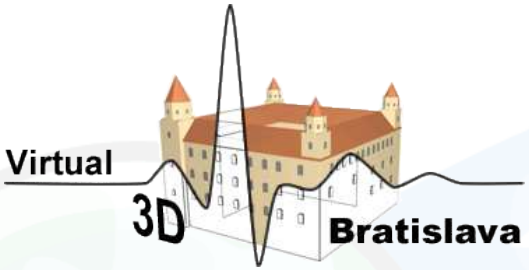
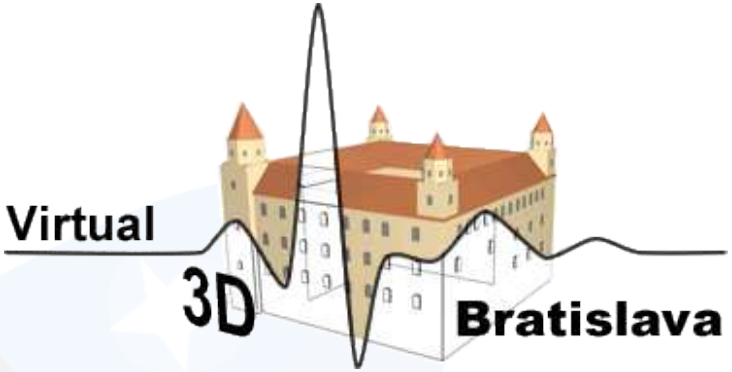


Virtual 3D Bratislava: Retrospektíva a Perspektíva

BOROVSKÝ, P. – CHALMOVIANSKÝ, P. – DAŘÍLKOVÁ, K. - ĎURIKOVIČ, R. - FERKO, A. - FTÁČNIK, M. – JANČOŠEK, M. - KUBÍNI, P. – MARTINKA, J. – NOVOTNÝ, M. – SAMUELČÍK, M. - STANEK, S. - ŠIKUDOVÁ, E. -TÓTH, Z. - VALIENT, M. – ZIMÁNYI, M.

FMFI UK Bratislava

Agenda

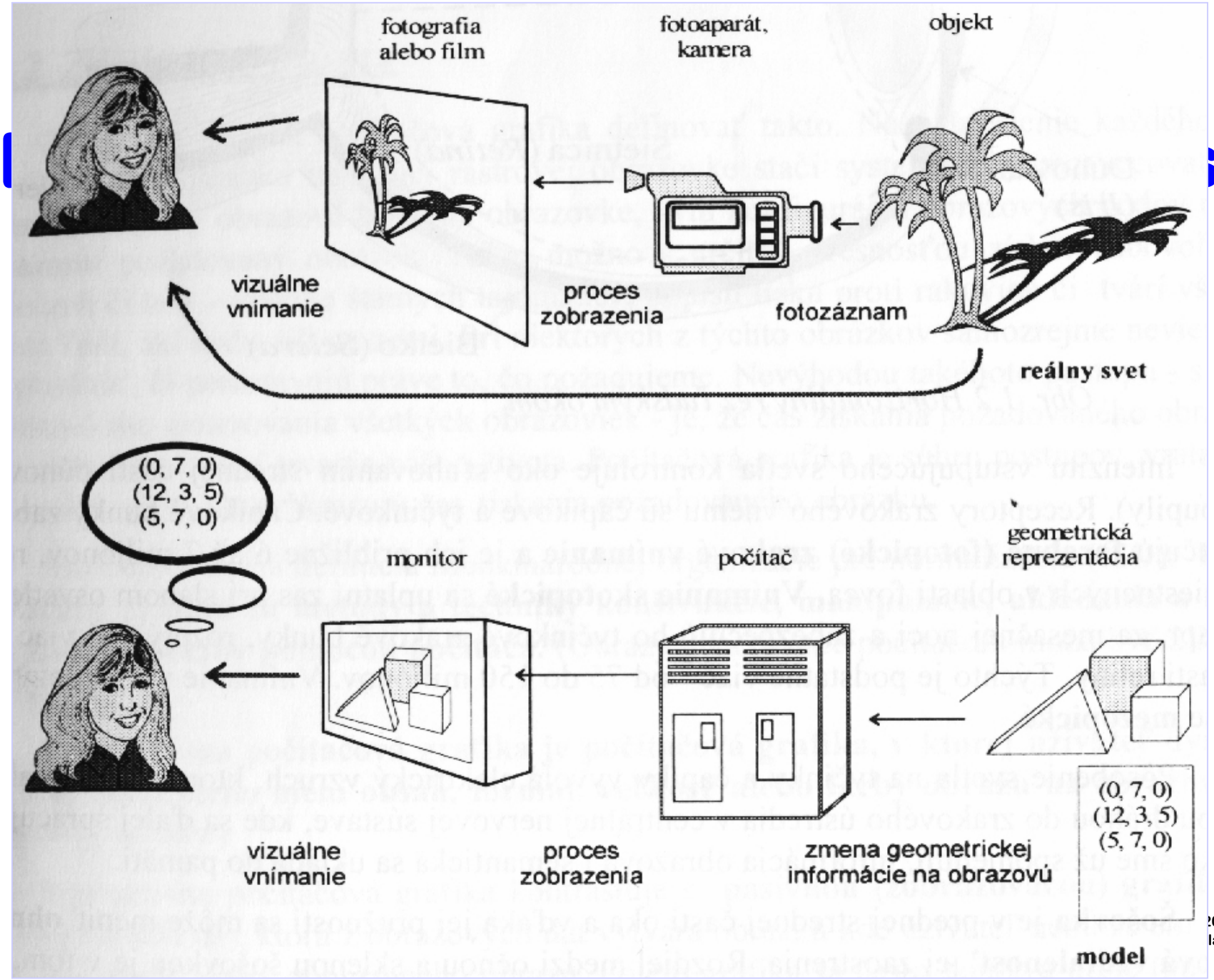


- Motivation
- Problem Formulation
- Cyber City Creation
- Specific Tasks in Virtual Habitat
- Semantic web & Digital libraries
- Selected Ideas
- Conclusions

Compare Reality - Synthesis

Photograph

Rendering using the deterministic method


fotografia
alebo film
fotoaparát,
kamera
objekt
vizuálne
vnímanie
proces
zobrazenia
fotozáznam
reálny svet
(0, 7, 0)
(12, 3, 5)
(5, 7, 0)
monitor
počítač
geometrická
reprezentácia
vizuálne
vnímanie
proces
zobrazenia
zmena geometrickej
informácie na obrazovú
(0, 7, 0)
(12, 3, 5)
(5, 7, 0)
model

CG Functional Unit

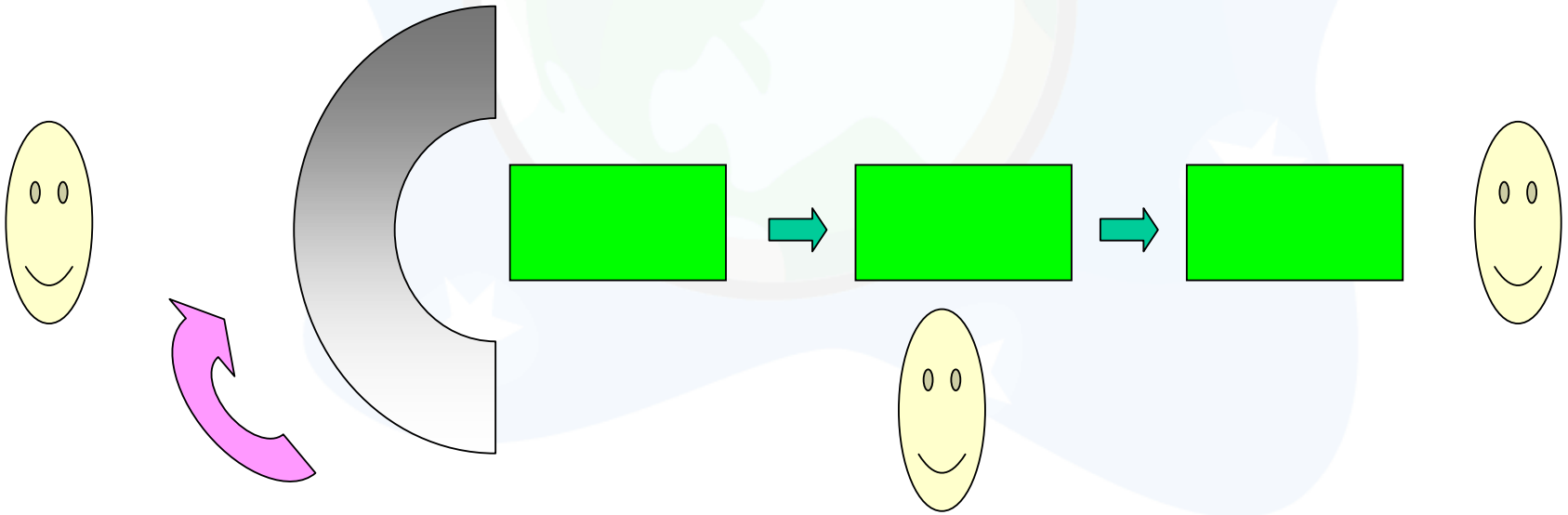
- **known model**
- **wireframe or surface representation:** geometric tranformations, visibility calculations, interpolations and raster manipulations
- **photorealistic quality:** the lighting and rendering equations solved to simulate the illumination, shading, shadows, natural and synthetic textures and colors
- **viewing:** parallel or perspective projections) create the image space
- **animation:** kinematic & dynamic data compute/capture, hierarchy of motions, interpolations in the scene and in the resulting sequence of frames (fps)

Photography ~ computer graphics

- **ISO: Computer graphics:** methods & techniques for construction, manipulation, storage and displaying pictures using computer.
- [Dobkin97]: Computer graphics is a radiometrically weighted counterpart of computational geometry
- 8D (x, y, z, t) (r, g, b, transparency)
- Schnellkurs

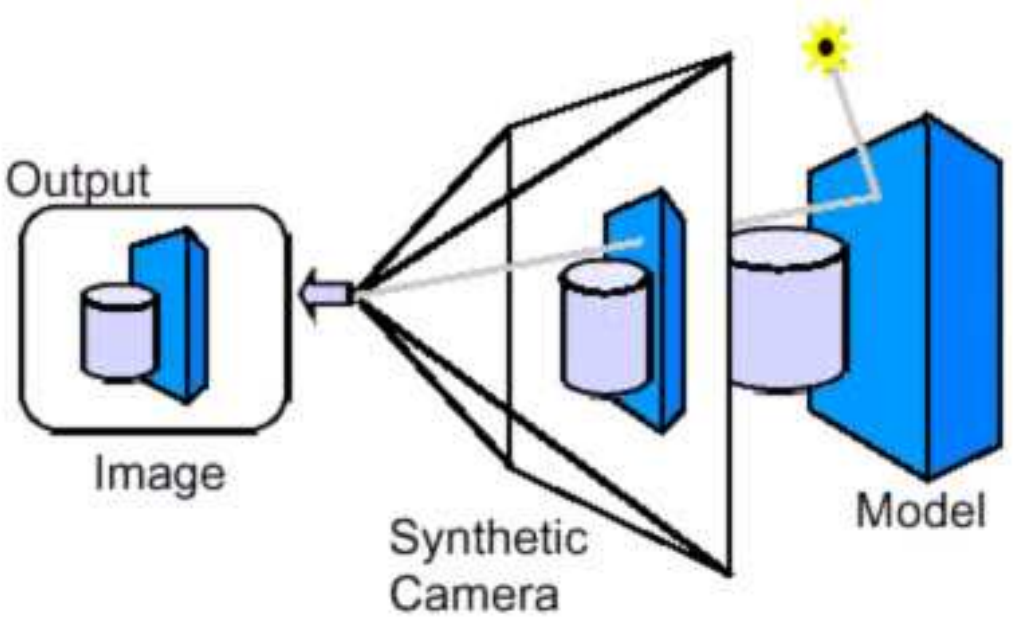
CG Reference Model

- White box… Black Box: known to unknown
- Problem, model, algorithm, software, results…



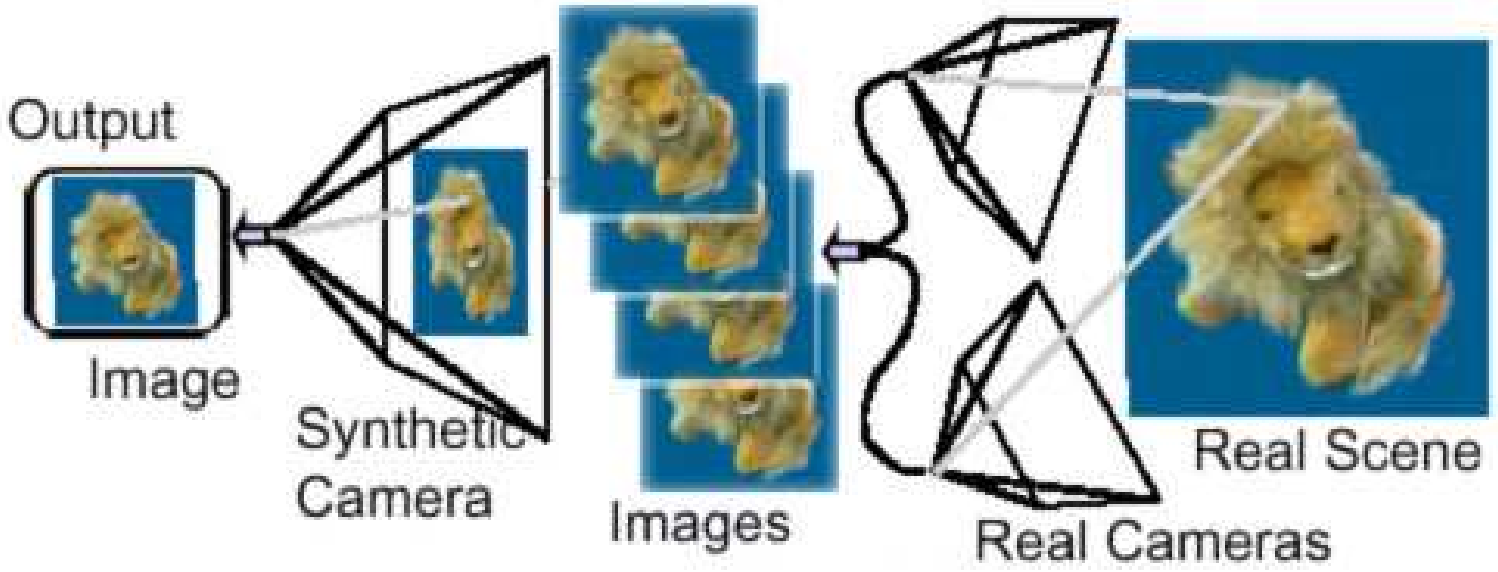
- Programmer… GS author… user
- Application… graphics system… g. workstation

Model-Based-Rendering



The real scene built with geometric objects

Image-Based-Rendering

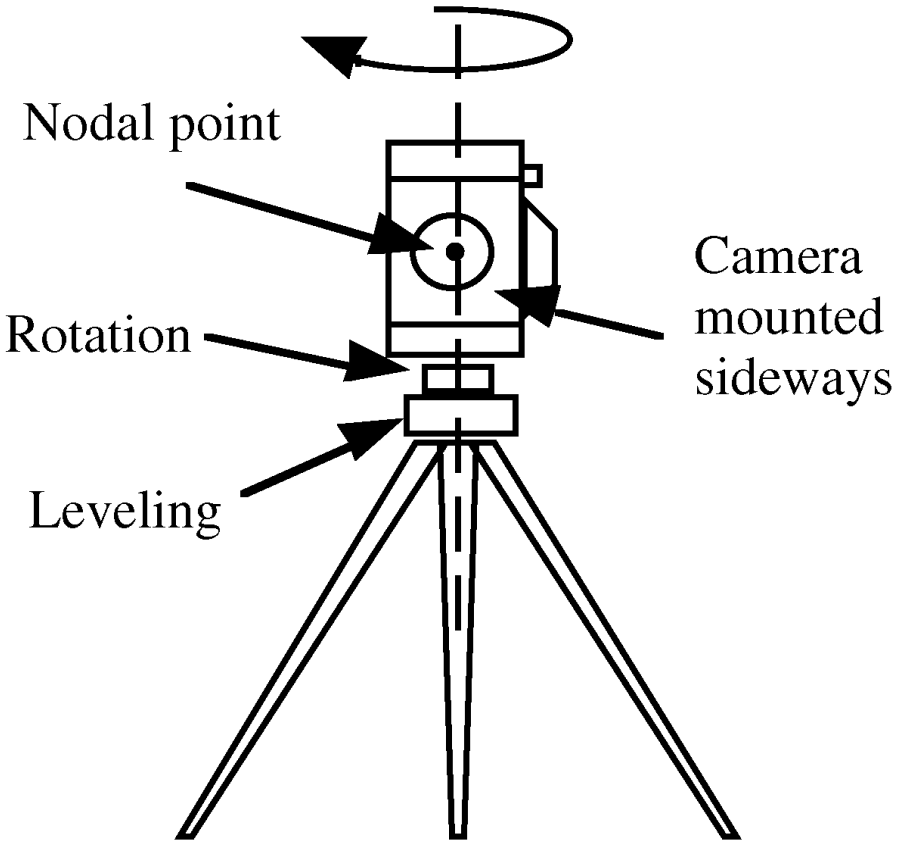


- **Varied views on real scene combined to the new one**

- **[McMillan95]: Given a 3D model, generate a minimal set of images of the model such that for all subsequent query viewpoints, the correct image can be recovered by combination of sample images.**

