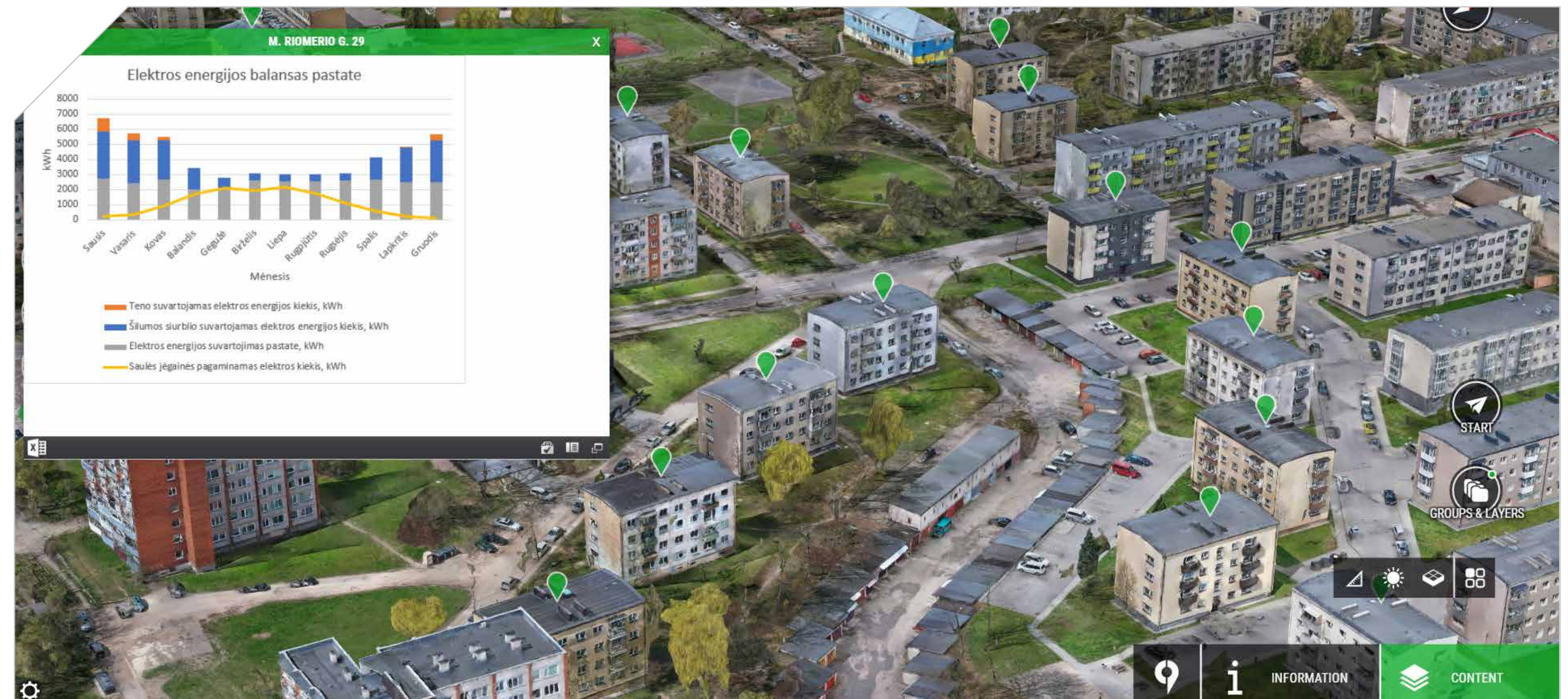


WORKING ON NATIONAL-BASED PROJECTS

E-modernisation

PARTNERS: KTU TEAM:

- LITHUANIAN ENERGY INSTITUTE (LEI) • LITHUANIA
- Vilma Kriauciūnaitė-Neklejonovienė,
- Rytis Venčaitis,
- Vytautas Bocullo



◆ WORKING ON NATIONAL-BASED PROJECTS

◆ E-modernisation



Dr. Vytautas Bocullo

Primarily responsible for the development and integration of the 3D model with the energy characteristics - the cost of electricity, energy for heating and hot water, and the availability of renewable energy sources.

What makes it interesting to you?

Working on this project combines new technologies such as drone photogrammetry with traditional construction technologies. This is how we digitize construction as an industry. The interdisciplinarity of the project allowed for a deepening of knowledge in building energy, especially in the application of solar power plants.

How important do you think this project is for the faculty, the university or the Lithuanian / European society as a whole?

The digital twin is a suitable tool for municipalities to prepare long-term infrastructure development plans, such as, in this case, quarterly apartment building modernization. The digital twin of the district created during the project combines the 3D model of the quarter with the energy characteristics and proposed solutions to reduce the CO2 footprint and increase the energy independence of the district creating an "energy island".





