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TWINNING IN THE DIGITAL REALM: EXPLORING THE POTENTIAL OF DIGITAL TWINS

Digital Twins Workshop: 3D Spatial
Challenges and Opportunities

First EnviLink Conference

**DIGITAL TWINS FROM THE PERSPECTIVE OF
ACQUISITION OF 3D GEO INFORMATION**

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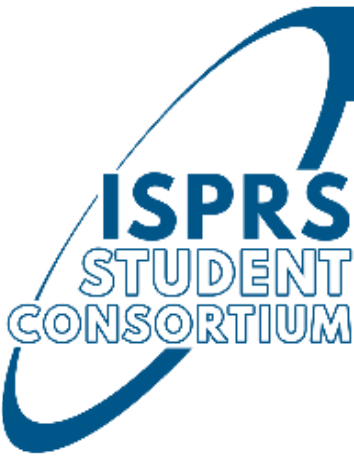
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We are constantly in search for passionate volunteers to be part of the ISPRS-SC Newsletter team. If you are a student or a young professional (between 20-35 years old), willing to lend your time and skills with the passion to tell stories, share knowledge and experiences, then join us as a CONTRIBUTOR to the Spectrum.

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Take the opportunity to work with the international array of experts at ISPRS SC to bring the latest stories and developments in the field of Remote Sensing, Geomatics, and Photogrammetry.

If you are interested, please email us at sc.isprs@gmail.com. We look forward to hearing from you.



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Greetings!

On behalf of the ISPRS SC Board of Directors, I extend a warm thank you for your readership of our latest issue of newsletter SPECTRUM on the theme “**Twinning in the Digital Realm: Exploring the Potential of Digital Twins**”. Your ongoing support is truly appreciated!

In this issue, we will delve into how Urban Digital Twins are revolutionizing urban planning, infrastructure management, and sustainable development. Urban Digital Twins represent a novel approach to understanding and managing urban environments. With the rapid urbanization occurring worldwide, the need for innovative solutions to address the complex challenges facing our cities has never been more pressing. I invite you to immerse yourself in the insightful contributions of esteemed scientists in the field of Digital Twins featured in this issue. We present you Dr. Paweł Bogusławski, Dr. Lars Bodum, Dr. Desislava Petrova-Antonova, Dr. Sander Oude Elberink in the spotlight section and Dr. Sisi Zlatanova, Dr. Mila Koeva , and Dr. Kristina Wolf in the IFOV section respectively.

Finally, I extend my heartfelt gratitude to all those who played a role in bringing this newsletter to completion. Your contributions have made this publication possible, and we are immensely grateful for your dedication and support.



YOGENDER YADAV
Website Administrator, ISPRS SC

Obituary

Cemal Özgür Kıvılcım

Cemal Özgür Kıvılcım was one of the students who participated in the 2004 ISPRS Congress held in Istanbul, Turkey, supporting the forum for international students and the following summer camp. He was one of the first leaders of the ISPRS Student Consortium, serving as Coordinator-in-Chief from 2006 to 2008. Given his contributions to the Consortium, he was appointed as Chair from 2008 to 2012 and became the recipient of the Willem Schermerhorn Award during the ISPRS Congress 2012 in Melbourne, Australia. His contributions during the formative years of the ISPRS SC established the organization as part of the Society as a whole and as the official representation of the youth in ISPRS.





Digital Twins Workshop: 3D Spatial Challenges and Opportunities

The Digital Twins Workshop held at the School of Built Environment, UNSW, Sydney, Australia, on 28th March 2024, brought together researchers and professionals from around the world to delve into the challenges and opportunities presented by 3D spatial technology in the realm of Digital Twins.

The workshop focused on exploring how 3D spatial technology has been utilized to construct, visualize, and conduct analyses and simulations within the domain of Digital Twins. Attendees engaged in discussions, exchanged experiences, and shared ideas to uncover the vast potential and solutions offered by Digital Twins.

Researchers from both Europe and Australia presented their insights, sharing lessons learned and innovative solutions developed through their work. Various presentations showcased Digital Twins across different applications, providing attendees with a comprehensive understanding of

its diverse uses.

Despite the event's physical location in UNSW Sydney, the online stream attracted an impressive turnout, with over 230 registrations from approximately 50 countries worldwide. The organizers expressed gratitude to participants who joined the discussion from different time zones, acknowledging those who connected in the middle of the night. Additionally, to ensure accessibility, online access to the presentations was made available for those who were unable to attend the live event.

ISPRS Student Consortium Board of Directors Website Administrator Yogender Yadav also presented on Digital Twins and their practical implementations in the urban built environments. He also presented about

ISPRS Student Consortium in his concluding slides.

To summarise, the workshop served as a platform for fruitful exchanges, fostering collaboration and inspiration among professionals and researchers in the field of Digital Twins. It provided valuable insights into the challenges faced and the emerging opportunities within this rapidly evolving technological landscape. With a global perspective and diverse expertise, the workshop contributed significantly to advancing the understanding and implementation of Digital Twins in various sectors.



Backsight: Webinar Series on Geospatial Environment and Health Analytics



ISPRS WG III/9 (Geospatial Environment and Health Analytics) has been organizing monthly webinar series on the 12th day of every month for the year 2024. The webinar sessions follow a standard format of opening speech given by the President of the ISPRS Technical Commission III, Dr. Laurent Polidori followed by two speakers on the related theme. The entire series is moderated by Dr Muralikrishna Iyanki, Chair of the ISPRS WG III/9 and has been receiving technical support from the ISPRS Student Consortium (ISPRS SC), so far provided by Ms Laxmi Thapa, president of the consortium.

The first webinar, with the theme- Earth Observation Systems (EOS) for Population Health Management, was organized on 12th January. Dr. Maged N Kamel Boulos, Professor at School of Medicine, University of Lisbon, Portugal initially delivered presentation on 'Metadata Catalogue & Online Portal of EOS Data for Health Research in Exposomics' and the second speaker. Dr Suchi Gopal, Professor at the Department of Earth & Environment, Global Development Policy Center, Boston University, USA presented on 'Breathing in Inequality: Geospatial Analysis Links Cancerous Air Toxins, Traffic Hotspots, and Environment Racism in US Cities'.

The second webinar organized in February was focused on the theme- Environmental & Health Concerns using Geospatial Technology. Dr. John P. Wilson, Professor at the University of Southern California and founding Director of the Spatial Sciences Institute at the University lectured on 'Tackling Global Warming, Air Pollution, and Urban Greening through an Equity Lens', whereas Dr. Sherif Amer, senior lecturer at the Faculty of Geoinformation Science at the University of Twente, the Netherlands and president of the International Society of Geospatial Health (GnosisGIS) offered his presentation on 'Spatial and Temporal Analysis

of SARS-CoV-2C Concentration in Municipal Wastewater in the Netherlands'.

The third webinar organized in March, following the same theme as the second, had Dr. Nitin K. Tripathi, Professor in Remote Sensing and Geographical Information System at Asian Institute of Technology, Thailand as the first speaker delivering the lecture on 'Smart Healthcare'. Dr. K.B.V.N. Phanindra, Associate Professor in Civil Engineering at the Indian Institute of Technology, Hyderabad, India lectured afterwards on 'Geostatistical Analysis in GIS for Environmental Monitoring'.

The fourth webinar in April was on the theme- 'Environmental Hazards and Terrain Modelling'. The speakers for this event were Dr. C.K. Shum, Professor and distinguished university scholar in the Division of Geodetic Science at the Ohio State University, USA, presenting on 'Satellite Geodesy: Climate Action Sentinel for Hazard Monitoring' and Dr. BS Daya Sagar, Professor & Head of the Indian Statistical Institute Bangalore Centre, India speaking on 'Mathematical Morphology in Digital Elevation Models'.

Each webinar session lasts for the maximum period of two hours and is experiencing user interaction through Q/A/chat messages and participants' directly asking questions to the speakers. The entire webinar series receives technical support from ISPRS SC, both in terms of hosting the webinar through zoom and promoting the event through its social media (Mr. Miguel Lagahit, ISPRS SC Social Media Coordinator) and the website (Mr Yogender Yadav, ISPRS SC Website Administrator). You can stay updated about future sessions of this webinar series by following ISPRS SC social media, checking its website and receiving email as the ISPRS SC member.

First EnviLink Conference

Nearly 170 individuals from Poland and abroad gathered for the first EnviLink conference, “International platform for exchange of experience between young scientists in environmental research,” organized by the Forest Research Institute (Poland).

The goal of the conference was to energize and bring together the community of young scientists in the environmental research. Held at the Forest Research Institute Conference and Exhibition Center in Sękocin Stary in Poland, the event attracted close to 170 participants. Over three packed days, 49 papers were presented in nine thematic sessions and an opening session. Additionally, 40 posters were displayed. Moreover, attendees had the chance to join two discussion panels and workshops on soft and technical skills. Participants came from nearly 50 different institutions, mainly scientific ones.

The opening session featured a keynote speech by the president of ISPRS SC, Laxmi Thapa. She highlighted the importance and benefits of joining organizations that bring scientists together. She spoke about the consortium’s role in facilitating knowledge exchange and idea-sharing among young people and scientific communities worldwide involved in photogrammetry, remote sensing, and geographic information sciences. Her call to actively participate in ISPRS SC activities clearly resonated with the audience.



Participants of the EnviLink conference

During the thematic sessions, invited guests from Poland and abroad shared their research findings in areas like forestry, urban greenery, ecosystem services, climate change impact modeling, water management in forest ecosystems, and mobility. These researchers used spatial, remote sensing, and photogrammetric data from virtually all possible sources and altitudes. The interdisciplinary nature of the conference showed that while young scientists may work in specific areas, the methods and data they use can be applied broadly across different fields. This creates great opportunities for collaboration.

In the discussion panels, participants talked about the

What motivated you to organize the EnviLink conference?

Young scientists these days, rarely have the opportunity to show the results of their research to a wider audience. At large events, their desire to speak is often overlooked, due to the participation of more experienced researchers. We noticed that there is a gap and a need for young people to gain experience at just such conferences. We are very close to the environmental sciences, and

challenges young scientists face. They emphasized the importance of networking, presenting at conferences, and participating in national and international associations. The second panel included representatives from the private sector in remote sensing and geographic information systems, who discussed the collaboration between science and business.

To provide a deeper insight into the EnviLink conference, we had the opportunity to speak with the organizers. Here are Mariusz Ciesielski and Maciej Lisiewicz from Forest Research Institute, who played a pivotal role in bringing this event to life.

for this reason we decided to organize a conference close to this subject, with geographic information systems as the main bonding element. Nonetheless, networking was an important factor in organizing EnviLink. We hope that the contacts made during the conference will contribute to the creation of interdisciplinary teams in the future.