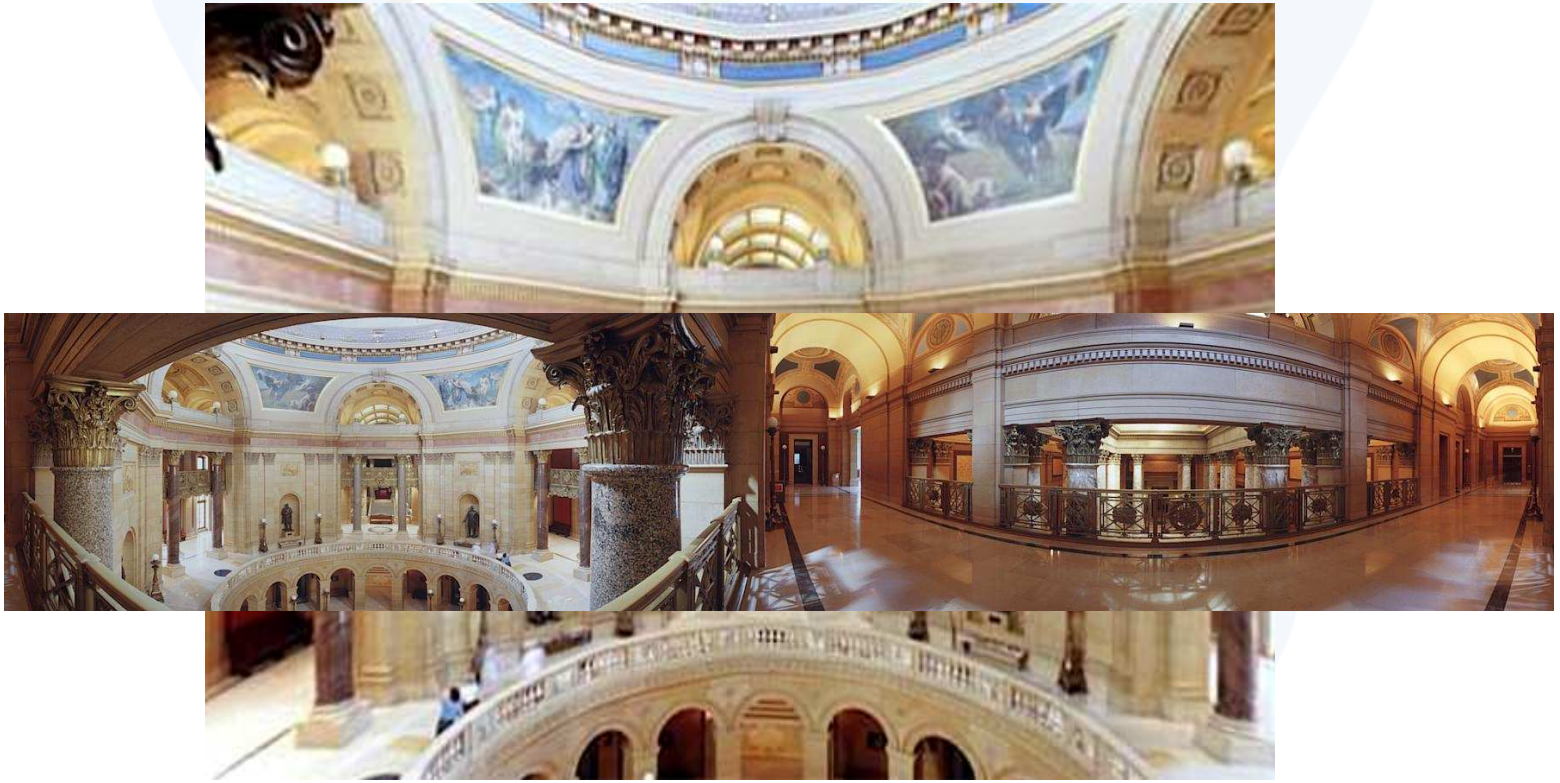
Recording Systems

- Rotating Platform
  - CCD-lines
  - CCD-camera
  - Stereocameras pair



- Panoramas from
- exponed positions

From Panoramic Images to Image Synthesis



Functionality 4 Panoramas

- Panorama image equalize
- Inner side of a cylindric panorama texturing
- Look up from the central axis
- Camera rotation: turn and declination
- Zoom
- (Virtual Louvre, VHCE... Apple, Dersch)

Rendering Spectrum

- Images — Geometric models
- Appearance based — Physically based

- **Lumigraph, light field, sprites, layers, bilboards, triangles, global illumination**
-
- J. Lengyel 1998 Siggraph Paper, Haines-Moeller

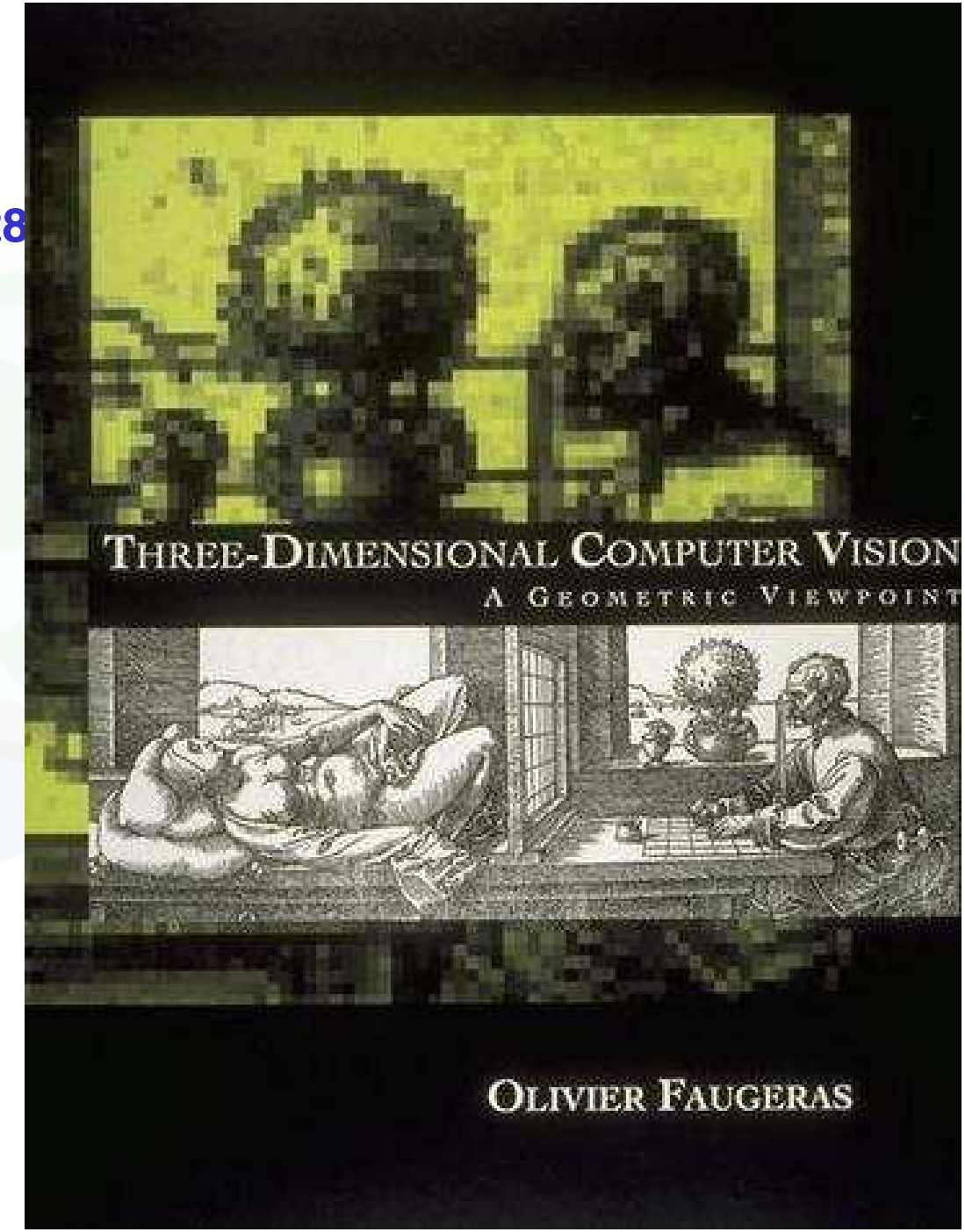
Computer Vision

- **Image(s) – Analysis - Model**

- MIT, M. Minsky – semestral AI project
- Gibson 1945 – monocular, stereo, ambient vision
- D. Marr… ECCV 2004 Prague

A. Dürer (1471-1528

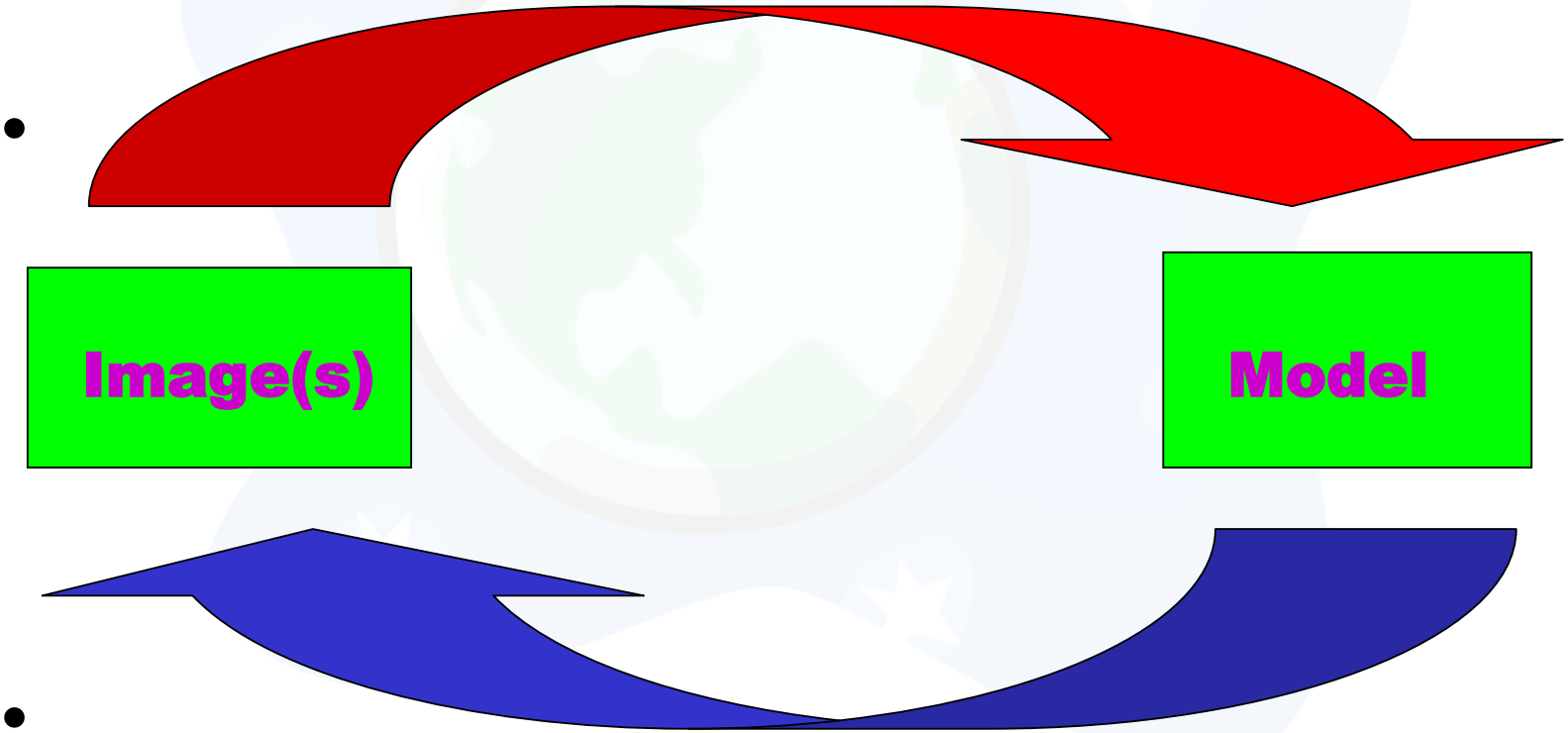
- ...



CV Functional Unit

- **unknown model, images or nonpictorial data**
- **preprocessing:** data converted, digitalised, transformed linearly or nonlinearly, filtered, compressed, segmented, etc.
- **image analysis/pattern recognition:** feature extraction, classification, and interpretation giving the model.
- **output:** description of the previously unknown model

Computer Graphics & Vision



- M. Pollefeys: From Images to Images

Inverse Problem

- Questionable notion (Skiena in Goodman)
- Alternatives: reconstruction, parameter estimation, inverse rendering…
- Ill-posed reconstruction problems: CV, surfaces from data points, computer tomography, 3D models from 2D images, shape from stereo, shape from video, shape from motion…
- Static and dynamic versions
- **Given two different geometric structures A, B and transformation T such that T(A) = B. Construct a structure A': T(A') = B**

Graphics & Visual Computing

ACM Computing Curriculum

at http://www.computer.org/education/cc2001/final/gv.htm:

Graphics & Visual Computing (GV):

Computer graphics.

Visualization.

Virtual reality.

Computer vision.

Computer Graphics

***Computer graphics** is the art and science of communicating information using images that are generated and presented through computation. This requires:*

***(a)** the design and construction of models that represent information in ways that support the creation and viewing of images,*

***(b)** the design of devices and techniques through which the person may interact with the model or the view,*

***(c)** the creation of techniques for rendering the model, and*

***(d)** the design of ways the images may be preserved. The goal of computer graphics is to engage the person's visual centers alongside other cognitive centers in understanding.*

Visualization

Visualization. ***The field of visualization seeks to determine and present underlying correlated structures and relationships in both scientific (computational and medical sciences) and more abstract datasets.***

The prime objective of the presentation should be to communicate the information in a dataset so as to enhance understanding.

Although current techniques of visualization exploit visual abilities of humans, other sensory modalities, including sound and haptics (touch), are also being considered to aid the discovery process of information.

Virtual reality (VR)

VR enables users to experience a three-dimensional environment generated using computer graphics, and perhaps other sensory modalities, to provide an environment for enhanced interaction between a human user and a computer-created world.

Computer vision (CV)

Computer vision. ***The goal of computer vision (CV) is to deduce the properties and structure of the three-dimensional world from one or more two-dimensional images. The understanding and practice of computer vision depends upon core concepts in computing, but also relates strongly to the disciplines of physics, mathematics, and psychology.***

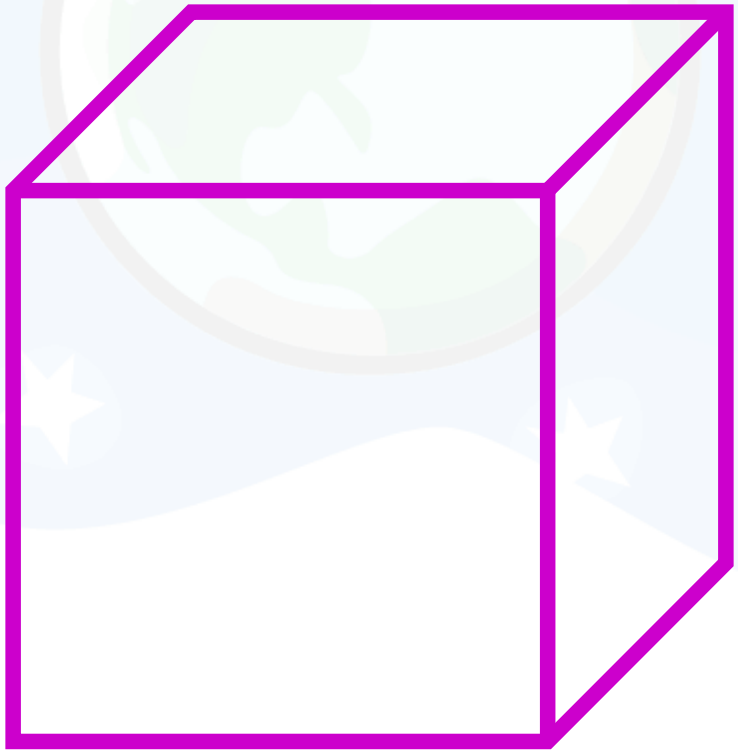
Inverse Problem

- **Given two different geometric structures A, B and transformation T such that T(A) = B. Construct a structure A': T(A') = B**

- Definition by Steven S. Skiena, p. 481 in Goodman-O'Rourke. Handbook of Discrete and Computational Geometry. CRC Press 1999.
- B – set of 2D measurements (photos)
- A, A' – 3D scenes, real or virtual worlds, A' (3D copy)

Inverse Problem

- **Ambiguity => no unique solution**



The Simplest Inverse Problem

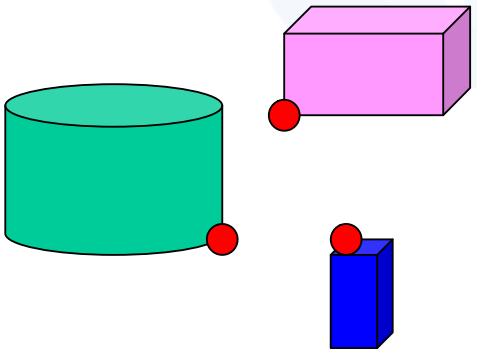
- Coordinates (x_1, x_2), (y_1, y_2), (z_1, z_2)
- Real constants a, b, c, d, e, f

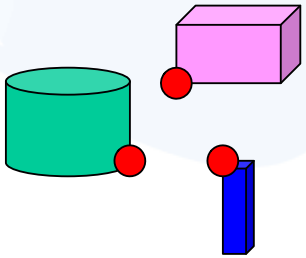
- Transform:
- $f(x1) = a^* x_1 + b^* x_2 + e$
- $f(x2) = c^* x_1 + d^* x_2 + f$

- Any composition of rotation, zoom, translation

Affine Transform in 2D Wanted

- How can one find the affine transform f(x), which approximately transforms one set to another?
- Theorem (after M. Barnsley). Affine transform is given by triplet of function values.





