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Innovating Multidimensional Urban Visions

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1 ABSTRACT

MUVIS (Multidimensional Urban Visions) is an applied research project aimed to create an extensible platform for online participatory urban planning and multidimensional visualization. MUVIS will offer the people, local authorities, and investors a dialogue of all participants. In the Virtual Petrzalka case study we facilitate model creation and visualization as well as support discussion of urban visions and plans. MUVIS offers a recent technology solution, transfers the ideas from academy to practice and attempts to affect – in the best possible way – the future of our cities. Our ongoing project is supported from an EU structural grant scheme OPVaV-2008/4.2/01-SORO; with ITMS code 26240220009. In this paper we overview the methodology, technology, and digital content creation and presentation. We describe selected problems in Bratislava urban planning in the past and we discuss our approach.

Keywords: 4D visualization, urban planning, online presentation, virtual environment

Figure 1: Historic urban area visualizations: (a) left, a painted veduta of Bratislava, (b) right, a screenshot from Virtual Bratislava Navigation Tool by Stanislav Stanek. Aerial photo courtesy of Eurosense Slovakia, terrestrial photos by Matej Zeman. The popular painting from 18th century serves as a symbol for the old city, e.g. at http://www.bratislava.sk/.

2 INTRODUCTION

Bratislava (Pressburg, Posonium, Istropolis) belongs to those places in Central Europe where the urban development and phenomenon of genius loci [Norb00] suffered a lot from multiple historical and ideological discontinuities. One of the victims of urban deformations was the Bratislava Castle, visible in Fig. 1 in its old shape and from the aerial photo, dated 2003. In the year 2009, the archaeological research discovered an old Celtic castle underneath the current Bratislava Castle, probably – according to Austrian professor Werner Jobst - the lost Carnuntum [Mus10], the capital of the Noricum province, mentioned by Tiberius mission in written history - in the year 6. The castle building with its four towers, among others the favorite place of Mary Therese was destructed by fire in 1811. Considered as a symbol of feudalism, this ruined memorial without a roof and surrounding prominent urban area was not renovated until about 150 years later the fire. Next to the castle we can find probably the top anti-cultural damage of a historic old town – a highway between the Castle and the Coronation Church. The valuable historic urban area, an original place of history and local atmosphere, was cut by modern transport route built as a prolongation of a postmodern bridge. Despite these urbanistic atrocities, the biggest urban area under permanent public discussion is Petrzalka, illustrated in Figure 2. Petrzalka is a giant habitat built from the cheapest housing alternative – panel buildings. Its 150 000 population makes Petrzalka, so to say, the third biggest city in Slovakia. As the current urban disaster cannot simply be replaced, we hope to open a new communication channel for public participation in its current and future urban development and improvement. The abovementioned context motivated our decision to choose Petrzalka as the study for the MUVIS project. Virtual model of Petrzalka will extend the existing virtual model of historic Bratislava southwards and MUVIS will be verified, tested, and evaluated using this urban database.

The alienation of modern architecture and urbanism is identified by many authors and public participation is often proposed as a promising alternative. MUVIS is an extensible platform for online participatory urban planning and multidimensional visualization. Exploiting a layered multidimensional content structure, aware of time and space in the virtual city, MUVIS users will share and co-author “The City as a Process in Time and Space” [Fers02]. At the CORP 2010 conference we present the current version of our solution.

The rest of the paper is structured as follows. We introduce the previous work, methodology and technology. In more detail, we present the project achievements and decisions. Finally, we conclude and discuss the future work.