What feedback have you received from participants, and how do you plan to use it for future editions of EnviLink?

The feedback from participants has been overwhelmingly positive. Many attendees appreciated the variety and depth of the thematic sessions, as well as the opportunity to network with peers from different countries and institutions. Participants also expressed interest in having more opportunities for informal networking, such as gala dinner or coffee breaks designed for mingling. For future editions of EnviLink, we plan to incorporate these suggestions by increasing the number of interactive sessions and providing more dedicated time for networking.



Co-chairman of the Organizing Committee Dr. Maciej Lisiewicz

What advice would you give to other organizations planning to host similar conferences?

Our advice to other organizers is simple: if you have an idea for a conference, just go for it and make it happen. Initially, we didn't plan for EnviLink to have such an international reach, but over time, it gained significant momentum. Start with a clear vision and be open to adapting and expanding your plans as you go along. Engage with potential participants early on, and don't hesitate to reach out to international communities. Also, focus on creating a diverse and engaging program that includes a mix of presentations, workshops, and networking

opportunities. Most importantly, believe in your vision and be persistent in bringing it to life! If

you want to get more information, feel free to contact us and we will be happy to share our experience.



Co-chairman of the Organizing Committee Dr. Eng. Mariusz Ciesielski

This year's EnviLink edition was funded from funds of the Polish state budget granted by the Minister of Education and Science within the framework of the Programme Excellent Science II – Support of scientific conferences. The next EnviLink conference is coming in 2026!



Figure 1. This is how the surveying looks like in the field.

DIGITAL TWIN FOR THE UNDERGROUND TECHNICAL INFRASTRUCTURE

Under our feet, most of society's technical infrastructure is buried, and one of the consequences of our continued urbanization is a constant increase in excavation work. The more we dig into the ground, the higher the risk of unintended damage to utility lines and cables. These damages that are very costly in direct costs and even more costly in indirect costs (Makana et al., 2016). The challenges the construction and supply industry faces are how to avoid expensive excavation damages while also documenting the utility line information using digital solutions, where the exchange of pipeline information is an independent goal.

Creating a digital twin of the technical infrastructure underground offers a transformative approach to managing and optimizing the vast, often unseen networks that connect and support our societies. This virtual replica of the real-world subsurface infrastructure allows for real-time monitoring, analysis, and simulation of the infrastructure's condition and performance. By harnessing the power of digital twins, cities and organizations can proactively identify potential issues before they escalate, plan maintenance more efficiently, and minimize the risk of costly accidental damages during excavation works.

Additionally, this technology facilitates better decision-making by providing a comprehensive understanding of the infrastructure's interdependencies. Implementing a digital twin ultimately leads to enhanced safety, reduced costs, and improved sustainability in managing underground assets.

How can we create this digital twin without introducing costly procedures? The answer to that question is to use methods that are at hand and do not require advanced skills when the user is surveying the underground utilities. As part of the overall goal to do a 3D reconstruction there has been developed an app-based Reality Capture solution for smartphones called SmartSurvey™ (Hansen et al., 2021). After filming the scene, you upload the video to a 3D web platform named PointView™ where the video is processed and converted to a 3D point cloud. PointView™ uses Potree, a free open-source WebGL-based point cloud renderer (Schuetz, 2016), as its 3D rendering framework. This solution is based on principles from close-range photogrammetry where video recordings from smartphones are the data source for the 3D reconstruction (Figure 1).

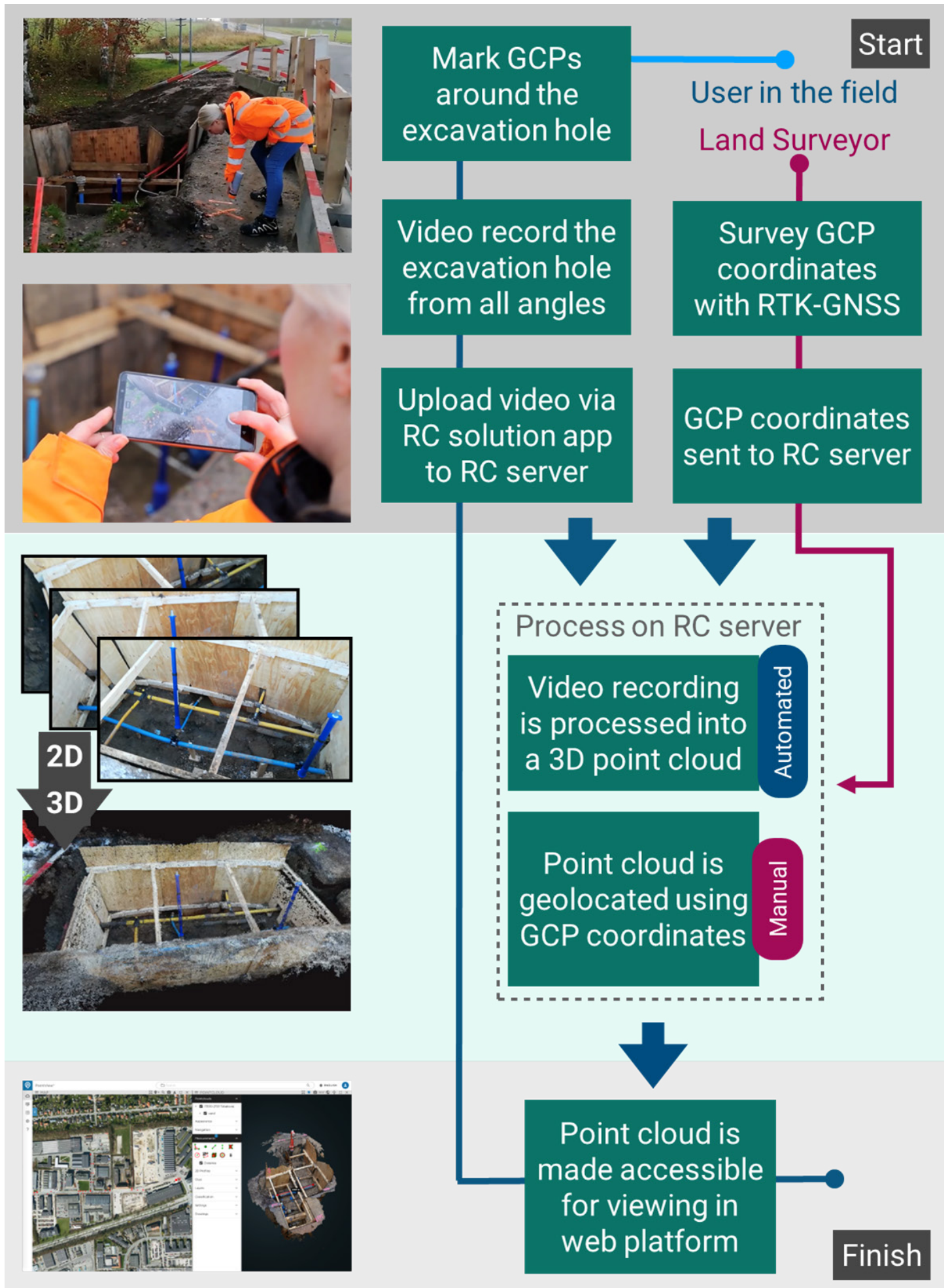


Figure 2. The process that is necessary to produce the digital twin with the help of SmartSurvey™ and the PointView™ service.

During the video capture with a smartphone, it is important to establish a geospatial reference with both good relative and absolute accuracies. This can be done with two separate methods. The original method included establishing Ground Control Points (GCP) that must be measured with GNSS-RTK or similar traditional surveying methods. The more recent addition to the method is the use of a GNSS-RTK antenna attached to the smartphone. This option has shown to be accurate enough for good quality georeferencing and removes the additional surveying of GCP (Figure 2).

When the point cloud is produced it can be used as a visualization of the underground situation in a point cloud viewer or together with other georeferenced layers.

Already using the georeferenced point cloud as a visual guide and being able to identify features makes it very useful for planning and exchange of information between different actors in the industry, but we wanted to go further and do feature extraction from the point clouds. This is currently being worked on, by developing a 3D dataset to train (deep) learning-based methods, allowing recognition of utility line types and components from point-clouds, easing planning and maintenance of underground infrastructure, as it limits, or as a minimum supports the manual analysis of point clouds, rendering this process less prone to faulty interpretations.

Finally, some perspectives for this project – what waits ahead when establishing digital twins of the technical infrastructure underground? This has both some positive elements related to following initiatives on open data and establishing standards and common procedures within this domain. But we also need to be honest with ourselves and realize that working with accurate data for our common technical infrastructure can relate to cyber threats and be abused by powerful regimes that want to hurt us. This fact makes it necessary to work more on data security and data access procedures.



About the Author

Lars Bodum is currently an Associate Professor at Department of Sustainability and Planning, Aalborg University where he leads the project: The Digital Underground. He is part of the research group Planning for Urban Sustainability (PLUS) with projects and teaching that mainly relate to the geospatial domain. He was part of the cross-disciplinary group of researchers at Aalborg University who developed and led the VR Centre North in 1999 and he headed the Center for 3D GeoInformation from 2001 to 2007 the same place. He co-authored the dominating textbook used in teaching “GIS and Geodata” in Denmark. During a 6-year period, he headed the Department of Sustainability and Planning. He received both his MSc and PhD degrees at Aalborg University in Planning and Geoinformatics.

Besides the job at Aalborg University, he is currently a member of the board of Geoforum Denmark, a branch-organization for different actors who work with geoinformation in Denmark.

THE TEAM



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GATE CITY DIGITAL TWIN PILOT PROJECT

by Dr. Dessislava Petrova-Antonova



Figure 2. 3D City Model

Several use cases are in progress, covering walkability, air quality, pedestrian wind comfort, and urban heat islands.

Future Cities is one of the application domains for research of GATE Institute, where the focus is on City Digital Twins and data spaces as complementary technologies and innovative models. They enable smart data sharing, simulations, and data-driven and evidence-based decisions in many city aspects – urban planning, transport and mobility, socio-economic sectors, etc.

GATE City Digital Twin Pilot Project aims to implement the digital twin as a technical solution that scales to real-world problems, including design, exploration and experimentation of urban environment and processes. The related objectives are as follows:

- Produce a high-quality 3D city model by applying the concept of the digital twin;
- Semantically enrich the model with dynamic and real-time data;
- Further use the model for simulation, analysis and visualisation by applying the basic idea of the digital twin – “design, test and build first digitally”.
- Promote the exploitation of the digital twins in city processes and service production.