1. Coordinate system (O, x, y).

2. Denote 3 points in the original set by

(x1, x2), (y1, y2), (z1, z2).

3. Denote 3 corresponding points

in the transformed set as

(fx1, fx2), (fy1, fy2), (fz1, fz2).

4. Solve for a, b, e the following system

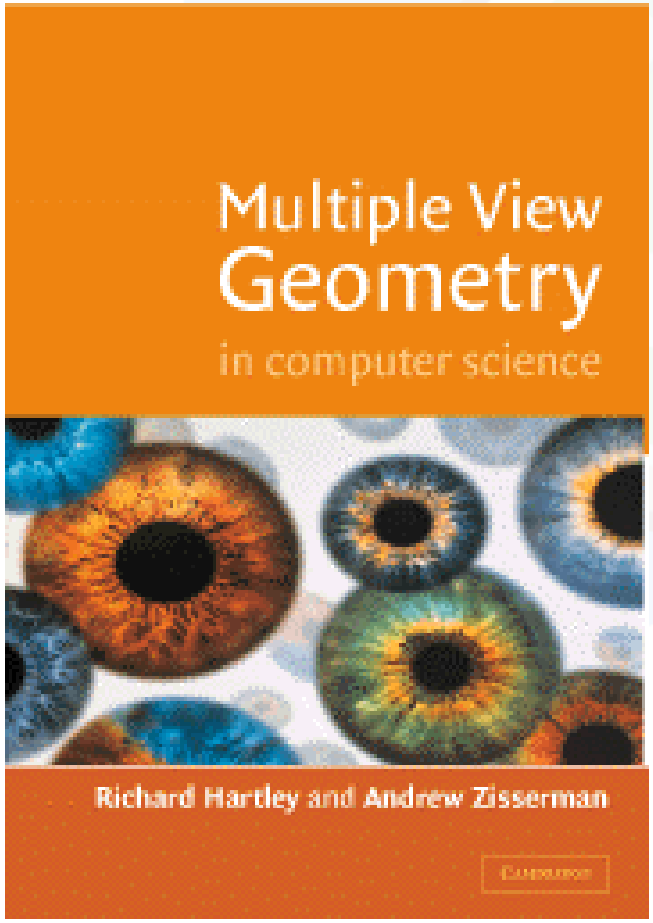
$$x1*a + x2*b + e = fx1$$

$$y1*a + y2*b + e = fy1$$

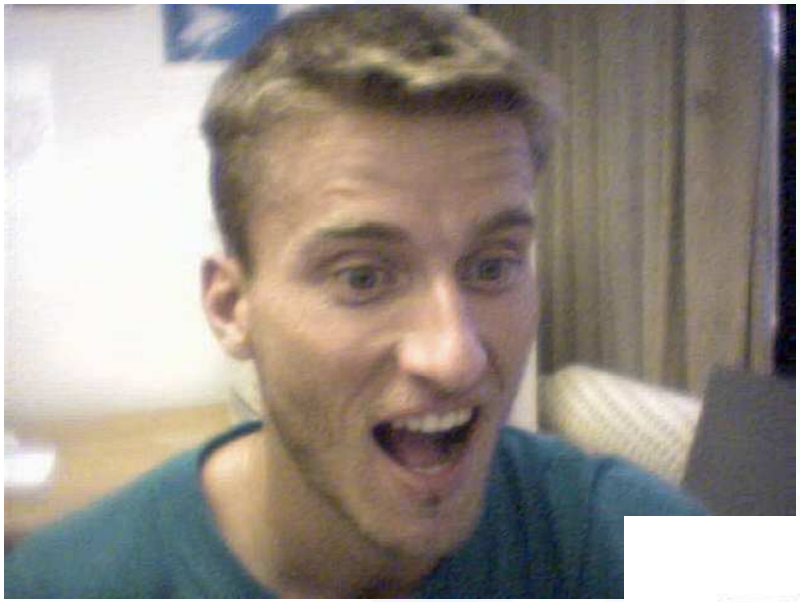
$$z1*a + z2*b + e = fz1$$

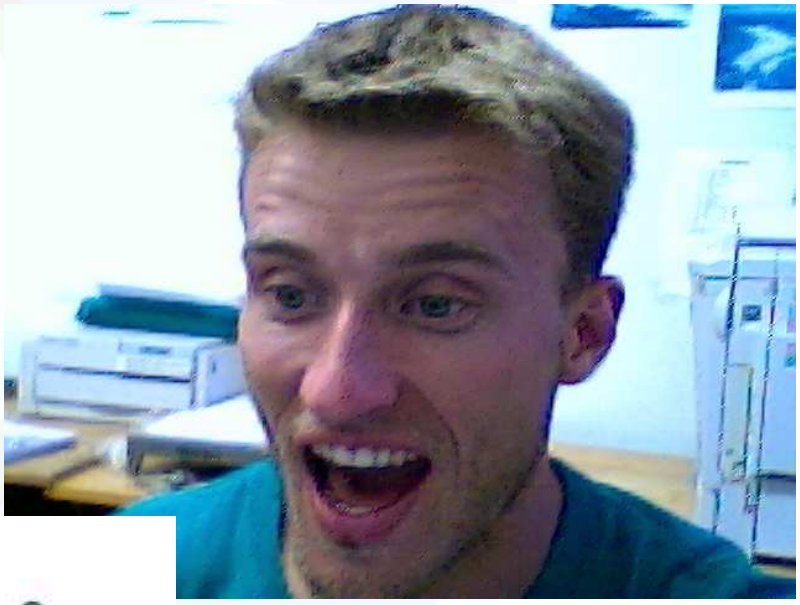
5. Analogously for c, d, f.

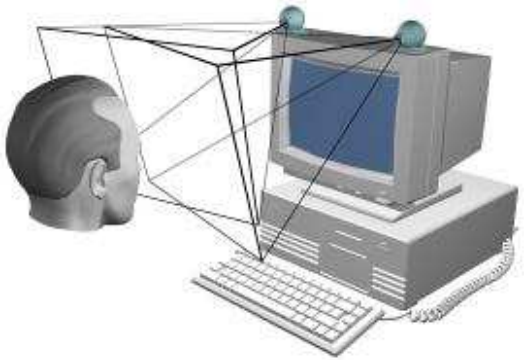
More Cameras/Views



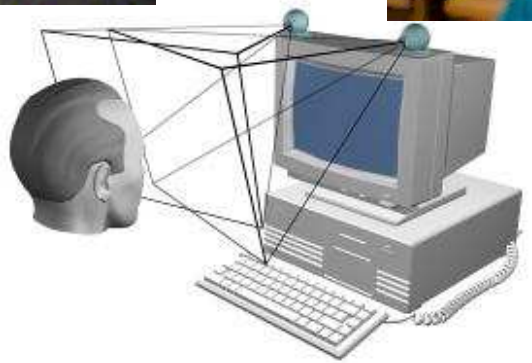
Epipolar Case – Stanislav Stanek





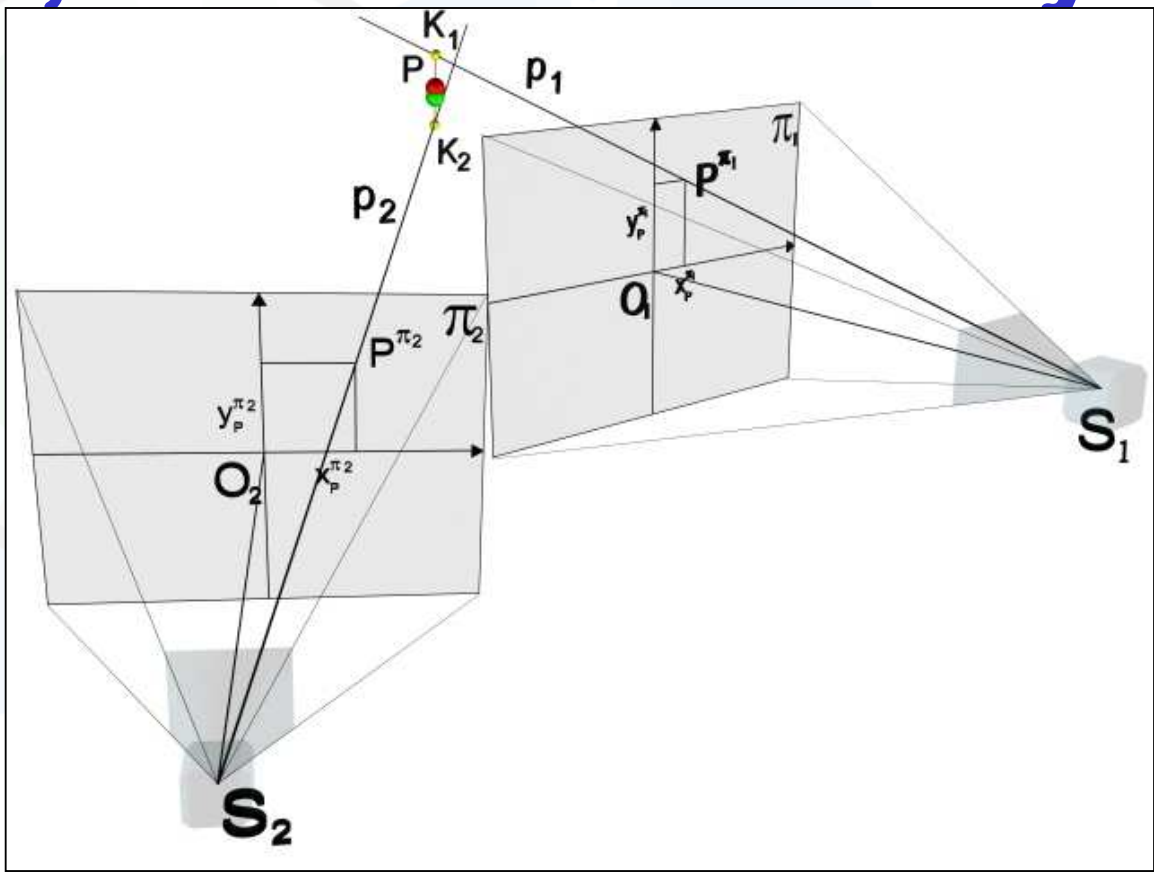


Cameras Calibration



Two Cameras, Two View Geometry

- S. Stanek
- MPEG-4

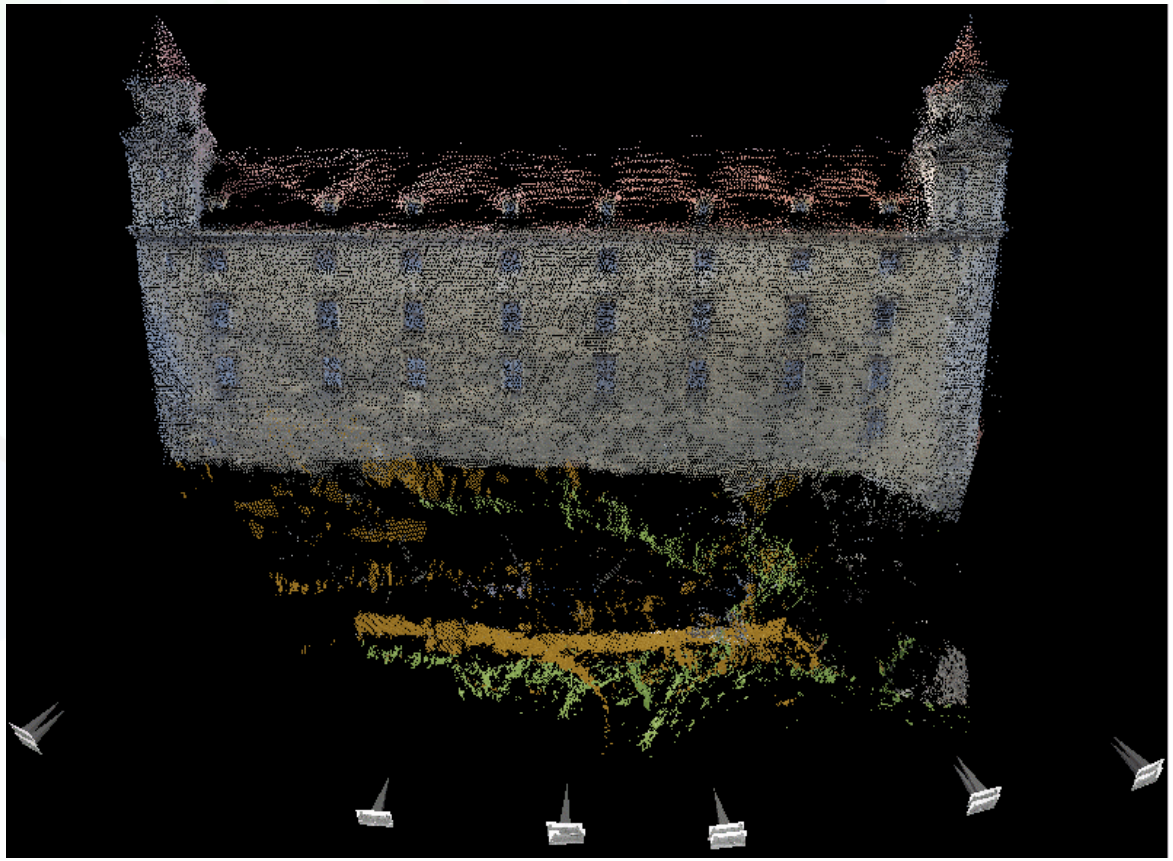


- Fundamental Matrix (3 Cameras ~ Trifocal tensor, 4 max)

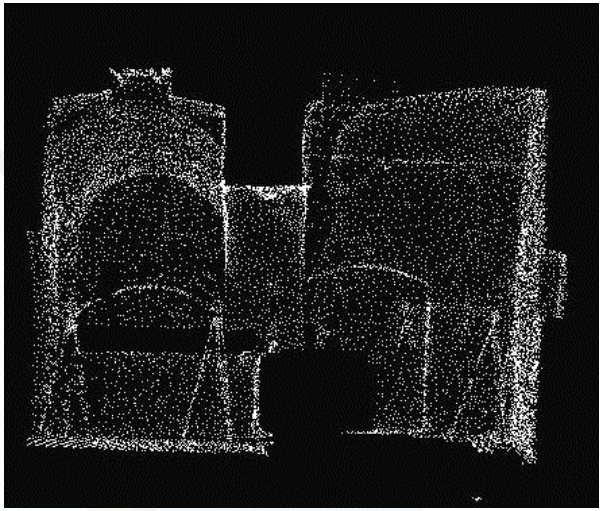
Urban 3D Reconstruction, Bratislava Castle