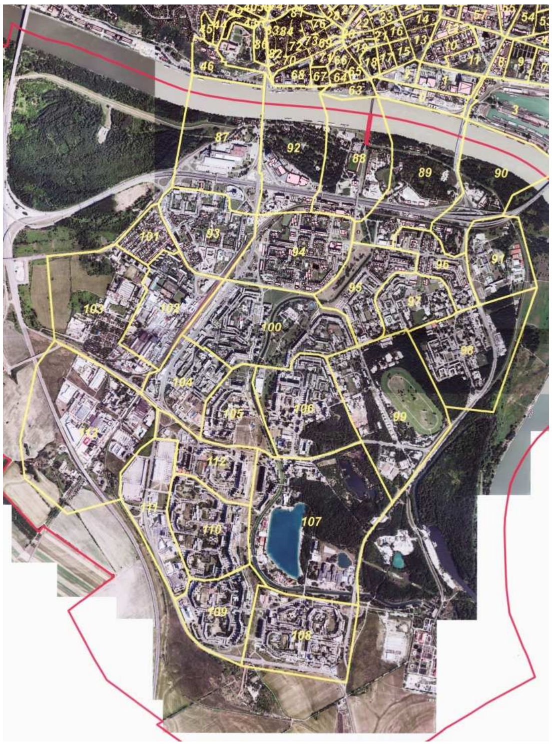

Figure 2: Bratislava historic center is separated from Petrzalka by the Danube river. Petrzalka is a controversial urban area with many unsolved problems. The biggest and longest blocks of panel houses are nicknamed the Chinese Wall. One of the general solutions for the future urban development seems to be the public participation in decision making processes. (The whole area was subdivided into smaller areas for the purpose of model creation. Building our urban database starts with aerial images, rooflines and building footprints from Cadaster Portal of Slovak Republic. Aerial photo courtesy of Eurosense Slovakia.

3 PREVIOUS WORK

The planners of urban solutions search for shapes and functions on multiple scales, forming a new version of “urban text”. However, there is no complex vocabulary of scales, shapes and functions, they are discovered and created ad hoc. There are lucky cases – as for example Graz, which is described by the UNESCO's World Cultural and Natural Heritage List: “The urban complex forming the historic centre of the city of Graz is an exceptional example of a harmonious integration of architectural styles from successive periods. Each age is represented by typical buildings, which are often masterpieces. The urban physiognomy faithfully tells the story of its historic development. Graz is a particularly fine example of the living heritage of a central European urban complex that was under Habsburg rule for many centuries. The old city is a harmonious blend of the architectural styles and artistic movements that have succeeded each other since the Middle Ages, together with cultural influences from the neighbouring regions.“ And there are unlucky case, one of which is Petrzalka, where the change causes alienation, anonymity, missing infrastructure and another entries on the long list of multidimensional damages.

The organicity of change and proportionality of shapes can be approximately measured using fractal geometry [Sali03]. We estimate the Waterfall by Wright induces a largely different measure compared to the Bratislava highway cut through the heart of the old town – placing the Coronation Church facade right next to everyday pressure of trucks, cars, and buses. The collective imagination in this case is not formed, but deformed. The first experiments with Bratislava fractal measurements arise in a PhD research project [Mesz10] at the Faculty of Architecture, Slovak University of Technology.

The city has, among other places (squares, riversides, streets, quarters), the city verticals, given by towers, memorials, silhouettes, rivers and wells (old water sources). The oldest known ancient algorithm for founding a new city has been preserved in Latin books. The founders of Rome were the Etruscans – "engineers" invited by the rural Romans who had no knowledge in the field. The Etruscans computed the city location, ploughed the city border around, erected the city tower to transcend the city to the sky and – nearby – they dug a mundus. The mundus was not necessarily a well. It was the root of the city, transcending the city downwards, into the earth and into the depth. (One can see in erecting and rooting the male and female principles.) The Etruscan language, being isolated from Indo-European languages, has been not preserved up to now. Despite the fact that we do not know the language, we have two fundamental Etruscan words in the international language – urbs (the city) and mundus (the world, the meaning was changed by the Latin users).