District Lozenets of Sofia is selected as a pilot area to implement the city digital twin. A 3D model is developed for it based on the CityGML 2.0 standard. In addition, domain-specific data models are used or specially elaborated for specific use cases. Real-time sensor data is integrated into the 3D city model, a step towards the new version 3.0 of the CityGML standard. The data is currently collected in the GATE City Living Lab, equipped with air quality monitoring stations, noise sensors and pedestrian counting radars.

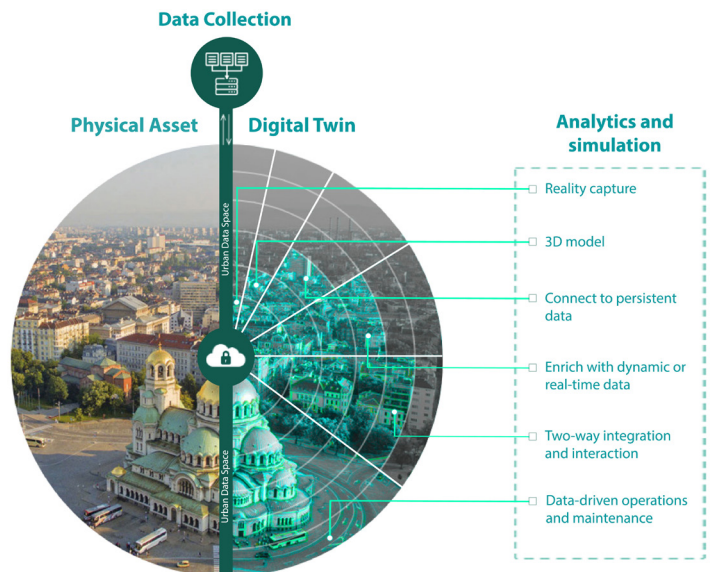


Figure 1. City Digital Twin Concept

15-minute Walkable Cities: The 15-minute city is a paradigm that aims for citizens to live within a short walk or bike ride of their daily needs. This motivates the work on supply-demand analysis of urban facilities and dynamic location-allocation models considering citizens’ needs for 15-minute walking access to kindergartens, schools, health centres, offices, parks, etc. The proposed solution is applied to a kindergarten coverage assessment of Sofia. The results show that even without applying a 15-minute walking limiter, more than 11,000 children remain unserved by kindergartens. Enrolling children

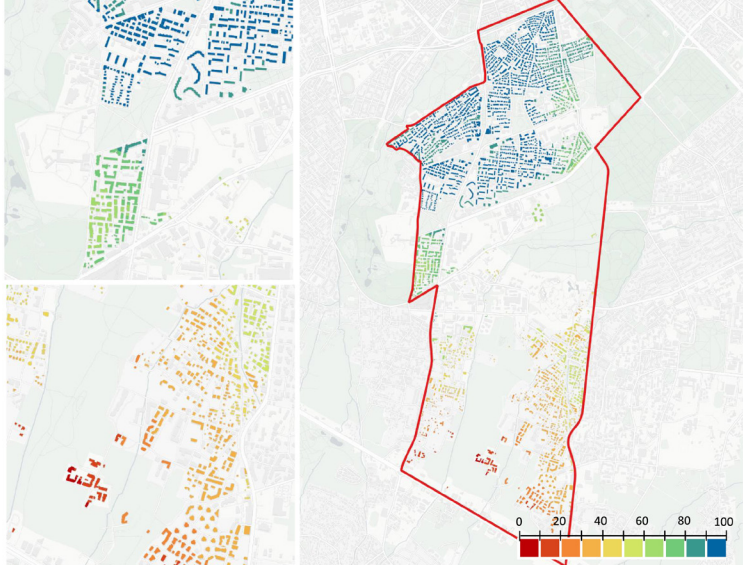


Figure 3. Walkability Index in District Lozenets, low Walkability Index in red, and high Walkability Index in blue.

kindergarten without considering the 15-minute walking leads to negative effects such as unbalanced social infrastructure and traffic generation.

A Walkability Index of Sofia is developed as a tool for measuring the walkability of the neighbourhoods and communities. It assesses the accessibility of the residential building to different points of interest (POIs). A total of 27,865 POIs are collected and divided into 8 main groups (health, green spaces, schools, public transport, kindergartens, culture, sports, retail and services). In addition, subgroups are defined, having different weights according to their significance for walkability.

Spatial-Temporal Air Quality Prediction:

Air pollution is still a significant health concern in Europe. People in bigger cities like Sofia tend to be exposed to higher concentrations of air pollutants. The air quality use case is based on a spatial-temporal air quality analysis, combining the measurements from different sensor stations across the city. Methods from uncertainty quantification, statistical modelling and machine learning are used to predict air pollution in time and space.

Simulation at Different Scales:

Pedestrian wind comfort is studied with the help of Computational fluid dynamics (CFD). The outdoor CFD simulations are a part of evaluating different urban designs and support city authorities to make informed decisions on ensuring a safe urban environment where the wind does not pose any threat to pedestrians. Indoor air quality and thermal comfort are simulated as factors affecting occupants' health,

performance, and overall well-being. The results highlight measures that can be taken to improve the indoor environment. Furthermore, the overall building design, ventilation and heating effectiveness are assessed and optimised through different what-if scenarios, reducing energy consumption and saving costs.

Urban Heat Islands: Recently, many countries have faced challenges due to the growing urban population, including health and human comfort, rising energy demand, traffic congestion and, more especially, Urban Heat Islands (UHIs). In this context, the research aims to numerically estimate the impact of UHI on the air temperature in Sofia and its surroundings using the Weather Research and Forecasting (WRF) model with very high resolution. It also estimates the impact of building energy consumption and transport separately. Part

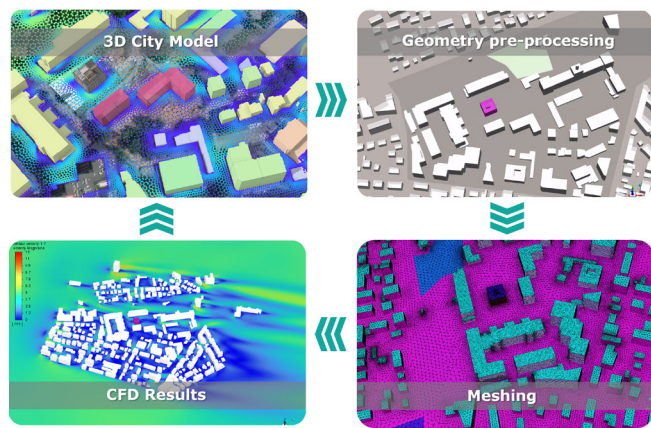


Figure 4. CFD wind simulation around GATE building.

of the research is the development of an energy atlas of Sofia. The energy consumption tolerance of individual buildings is calculated and used to enrich the 3D model of the study area. It is an essential tool for researchers, society and local governments in coordinating climate action and setting zero-emission goals.

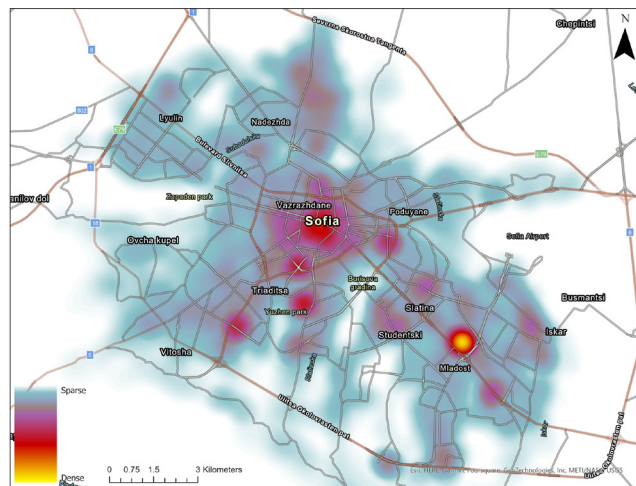
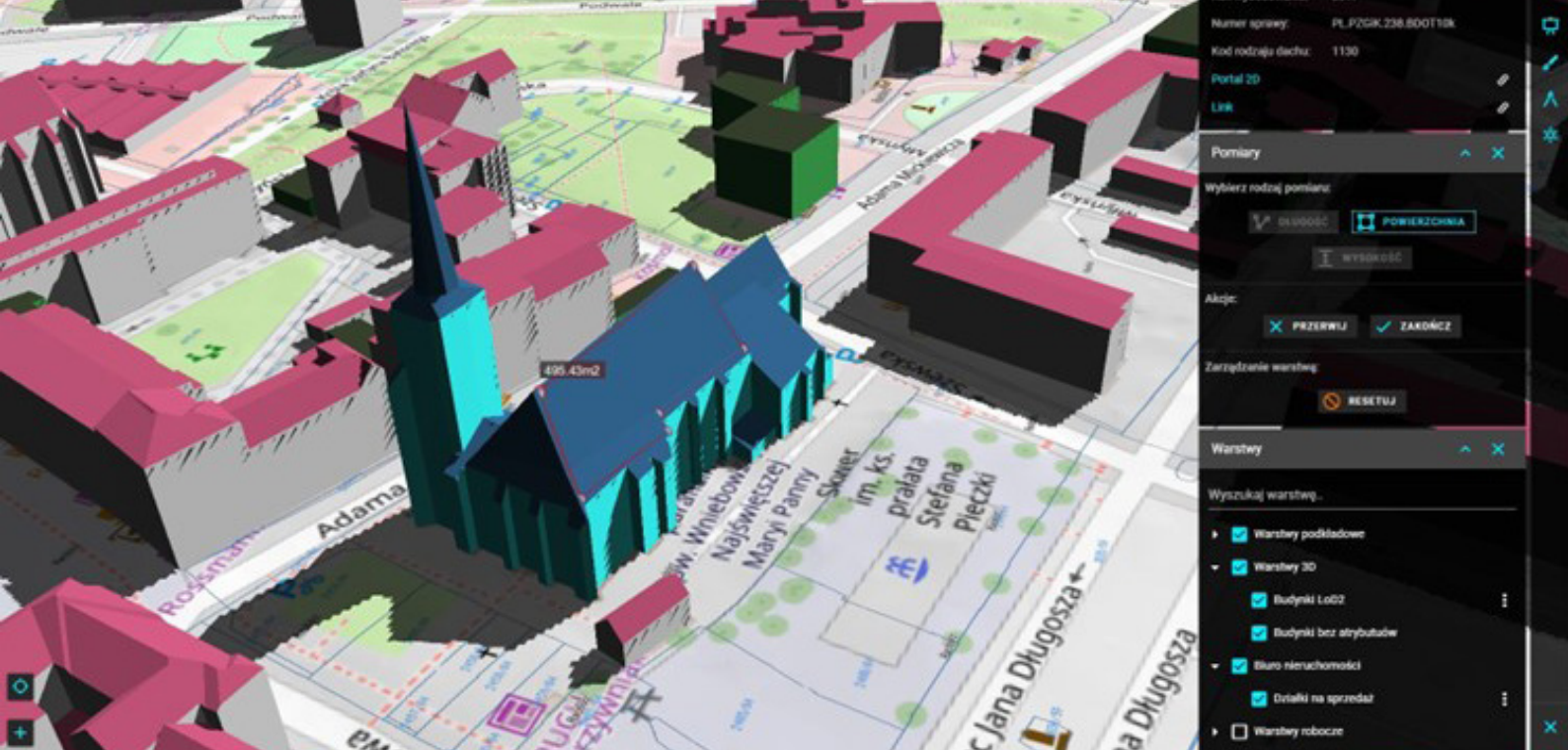


Figure 5. Energy atlas of Sofia, showing high energy consumption scenario.