- S. Stanek
- The first one
- MetropoGIS
- Canon D30

- Laser data
- For Well

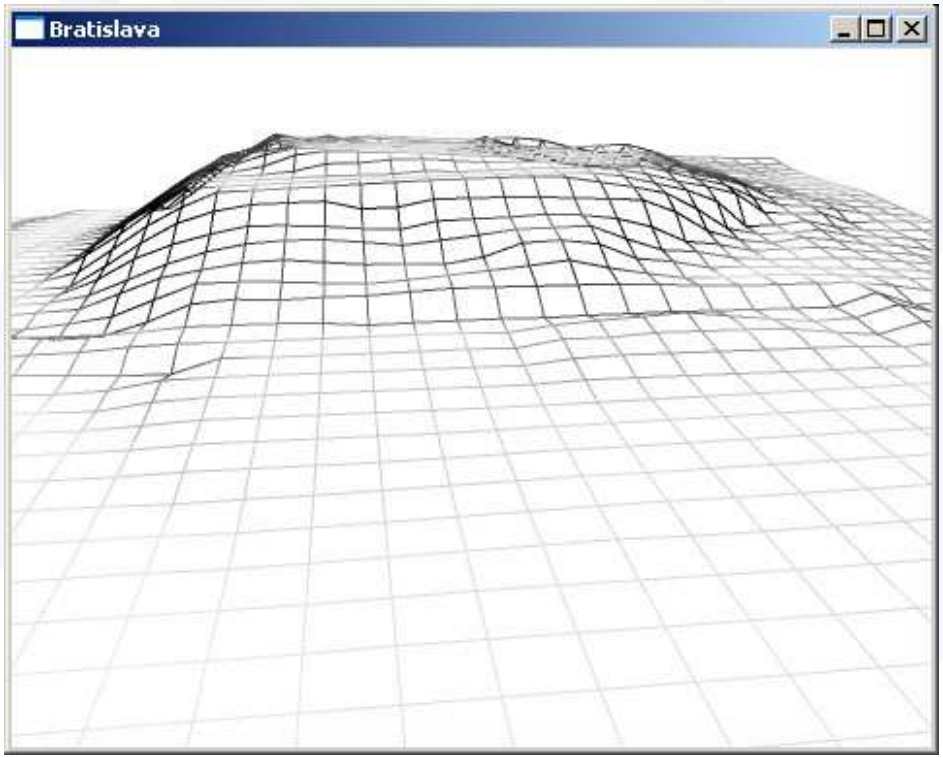


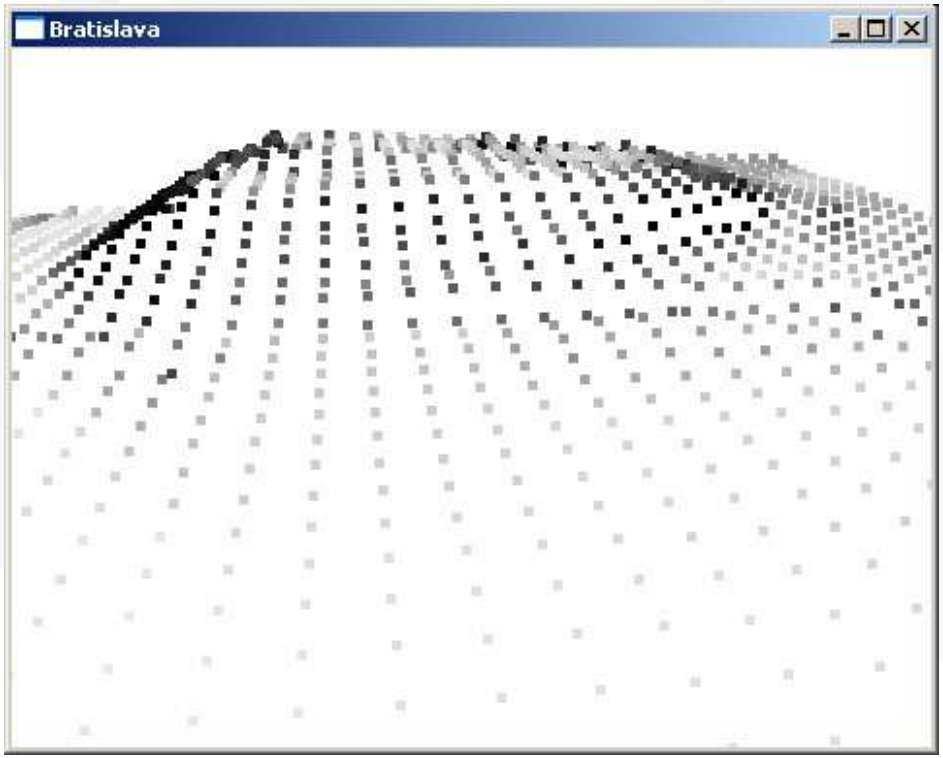
Hradná studňa – Castle Well

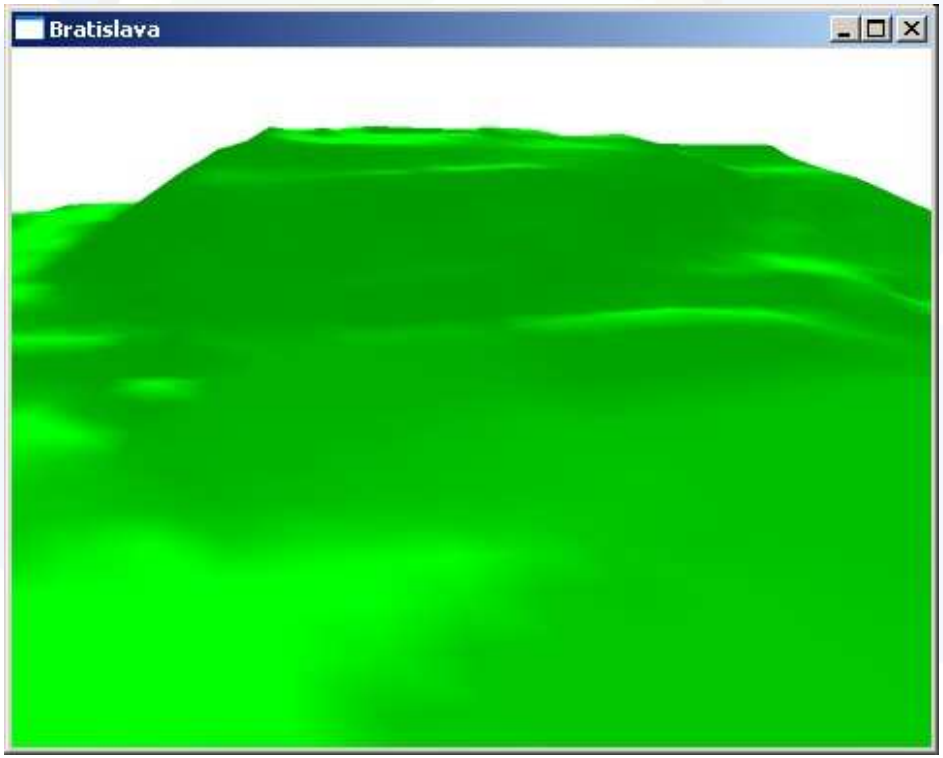


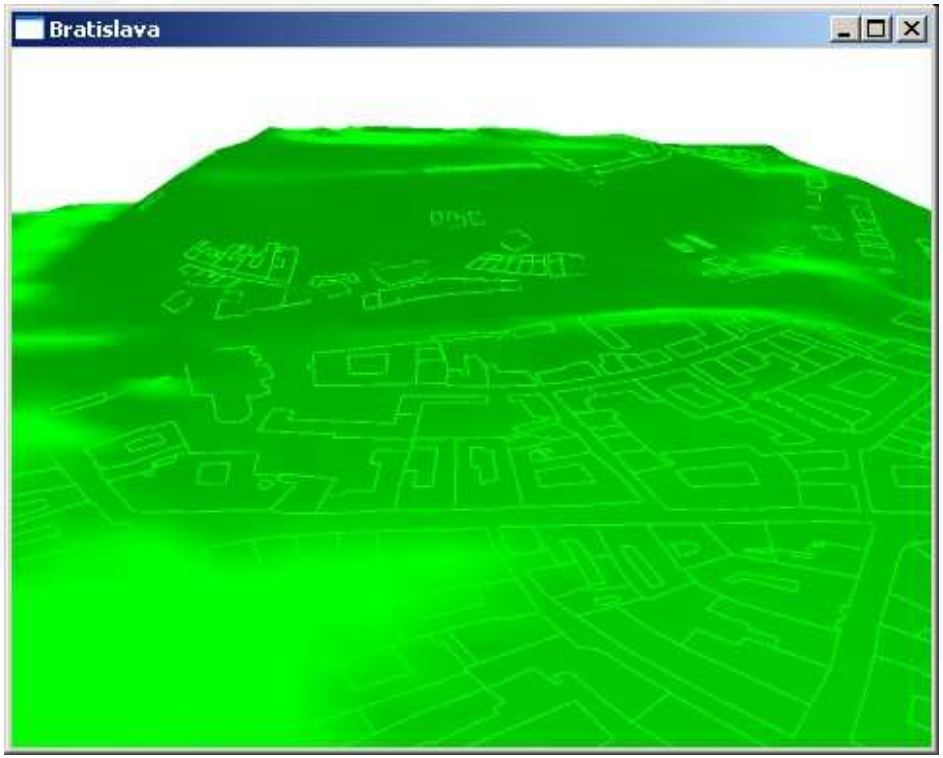
Model Building Pipeline

- Callibration
- Acquisition
- Registration
- Point Creation
- Model Creation
- Model Compression
- ROTH, G. 2000. Building Models from Sensor Data. *Pp. 87-104 in LEONARDIS, A. et al. Confluence of CV and CG. NATO Science Series.*


Bratislava


Bratislava


Bratislava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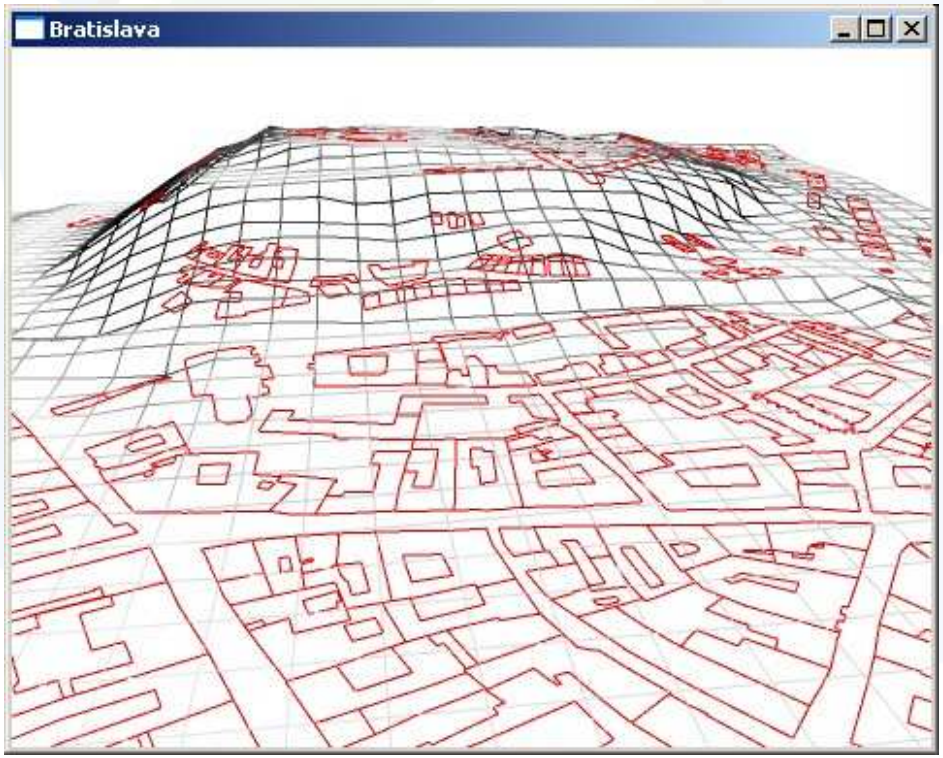
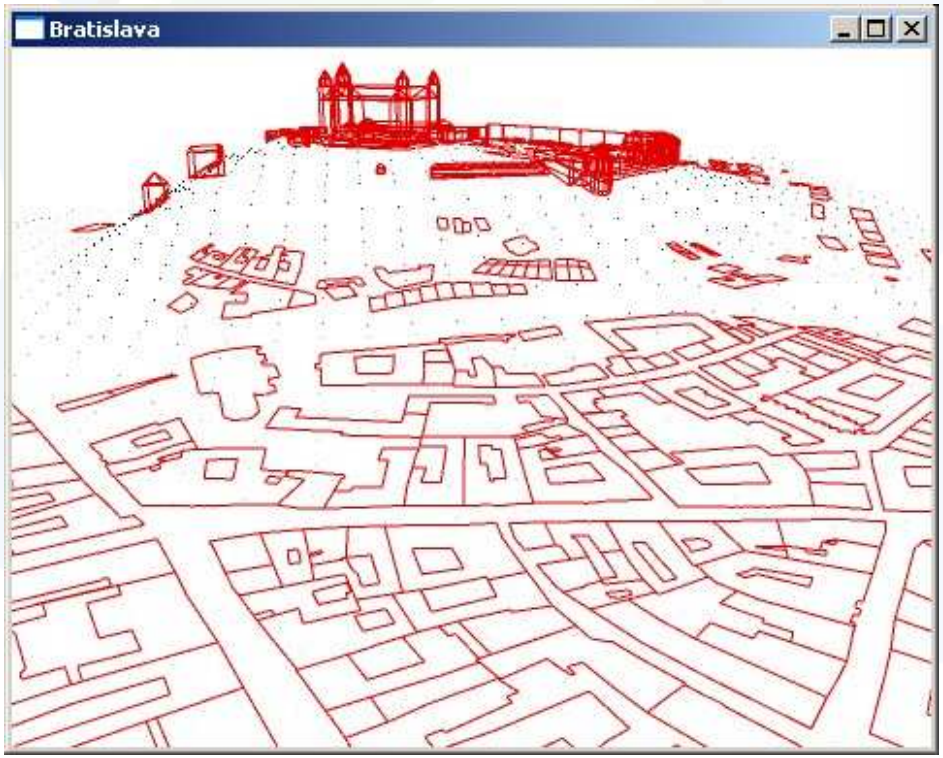

Bratislava


Bratislava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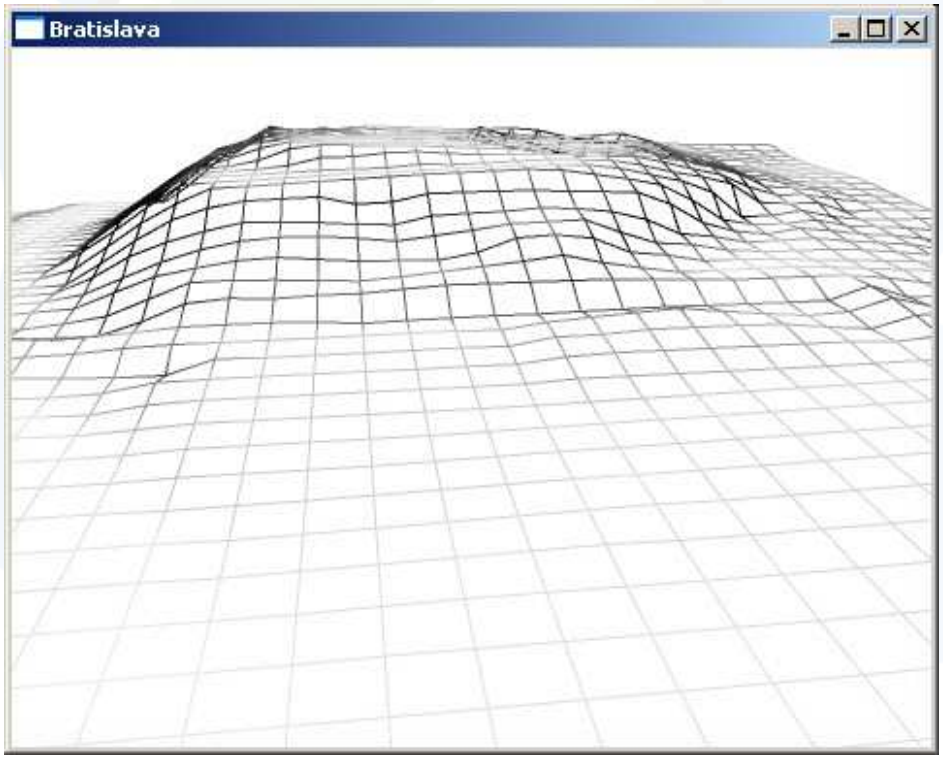
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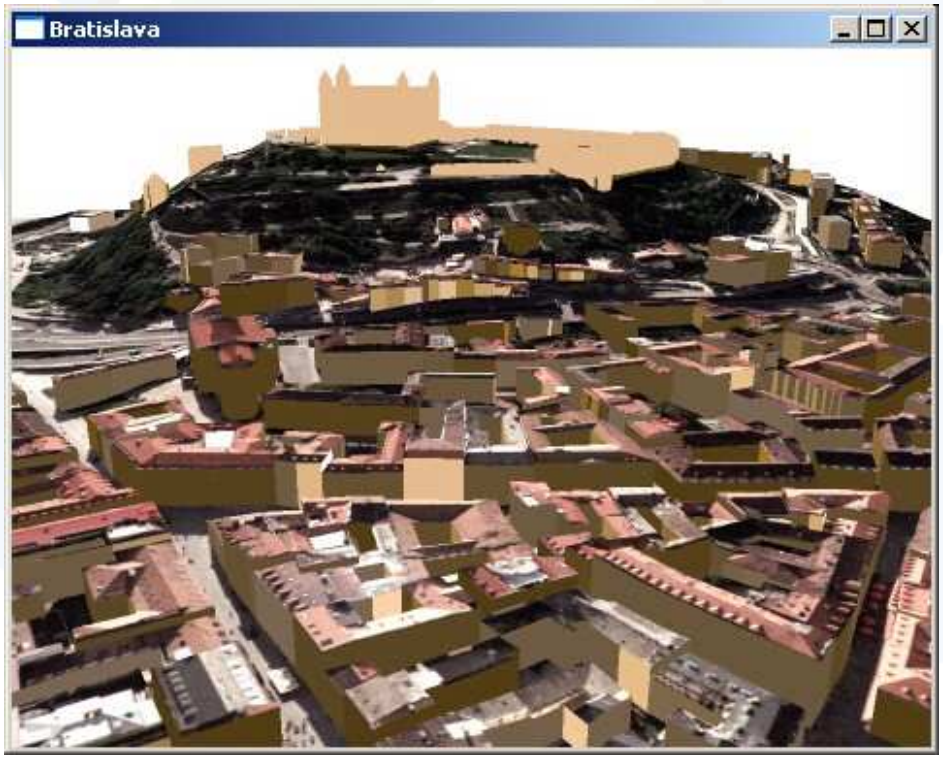
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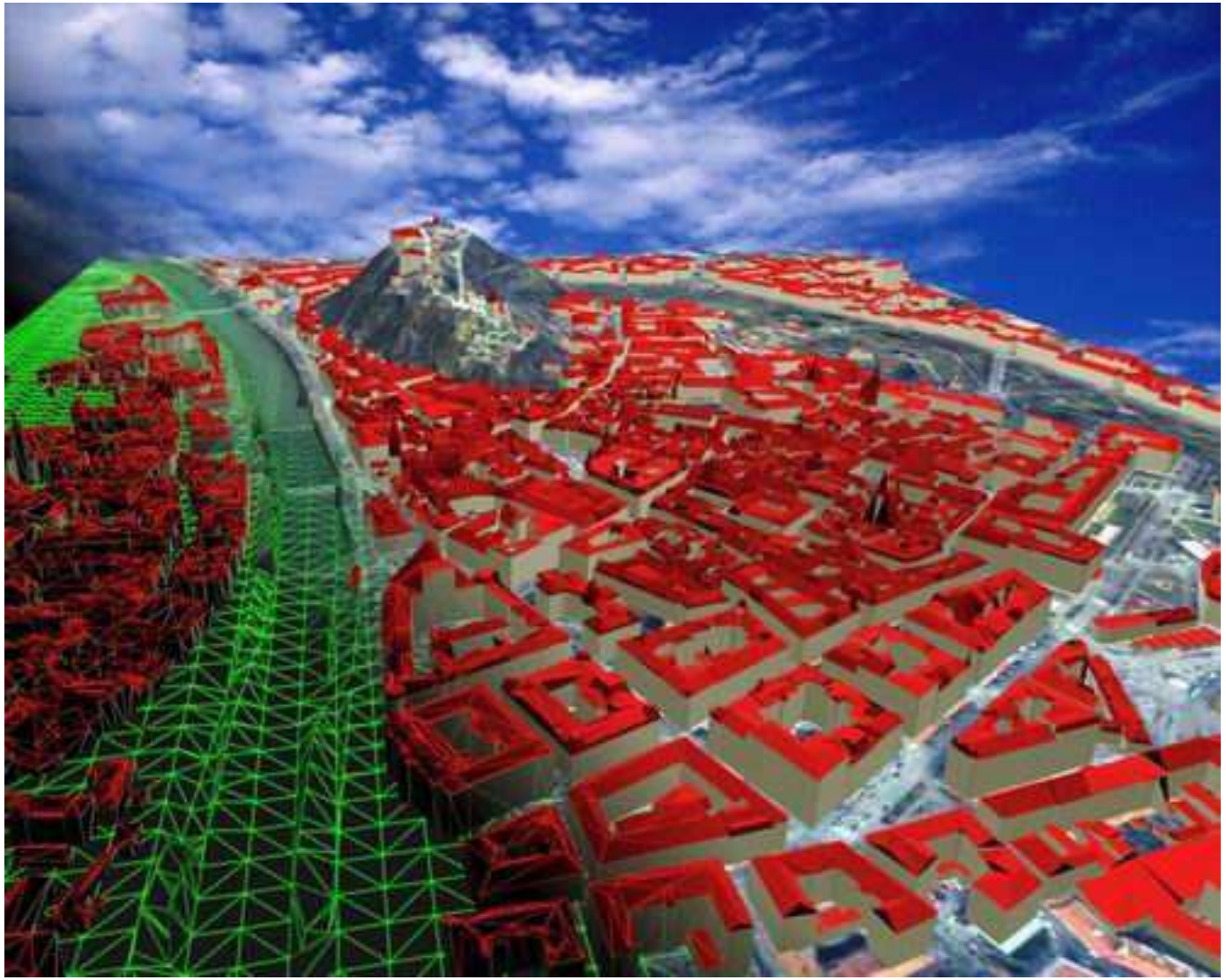
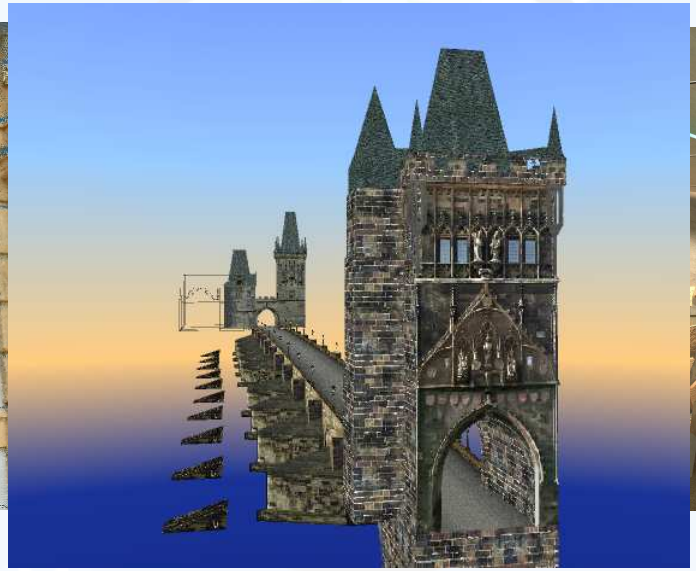
Virtual Graz (TU Graz, prof. Leberl)