There are several well-known urban thinking milestones, for city creation [Vitr09], for its perception Lynch's Image of the City [Lync60]. His perceptual notions – especially imageability – express the readability, areas, squares, borders. Individual perception of a particular place, genius loci, has phenomenological explanation in [Norb81]. The place is, after Forte, the author of virtual museum definition [Qvor01], the opposite of an alienated space (e.g. hypermarket). The architectural alienation is discussed e.g. in [Bang07], the alienation of architecture and urbanism was studied e.g. by Rem Koolhaas, and socio-psychological problems of urbanism in [Mits69]. Bangs judges that the architecture missed classic craft in mastering proportions and preserving archetypes like cave, glade. The habitat (flat, house) should balance the needs for privacy and public space, which is not possible in noisy panel houses. Nowadays, nobody has a legal way to coordinate investors egoisms, which would lead [Mits69] to unthinkable limitation of private property rights. Therefore, long-term public participation (PP) is one of the experiments to overcome the alienation. The Aarhus Convention [Aarh98] is a new sort of an environmental deal, trying to harmonize both human and environmental rights [Jokl07, p. 73]. PP can be characterized as a forum for exchange of opinions, experiences, knowledge, organized to support communication of all segments, solving the specific problems in given area [Renn95]. PP can support social inclusion, better concurrency, social cohesion, environmental balance and public feed-back for decision making [Gave98]. PP classification and its computerized support is offered in [Jokl07, p. 73n] and PP is mandatory in Germany by law [Jokl07, p. 79]. The risky aspect of PP is that the public is not prepared for it. Therefore, MUVIS mission includes the technology enlightenment/evangelization part, as well. We distinguish GIS as a professional planning tool used for decision-making [Jokl07] from PPGIS (Public Participation Geographical System), combining methods and technologies, conveying interactive presentation of various alternatives of geospatial data, based on problem-oriented selection. A recent survey of PPGIS projects and dilemmas has [Kyem09]. Another alternatives represent geobrowsers (Google Earth [GooE09], MS Virtual Earth [MSVE09]), compared e.g. in [Lebe07], and VEPS (Virtual Environment Planning Systems) [Jokl07]. The functionality of each of the above alternatives necessarily covers file and database management, search and navigation in space, time, or semantics, calibrating, filtering and storage, versioning, urban database editing, multimedia presentation of ideas, feedback, comments, forum and voting subsystems. As they are VR systems, their architecture can be broadly subdivided into four categories scene graph, semantic database, generic system or distributed system [Guti07]

3.1 Cyber Cities

The vision of future internet outlines the Semantic Web [Bern01], requiring autonomous agents and globally built ontologies like CIDOC CRM [Crof05] for cultural heritage and [Jan09] for geodata. The cyber cities [VirC09] methodology started with a few chapters in [Leon00]. Work Flow Issues for automation analyzes F. Leberl et al. [Lebe00] in three parts 1. Aerial photogrammetry, 2. Digital canopy elevation model, and 3. Building geometry extraction. The Model Building Pipeline) is characterized by G. Roth [Roth00]: 1.

Callibration, 2. Acquisition, 3. Registration, 4. Point Creation, 5. Model Creation, 6. Model (Mesh) Compression, 7. Texture creation. Multiple modifications elaborated [Ferk04], [Lebe07], [Klei09], where even „ontologic scales " appear and from where the evaluation [Mose08] for virtual Berlin [VirB09] is inspired. MS Virtual Earth workflow is described in [Lebe07] as: 1. Surface Point Cloud, 2. Orthorectified Image, 3. Classification Map, 4. Bare Earth Topography, 5. 2.5D Textured Buildings. There are also experiments with procedural cyber city creation which can be used for less important city parts or in computer games where the exact model is not necessary. The goal of virtualization can be formulated as converting space into places, where place is defined by Christian Norberg-Schulz as "dynamic unity of architecture, population, and iteractions among them" [Came07, s. 337]. There are three levels of quality for virtual places 1. Visualization virtual places, 2. Activity-based virtual places, and 3. Hermeneutic virtual places – culturally coded places where one can hide himself, identify with, own or collect cultural objects (in our case visions, presentations, opinions). The fundamental double-book on semiotics for virtual reality is Virtual Space [Qvor01] and Virtual Interaction [Qvor02], whereas the VR technology seems to be best taught in [Guti08]. The alternative for W3C Semantic Web initiative are represented by digital libraries, e.g. Europeana [Euro09]. The quality measure for virtual museums can be found in [Came07], but a specialized cyber city reference and a generally accepted measure of the quality of virtual museums is stil missing. Obviously, the (low-level) geometric and radiometric errors in subspaces of 8D (x,y,z,t,r,g,b,alpha) state space can be evaluated using standard measurement or estimation methods. The complexity in the field is discussed in [Zara02].