Courtesy of [infoSolutions](#) Urban digital twin of Racibórz, Poland

DIGITWINS4PEDS PROJECT

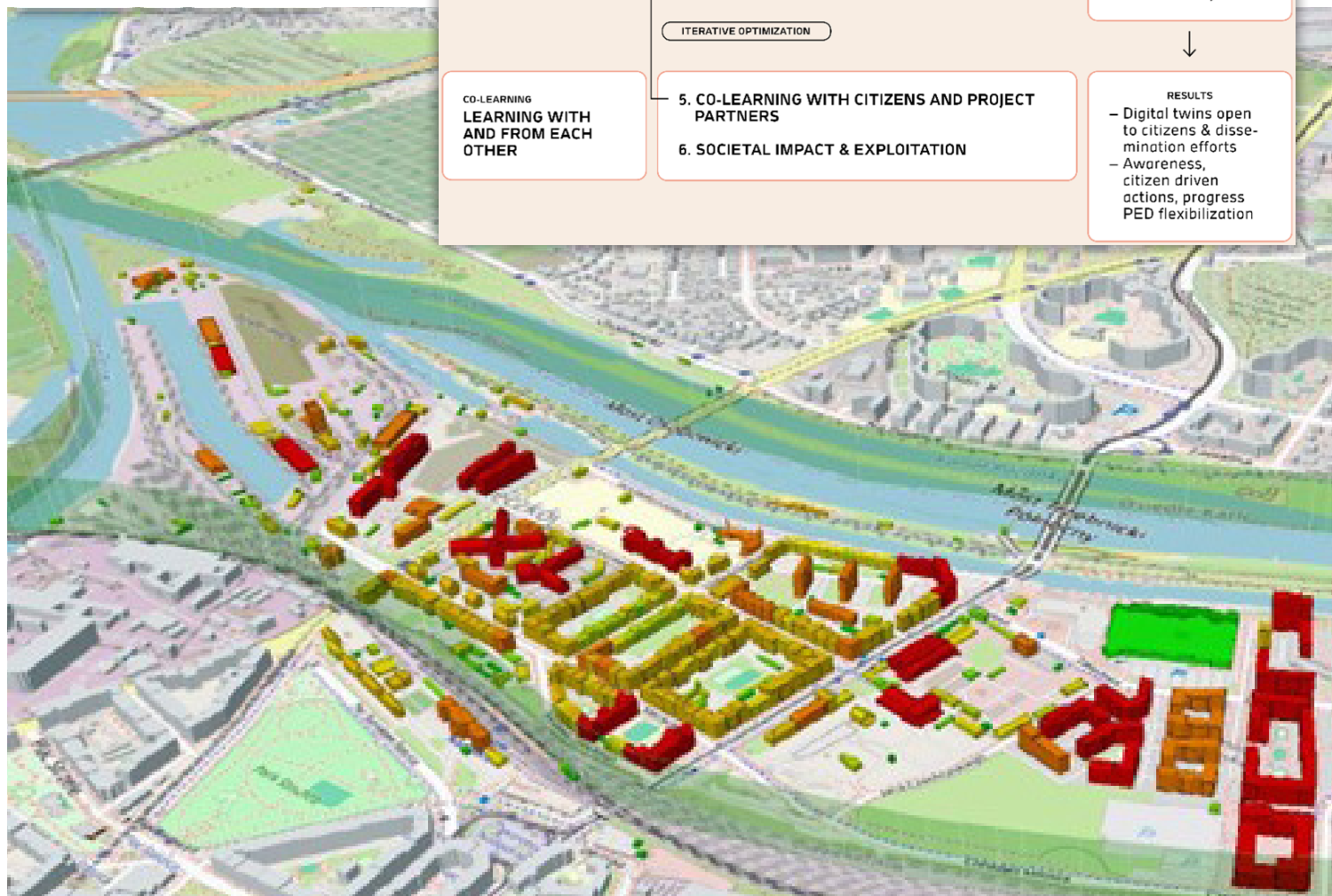
Digital Twin is a relatively new term but the idea behind it is not. It was started several years ago, when the first digital models were developed using computers. These models simulated real objects and phenomena in a digital form. Originally, they were used for nice visualisations, then various simulations. It was very helpful for supporting decision making by experts. However, some models became outdated with time. They did not evolve together with reality. They could be updated or created from scratch if new input data was collected and made available. Very often it was a lengthy process, which was acceptable in case of systems that do not change quickly, but it was not enough for dynamically changing reality. The solution to the problem was sensors. Technological development gave us the Internet of Things, where various sensors were connected via the Internet and provided a big amount of data. Frequent updates, even in real time, became possible. Models were fed with new data coming from numerous sources and immediately used for simulations. Because of that, spatial models were 'promoted' to smart models. It

was a big progress, but still, it was a one-way road – data flew from the real world to a digital model. The next phase of development – digital twins – introduces two-way communication. Now, the feedback from simulations can change the real world and the real world will change the digital twin via sensors. One can ask, how does the world change during this process? Many examples can be provided. One of the sensors measuring temperature of an aircraft engine detects rapid increase of a temperature, quick analysis excludes sensor malfunction, simulation of possible scenarios is run, which triggers an alert of potential explosion, this triggers emergency cooling system, the temperature drops, everything is back to normal.

The aircraft engine example is quite simple, perhaps naïve, but shows the idea of communication with the real world and importance of simulations performed on a digital model which is a core of each digital twin. Another example which is widely investigated around the world is an Urban Digital Twin (UDT). It is a digital representation of the real

world and various aspects of the living environment in rapidly developing cities. This is an increasingly important area of interest for national governments of quickly developing countries. More and more people live in cities which become overpopulated with limited possibilities for further expansion. Very often they are focused on consumption rather than production. As a consequence, they are not self-sufficient and depend on satellite areas. This applies mainly to food production, but also energy. Many problems are related to logistics and effective transportation of goods and resources.

A concept of the DigitalTwins4PEDs project

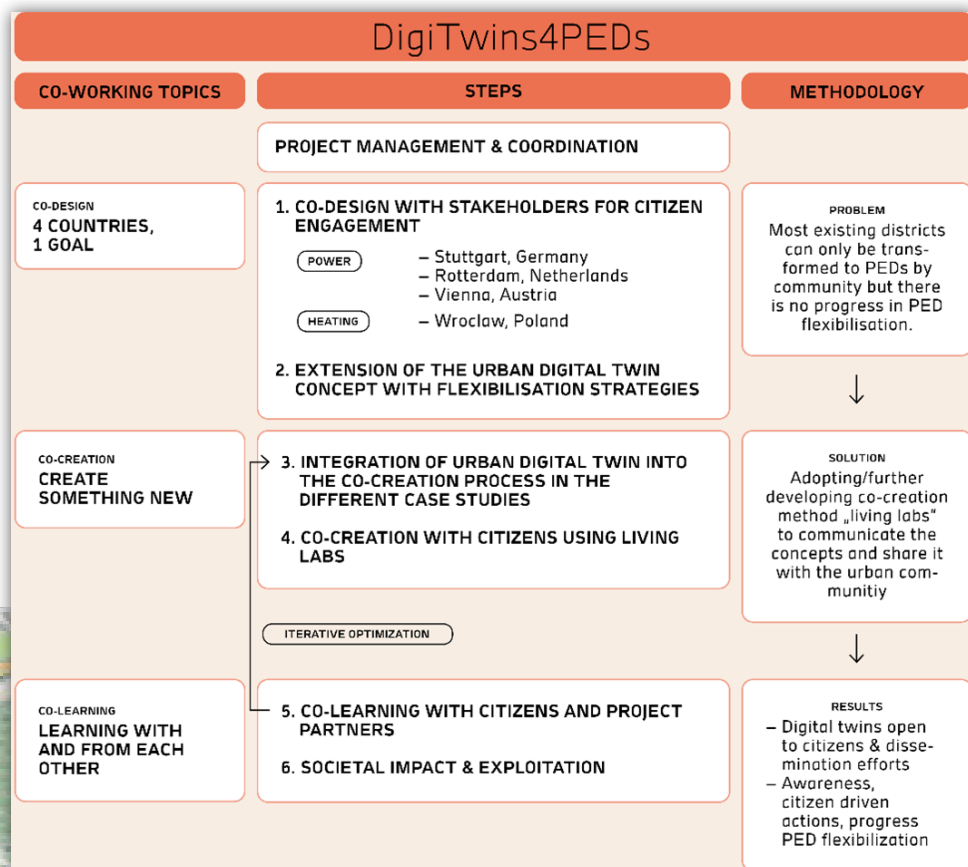


Courtesy of infoSolutions

A case study in the DigitalTwins4PEDs project – Kleczków district in Wrocław, Poland.

In the DigiTwins4PEDs project¹ – Utilisation of Urban Digital Twins to Co-create Flexible Positive Energy Systems for Districts (<https://digitwins4peds.eu>) we utilise the potential of urban digital twins. We open up a wide range of possibilities for modelling the

energy aspects in cities. The core engine is based on a 3D city model. Various data sources are used to feed it and cover case studies in four cities: Stuttgart, Wrocław, Vienna and Rotterdam. They are investigated by researchers, companies and municipalities



from Germany, Poland, Austria and the Netherlands. Digital communication tools for citizens and various stakeholders are aimed at education and bottom-up green transformation. The proposed solution should influence decisions made by communities towards the use of environmentally friendly energy sources located in their neighbourhood, while implementation progress and impact on the environment can

be measured based on actual consumption readings provided periodically by municipalities. Once the final prototype is developed, it should be possible to implement in other places to support creation of positive energy districts leading to energy self-sufficient, net zero-energy cities.