Virtual Heart of Central Europe



Feature-based Approach

- P. Kubini – face tracking and robot vision
- Veszprem, Graz, Warszawa…

Feature-based Approach

- M. Jančošek – MSER (maximally stable extremal regions) – towards automatic correspondence
- I. Kolingerova, K. Karner, J. Bauer - triangulations

Sample images

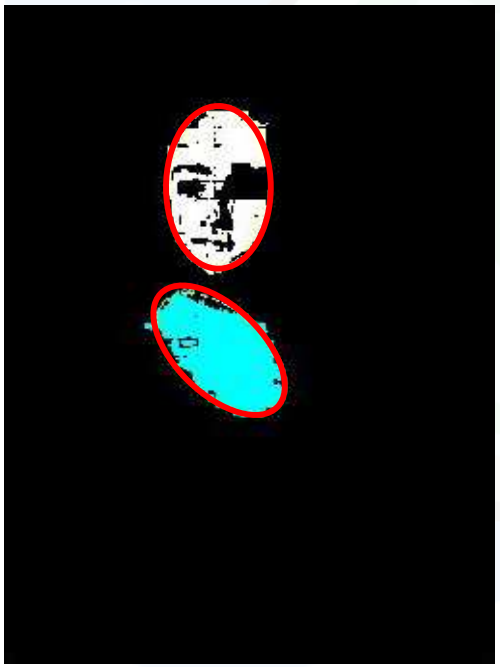
Portrait of Countess Sophie Matiuskina (1755-1796)

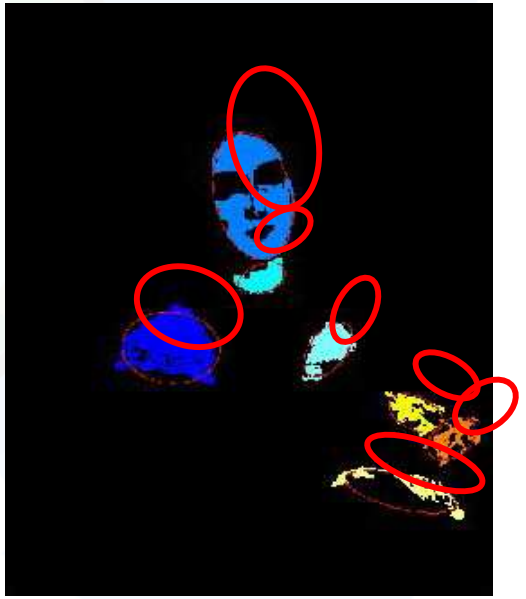
by Kirill Ivanovich Golovachevsky

Portrait of M.A. Bek

by Karl Pavlovich Bryullov

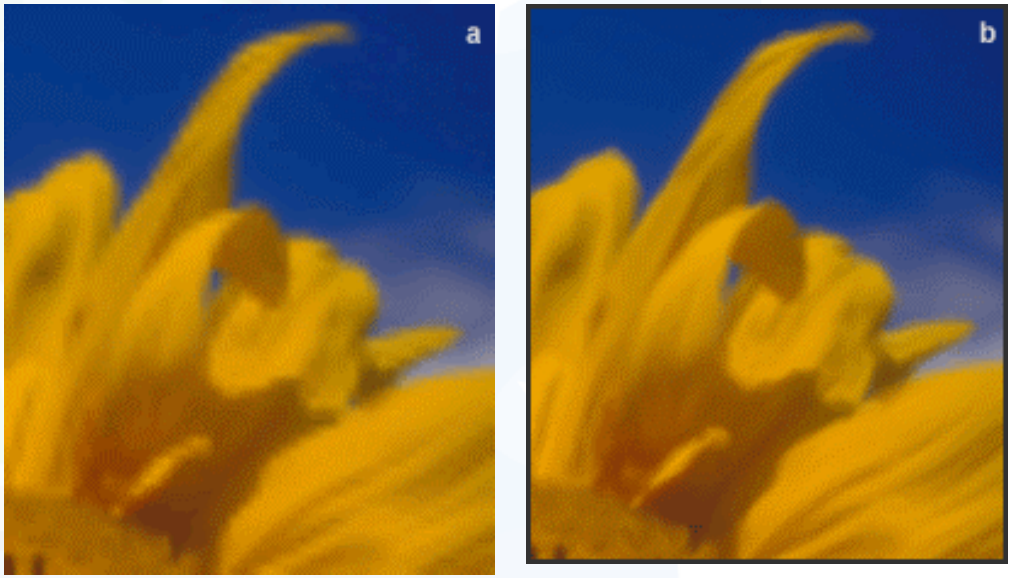
Ellipse fitting results – Ela Šikudová





Towards an Optimal Texture Reconstruction

- Zsolt Tóth



- **Data Dependent Triangulations**
- Cena rektora UK 2004
-

Real-time Lighting and Shading

- **M. Valient**
- **Lighting and Shading for Real-time Applications**

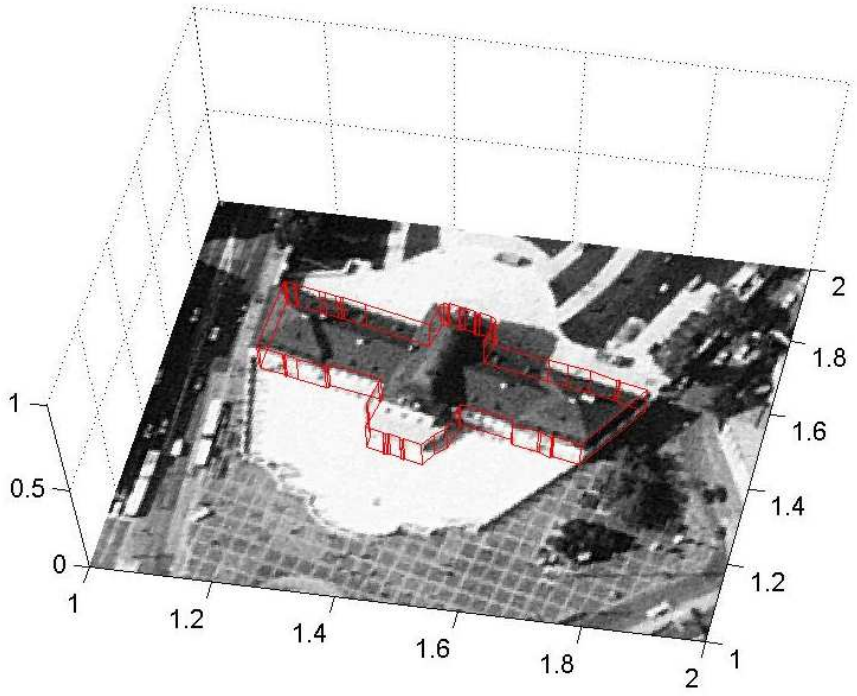
- ENGEL, W. F. et al. 2003. *Advanced Lighting and Shading with Direct3D 9*, Wordware 2003.

Real-time Rendering Engine

- T. Bujnak
- Algorithms for Real Time Graphics
- Siemens Excellence Award 2004

3D Modeling from Photographs

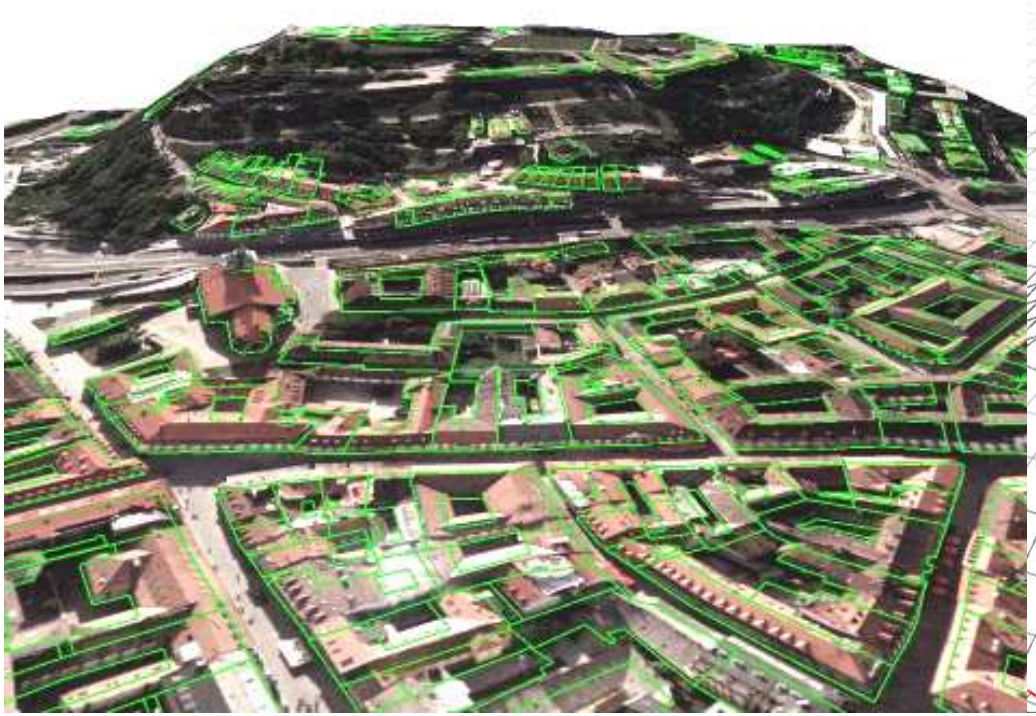
- Kateřina DAŘÍLKOVÁ
- Building extraction, shadows…
-

