Photogrammetry 4.0 – Integrating Photogrammetry, Computer Vision, Computer Graphics and Serious Gaming

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1. Introduction – Motivation: Why 3D and 4D Apps?
2. Data Collection (in situ and interactive)
3. Data Fusion & 3D Modeling
4. App Design and Implementation
5. Conclusions
1. Introduction – Motivation for 3D/4D Apps for Mobiles

Create awareness for Smart Cities, Cultural Heritage, City developments etc. for different age groups using mobile devices:

1. Kindergarten kids
2. Primary and Highschool pupils, Teenagers
3. Students at Universities (future decision makers and academics)
4. Adults (Virtual Tourism, Home-based learning, etc.)
5. Elderly and Handicapped persons (suffering for mental deceases etc.)

Smart City developments, Cultural Heritage, etc. are so important transformations, that we have to boost them using all available channels!
1. Introduction – It is all about Collaboration!
1. Introduction – 4th Industrial Revolution & Photogrammetry 4.0

- 4th Industrial Revolution: Make all geospatial data available, connected and accessible
- Use Data Mining technologies for data interpretation: AI, deep learning, machine learning, etc, otherwise the potential of the data cannot be exploited
- Create digital twins (or connect the physical with the digital world) by AR and VR technologies -> **MR Mixed Reality**

- 4IR Europe’s View: Self-organizing systems and products, nested, connected and autonomous! Billions of funds available for the 4IR!

All these challenges can be overcomed only by close collaborations!
1. Introduction – 4th Industrial Revolution & Photogrammetry 4.0

Photogrammetry is a very old discipline, can be traced back to the MA

- Analogue photogrammetry (1840 - 1970) -> Photogrammetry 1.0
- Analytical photogrammetry (1950 – 2000) -> Photogrammetry 2.0
- Digital photogrammetry (1980 till now) -> Photogrammetry 3.0
- Embedded photogrammetry (2010 and in future) -> Photogrammetry 4.0

Photogrammetry 3.0: Laser scanning, Structure-from-Motion, Dense Image Matching, point cloud generation, automatic point cloud interpretation etc.

Photogrammetry has huge potential for 3D and 4D reconstructions, and was the leading discipline to deliver 3D city models for smart cities! (The Berlin example, 3D geometry by ifp/Virtual City systems 2008, texture by Autodesk)

Smart City 3D Berlin: more than 30 parties are using the basic geodata!
virtuelles Berlin

3D-Stadtmodell in Google Earth
1. Introduction – Motivation for Photorealistic Modeling
2. Data Collection (LiDAR, CV, Laser Scanning)

(a) LiDAR DSM  
(c) Point clouds from CV

(b) LiDAR DEM  
(d) Point clouds TLS
3. Data Fusion – 3D Modeling

(a) LiDAR DSM
(b) LiDAR DEM
(c) point clouds from aerial Photos
(d) the roof landscape
3. Data Fusion – 3D Modeling

(e) 3D CAD (Leica Cyclone)
(g) Interactive 3D (3ds Max)

(f) VR Block (Trimble SketchUp)
(h) Rendering (Unity 3D)
3. Data Fusion – 3D Modeling – Time Integration
4. App Design and Implementation

- Operating Systems: Android, iOS, MacOS & Windows
- Realtime 3D environments using OpenGL ES 3.0
- Autoscale & orientation of the GUI
- Additional steering using accelerometers and gyroscopes
- Text, audio and video narration in 2 languages (German, English)
- Augmentation through target tracking
- Trigger scenes through GPS
- Interactive map display with turn-by-turn directions
- Overlay original site artefacts with reconstructions

Example: NVIDIA Shield Tablet
5. Conclusions

- 3D and 4D Apps are creative tools for Smart Cities, Cultural Heritage preservation etc, running on mobile devices, in cars, in games etc.
- As said in the intro Smart Cities and Cultural Heritage is so important, that we have to look for boosters – here it is!
- Many interesting technologies just started – make the best out of it!
- The story telling part must be adapted to the user level (Kindergarten – Schools – Universities – Daily Usage – Handicapped Persons). Here again Ontology comes into the game

- **With these 3D/4D Apps we offer „Smart City Edutainment“!**

Imagine the no of smartphones worldwide – 3D/4D Apps make fun, and are very valuable - we are just at the beginning!