These are only a few examples, which do not cover the full range of digital twins. But they

show the potential of twinning the real with the digital world. Wrong decisions taken in the digital world can be easily fixed, while mistakes done in real life are often costly and may affect many people. This is the best reason to develop digital twins for modelling innovative solutions and measuring their impact on our world.

¹ DigiTwins4PEDs is a project directly supported by Federal Ministry for Economic Affairs and Climate Action (Germany), National Centre for Research and Development (Poland), The Dutch Research Council (the Netherlands) and FFG and Federal Ministry Republic of Austria (Austria) under the Driving Urban Transitions initiative by JPI Urban Europe. Participating institutions in Germany: HFT Stuttgart (consortium leader), Landeshauptstadt Stuttgart; in Poland: Wroclaw University of Environmental and Life Sciences, infosolutions Sp. z o.o., City of Wroclaw; in the Netherlands: Technische Universiteit Delft, Gemeente Rotterdam; in Austria: AIT Austrian Institute of Technology GmbH, Universität für Bodenkultur Wien, Stadt Wien.



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Dr Boguslawski obtained his MSc degree in Computer Science from Bialystok University of Technology in Poland, and PhD from University of Glamorgan in the United Kingdom. He worked as a researcher at universities in Malaysia (Universiti Teknologi Malaysia), United Kingdom (University of the West of England) and Poland (Wroclaw University of Science and Technology). Currently, he is the Head of Geoinformation Unit at the Wroclaw University of Environmental and Life Sciences in Poland. He is also a Co-Chair of the ISPRS Working Group IV/1 'Spatial Data Representation and Interoperability'.

His research interest is related to spatial modelling – from data structures and data models to implementation of 3D building and city models. These models are used in different applications: indoor navigation, hazard analysis, evacuation simulation, shadow analysis, terrain modelling and many others.



DIGITAL TWINS FROM THE PERSPECTIVE OF ACQUISITION OF 3D GEO INFORMATION

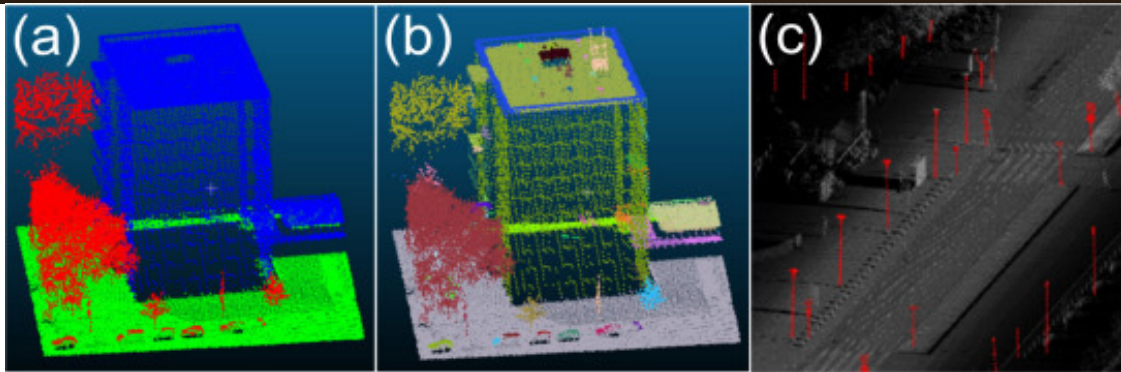


Figure 1. Deep learning methods on point clouds focus on problems of (a) classification of buildings (blue), outdoor objects (red), and ground (green) from each other, (b) segmentation of individual objects (colored trees and cars) and delineation of building shapes (blue roof outlines), and (c) detection (red pole-like street objects). Images are from Yang et al. (2020) and Lehtomäki et al. (2010)

Digital twins are digital replicas of a certain physical object, environment and/or event. In the field of geo-information Digital Twins were introduced around 2015. In the ISPRS organization Digital Twins were only formalized in several Working Groups established in 2022. Even though the term ‘twin’ is a broad concept, it seems that Digital Twins are “here to stay”.

Why is the term confusing?

The term “twin” has a few different flavours, from being strict in the sense of identical twins with the same DNA, born at the same time, to more loose interpretations like two things being closely related to each other, like in “twin cities” that are linking one city with another city in a different country, for the purposes of friendship and cultural exchange.

The Digital Twin is somewhere in the middle of the two flavours. It is far from identical in the sense of material representations, geometric and physical simplifications, origin, age and many other properties that are hard to correctly digitize. At the other hand, it is also the freedom of digital twins to model a situation which may vary from “as realistic as possible” for visualisation purposes to simulating extreme events with a series of assumptions and simplifications. At least, Digital Twins should somehow represent the real object or event.

From a mapping perspective

From a mapping perspective there is actually nothing new about generating content for digital twins. The methods for generating digital representations of the earth surface from Earth Observation data origin from the

1960’s. Hand in hand with the advancements in computing power and higher image resolution, the software to produce digital maps became more powerful, later also in 3D. Processing data towards 2D or 3D geo-information has always been tuned towards the user requirements and data properties. Sure, user requirements may be specific as Digital Twins may have multiple users and data properties may change in a digital twin as there may be more information from different sources that all come together in this digital environment.

Opportunities ahead

It is the combination with other recent developments that justifies the fuzz about DT’s in mapping. To name two most prominent developments: deep learning and UAV’s. Deep learning algorithms in images and point

clouds have boosted the quality of semantic segmentation of those datasets, making it easier and faster to automatically extract 2D and 3D information (Lehtola et al 2022). Vice versa, DT's can help in generating realistic training data for a better performance of deep learning networks (Brosinsky et al, 2023).

UAV's are capable of capturing high resolution images and point clouds at a local scale. Wu et al (2023) showed that UAV data can be captured almost autonomously to enhance 3D city models. After a detection step of outdated or incorrect parts in 3D building

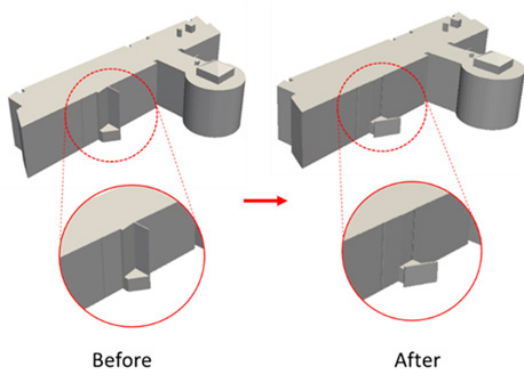


Figure 2. Improvement of 3D building models after local UAV image acquisition. Source: Wu et al, 2023.

models, a flight plan is calculated to capture high resolution UAV images for the generation of 3D point clouds, in order to correct the 3D building models. The flexibility in time and space make UAV's so interesting for DT's: they can add a bit of dynamic and recent information to the more static city models.

The production of content for Digital Twins at city scale consists of several interesting challenges. After all, for a digital twin we need input that represents the living city in a digital model. Do we need to start from scratch, or can we make use of existing 2D/3D geo-information? Which sensors can best be used to capture the environment? How and when should the measurements be done? At ITC University Twente we have taken the rise of Digital Twins, with all related challenges and questions, as an opportunity to combine our staff and students efforts on producing and using 3D models. Initially to strengthen our capacity

with ITC, but with the aim to collaborate with external partners in this field. One example that touches both education and research is the development of courses and Python tutorials in cooperation with Dr Florent Poux (Poux, 2023) for students with different types of background, e.g. geoinformatics and urban planning. We look forward to collaborating with colleagues on research projects and proposals in the field of generating content for Digital Twins.



About the Author

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Sander Oude Elberink graduated as Geodetic Engineer from Delft University of Technology in 2000, and finished his PhD on the Acquisition of 3D Topography in March 2010 at the University of Twente. In September 2005, Oude Elberink started his PhD research on "Acquisition of 3D topography" at the International Institute for Geo-Information Science and Earth observation (ITC) in Enschede. His research was part of the project '3D Topography' which received the RGI Innovation Award in the category science in 2007. He received a young author's award for best papers at the ISPRS congress in Beijing, China in 2008. In 2009, Sander received the ITC research award for a journal paper on 3D road reconstruction, which was co-authored with George Vosselman and published in the Photogrammetric Record. From September 2009, Sander holds a position of assistant and later associate professor at the department of Earth Observation Science at ITC. In 2016, Sander received the ISPRS Giuseppe Inghilleri award for his high quality and innovative research in 3D landscape modelling that has successfully been transferred to practice to serve the society. Since 2016, Sander is a member of the ISPRS Scientific Advisory Board (ISAC).

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KRISTINA WOLF

Kristina has a deep enthusiasm for public safety and disaster risk management, which stems from her research at the Tohoku University in Japan. She holds an M. Sc. in Management Information Systems and an MRes degree in Geospatial Data Science. Using her passion for technology and desire to help people in adverse events, she joined the Centre for Doctoral Training at Newcastle University to pursue a PhD in Geospatial Systems.

Kristina's PhD focused on multi-agency real-time incident management and impact assessment.

During her work, Kristina was a project officer for a UKSA-funded project to explore the use of satellite imagery for emergency services.

She worked with the East Riding Yorkshire Council to demonstrate how a highway major incident dashboard can support transport resilience to severe weather and flooding.

As part of her PhD research, she visited the Center for Urban and Regional Analysis at The Ohio State University in Columbus (USA).

Can you briefly tell us about your research interests?

My field of research is geospatial data science and systems engineering, with a focus on developing applications for the flooding and transport domain.

My work integrates spatial datasets on real-time weather, hazards and transport to support multi-agencies in incident management and flood impact assessment. As part of my work, I implement geospatial-based workflows to analyse data and visualise results in spatially-enabled dashboard solutions. Multi-agencies can then use different views to better understand the current incident situation and answer questions, such as:

- When and where do most incidents occur during a heavy rainfall event?
- Which critical infrastructures are affected by flooding?
- What impact does flooding have on the travel time?

Who or what inspired you to become a scientist in this research field?

The inspiration for my research field stems from my visit to Japan during my Master's studies. I spent a research semester in Sendai and studied in the GIS and Transport lab at Tohoku University.