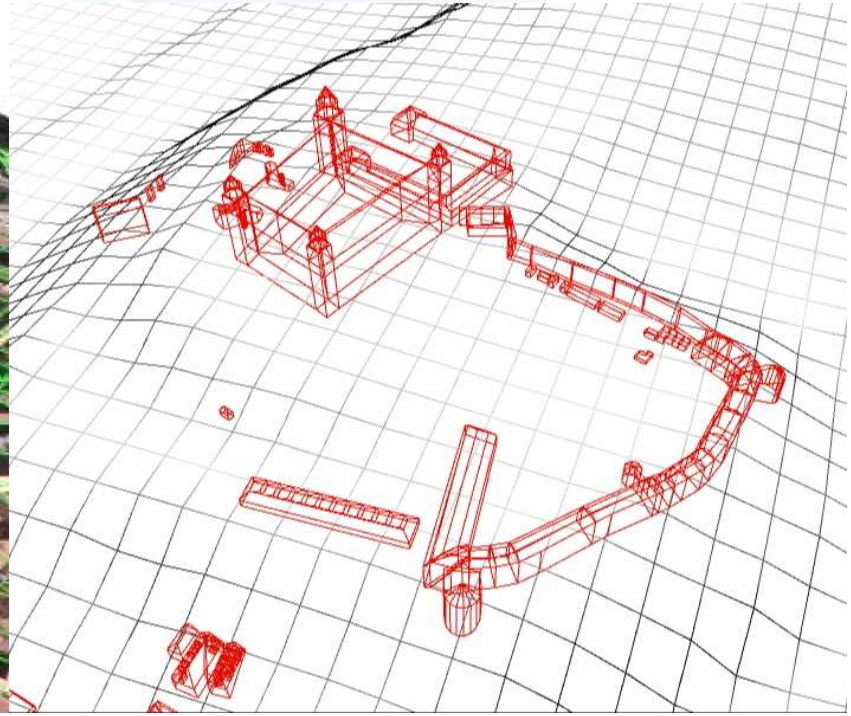


Vegetation from Photographs

- In Cooperation with FNS CU
- Katka Smoleňová

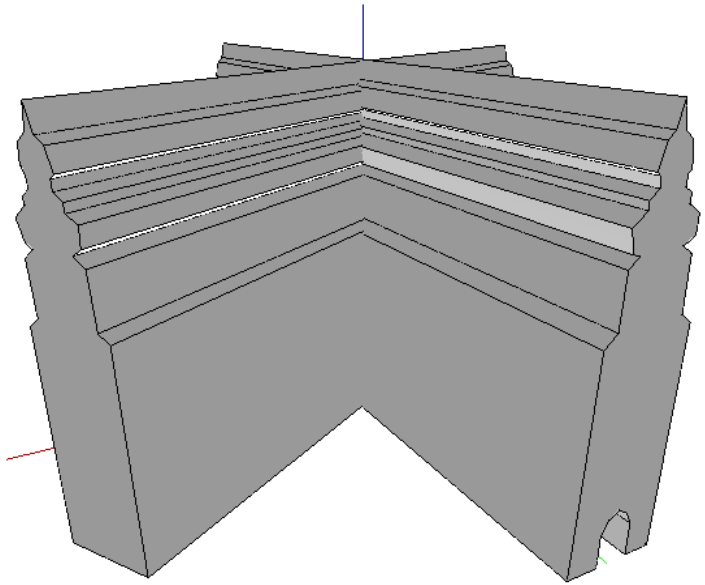
Terrain & Cadastrial Data, P. Borovsky

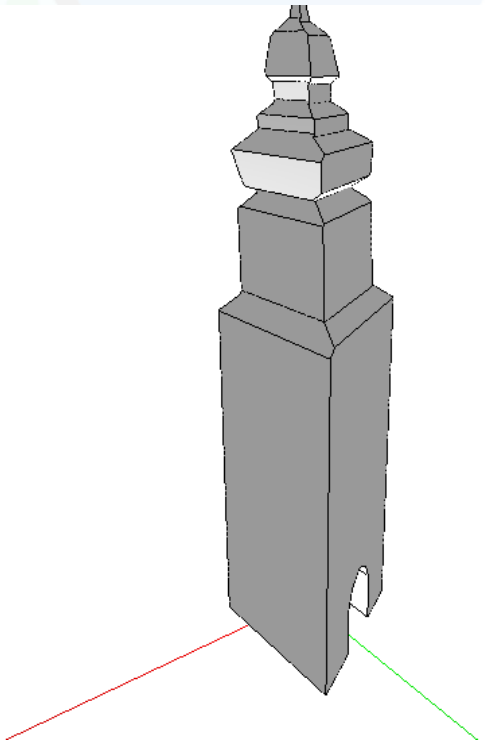




Data by Bratislava Magistrat

Silhouette Modeling, M. Samuelcik





One View Gemoetry, Symmetric Objects

Terrestrial Modeling, M. Zimanyi

Aerial Photos Texturing, P. Borovsky

Data by
EUROSENSE

Texturing with Terrestrial Images by Jan Lacko

- Building roofs reconstructed by Eurosense from aerial photos

Taxonomy

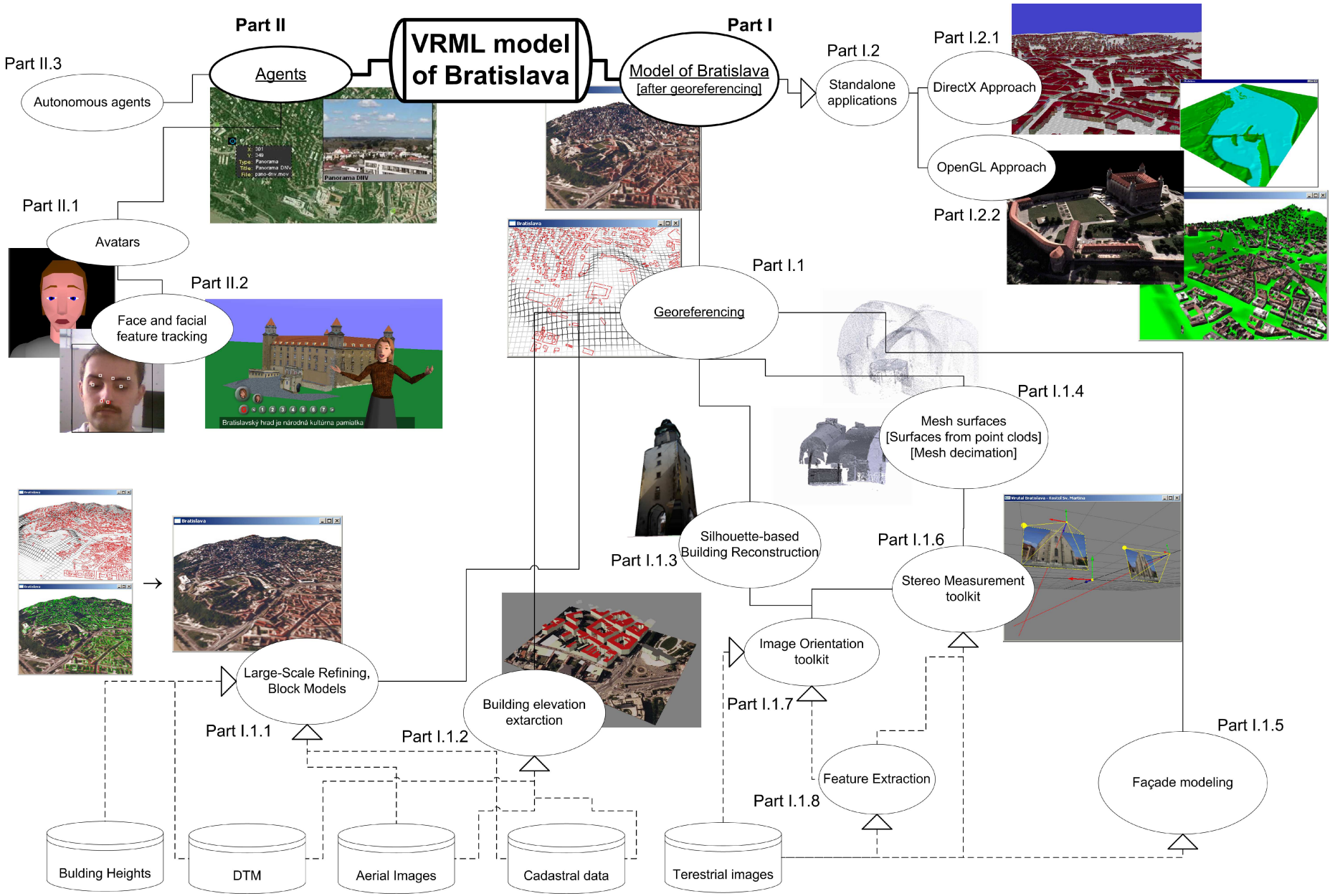
- CT scans
- airborne cameras (satellite, airplane)
- terrestrial photos, calibrated or uncallibrated camera, knowm or unknown motion,
- cadastral, terrain, and project (CAD) data,
- panoramas, cubic, cylindric, spheric,
- foveal images,omnidirectional
- range images from laser measurements,
- video sequences,
- omnidirectional camera by Vasek Hlavac,
- others (handmade sketches, verbal description in an old chronicle...)

Another Taxonomy Criteria

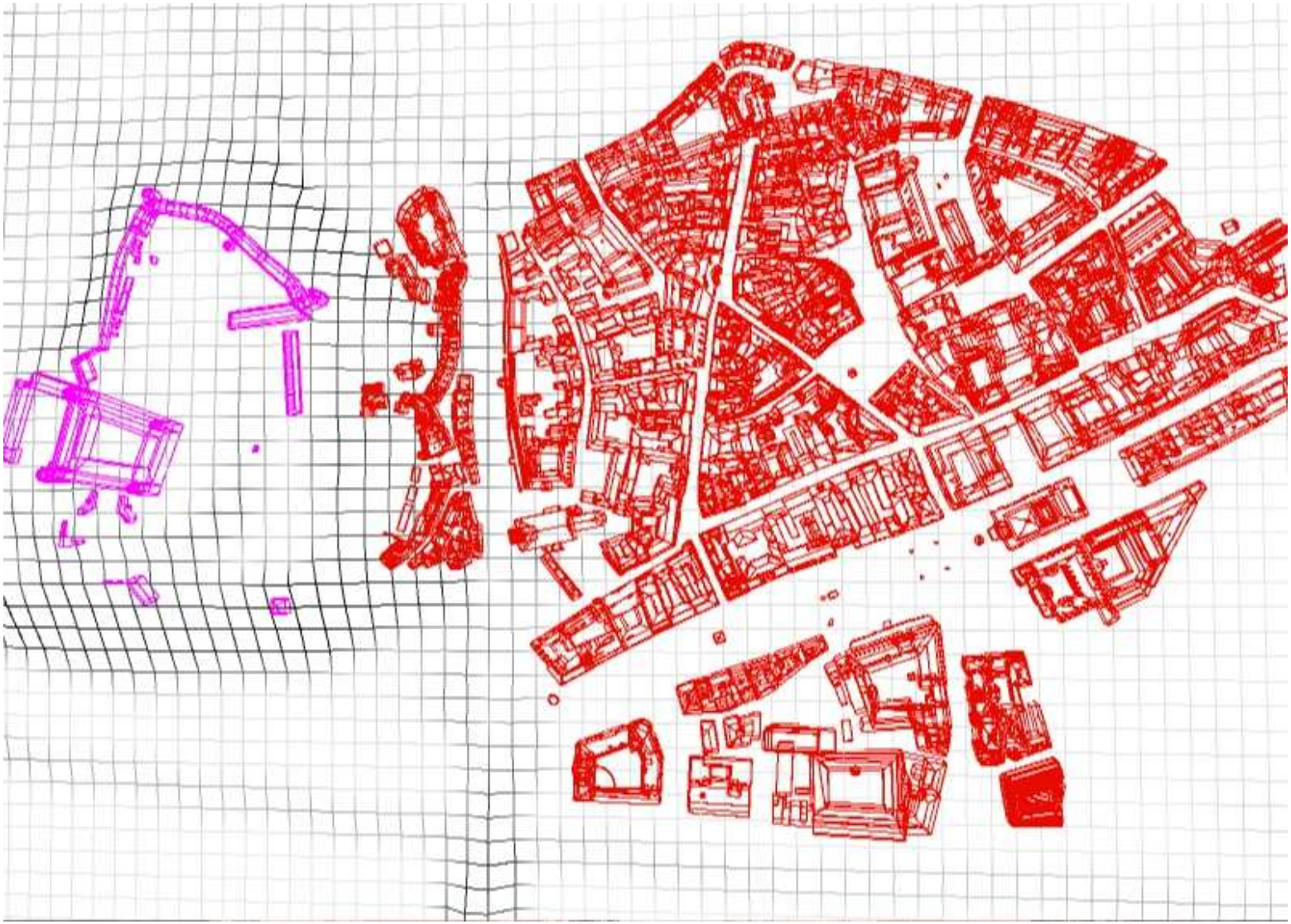
- Content
- Output purpose, tools…
- In total, 3D array of possibilities, where live particular workflows
- In search of standard…
- QVORTRUP: VE documentation/creation, navigation, cooperation

Workflow by Marek Zimanyi

- A Tour into the future 3D xerox…

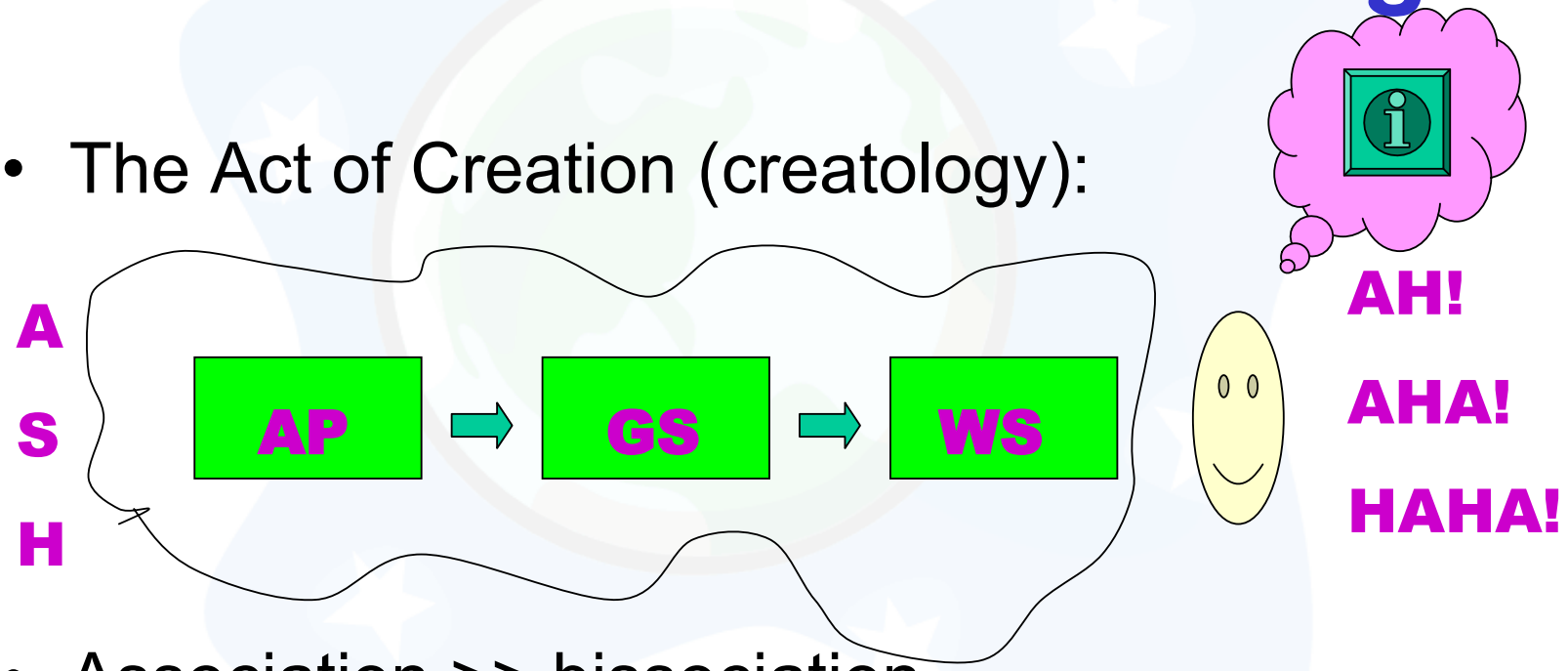

VRML model of Bratislava
Part II
Part I
Part II.3
Autonomous agents
Agents
Part II.1
Avatars
Part II.2
Face and facial feature tracking
Model of Bratislava [after georeferencing]
Part I.2
Standalone applications
Part I.2.1
DirectX Approach
OpenGL Approach
Part I.2.2
Part I.1
Georeferencing
Part I.1.4
Mesh surfaces [Surfaces from point clods] [Mesh decimation]
Part I.1.3
Silhouette-based Building Reconstruction
Part I.1.6
Stereo Measurement toolkit
Image Orientation toolkit
Part I.1.7
Feature Extraction
Part I.1.8
Façade modeling
Part I.1.5
Large-Scale Refining, Block Models
Part I.1.1
Building elevation extarction
Part I.1.2
Bulding Heights
DTM
Aerial Images
Cadastral data
Terestrial images

AMVH, APVT, Strapamo, APVV…



On Model of a Human Being

- The Act of Creation (creatology):



- Association >> bissociation
- Arthur KOESTLER: no labyrinth, no mouse, just bissociating two contexts

Genius Loci

- Genius Loci = Spirit of the Place, LokalGeist?
- Etruscans – mundus, urbs, Roma
- Genius Loci ... Phenomenology
- NORBERG-SCHULZ, CH. 2000. *Genius Loci*.
- Implications (Hegel, Marx, Heidegger)
- Bogdan Bogdanovic in Vienna

World Cultural Heritage

- UNESCO
- 700++ items
- 30++ in AT, CZ, SI, SK, nearly no 3D models
- European added value is not added
- Digital preservation, documenting, publish...
- „... to enable Europeans to be consciously (and interactively) proud of their contribution to the World Cultural Heritage“

City = process in time & space

- CORP 2002 paper by Bettina Kohler, Peter Ferschin et al. from IEMAR TU Wien team:

- The City as a Process in Time and Space
- Luton University research – „movie“

- Next slide shows this at the first glance

Urban Process in Time & Space

- Real world photo by A. F., Graz 2001

Digital Storytelling

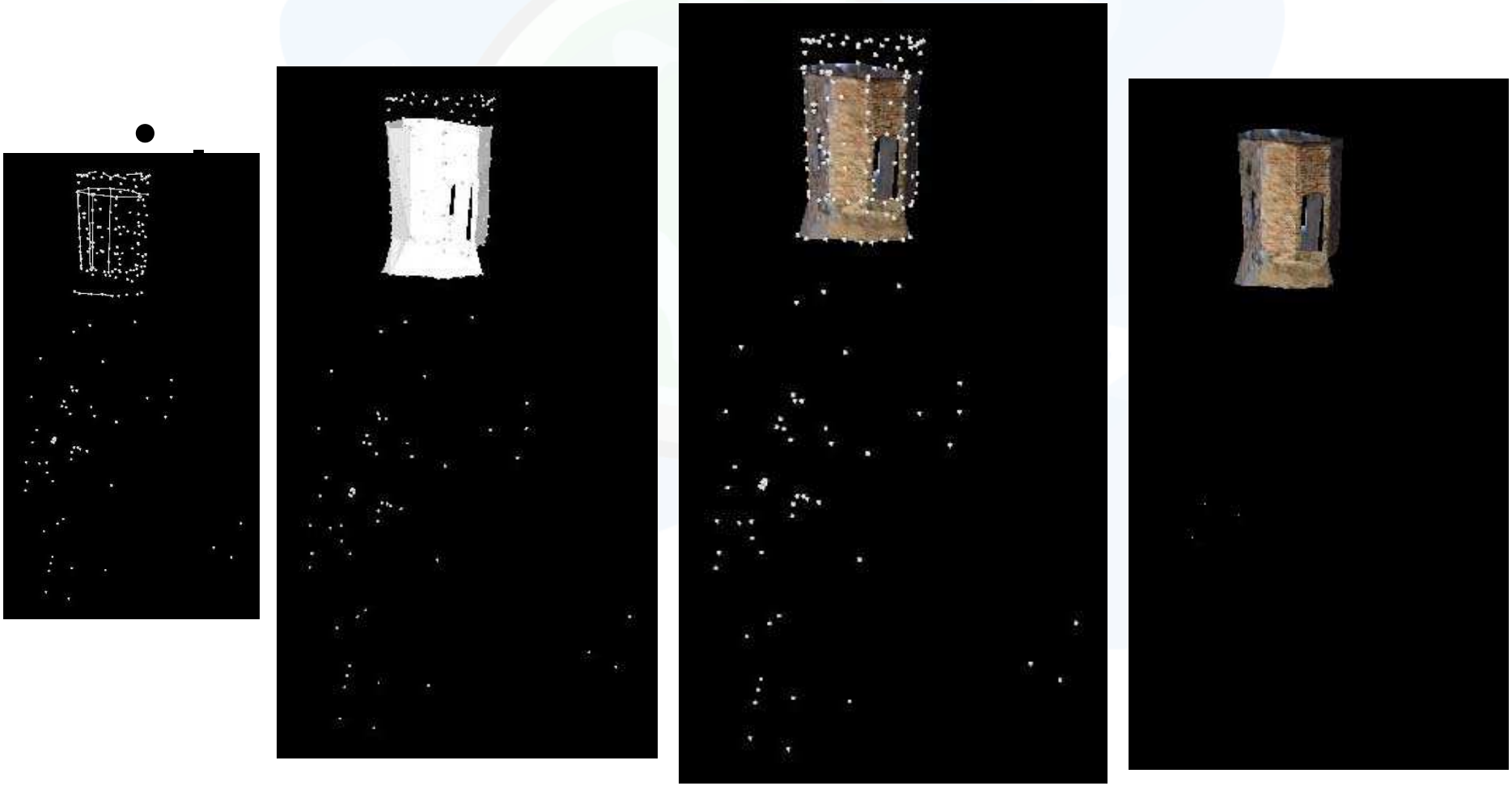
- 2000-- Drama – Aristotle, conflict
- 1929 Fairy tales – Vladimir Propp, 30+ situations
- e.g. Umberto Eco on James 007 Bond stories
- ...
- 2000++ Yann Martel – The Life of Pi - “the ultimate art of storytelling”
- Semiotics, VR is a semiotic system

