Smart Cities and Urban Digital Twins

The Immersive Realities Working Group is a joint initiative of the TUM Think Tank and the Professorship of Public Policy, Governance and Innovative Technologies at the School for Social Sciences and Technologies. The Working Group aims to investigate and shape the interactions of immersive technologies and their applications with society, politics, and the economy in the coming years. Ultimately, these efforts aim to support the development of open and human-centric immersive technologies and realities, that encode and promote European values, facilitate knowledge sharing, and support its builders, shapers, and users. The working group will focus on the impact of the use of immersive technologies on society and the lived experience of individuals. From the vision of a global Metaverse to countless open or closed applications of extended realities, a supposedly fragmented archipelago of applications can be fused into one common goal: to "unflatten the internet".

By focusing on different use cases and discussing ongoing projects, we want to sharpen our perspectives and explore opportunities and challenges of immersive technologies on a global, but also on a regional and local scale. All working group members are invited to share brief reflections of the week's discussion to start conversations beyond the sessions and define interesting paths for further exploration.

You can find brief topic descriptions and our comments for our session on smart cities and urban digital twins below.

1. Connected Urban Twins

Connected Urban Twins is one out of 73 selected Smart Cities model projects. The German Federal Government's funding programme supports cities and municipalities in implementing the opportunities in terms of sustainable urban development provided by digitalisation.

Key actors include the City of Hamburg, Leipzig and Munich as partner cities, 70 specialists in the team, 23 contributors in Munich (Department of City Planning and Building Regulation, IT Department, Department for Urban Planning and Building Regulations), as well as collaborators at TUM in the area of geo and traffic data.

The vision of the project targets efficiency and connectedness of the digital twin, integration of solutions and datasets, and application-oriented development. The use of the digital twin is the objective, not its mere existence, with a solid urban data platform, as a living model. Applied technologies range from 3D-models to VR and AR with a variety of data sources.

Reflections and Comments

Use of Remote Sensing and Digital Twins for Natural Disaster Planning (Brittany Engle)

> As the effects of Climate Change impact us on a global scale, we will continue to experience the consequences of increasingly intense natural disasters, from extensive flooding to acute droughts and wildfires. The use of remote sensing and digital twins play vital roles in city and natural disaster planning. By providing science backed data to communities, we can strengthen the resilience of society by reducing its risk for disaster through the: mitigation of its exposure to hazards, mitigation of its vulnerability and by increasing its preparedness and capacity to respond to disasters at a local, regional, and national level.

Digital Twins and Immersive Technologies Enhance Cooperative Planning and Approval in Urban and Rural Infrastructure Projects (Daniel Saad)

> Digital twins and immersive technologies can facilitate the planning and approval of infrastructure projects, not only in urban areas but also in rural areas, due to their cooperative nature and the data behind them. This includes the design and planning of routes or wind and solar power plants, which often meet resistance from the local population. Through immersive technologies, planning can be made more cooperative, thus avoiding misunderstandings and facilitating joint solution-finding. Citizens can experience the virtual world of an image of their community before the actual approval of the infrastructure project, and thus give feedback or suggestions for improvement in time. The deliberative discourse can thus be strengthened.

Democratizing access to the Connected Urban Twin (Sofie Schönborn)

> This project builds on the idea of a "living model" that includes 3D models, VR, AR and many different sources of data. This implies the need for continuous updating and accurate (real-time) data. It also presents the foundation for many different applications, of

which some are trialed right now (e.g., showcasing different urban design options or scenarios and simulating a new bike lane in VR), but potentially many could follow. As this project and the connected urban twin build on different data sources, open data or data sharing between different entities will likely be needed and should be encouraged. The city might think about democratizing access to this data (data sharing or open-sourcing), to also enable start-ups and other organizations to build new solutions on top of this and with this catalyze innovation based on this digital foundation.

Participatory Design space between urban planning with citizens, stakeholders and NGOs (Carrie Lau)

Perhaps one of the most commendable facets is the recognition of citizens as essential stakeholders. The mention of a participation tool suggests a move towards more inclusive and participatory urban development, wherein the feedback and needs of the citizens are prioritized. Politicians, too, are rightfully identified as critical players, given their influential role in policy-making and governance.

Environmental Impact of the Connected Urban Twin in Munich (Sofie Schönborn)

During the session, a question was raised regarding the environmental implications and impact of the project, which could not be definitely answered (yet). The computational infrastructure for data storage, processing and sharing required for this connected urban digital twin likely entails significant energy demands. While the project delineates multiple collaborators and stakeholders, a comprehensive assessment of its environmental impact — spanning energy consumption, pressure on the grid, use of components and other impacts on the environment — remains a crucial area yet to be thoroughly examined. As digitalization gains prominence in urban development, driven by institutions like the Federal Ministry of Housing, Urban Development and Building, it becomes paramount to ensure that technological advancements align with environmental sustainability. Thus, a holistic evaluation of the Connected Urban Twin initiative should consider not only its technological milestones but also its environmental footprint and adaptability to the multifaceted needs of urban spaces.

2. Mirror Worlds, Shadowlands and Urban Doppelgangers

Mirror Worlds, Shadowlands and Urban Doppelgängers" takes place at the TUM Chair for Architectural Informatics in collaboration with the XR HUB Bavaria within the project XR STAGE . Built upon the Augmented Reality Platform "AR-VOS" by the artists Tamiko Thiel and Peter Graf. The researchers experimented with XR-media (like Augmented Reality) through workshops and experimental design approaches exploring hybrid experiences of superimposing and intersecting physical and virtual urban worlds. This resulted in a virtual "mirror cabinet" through the gathering of data, building of digital worlds, and scanning of spaces.

Reflections and Comments

Cultural exchange and understanding (Daniel Saad)

> Virtual worlds could help us better understand cultures or grievances in other countries (similar to this video). We could strive to comprehend cultural misunderstandings through the design freedom of virtual worlds. How do other cultures perceive us (from the perspective of the counterpart)? How do we understand our own cultures (from our perspective)?

Graffiti and Street Art Culture in Urban Space (Carrie Lau)

> I believe this presented project will greatly enhance understanding from an artist's perspective and demonstrate how art can be integrated into our everyday surroundings. Many cities worldwide still restrict street artists from expressing themselves due to concerns about negatively impacting the city's image. I believe this project can undoubtedly bridge the gap in understanding for multiple stakeholders.

Art and Design (Anton Hiller)

> Art and design are definitely supporting! People feel touched in a different way and they (mostly) become more open to special topics. If muc.xyz can help with the network in this area it would be a pleasure for us.

> A Connected Urban Twin, which involves creating a digital twin of a city to simulate and optimize various aspects, can significantly contribute to sustainability and climate protection. It allows urban planners to model and analyze different scenarios for resource allocation, energy consumption, transportation systems, and more. This digital representation helps identify inefficiencies, optimize urban designs, and implement strategies to reduce carbon emissions, promote renewable energy sources, enhance public transportation, and create more green spaces. Overall, it enables data-driven decision-making that can lead to a more sustainable and climate-resilient urban environment.