The Tohoku region was significantly impacted by the Great East Japan Earthquake in 2011.

Years later, during my visit, I interacted with researchers and locals, and after experiencing several earthquakes, I learnt first-hand the importance of community engagement and learned a lot about resilience management.

This is when I wanted to use my passion for information technology and GIS to help build solutions that can help communities and emergency services during natural disasters.

Among the research projects you have conducted, can you share with us a specific project that you liked the most?

I really enjoyed my PhD project. In alignment with my interests, my research aimed to demonstrate how geospatial technology can facilitate data linkage and exchange across multi-agencies and support different stages of the emergency framework: before the event to better prepare, during the event to respond, and after the event to assess impact and help recover.

During my PhD, I particularly enjoyed engaging with stakeholders. It was a valuable experience interacting with stakeholders including fire and rescue services, police and ambulance, environmental agencies, county councils, highway authorities, and governmental departments.

Building on the existing body of knowledge from literature, I learned many perspectives on current stakeholder needs and analytical requirements that can help improve future solutions.

I also had the great opportunity to do a research visit at The Ohio State University. I gave a webinar on digital twins for incident management and collaborated with fellow researchers on research projects. My work on assessing publicly available images of natural hazards using computer vision algorithms was accepted and presented at two US conferences.

- Towards a digital twin for supporting multi-agency incident management in a smart city (<https://www.nature.com/articles/s41598-022-20178-8>
 - Behind the paper: <https://communities.springernature.com/posts/towards-a-digital-twin-for-supporting-multi-agency-incident-management-in-a-smart-city>
- Assessing the impact of heavy rainfall on the Newcastle upon Tyne transport network using a geospatial data infrastructure (<https://doi.org/10.1016/j.rcns.2023.07.001>)
- Beyond conventional hazard maps: Assessing flood impacts using real-time data from smart device (<https://zenodo.org/record/6410100#.Yml3TNPMJhE>)

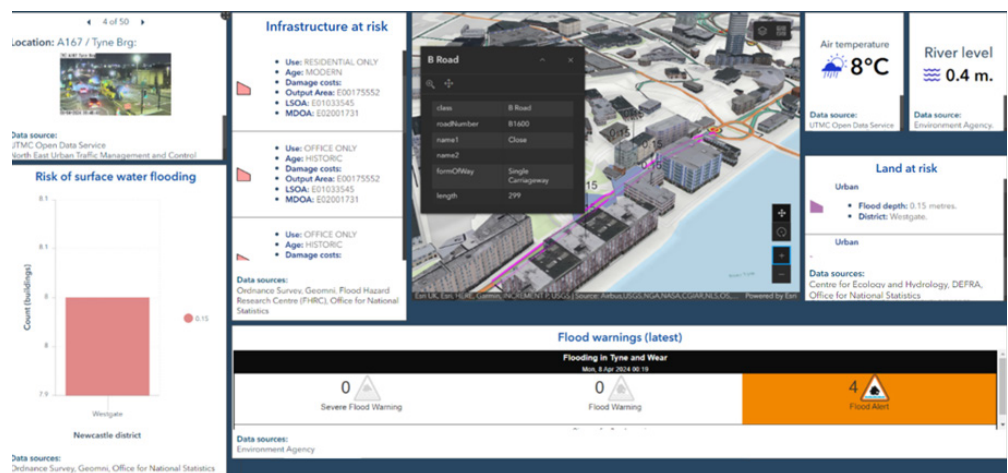


Figure 1: This figure illustrates a geospatial dashboard solution with examples of urban parameters such as CCTV images, air quality, river levels, flood warnings, land cover, buildings and roads. Here, we use data from the Environment Agency to visualise potential flooding impacts. Using the results of bespoke flood modelling tools, city stakeholders can simulate the impact on the environment, buildings and transport network. Combining the analysis and visualisation in a common dashboard solution can provide multi-agencies with valuable insights into environmental risks and help take proactive measures to minimise potential damage.

- Supporting geospatial climate hazard reporting using computer vision and text generation of social media imagery (<https://zenodo.org/record/7834890>)
- Tech in the City Seminar: Integrating multi-scale real-time data for safe and resilient communities (<https://cura.osu.edu/events/integrating-multi-scale-real-time-data-safe-and-resilient-communities-kristina-wolf>).
- Assessing Flood Impacts Using a Multi-Scale Geodatabase for Newcastle (https://mediaspace.esri.com/media/t/1_zeed18lc).

What is the importance of digital twins?

Digital twins visually represent real-world assets, infrastructure, systems and processes.

In cities, stakeholders often use different systems to communicate incident-relevant data and report on the current situation. Digital twins can help integrate various datasets from the physical infrastructure, weather, traffic and environment, creating a common operating picture across different city authorities.

Thus, digital twins combine different technologies, supporting 3D models, maps, performance indicators, graphs and lists that help monitor different city assets, analyse their performance and simulate scenarios that can lead to better-informed decisions and policies.

Using historical- and (near-) real-time data, digital twins can help in:

- Analysing the impact on air quality following the introduction of low-emission zones;
- Navigating efficiently to potential incident sites from known responder locations considering real-time hazard and weather data; and
- Managing traffic using current vs. average traffic flows and information on current incidents and ongoing road closures.

A common operating picture provided through a digital twin can improve the overall situational awareness and multi-agency collaboration during incident management.

How have the technologies developed and helped in faster and reliable data acquisition?

Digital twins benefit from technologies that have evolved significantly in recent years and become more accessible to a wide range of users and sectors.

Regarding data acquisition, digital twins benefit from using various sensors and IoT technology in the urban environment, which enable data exchange and communication between the physical city and the digital model.

Different internet-enabled devices, such as smart sensors, help to collect data, such as temperature, precipitation and air quality, which can be transmitted wirelessly.

This enables urban stakeholders to monitor the city and analyse critical parameters.

Cloud computing provides additional support for digital twins by offering scalable infrastructure resources, computing power, and storage solutions for processing, managing, and analysing large volumes of urban data, e.g., data streams from weather sensors and traffic detectors.

Advances in AI-based algorithms can further accelerate data analysis. For instance, AI-based algorithms can help analyse images and detect critical assets impacted by flooding. Supporting stakeholders in analysis can help identify environmental anomalies and help them prioritise their response.

What do you consider your greatest achievement? Can you tell us a challenge that you faced in your career, how you overcame it and what you learnt from the experience?

It was a great achievement when the Women's Engineering Society selected me as one of the 100 finalists for the Women in Engineering 2023 Safety and Security Award.

I was very proud of the recognition of my work, as I conducted much of my PhD research during the COVID-19 pandemic, a phase of great uncertainty.

During that time, I was very grateful for the various stakeholders involved in my research, who took the time to discuss the current processes with me via Zoom/ Microsoft Teams or over the phone, identify gaps, and help answer my research questions. Although face-to-face communication would have been preferred to better understand current processes and discuss improvements, due to limited resources at that time, I learned other soft skills, such as interacting digitally with various groups and sharing research results in different formats.

What can you say about the current trends in scientific research related to efficient use of digital twins in various applications?

Cities are complex and dynamic entities that are constantly changing. We already see examples of different cities that have created 3D models as a foundation to support stakeholders in testing and analysing various urban planning scenarios. City authorities use digital twins for constructing infrastructure, managing public services, and planning maintenance works. They further integrate real-time data from internet-enabled devices to monitor systems, processes and travel flows.

Using the virtual city model to run simulations and analysis in the urban environment can help optimise urban workflows, assess potential risks, minimise costs, and inform future policy decisions.

In the future, we will hopefully see more proven examples of how stakeholders realise the full potential of digital twins by turning raw data into actionable insights that help make cities more resilient to climate change and help reduce the impact of extreme weather events.

What do you think are the possible contributions of international organizations like the ISPRS Student Consortium in knowledge dissipation in Digital Twins?

Using its expertise and global network, ISPRS has a variety of activities that promote a better understanding and application of digital twins such as:

Workshops and webinars that researchers and practitioners use as platforms to present and discuss their current research and exchange best practices.

Different publishing opportunities showcase real-world examples of digital twins, demonstrating various technologies' integration of heterogeneous datasets and the application of machine learning and AI.

ISPRS can further foster interdisciplinary research, where experts from different disciplines collaborate to address complex challenges across various domains, such as climate change, smart mobility, and emergency response.

Through its platform, the ISPRC also offers educational resources, such as online courses, tutorials and guides that provide the necessary foundations for digital twins and share knowledge with students, researchers, and professionals on how best to use this technology.

What is your advice to the youth and how can one be motivated to pursue research in Digital Twins?

I advise young people to stay curious and take on new challenges.

The digital twins' landscape constantly evolves as technological boundaries expand, bringing new advances and research potential. I want students to understand that their work and research can help make a difference in the real world.

Students will likely find areas within digital twin technology that match their interests and motivate them to research fields, e.g. urban planning, healthcare, manufacturing and sustainability.

I would also emphasise the benefit of having a mentor who can provide valuable guidance, support, and advice on available educational resources.

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Research Interests and Expertise:

Co-development and application of innovative methods using geospatial and remotely sensed data for City Digital Twin or 3D City Model creation, enhancing mapping, resource management, and decision-making for cadastral and urban planning applications, among others.

Mila Koeva is an Associate Professor in “3D City Digital Twins based on geospatial technologies for improved land management and urban planning” at the University of Twente, Faculty of Geo-Information Science and Earth Observation (ITC). She has a Doctoral degree from the University of Architecture, Civil Engineering, and Geodesy in Sofia in “3D modelling in architectural photogrammetry”. She is the leader of Digital Twins Geohub at the University of Twente, Chair of ISPRS WG IV/9 on Digital Twins and FIG WT 7 on AI4LA.



MILA KOEVA

Can you briefly tell us about your research interests?

My academic and professional journey has always been centered around the innovative use of geospatial and remotely sensed data. For many years, I have focused on the acquisition and processing of data through satellite imagery, aerial photography, and UAV (drone) technology for cadastral mapping and urban planning, among other applications. Additionally, I am passionate about automatic feature extraction from images to support faster and more efficient cadastral mapping and city modeling. Moreover, my interests include the collaborative development and application of cutting-edge methodologies that utilize geospatial and remotely sensed data, especially in the areas of 3D city modeling and the emerging field of City Digital Twinning.

Who or what inspired you to become a scientist in this research field?