- QVORTRUP, L. ed. 2001/2. *Virtual Interaction/Space*

Virgin Tower Movie – P. Gejgus

- 

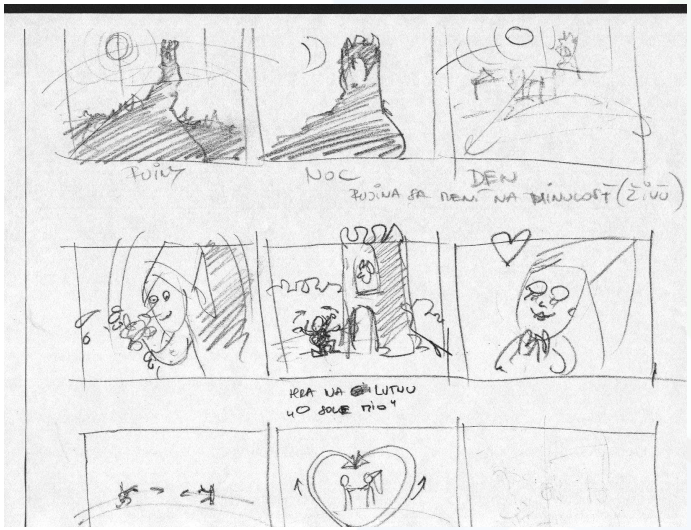
V. Tower Modeling by K. Darilkova

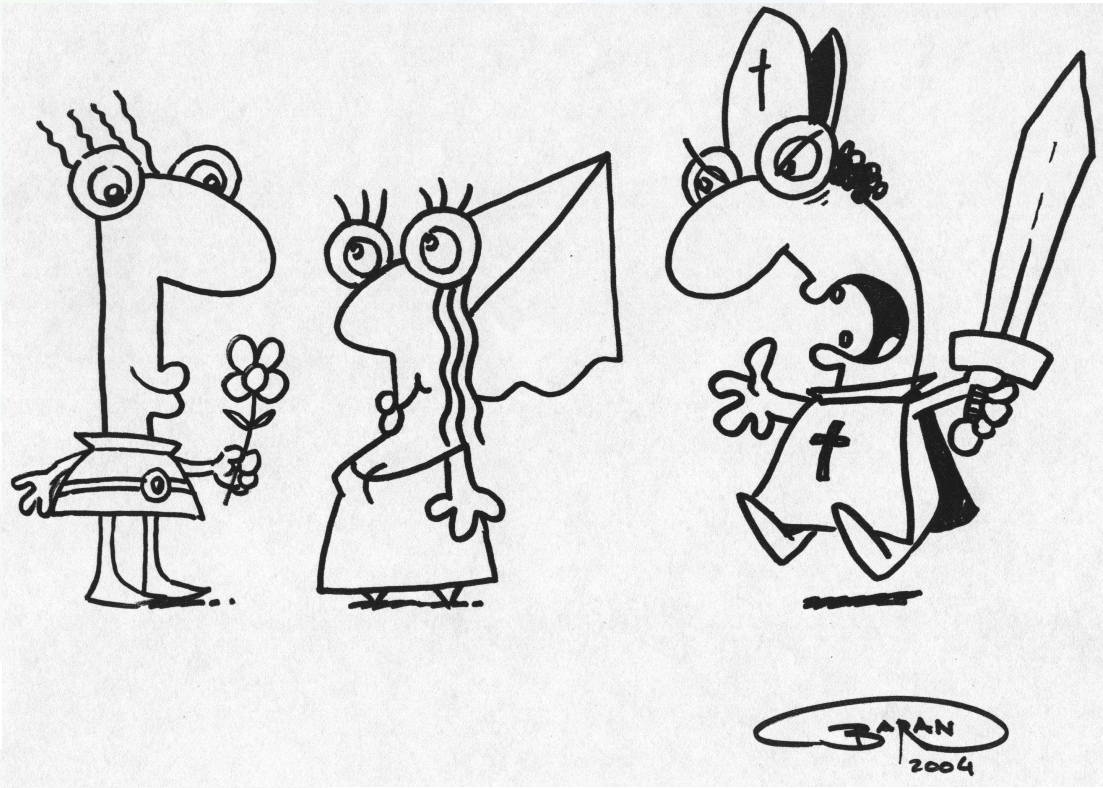


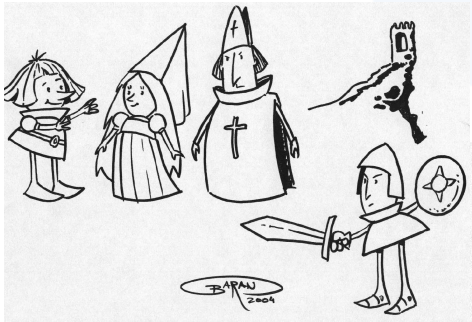
Virgin Tower Story

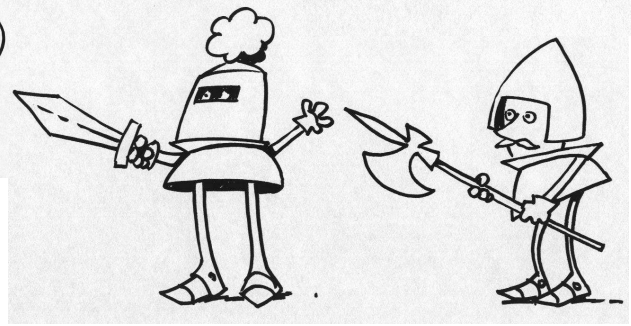
- Prohibited love sujet (Romeo&Juliet type)
- She, He...
- ... and the bad guy from Kärnten
- (her uncle, and a bishop, very keen to control her future heritage)
- He is the owner of Devin castle, wedding
- Sad story, no happyend: 2 graves
- “The most beautiful Bratislava legend”

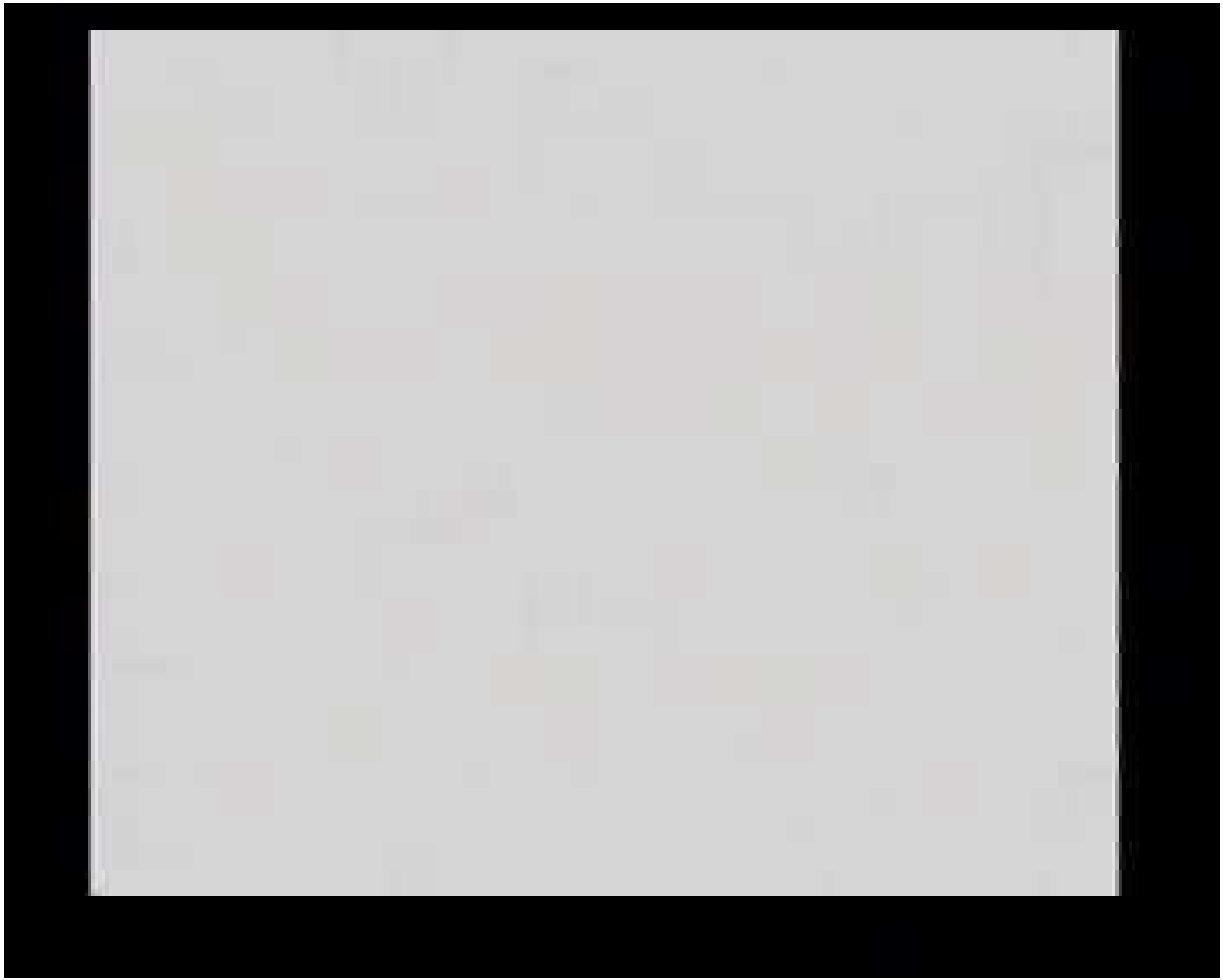
Virgin Tower Story – Jaro Baran











Virtuálna 3D Bratislava
Valné zhromaždenie SISp

Február 9, 2006
Družba, Bratislava

Jumping Game – Play with a Virgin

by M. Novotny, A. Mintal, M. Matousek, A. Ferko

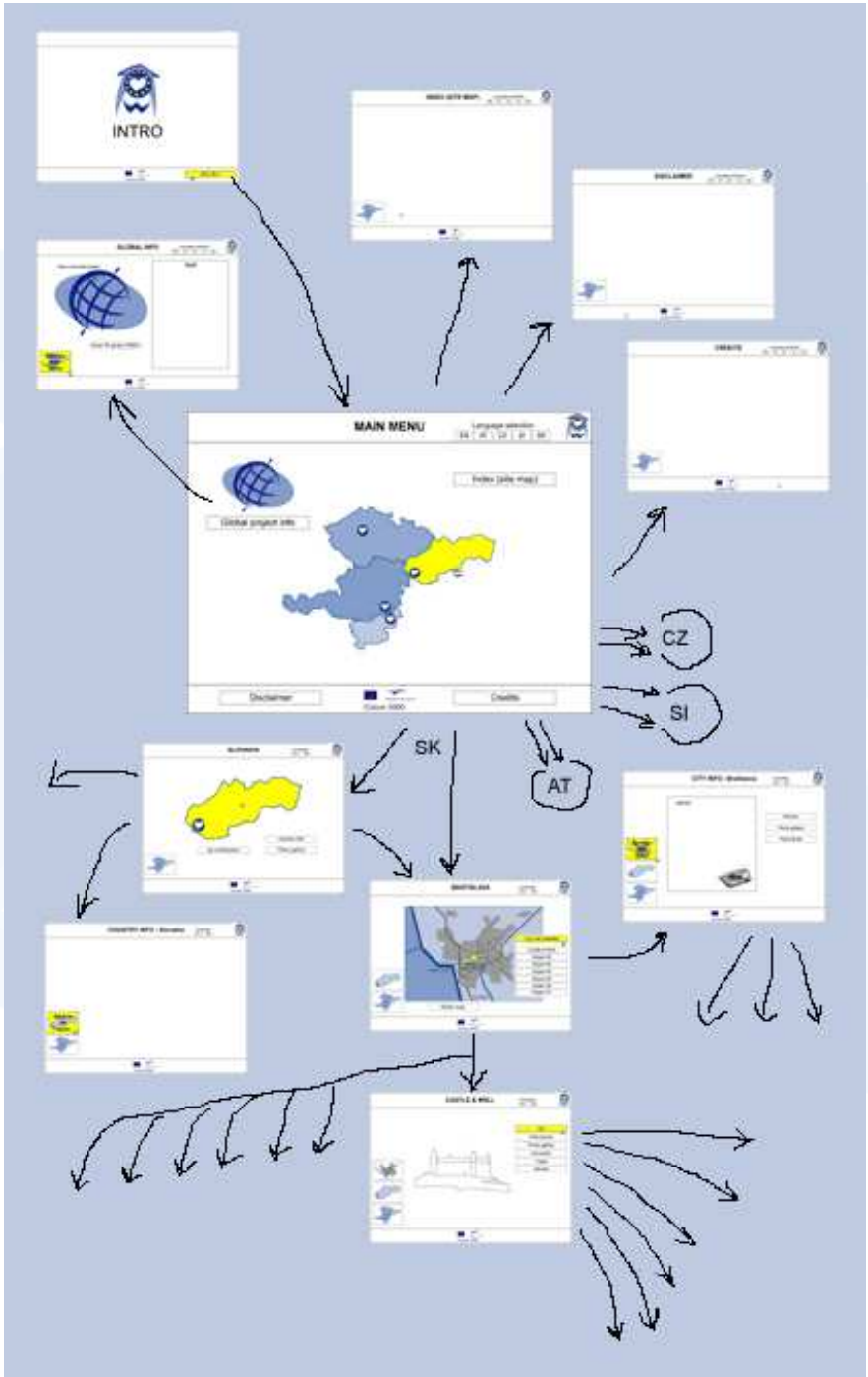
On Model of a Human Being

- Each human being includes/shares:
- Child, visual, emotional, creative … V
- Adult, symbolic, rational … S
- Parent, auditory, moral … A
- and something “crowded”, transactional scenarios

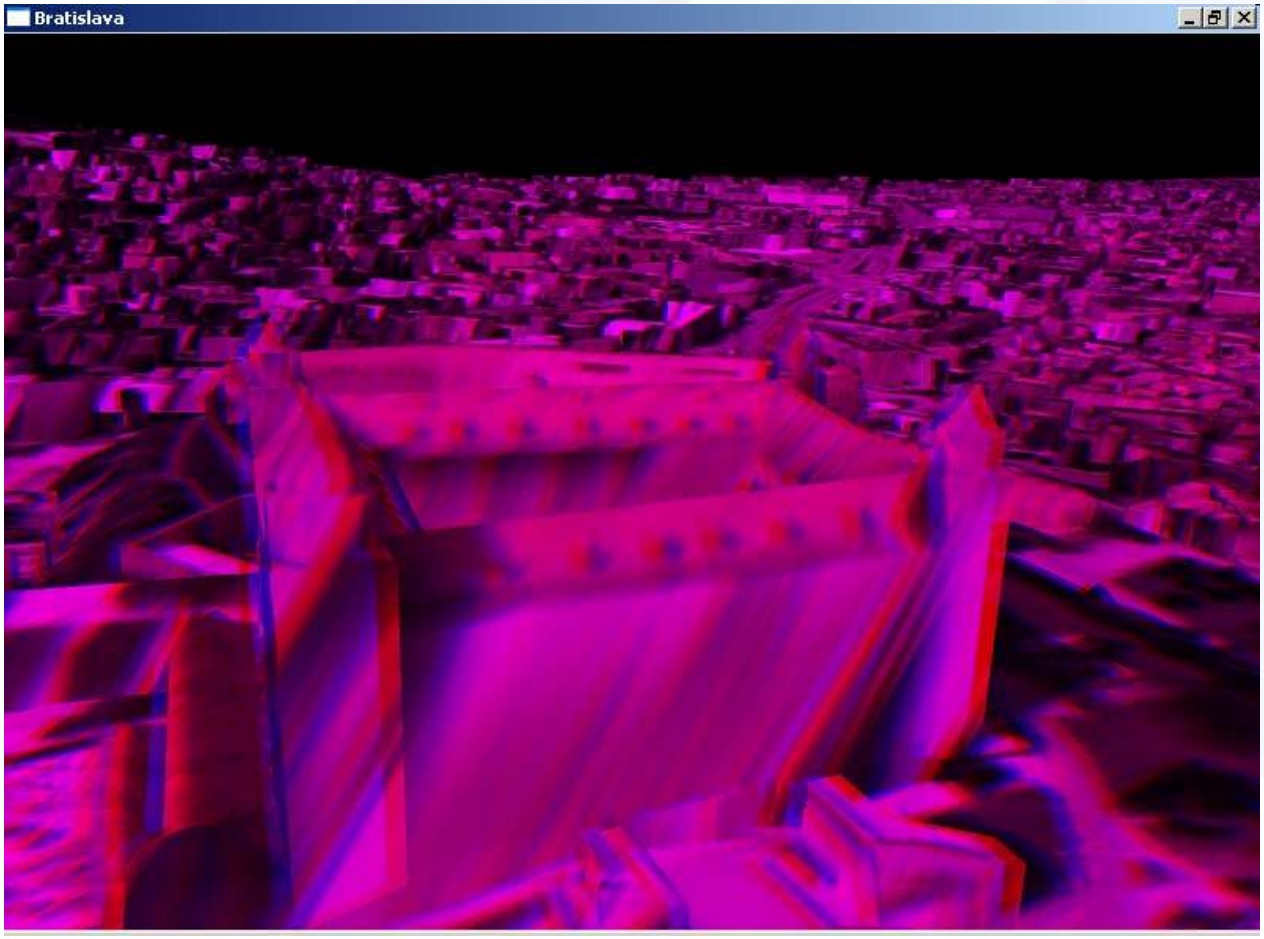
- D. GOLEMAN, Emotional Intelligence. 1998.