EDUCATION

FOR PROFESSIONALS

New course for professionals

National Construction Information Classification System

In 2021 for first time CSCI team presented a new course “National Construction Information Classification System”. In recent years, Lithuanian government has applied some laws, according using BIM in civil objects constructions. During the BIM-LT project, the initial requirements for the national construction information classification have been designed already. As we know, in the stages of the building life cycle, more and more digital data is generated, which has enormous potential when it can be understood by a machine (computer). Structured or classified data is the basis of building information modelling (BIM), enabling the application of BIM for a variety of purposes: cost calculations, energy and structural condition modelling, digital manufacturing, building and property management, collision checking and control, simulations. In this course participants can learn more about legislation, classification systems and implementation.



Other programs:

Data Analytics and Applied Machine Learning

Program will provide knowledge and practical skills in solving engineering, financial and other tasks and problems using data analytics and machine learning methods and tools. During the lectures, lecturers will provide knowledge of data analysis, help to develop skills in using various machine learning methods to solve different types of tasks (regression and classification), introduce the software tools to solve those problems.

Building Information Management

Program is designed to acquaint building builders, designers, construction professionals, building property managers with the basic principles of building information management and its applications. The program is based on the material from BIM expert Phil Jackson and experience in the UK construction industry for the work of civil engineers and architects in the digital environment.

FOR UNIVERSITY STUDENTS

CSCI Kaunas digital twin project is used in various study modules. Partners of CSCI participate in Internship day, visit students and organize field trips to construction objects. Now it's more common for students to choose Master studies topics, related to CSCI projects and activities.



Master studies final projects related to CSCI activities

Martynas Arbačiauskas

Supervisor – dr. Darius Pupeikis

Partner for research - INHUS

INVESTIGATION OF PHOTOGRAMMETRIC 3D MODELS APPLICATION POSSIBILITIES TO DETERMINE BRIDGES GEOMETRIC CHARACTERISTICS

The purpose of this master's thesis is to investigate the geometric accuracy of 3D models based on reality capture technologies (LiDAR, photogrammetry) and to determine its use cases analysing bridge structures, capturing data using unmanned aerial vehicle.

There are two case studies. The first case study's purpose is to investigate reality capture technologies possibilities to determine construction defects. The second case study's purpose is to investigate the accuracy of created photogrammetric 3D models' geometric. After establishing the geometric accuracy of photogrammetric 3D model possibilities of measuring constructions are investigated. Conclusions are given for the results.