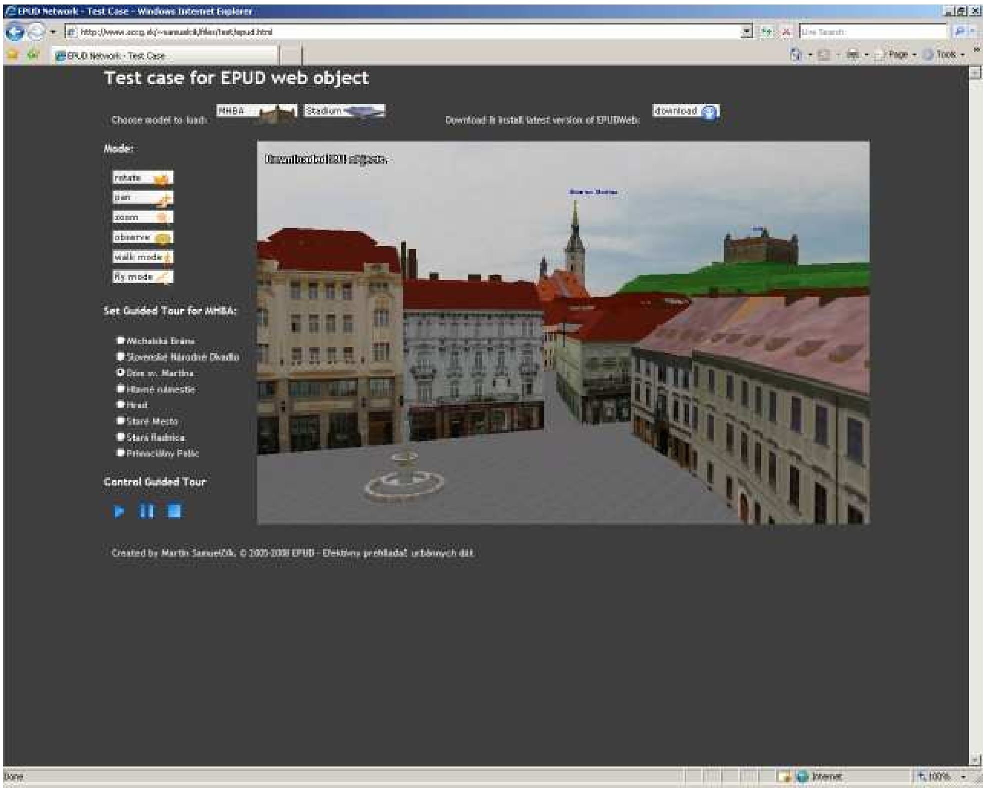

Figure 3: Historically, one of the first experiments to fly over virtual Bratislava using Microsoft Internet Explorer. The screenshot displays Bratislava Castle without vegetation and the Coronation Church tower as seen from the Old City Hall through Main Square. EPUD software tool used as web object here.

3.2 Virtual Bratislava

Chronologically, the development of Virtual Bratislava model and related methods can be traced back in time through multiple academic projects over a time span of about 10 years: MUVIS, Multidimensional urban visions (OPVaV-2008/4.2/01-SORO; 26240220009), Geometry Processing for Virtual Reality (VEGA 1/0763/09), Complexity of Geometric Algorithms for Realtime Rendering in VR (VEGA 1/3083/06), PM3Donline (AV 4/0023/05), EPUD (APVT-20-P05105), Natural Phenomena Visualization using Unstructured Grid (ASO SK-04-BA-010), STRAPAMO 18: MetropoVis, Virtual Heart of Central Europe (www.vhce.info, Culture 2000 n. 2003 - 1467/001/001 CLT CA12), Virtual Environments for WWW (VEGA 1/0174/03), Navigation and Cooperation in Virtual Environments - Virtual Bratislava (APVT 20-

025502), Advanced Methods for Virtual Habitat (Aktion AT-SK No. 323-6/2003), Computer Graphics and Image Processing Applications (VEGA 1/7666/20), and Multimedia Historic Bratislava DVD (MDPT 456/131/2005). These group projects were solved in accordance with tens of dissertations, master and bachelor theses [Beha08], [Dušk09], [Feki07], [Majo09], [Varh09]. The complete list of all coauthors includes up to 200 names.