Data (S, V, A)

- GUI with sound effects (Flash)
- Stills, panoramas and texts
- LOD stories and LOD avatars
- Movies, animations, and games (very short)
- Interactive VRML models (Cortona)
- Data containers, XML


INTRO
MAIN MENU
CZ
SI
SK
AT

Passive Stereo by P. Borovsky

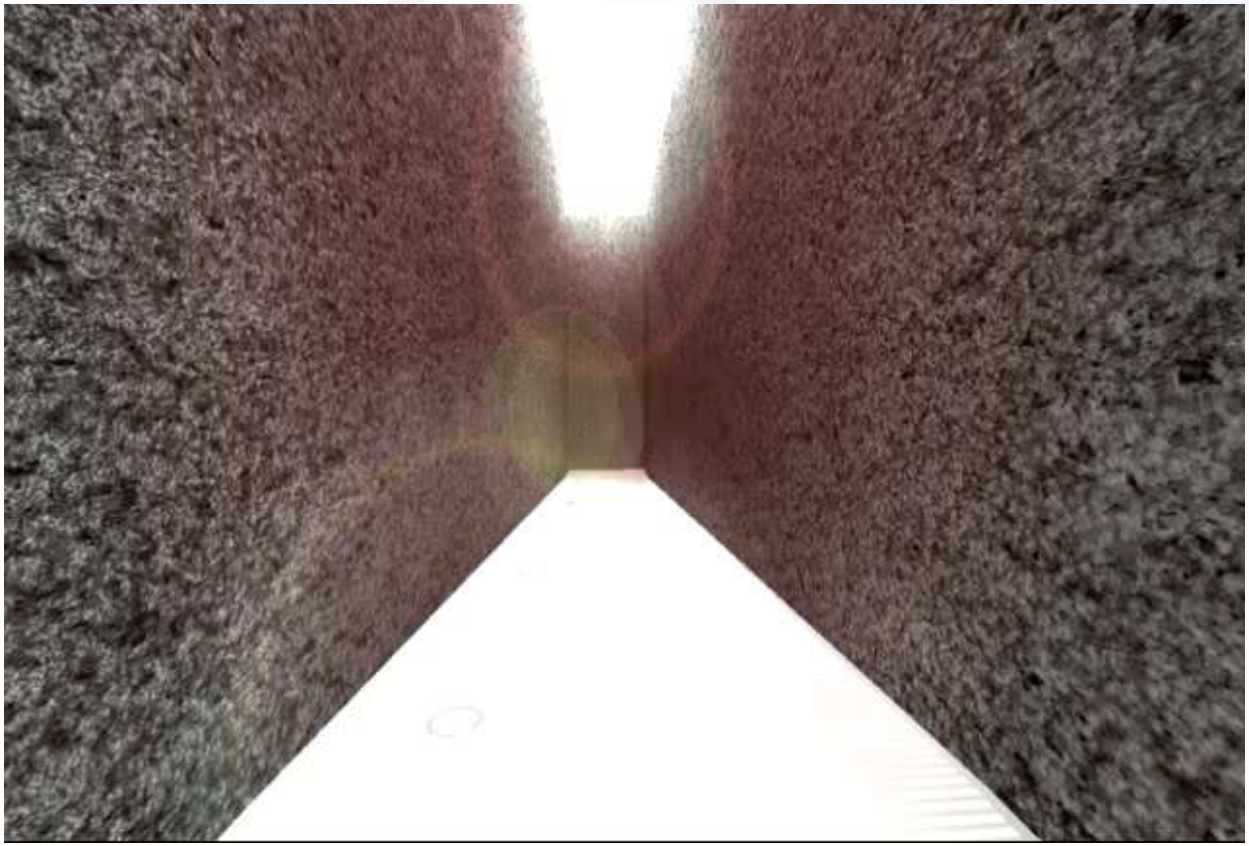


Avatar by Stanislav Stanek

- .

Chatam Sofer M. by J. Krizik

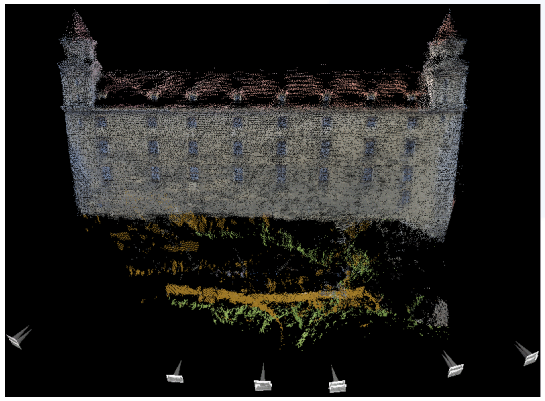
- .



Urban context movie by P. Borovsky

Bratislava

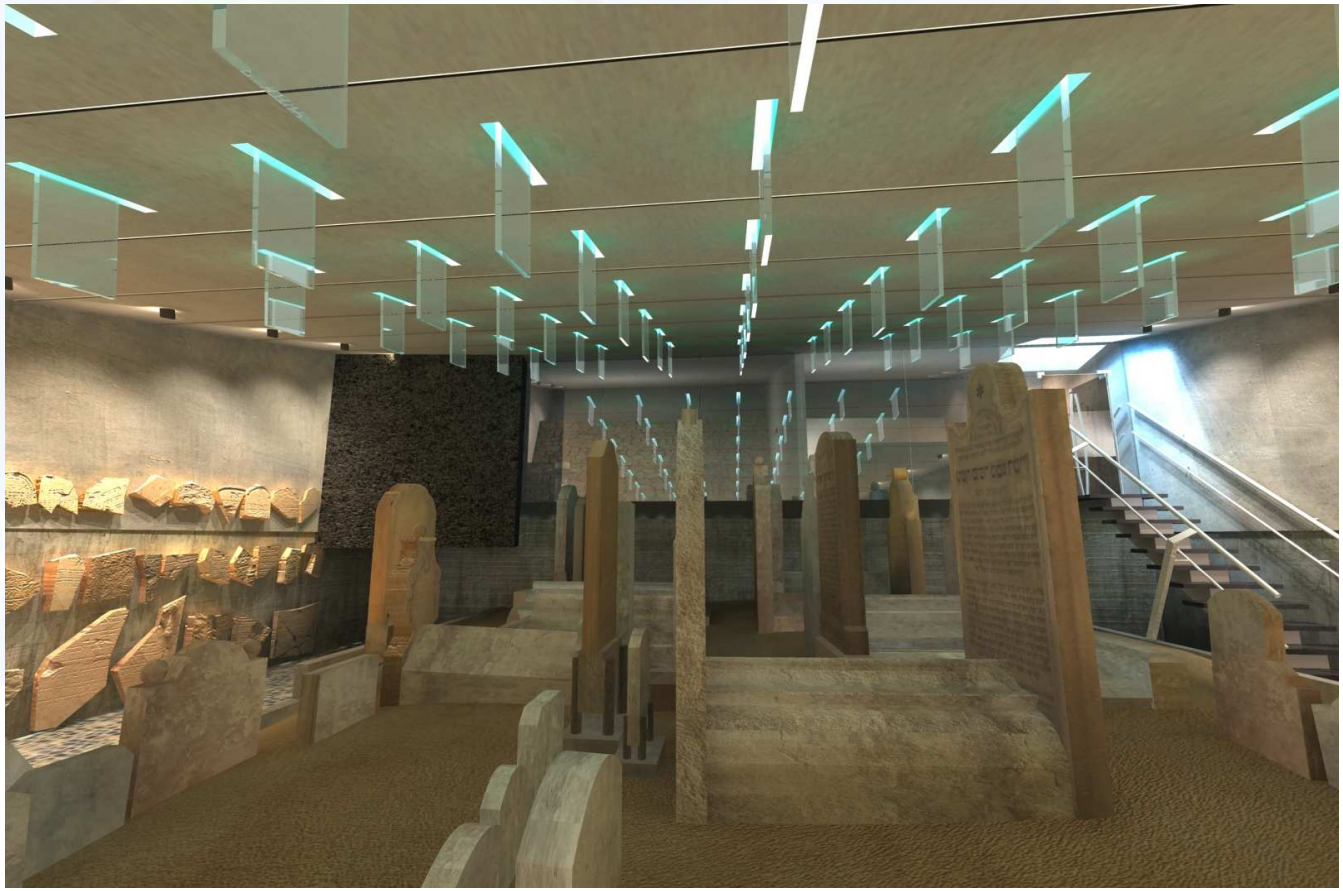
Bratislava Memorials



Bratislava

Chatam Sófer M. by J. Krizik

- WCH?



Virtual Heart of Central Europe, Culture 2000

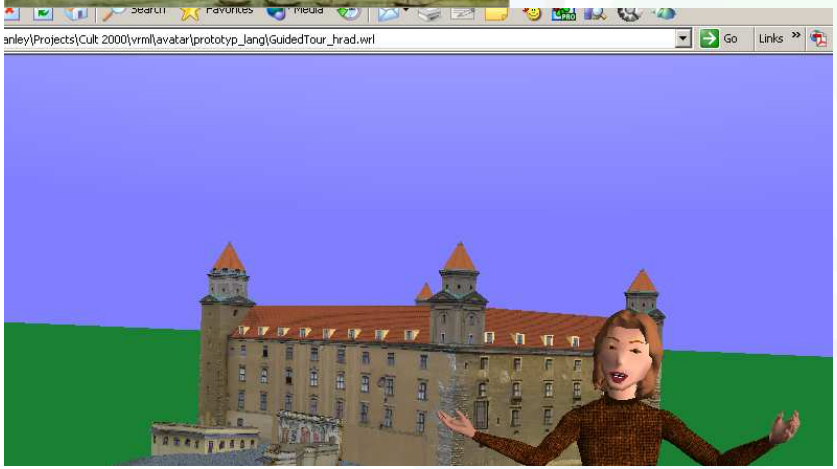
J. Martinka et al.

- Awarded by EuroPrix Quality Seal and Slovak Prix Grand Award

www.VHCE.info

- 330 kEUR, 150 kEUR from EC
- follow-up 2006-2007 (SK, SI, PL, CZ), submitted, 256 kEUR

Navigation&Cooperation in VEs: Virtual Bratislava (2002-2004)



http://www.sccg.sk/~projects/

- 900 000 SKK, 506 000 SKK from Slovak government, APVT agency
- Follow-up 2005-2007, APVV agency
- Key researchers M. Zimanyi, S. Stanek & P. Kubini

Semantic Web

- The end of WWW
- BERNERS-LEE, T. et al. 2001. The Semantic Web. *Scientific American*, May 2001.
- Ontology, AI, avatars & autonomous agents
- Information (digital libraries) vs. Knowledge & creativity support (semantic web)
- Dilema ☺ (thesis, antithesis, synthesis)

Rennaissance Analogy 4 WWW

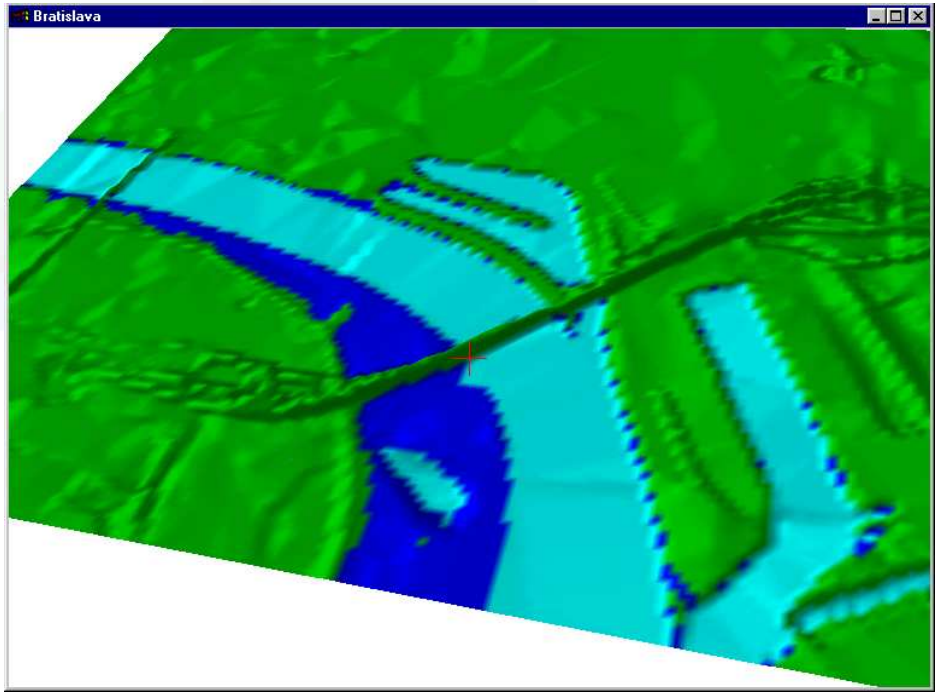
- Guttenberg, Rabelais, Bakhtin
- Tim Berners-Lee, ?, ??
-
- Rennaissance team

Contexts

- **Semantic Web, Digital Libraries, Cultural Heritage – EC trends**
- **Culture 2000 – bridging past & future**
- **Projects AMVH, APVT, VEGA, Culture 2000, Strapamo, APVV Transfer**
- **Future – interiors and exteriors, urban model applications, virtual museum, multimedia CD for Bratislava tourists…**

Conclusions…

- Cyber city algorithm for Central Europe
- New original framework for genius loci approach
- Urban planning, virtual museum, flood simulation... exteriers and interiers
- Algebraic geometry
- for modeling of very
- complex objects
- … future work



Data Courtesy

- Magistrát hl. mesta SR Bratislava
- Eurosense, s.r.o.
- Centaur, s.r.o.
- VRVis, Austria
- Original stories by Maria Durickova, Vladimir Ferko, and Peter Sevcovic
- Avatar voices by Eva Ferkova, Mirka Zimanyiova, and Milan Ftacnik
- Computer game by Matej Novotny, Michal Matousek, Andrej Mintal, and Andrej Ferko
- Animations by Jaro Baran, digital stories by Andrej Ferko
- Photos by Matej Zeman
- VHCE Logo, Design and Framework by Jozef Martinka

2002-2006 Projects Survey

- AMVH – Advanced Methods for Virtual Habitat
- VEGA – Virtual Environments for WWW
- APVT – Navigation and Cooperation...
- Culture 2000 – Virtual Heart of Central Europe
- Strapamo-18
- APVV – Efektivny prehliadac urbannych dat
- MDPT – Multimedialna historicka Bratislava
- Podane – Culture 2006, APVV – Urban Models

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- Prof. Leberl, Prof. Bischof, and TU Graz team
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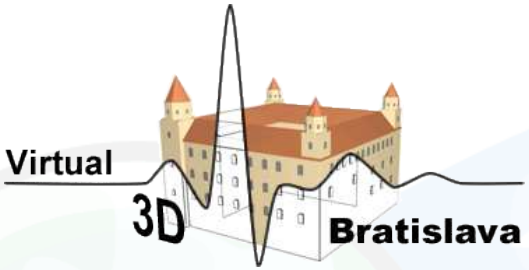
- Grants from SAIA Aktion Rakúsko-Slovensko, Strapamo, EC Culture 2000, VEGA, APVT, APVV Transfer, MDPT SR



Virtual 3D Bratislava: Retrospektíva a Perspektíva

BOROVSKÝ, P. – CHALMOVIANSKÝ, P. – DAŘÍLKOVÁ, K. - ĎURIKOVIČ, R. - FERKO, A. - FTÁČNIK, M. – JANČOŠEK, M. - KUBÍNI, P. – MARTINKA, J. – NOVOTNÝ, M. – SAMUELČÍK, M. -STANEK, S. - ŠIKUDOVÁ, E. -TÓTH, Z. - VALIENT, M. – ZIMÁNYI, M.

FMFI UK Bratislava