Karolis Jackonis

Supervisor – dr. Darius Pupeikis

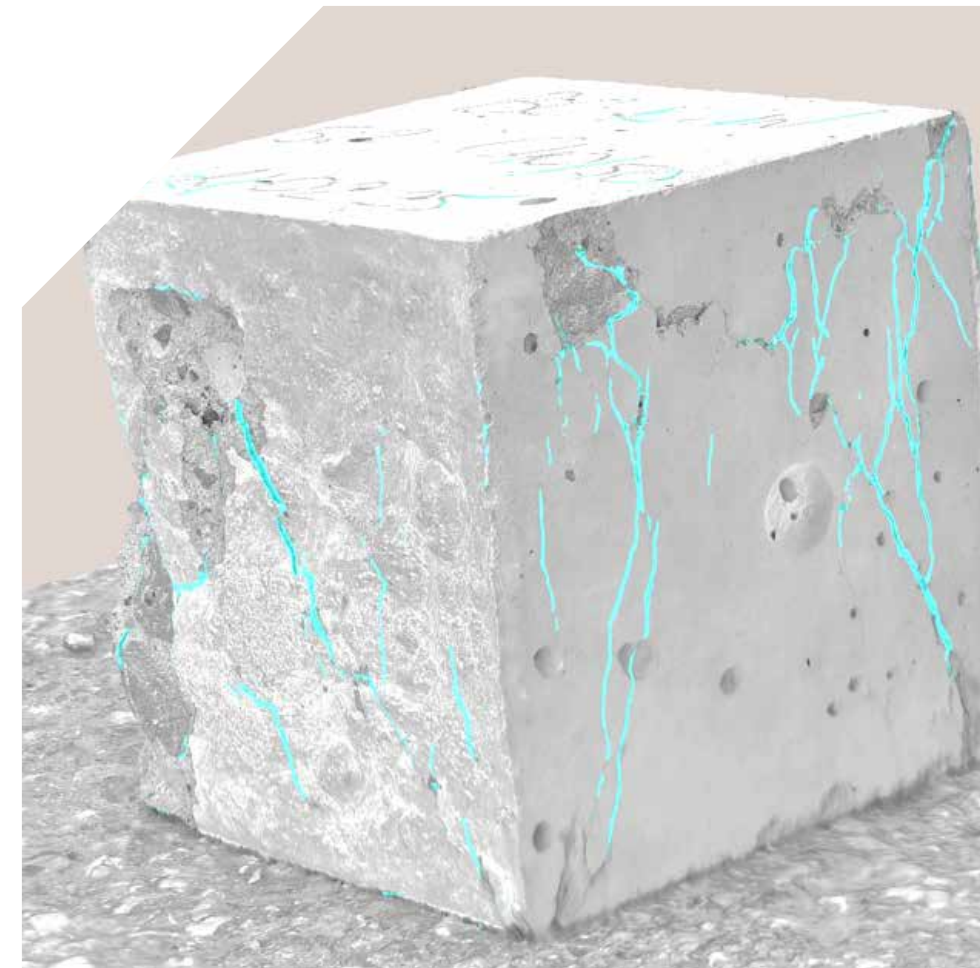
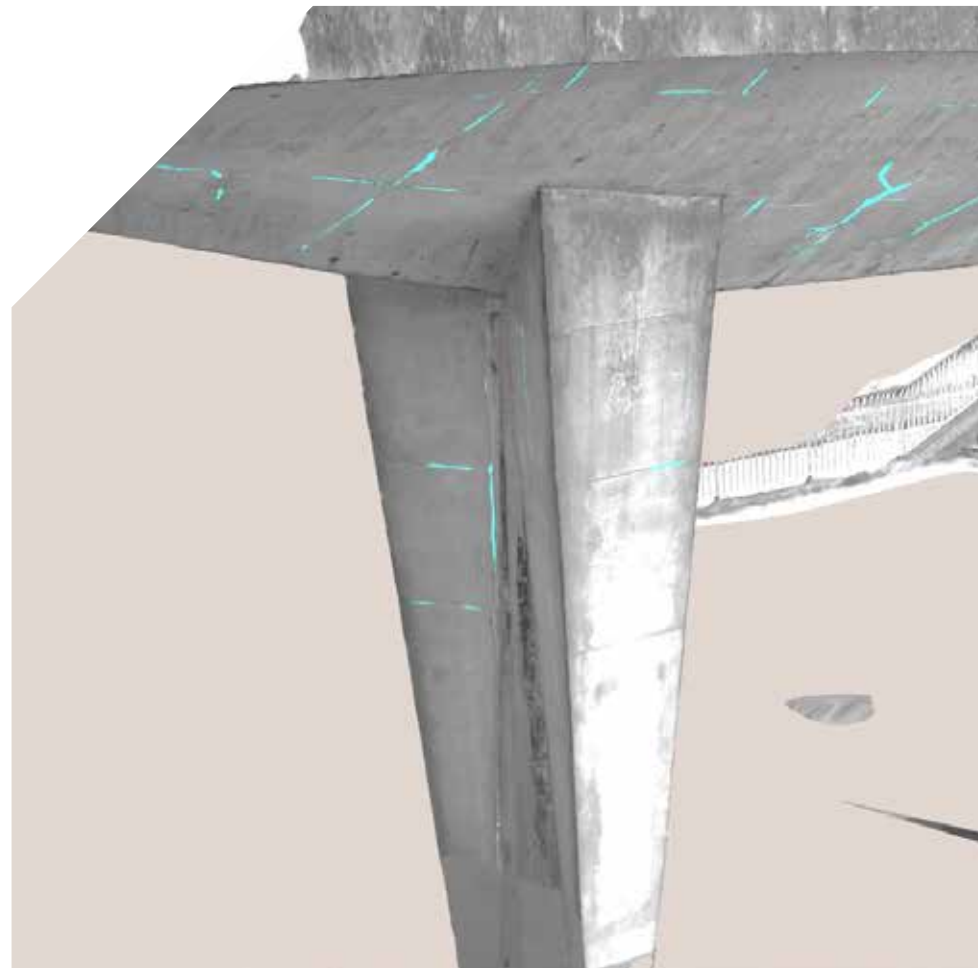
SEMANTIC ENRICHMENT OF BUILDING INFORMATION MODEL ELEMENTS USING MACHINE LEARNING ALGORITHMS

Semantic enrichment of building information models using machine learning methods was considered in master's thesis. Two separate, main and validation, dataframes that were formed using the open standards (IFC) were used. Python 3 programming language and "Jupyter Notebook" programming site are used to compute the classification algorithm. Data structurization library "Pandas", machine-learning algorithm placement library "Scikit-Learn" and mathematical analysis methods library "NumPy" were used to write the algorithm. Random Forest, Support Vector machines and Artificial Neural Network machine learning methods were applied to the algorithm. In order to specify the accuracies, to the machine learning method that yielded best results (Random Forest in both cases), based on the prognoses indices, K-Folds method was additionally applied. Machine learning methods with specified accuracies (0,8135 when main dataframe was used and 0,8607 when validation dataframe was used) were finally used to classify the nondescribed building model elements (IfcBuildingElementProxy).