It was never my intention to become a scientist, despite my grandfather’s encouragement. He held several university degrees and always pushed me towards science from my childhood. Instead, I dreamt of following my mother’s footsteps in the field of architecture. I studied at an architectural college before delving into geodesy at the University of Architecture, Civil Engineering, and Geodesy. Nonetheless, my interests soon shifted towards photogrammetry and the utilization of remotely sensed data for cadastral and urban planning applications. I worked on these topics for almost 13 years in both governmental and private institutions, where I owe a lot to my former boss, Alexander Lazarov. He gave me the chance to learn and develop in this challenging yet very interesting field. In addition, I deeply appreciate Prof. Jaap Zevenbergen’s consistent support and

mentorship throughout my academic development, for which I am extremely grateful. My passion for 3D city modeling, which began during my university years, has only grown stronger over time. Driven by this growing interest, I pursued a Ph.D. in 3D modeling and am now deeply involved in research and projects related to City Digital Twinning. Throughout this journey and my current career development, Prof. Sisi Zlatanova has always been a role model for me.

■ **Among the research projects you have conducted, can you share with us a specific project that you liked the most?**

The biggest and the most challenging project for me was called “[its4land](#)” - Geospatial technology innovations for land tenure security in East Africa. On the one hand, I am very proud of leading such a big project of 4 million Euros, 8 consortium partners and 6 countries. On the other hand, it was quite challenging. There are millions of unrecorded land rights in sub-Saharan Africa which are still not mapped. Therefore, in the “its4land” Horizon 2020 project we developed the “its4land toolbox” following a fit-for-purpose land administration approach. The innovative technological solutions of the toolbox include smart sketch maps, Unmanned Aerial Vehicles (UAVs) data acquisition, an interactive boundary delineator tool using remotely sensed data, as well as sharing and publishing land information through geocloud services. I learned a lot and enjoyed a lot working on this project. In the end, I was quite happy that our efforts have been recognized since the project received the “[Geospatial World Innovation Award](#)”. Link to publications: [\[URL\]](#)

Currently, we are enthusiastically working on projects in which we are aiming to develop City Digital Twin solutions in support of a sustainable world. [\[URL\]](#)

■ **What is the importance of City Digital Twins?**

The importance of City Digital Twin technology lies in its ability to integrate and analyze vast amounts of data from diverse sources, including IoT devices, sensors, and existing urban databases. This integration enables the creation of a comprehensive, real-time 3D model of a city, facilitating detailed analysis and simulation of urban dynamics. For engineers and planners, it offers a powerful tool for scenario testing, infrastructure optimization, and predictive maintenance, allowing for informed decision-making and proactive management of urban environments. Having city digital twins, stakeholders can work on the optimization of traffic flows, energy consumption, and emergency response strategies, among other urban systems. Moreover, City Digital Twins can support the iterative testing of urban designs and policies in a virtual environment before any physical changes are made, reducing costs and potential risks associated with urban developments. Through these advanced technical features, City Digital Twins play a critical role in the evolution of smart cities, enhancing decision-making processes and operational efficiencies.

■ **How have the technologies developed and helped in faster and reliable data acquisition?**

The technological advancements have not only accelerated data collection processes but also enhanced their reliability, enabling the creation of highly accurate and dynamic urban digital twins. Photogrammetry has evolved with the advent of high-resolution data acquisition methods further developing into automated image processing, providing a foundational layer for digital twins by offering precise spatial geometries of urban environments. Remote sensing technologies have expanded their capabilities with improved sensor resolutions and the deployment of new satellites, facilitating comprehensive and up-to-date overviews of large geographic areas. This global perspective is essential for monitoring urban expansion and environmental changes. Geoinformation technologies, underpinned by advanced GIS software, integrate and manage diverse spatial datasets. These platforms have become more powerful with the inclusion of AI and machine learning algorithms, which help in the analysis and visualization of complex urban data. AI and automation play a pivotal role in processing the vast amounts of data required for creating digital twins. AI-supported Digital Twins enable the efficient analysis of patterns, forecasting of urban dynamics, and optimization of city operations, transforming raw data into valuable input information for analysis. Sensor data from the Internet of Things (IoT) devices provide continuous streams of real-time information about various urban parameters, such as traffic flow, air quality, and energy

usage. This real-time data integration ensures that digital twins mirror the current state of the city. In addition, City Digital Twins can offer simulations in support of decision-making with regards to the future state of the city. Currently, open-source computational methods and openly shared data encourage innovation and collaboration among researchers, developers, and urban planners for the development and utilization of digital twins. In conclusion, the above mentioned technologies and methodologies have improved the speed and reliability of data acquisition for City Digital Twinning. They provide a comprehensive and detailed current representation of urban environments, crucial for effective planning, development, and sustainability efforts in cities worldwide.

What do you consider your greatest achievement? Can you tell us a challenge that you faced in your career, how you overcame it and what you learnt from the experience?

Working in the dynamic world of technology, one challenge is staying up to date with developments. My natural curiosity and willingness to learn drive me to keep pace with technological advancements. On a personal level, balancing a career with being a mother to two amazing girls has been a significant challenge. Additionally, moving to the Netherlands to advance academically, while ensuring my family remains healthy and successful has required continuous effort. It was tough, but with love, and continuous support from my family and husband, I've overcome this challenging period. I've learned to be grateful for every day and to offer kindness and support to others.

What can you say about the current trends in scientific research related to efficient use of remote sensing in various applications?

Current trends in scientific research are leveraging remote sensing technology to revolutionize various applications, aiming for efficiency and broader impacts. This includes advancements in environmental monitoring, urban planning, agriculture, and disaster management. Researchers are focusing on integrating remote sensing with artificial intelligence and machine learning to analyze large datasets more effectively, enabling precise predictions and real-time monitoring. There's also a push towards making remote sensing data more accessible and interpretable for decision-makers, ensuring that insights derived from this technology can be readily applied to solve real-world problems. This interdisciplinary approach means a promising future where remote sensing plays a crucial role in sustainable development and resource management.

What do you think are the possible contributions of international organizations like the ISPRS Student Consortium in knowledge dissipation in Digital Twin?

International organizations such as the ISPRS Student Consortium are uniquely positioned to foster knowledge dissemination. Using the ISPRS global network, they can facilitate the exchange of cutting-edge research and best practices among students, academics, and professionals worldwide. Through organizing educational workshops, publishing insightful research, and fostering collaborations across borders, they can play a crucial role in equipping the next generation of scientists and engineers with the necessary skills and knowledge. Additionally, they can act as a bridge between academia and industry, promoting the adoption of Digital Twin technologies in solving real-world challenges. This collective effort not only accelerates innovation but also ensures a wider understanding and application of Digital Twin technology across various sectors.

What is your advice to the youth and how can one be motivated to pursue research in City Digital Twin?

My advice to young people interested in City Digital Twin research is to start by exploring their curiosity about innovative methods. Keep your motivation alive by connecting with communities and experts in the field through social media, forums, and attending relevant events. Dive into projects, even small ones, to apply what you learn and see the real impact of your work. Remember, your research can lead to significant advancements in areas such as smart cities, environmental conservation, and beyond. Let the excitement of making a difference with cutting-edge technology drive your journey.

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SISI ZLATANOVA

Research Interests and Expertise:

3D modelling, Voxel modelling, 3D spatial data structuring, 3D Indoor modelling and navigation, 3D data integration (BIM and GIS), systems for emergency response, SpatialDigital Twin. Laser and photo bathymetry, Point cloud processing, Scientific software development.

I am a professor in 3D geospatial modelling, leading GRID lab at UNSW, an adjunct professor at RMIT, president of ISPRS TCIV Spatial Information science for the period 2022-2026. I graduated from University of Architecture Civil Engineering and Geodesy, Sofia Bulgaria and obtained my PhD degree at the Graz University, Graz Austria on 3D modeling for urban development.

Can you briefly tell us about your research interests?

I am a graduated surveyor and I have been always fascinated by measuring and modeling the real world. I have been actively involved preparing maps for different applications (roads and building construction) since a very early age helping my father who was a surveyor. I devoted myself to learning surveying and photogrammetric techniques during my student years. I loved the stereo photogrammetric instruments, where it was possible to observe 3D models. Gradually, I started thinking of somehow preserving the 3D models and not flattening them to become 2D maps.

Who or what inspired you to become a scientist in this research field?

Several individuals have played pivotal roles in igniting my enthusiasm for 3D modeling. Initially, it was Dr. Klaus Templi, a well-known lecturer in photogrammetry at ITC in Enschede, The Netherlands. Dr. Templi was already deeply immersed in exploring of 3D data structures with his PhD students, determining the most suitable topological data structure capable of accurately representing the complex relationships between objects in 3D space. Under his guidance, I began actively acquainting myself with concepts and representations utilized by computer graphics. I had the privilege to be

supervised by Prof. Franz Leberl (founder Vexcel Imaging) and Dr. Michael Gruber from the Computer Science and Vision Institute, Graz University, Austria. Their invaluable mentorship and collaborative efforts helped me refine my ideas and the completion of my PhD research. Since then, my scientific interests have been exclusively centered around various 3D topics, encompassing the advancement of data structuring, integration, and analysis methodologies.

■ Among the research projects you have conducted, can you share with us a specific project that you liked the most?

There are a couple of projects that I enjoy talking about. The first one is the SDI for the Port of Rotterdam. Together with Eindhoven University, we had to propose a data model (spatial schema) for the complex work of the port. This was the first project in that we faced the problem of 3D integration of GIS and BIM data. We had to develop a new IFC representation for quays and Port of Rotterdam. The full report is [here](#). The quay extension of IFC is [here](#). This project was awarded the second influential project by the funding organization.

The second exciting project was the [SIMs3D project](#). This project was dedicated to developing procedures for 3D indoor reconstruction and navigation. Several very interesting approaches were published.

The third project is from UNSW. We have worked on developing Liveable City Digital Twin for the city of Liverpool (in Sydney). The [project](#) developed a 3D model and tools for shadow computation. Live demo of the developed prototype system is developed [here](#). The paper that gives an overview on the system architecture is available [here](#). Several related papers on [BIM geo-referencing](#) or [management of 3D data](#).

■ What are the importance Digital Twin?

The Digital Twin came as a new notion to represent something that we the geoscientists have been working for long time: creating and maintaining 3D model of real world. However, the Digital Twin brought a new component – the link to the real world. Through the years we have been linking sensor data to the 3D model for smart cities, or incorporate the vision of communities, via public participation systems or including dynamic data for monitoring of mobility, etc. Hence, for many of us the questions was: is Digital Twin a new name for something old? I would say NO. Digital Twin provides a more generic vision about the link between real and virtual world. It differs from previous geospatial attempts in two aspects: 1) integration of much more data, specifically real-time data, 2) providing more extensive simulations and predictions. Specifically interesting are the predictions, which should provide a knowledge about investigated phenomena by continuously updating the prediction model with real-time data.