In this paragraph we mention selected experience and/or results from the above projects, described more in [AMVH03], [Ftac07], [PMZA08], [Ferk09]. The first online 3D Bratislava models were cultural heritage highlights at [VHCE09], optimalized for IE (2004) [Ferk04], namely the Bratislava Castle, a National Cultural Monument and the well-known landmark (Figure 4), or St. Martin's Cathedral (also know as Coronation Church), a three-ships gothic church where 11 kings and 8 queens (including Mary Therese) were crowned between 1563-1830. The first Slovak virtual museum is specified in [Mrva07], [Ferk09] and published online [PMZA09]. As the real museum is in an old castle surrounded by a historic park, we also developed a method of park reconstruction using, to a certain extent, dendrological data [SmHe08], [Ferk09]. Laser measurements were needed for the Bratislava castle well reconstruction. Combining real data and hypothetic lighting scenario, we reconstructed the interior of Chatam Sofer Memorial, presented at [VHCE09]. For Multimedia Historic Bratislava DVD [Ftac07], [Boro08] we experimented with sound gallery for presenting the emotional history highlights and with a matrix-like organization of digital content – in one direction the memorials, city sights or themes and in the second direction, orthogonally to the first ione, the output media – photographs, videos, 3d models. The navigation thus becomes intuitive and idiomatic in sense of [Coop95] and even elderly people our novel multimedia kiosks can navigate quickly. The ideas from applied research project were combined with basic research findings – geometry processing using data-dependency [Toth06], mesh refinement [Noci07], specialized triangulations, false fundamental matrices for speeding-up epipolar reconstruction, extracting semantics from pictorial data [Šiku03],[Šiku06a], [Šiku06b], information visualization [Novo07], encrypting mutimedia data, video segmentation [Cern06], image-based and real-time rendering methods, reconstruction quality [Samu08], [Lack09], streaming, guided tours planning and empathic avatars [Stan09]. For presenting the past, we experimented with digital storytelling, which resulted into the discovery of LOD-stories [Pat10]. However, some problems remain open and the vision of a 3D xerox, i.e. an automatic conversion of input data into a cyber city or museum, requires much more efforts, ideas, and future work. For cybercity internet presentation the real-time rendering in an online environment seems to be the crucial one.

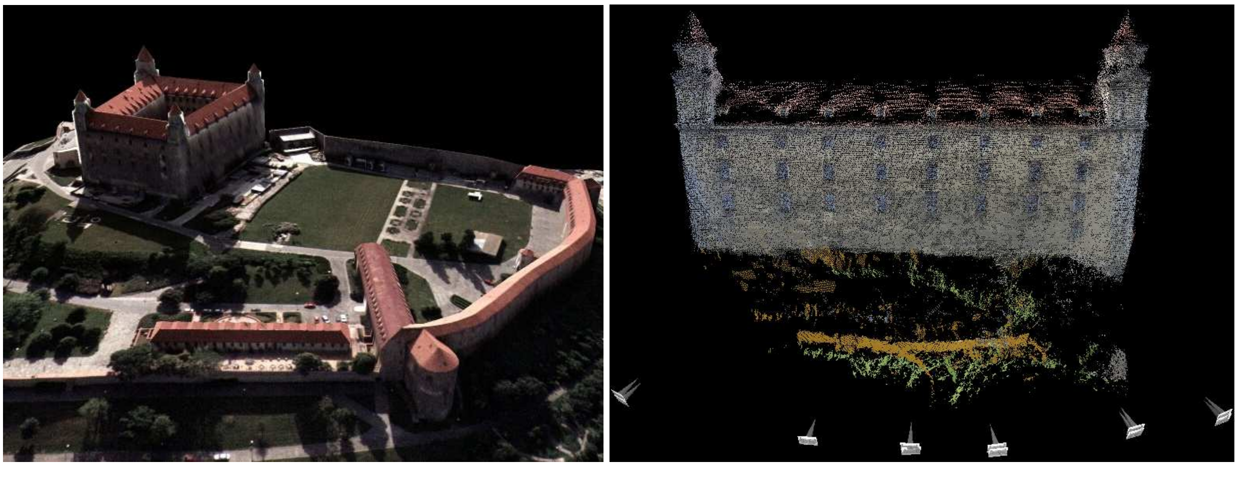

Figure 4: The first 3D urban models: (a) Castle reconstruction with the kind help of Eurosense Slovakia, provided by Peter Borovsky, and (b) the first MetropoGIS reconstructed castle façade by Stanislav Stanek. Input camera positions and the ghosts before their elimination are shown. By the way, the grass area in (a) covered the lost Celtic palace (Carnuntum?).