Julius Meištininkas

Supervisor – dr. Vytautas Bocullo



THE APPLICATION OF ARTIFICIAL INTELLIGENCE FOR CRACK DETECTION IN PHOTOGRAMMETRY MODELS

During experiments variety of objects were tested: from small samples to real structures. The experiments with small concrete cubes (100 x 100 x 100 mm) revealed that the number of cracks could not be detected by the software and some other surface elements were identified as cracks. In order to determine how image properties (colour and contrast) affect the results of automatic crack detection, before modeling, sets of photographs were modified. Performed tests showed that image modifications should be chosen according to object surface and environmental conditions. When the surfaces of constructions are motley coloured, for best results, the sets of reduced contrast images should be used, whereas, for monolithic structures with visible seams, the usage of black and white photographs would be a better choice. When the concrete surface texture and colour are uniform (except cases when

the surface is dark or dark shadows are formed) it is recommended to use photographs with increased contrast. It will allow detecting even very narrow cracks. After experimenting with concrete cubes, tests were carried out with three real structures: a segment of a pedestrian bridge provided by the software manufacturer, a pedestrian viaduct located in the village of Gaižiūnai, and finally hotel “Britanika”. Experiments revealed that photogrammetric models generated using photos that were taken from a great distance are not suited for automatic crack detection, because the quality of recreated surfaces is insufficient. To reduce processing time, the number of viaduct photographs was diminished. Consequently, separate viaduct fragments were created, scattered below the boundaries of the main model. For this reason, it is not recommended to reduce the number of photographs from the already existing set. In the end, recommendations for concrete structure assessment using “ContextCapture” software are presented.

FOR HIGH SCHOOL STUDENTS



Design. Construct. Engineer! Lithuania

During the project, participants work in teams of 5 (+-1) students. During the year-long project, teams have to perform the analysis of the received task, find out the client's needs, the current market, the location of the building. Come up with your project idea, logo, provide a description. Later, plan spaces, style, prepare 3D drawings and visualizations. Throughout the project, meetings with various experts, mid-term reviews, excursions take place. Participants are consulted by lecturers and students of Kaunas University of Technology. In 2021, we finished a second season with Music House task and started a third season with Education center project.



PARTNERS:

- ◆ CLASS OF YOUR OWN • GREAT BRITAIN
- ◆ BENTLEY SYSTEMS • GREAT BRITAIN
- ◆ LRT RADIO • LITHUANIA (for the second season)

PARTICIPANTS:

- ◆ KTU Engineering Lyceum
- ◆ Vilnius Žemynos Gymnasium
- ◆ Panevėžys J. Balčikonis Gymnasium
- ◆ Kaunas Saulės Gymnasium
- ◆ Klaipėda Ažuolyno Gymnasium
- ◆ Šiauliai J. Janonis Gymnasium

KTU TEAM:

- ◆ Viktoras Jasaitis,
- ◆ Laura Jankauskaitė-Jurevičienė,
- ◆ Ignacio Villalon Forne



Viktoras Jasaitis

Responsible for coordinating project, from events to support for participants.

What makes it interesting for you?

This project is amazing for its flexibility and the energy that the invited professionals, high school students or teachers contribute to it. Just one call to the executives of big companies, always busy architects, a letter to students or people well-known in our society is enough for them to agree to take the time and share their knowledge with participants. Let's not forget that they themselves participate in the project completely voluntarily, during their free time after school and are able to create great projects. This dedication fascinates me.

What you learned from this project?

It's interesting to see how students try to create their own projects. We give them the main task of what and where they need to design and various guidelines on what tasks and questions should be answered for themselves in order to prepare the best option. It is amazing to see how different groups of students pay attention to different aspects of the project, some are more interested in the idea and its design, others focus on creating 3D models, and others are more interested in creating a great plan. It's like playing in a huge sandbox. And what they have created is best understood when they begin to present it to others. Hence, the general perception that in order to understand something yourself, one must try to explain it to others.

Why this project is important?

While we hope the project will help students look at the profession of civil engineer or an architect differently, our goal is broader. All participants and teachers have the opportunity to learn about the hottest news in the field, understand how advanced the construction and architecture sectors are, communicate with real professionals and learn to work on teams to implement projects. We hear from teachers and students how a year-round project teaches them to plan their time and lose fear of making presentations. We hope that such students will feel more confident and will know more precisely what they want to do in the future, what career path they will choose. And to understand what is important in civil engineering field.



KTU Centre for Smart Cities and Infrastructure
Kaunas 2022