■ How have the technologies developed and helped in faster and reliable data acquisition?

In the last decade, many new sensors and devices have been developed to measure and monitor different aspects of daily life, construction, and the environment. However, the raw data is only the first step in understanding the real world. The data must be filtered, processed and integrated with other data to serve a specific application or goal. The large volume of measurements and data allow us to train and employ AI models, which can further speed up the analysis. Hardware has been devised for fast computing, such as NVIDIA AI platform, AI supercomputers and AI models.

■ What do you consider your greatest achievement?

I have worked in almost all areas of 3D modeling, but I value most the work on 3D topological relationships, the research on 3D indoor navigation, and now voxel modeling. I am still considering my research on 3D topological relationships as one of the leading in my carrer. I have investigated all possible relationships between points, lines, surfaces, and volumes in 3D dimensions. This was

exciting theoretical work. However, it is quite complex for implementation.

With a large group of researchers (PhD and MSc) I have worked for many years on 3D indoor navigation. We investigated different navigation paths, obstacles, modes of movement, guidance, seamless indoor/outdoor navigation, approaches for tracking and now evacuation. The research of one of my PhD students was published in a [book](#). Many of these concepts and developments contributed to the OGC standard [IndoorGML](#). We are now in the process of releasing IndoorGML 2.0.

Can you tell us a challenge that you faced in your career, how you overcame it and what you learnt from the experience?

One of the most significant research challenges I've encountered revolves around the intricacy of 3D models, particularly those representing indoor environments. Conducting 3D operations on indoor boundary representations (B-reps) poses substantial computational effort and validation difficulties. These models can be derived from point clouds or delivered as BIM data. Regardless of their source, the obstacles are multiple.

In addressing this complexity, we have embarked on an exploration of voxels. These are 3D pixels and form a regular grid. Voxel are not a novel representation method and have seen extensive use in fields such as geology, medicine, and climate science. They are also frequently employed in point cloud processing. However, their widespread application for 3D modeling of urban environments—both indoor and outdoor—remains largely untapped. Some exciting universal navigation approaches can be found in these two papers.

<https://doi.org/10.1111/tgis.13002>

<https://doi.org/10.1016/j.autcon.2018.07.025>

What do you think are the possible contributions of international organizations like the ISPRS Student Consortium in knowledge dissipation in Digital Twin?

ISPRS Student Consortium has the very important role of connecting young professionals and distributing knowledge about geospatial technology. The webinars that have been organized with the generous help of the Student Consortium are an excellent example of giving the opportunity to everyone on the planet Earth to follow last scientific developments, learn about exciting projects and virtually meet scholars. The summer schools that are also supported by the Student Consortium are another exciting activity to dive in detail in specific topics, built a network and make friends. I wish the Student consortiums to continue with the same pace.

What is your advice to the youth and how can one be motivated to pursue research in Digital Twin?

The concept of Digital Twins is undeniably complex, demanding collaboration across diverse disciplines. We can no longer afford to remain isolated within our respective silos. Digital Twins extend far beyond mere 3D models and spatial information. Depending on the specific objectives of a Digital Twin project, collaboration with professionals spanning a wide array of fields becomes imperative. This includes architects and urban planners, researchers from all branches of engineering, public health experts, business analysts, social scientists, and environmental researchers.

Maintaining close ties with computer science is essential, ensuring we remain informed of the latest technological advancements introduced by leading companies. The real world is multifaceted and immense, and therefore our approach to researching Digital Twins must mirror this expansiveness and openness. I would advise the youth to keep alloys in mind that collaboration across disciplines fosters innovations and enriches the potential applications and the impact of Digital Twin.

Note you can make few changes or add additional important questions that you would like to address

FORESIGHT:

Webinar on Visualization, HCI and XR

[ISPRS WG IV/5 \(Extended Reality and Visual Analytics\)](#) is back with its annual webinar series, with the first webinar of this year happening on Tuesday, 7th May 2024 at 9:30-11:00 CET.

You can register to this virtual event by clicking [here](#).

Below is the program outline:

| Time | Title | Speaker |
|-------------|--|--|
| 09:30-10:00 | Trustworthy Maps? Case Studies from Managing Emergencies | Dr. Amy Griffin, Senior Lecturer RMIT University of Melbourne, Australia |
| 10:00-10:15 | Q&A on Amy's Session | |
| 10:15-10:30 | Gamified XR for hazard preparedness in mining | Yan Wong, (incoming) PhD candidate, researcher, University of Pretoria, South Africa |
| 10:30-10:45 | 3D selection for point clouds in XR | Luca Fluri, MSc candidate, researcher, University of Applied Sciences and Arts Northwestern Switzerland, Switzerland |
| 10:45-11:00 | Q&A on Yan & Luca's Session | |

ISPRS SC will be providing technical support in terms of handling the zoom account and promoting the events. More details about the speakers are available at this [link](#).

UPCOMING EVENTS

| Event Name | Dates | Venue | Website |
|--|-----------------|---|---|
| ISPRS WG IV/9 3D GeoInfo and EG-ICE joint conference 2024 | 01-05 Jul 2024 | Vigo, Spain | http://3dgeoinfoeg-ice.webs.uvigo.es/ |
| ISPRS ICWG IV/III/II Academic Track of FOSS4G (Free and Open Source Software for Geospatial) Europe 2024 | 01-07 Jul 2024 | Tartu, Estonia | https://2024.europe.foss4g.org/ |
| IGARSS 2024 SUMMER SCHOOL | 4-6 July 2024 | National Technical University of Athens, Greece | https://www.2024.ieeeigarss.org/summerschool_program.php |
| ISPRS ICWG IV/III, WG IV/11 Workshop on 3D digital modelling for SDGs | 07-10 Jul 2024 | Trondheim, Norway | https://www.ntnu.edu/web/nordig-ai-lab/isprs-workshop-2024 |
| ICERS International Conference of Environmental Remote Sensing and GIS | 11-12 Jul 2024 | Zagreb, Croatia | https://alcar.geof.hr/icers/ |
| International Geoscience and Remote Sensing Symposium - IGARSS 2024 | 7-12 July 2024 | Athens, Greece | https://www.2024.ieeeigarss.org/ |
| COSPAR 2024 45th Scientific Assembly of the Committee on Space Research (COSPAR) and Associated Events | 13-21 Jul 2024 | Busan, South Korea | https://www.cospar-assembly.org/ |
| BUCEA International Summer School on Smart Cities 2024 | 14-22 July 2024 | Beijing - China | https://english.bucea.edu.cn/Admission/SummerSchool/ |

UPCOMING EVENTS

| Event Name | Dates | Venue | Website |
|--|-----------------------|-----------------------------|---|
| ISPRS Technical Commission V Symposium 2024 | 06 - 08 August 2024 | Manila, Philippines | https://www.isprs.org/tc5-symposium2024/index.html |
| ISPRS SC GeoAI Summer School | 09-13 August 2024 | Quezon City, Philippines | https://www.isprs.org/tc5-symposium2024/page12.html?page_id=859 |
| 2024 International Conference on Remote Sensing and Geographic Information | 21 - 23, Aug 2024 | Singapore | https://www.icrsg.org/ |
| SUNRISE Summer School 2024 | 8-14 September 2024 | Porto Cesareo (LE) - Italy | https://www.sunrise-summer-school.com/ |
| ISPRS Technical Commission IV Symposium 2024 | 22 - 25 October 2024 | Fremantle, Perth, Australia | https://www.isprs.org/tc4-symposium2024/index.html |
| ISPRS Technical Commission III Mid-term Symposium | 4-8 November 2024 | Belém, Brazil | https://selperbrasil.org.br/events/belem-2024-tc3-symposium/ |
| ISPRS SC/ACRS Summer school | 22 - 26 November 2024 | Colombo, Sri Lanka | https://www.survey.gov.lk/acrs2024/summer-school.php |

SCHOLARSHIPS *AND* OPPORTUNITIES

PhD

PhD Vacancy in Photogrammetry and Computer Vision (m,f,d)

The University of Luxembourg

Luxembourg

Deadline: 30 June 2024

<https://academicpositions.ch/ad/university-of-luxembourg/2024/phd-position-in-photogrammetry-and-computer-vision/218397>

PostDoc

Post-Doctoral Researcher; Project: “Delving into leaching in karst regions”

Trinity College Dublin

Ireland

Deadline: 30 June 2024

<https://www.earthworks-jobs.com/environs/tcd24061>

Jobs

Lecturer

University St Andrews

Scotland

Deadline: 17 July 2024

<https://www.earthworks-jobs.com/geoscience/andrews24062>

Researcher in Remote Sensing and ecosystem functioning

The Luxembourg Institute of Science and Technology (LIST)

Luxembourg

Deadline: 31 August 2024

<https://euraxess.ec.europa.eu/jobs/195189>

Researcher in Crop Modelling

The Luxembourg Institute of Science and Technology (LIST)

Luxembourg

Deadline: Not specified

https://app.skeeled.com/offer/650bdf8aa03afaca476c6454?show_description=true&utm_id=651c1ec817842830f513d5a0&utm_medium=CAMPAIGN&vq_campaign=085879ad-8a71-5360-9c80-f3e0068a2d9e&vq_source=662

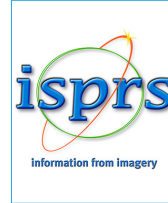
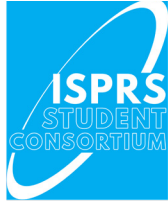
Assistant/Associate Professor, Computer Science

Texas A&M University - Corpus Christi

Texas, USA

Deadline: 15 September 2024

https://tamus.wd1.myworkdayjobs.com/en-US/TAMUCC_External/job/Corpus-Christi-TX/Assistant-Associate-Professor--Computer-Science_R-072285



Please visit our ISPRS SC web page

sc.isprs.org 🔍

where you will find more information about Student Consortium, our previous Newsletter issues, SC activities, photo galleries from previous Summer Schools, interesting links etc.

Are you a student or a young professional below the age of 35?

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On behalf of the **ISPRS SC Board of Directors**, the Newsletter team would like to thank all the contributors of the featured articles in this issue who shared their knowledge and research experiences with us. We would also like to acknowledge

Nicolas Pucino for co-leading the Newsletter and we also like to acknowledge design and proofread team in accomplishing the Newsletter issue. We are so proud of you!

ACKNOWLEDGEMENT

Stay safe, everyone!



SPECTRUM