4 OUR APPROACH

We define our approach as a cooperative creation and evaluation of possibilities in geometric-semantic domain. It might seem natural to just adopt one of the existing PP GIS solutions, but the financial and legal situation in transforming countries differs heavily from established market economies. For short, there is neither legislative nor market prepared for cyber cities, virtual cultural heritage, digital libraries, or digitization of museum collections. The complete initiative in this segment comes from academy and EU funding. This is the reason behind the obvious gap between functional virtual Berlin, Graz, or Vienna, already possible as everyday professional tool of respective divisions at city municipalities, and the striving virtual Prague, Bratislava, Budapest, Warsaw, Peterburg or Moscow, depending on academic projects and their (usually underfed) budget.

We identify three major target groups in the MUVIS project – authors, specialists, and public. Each of these groups comes with a different motivation, different skills and different information technology available. For example the latter are not well prepared for using modern information technology tools (e.g. we had to develop special urban reconstruction tutorials in Slovak for our own students [Ona07]). Wide public audience will share the MUVIS visualization and in given cases it will participate on urban planning forum. No special education is assumed and we can't count on a powerful hardware being used on their side either. These factors limit the amount of their active participation on creating or modifying the virtual space. The authors, on the other side, have the full access (passive and active) to the digital content and provide both the virtual working ground for the other two target groups and the administration of the project itself. They also maintain the database and develop future MUVIS version. The last group – the specialists – represent a force in the urban planning, coming either from the municipal administration domain or from the professional domain, such as e.g. architects, real estate developers etc. This group has a presumably higher level of experience than the general public yet still has not a limited access to the underlying digital content.

MUVIS cross-platform functionality necessarily covers file and database management, search and navigation in space, time, or semantics, calibrating, filtering and storage, versioning, urban database editing, multimedia presentation of ideas, feedback, comments, forum and voting subsystems for given localities. We combine two architectures - scene graph and semantic database to certain extent. Scene graph architecture supports the geometric criterion for visualization part. On the other hand, the urban database has to be constructed with respect to semantics. For possibly distributed memory system for preservation and storage of enormous datasets we take into account Bigtable [Chan06], proven in multiple similar projects, e.g. web indexing or Google Earth [GooE09].

The project development is subdivided into the design and development of three conceptually separate fields of functionality – a server-side application handling the storage, index and retrieval of digital content, an active-access providing client application (editor), and a passive-access client application (viewer).

The digital content used in our project is rooted in a 4D domain and extended by semantic relations between objects, by multidimensional object attributes and by multimedia content documenting the modeled places from an empathic point of view. The created database offers creating arbitrary and abstract relations through semantic triplets, thus supporting a higher-level knowledge built above the raw city model. The client-server protocol is open and platform-independent which creates opportunities for future extensions and involvement of other domain experts, such as statisticians, sociologists, ecologists and many others.

The editor is partly built upon our previous works on effective presentation of urban data and is being extended to facilitate both technological improvement, e.g. in the form of forming relations and higher-level semantics, and technical improvement, e.g. by introducing vegetation or variable lighting conditions.

The viewer development forks into producing a high-quality viewer oriented on the specialists and technically experienced public and a medium-quality viewer offering less options in both interaction and visualization but being more accessible to the wide audience. Thus, in the end, each of the user groups will be provided with tools to satisfy their needs without being bothered with excessive or overwhelming options or requirements. Each of them uses its own conveying technology, the high-quality viewer is based around our Effective Presenter for Urban Data [Samu08] and uses a GPU-accelerated client-side web object, while the medium-quality viewer uses Adobe FLASH technology which is available to the wider audience for the price of simpler and less detailed visualization.

As the specification of these modules is not open for public yet, we hope to present them in detail in one of our future publications.

We cooperate with EUROSENSE Slovakia, contributing with preprocessed aerial photos in the urban area shown in Figure 2. The detailed project requirements and functional specification take into account recent findings and they will be tested both with the full urban model and respective target groups within the case study Petrzalka.

5 RESULTS

Since the project start in September 2009, we continue to build the geometric model first. Data, tools, and methods from previous projects [Ferk04], [Boro07], [Boro08] are either adopted or under development to meet new requirements. Thinking about MUVIS in terms of cooperative creation and evaluation of possibilities in geometric-semantic domain, neither geometric nor semantic aspect can be reduced in given application area. This is why we require multidimensional attributes or metadata beyond the 3D/4D spatial domain. Current version of Virtual Bratislava model represents a cyber city heavy model, available on DVD. Microsoft® Virtual Earth™ is a geospatial mapping platform for layered data for given location [MSVE08], [WiVE08]. Google Maps is both service and technology [WiGM08], related to the virtual globe of Google Earth [GooE08], [WiGE08] and even extending to the outer space. Both global projects have limited use and precision and they simulate mainly flyover options and exploit satelite and aerial photos of Earth. Our previous project [Ftac07] can be considered as an analogy to Google Earth. The challenging task of online browsing or even editing higher precision urban models is done in Virtual Old Prague [VirP09] or Virtual Berlin [VirB09] by downloading data and/or viewer. MUVIS aims to offer an acceptable online solution. The result of the first experiments – with smaller dataset, part of Petrzalka - is illustrated in Figure 5. The model already includes the virtual vegetation and an inserted urban vision – visualization of one of the many alternatives of the ice hockey stadium for the forthcoming World Hockey Championship in Bratislava 2011.

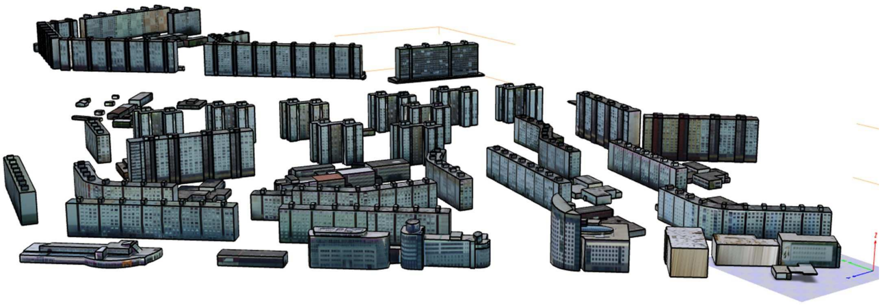

Figure 4: Initial Petrzalka dataset without terrain and vegetation. Data from EUROSENSE company.

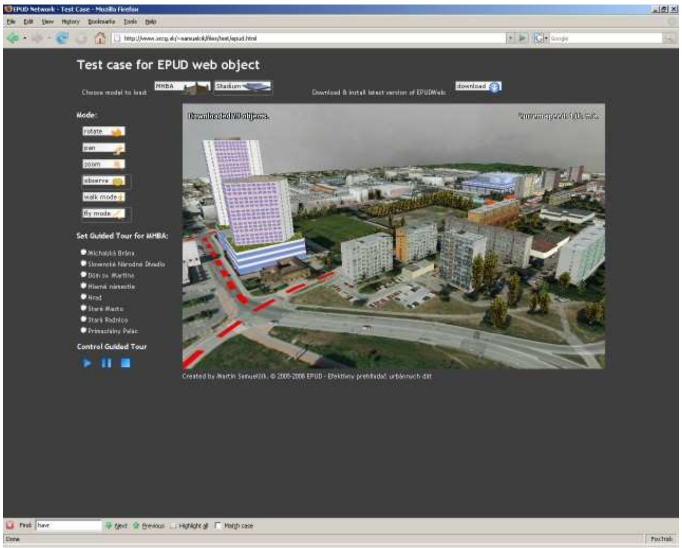

Figure 5: A model of a part of Petržalka in Mozilla Firefox using our EPUDWeb object.

The first piece of the final model and the parameters of the given experiment do not allow for interpretations. The design of the final interface will certainly differ from the prototype examples above. Last, but not least, the inserted urban vision was not included there by a member of the wide target group, but by an expert in the field. This is just the first view of Petrzalka part over internet. Our work is in progress and at the CORP conference we will present a more matured report.

6 CONCLUSION AND FUTURE WORK

MUVIS (Multidimensional Urban Visions) is an three-years applied research project for creating an extensible platform that will support online participatory urban planning and related multidimensional visualization. MUVIS will support and initiate public discussion and dialogue between the people, the local authorities, and the real estate investors. We use Virtual Petrzalka as a place to demonstrate our efforts in a real-world case study, a place to support creation and visualization of the current state and the future visions. MUVIS offers a state-of-the-art technology solution, transfers the ideas from academy to practice and attempts to influence the future development of our cities in the best was possible.

From the point of view of the widest target group, our intention is to enable people not only in poor Petrzalka to be consciously and interactively participating with their contribution to the future of their own environment. We hope that our model of cooperation, our workflow, and project results might be inspiring within the arising information society.

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