

#### Universität Stuttgart

Institute for Photogrammetry/Institute of Parallel and Distributed Systems







Implementing UN IGIF, UN FELA, Mission Zero CO2 and Safety in New Cairo – 3D Geospatial Infrastructure Updates and Knowledge Generation

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Meeting Juergen Dold & Dieter Fritsch, 7. January 2019

# Outline

- 1. Motivations
- 2. Experiences with Digital Twins since 25 Years
- 3. Digital Twin Generation 3D Berlin
- 4. The Pilot Project New Cairo
- 5. Processing of Satellite Data, Airborne Data
- 6. Summary and Future Expectations



## 1. Motivation - Politically

- Hexagon would like to increase the geospatial business in Arab and African countries
- Africa is the world's 2nd largest and 2<sup>nd</sup> most-populous region (behind Asia in both categories). 2016: 1,2
  Billion people, 2030: 2.5 Billion people in 15 years 50% increase of population.
- Africa's average population is the youngest amongst all continents. The median 2012 was 19.7, compared with the wordwide median of 30.4
- This increase in population needs a dramatic increase in: water supply, food, education, medical care, jobs and employment capabilities, and many, many more!
- Africa covers 30.3 million sqkm, which is 20% of the land area of the Earth
- Algeria is Africa's largest country by area, and Nigeria is its largest by population (2016: 200 million)
- The Egypt Example: 1950s: 50 million people 2020 100 million 2030 120-130 million. From 1 million sqkm only 5-7% can be urbanized! Thus, Land Management is very, very important!
- The young and educated work force should stay in Egypt and not leaving to work abroad!

# 1. Motivation - Politically

• ...

- Best practice in Higher Education: The German University in Cairo, Egypt. Launched in Oct 2003 with 800 students. Today 13,500 students are enrolled, 25,000 have been graduated since 2003. GUC represents 43% of transnational German High Ed projects! BTW: close to 50% female and 50% male students.
- GUC offers geospatial education in Architecture and Town Planning and in Civil Engineering. Hexagon supports GUC since 2011 by the set-up and maintenance of the Geospatial Lab!
- GUC got 12/2018 approval from the Berlin Senate to establish a private Technical University in Berlin The German International University (GIU), Am Borsigturm.

#### The Pilot Project New Cairo will be partnered by UN-GGIM, GUC, HxGN, Uni Stuttgart, and ...

- The Egyptian Survey Authority would like to modernize its cadastre (proposal to the World Bank, Washington, D.C.)
- The Egyptian Ministry of Housing, Infrastructures and Urban Communities needs new data for planning
- The Egyptian Ministry of Transportation needs also new data for monitoring roads, railways etc.
- The Egyptian Ministry of the Environment needs to be prepared for COP 27, Sharm

# 1. Motivation 2022 - Technically

- 2022 we celebrate 50 years of optical remote sensing -Landsat family since 1972
- 2019 we celebrated 20 years of High Resolution optical remote Sensing: IKONOS 09/1999, 1m PAN and 4m MS
- 2022 at present WorldView 3 & 4 Satellites, 30 cm GSD, many sats, EU Copernikus programme with SENTINEL satellites
- 2022 Info UN-GGIM: Every point on Earth is observed up to 8 times per day – Petabyte/day → Big Data
- 2022 we celebrate 20 years The German University in Cairo, Egypt



## 1. Motivation 2022 - Technically



- Data can only be processed by automated workflows:
  4th Geospatial Industrial Revolution Photogrammetrie 4.0
- Big topics: Data interpretation by AI, MachineL, DeepL, CNNs etc., we need many test sites!
- Smart Cities → Intelligent Cities -> need **2D**, **3D** and **4D** geom.
- Smart Cities -> Digital Twins -> Past, Present and Future economic, technological and social concepts for a liveable and ecologically healthy city
- 2022 Metaverse definition 30 years old, relaunch of Facebook
  2021 to be called "Meta"

## 1. Motivation 2022: The UN SDGs 2030



## 2. Experiences with LiDAR and Images

Smart Cities: Main focus of R&D at the Institute for Photogrammetry, Univ. Stuttgart, Germany, since 1992

- Development of software for automatic 3D City Modeling: Karlsruhe, 1997, Stuttgart, 1998, Heidelberg, 1998, Vienna 2000 using LiDAR and photogrammetry
- (2) Further software improvements for cooperation with virtualCity GmbH, Dresden, for automatic 3D Berlin covering 474.000 buildings and 900sqkm, 2008-2010
- (3) Develop software for automatic Digital Surface Model generation using Nadir and Oblique photogrammetric images, since 2009 presentation of **software package SURE 2011**
- (4) Start-up nFrames GmbH, Stuttgart with 2 staff members, 2014 for SURE software for Smart City reconstructions, 2019: 20+ staff, 2021 Esri acquired nFrames
- (5) 3D/4D Apps: The Calw VR Apps, Hermann-Hesse-Walk, Hirsau Monastery (2014-now), WILD T2 App

## 2. Experiences with LiDAR and Images (ifp, Stuttgart 1998)



Left: overlay of LiDAR with orthoimage

Right: Automatic adjustment of roof landscapes



# 3. Digital Twin Generation - 3D Berlin (ifp 2008-10)

#### • Project partner:

- virtualcitySYSTEMS, Dresden
  - Reconstruction of building geometry with ifp Software: in total 474,000 buildings covering an area of 890 sqkm, planning of honorarium: 1 building = 1,5 Euro (much too cheap!!!)
- Autodesk GmbH, Berlin
  - Texturing of 47,500 Nadir and Oblique images

#### • Project duration:

- Berlin East (March 2008 July 2008)
- Berlin West (November 2008 February 2009)
- 2018: More than 30 institutions use 3D Berlin for Smart City applications!

# 3. Digital Twin Generation - 3D Berlin (ifp 2008-10)

#### Supported Roof Shapes





## 3. Digital Twin Generation by Most Recent Technology Leica Geosystems CityMapper-2 Oblique Aerial Photography and LiDAR (2022)

- Optical SystemTwo nadir 150 MP cameras (RGB & NIR)
- Four oblique 150 MP cameras at 45° (RGB)
- Backside illumination (BSI) CMOS chip
- Mechanical forward-motion-compensation (FMC)
- Customised low-distortion lenses
- A choice of three focal lengths for low, standard and high-altitude operation
- LiDAR Sensor2 MHz pulse repetition frequency
- Gateless Multiple-Pulses-in-the-Air (MPiA)
- 3 cm range accuracy
- Oblique scan pattern
- Even point distribution across data set
- USGS LiDAR quality Level 0 data from up to 2 km altitude



Typical data quality of airborne mesh captured with the Leica CityMapper-2

47 GLG

# 4. The PSN Pilot Project New Cairo (ca. 80sqkm)



Example: Berlin Center (left)- OpenStreetMap 3D

German University in Cairo, New Cairo (right) – OSM 3D



## 4. The UN-GGIM PSN Pilot Project New Cairo (ca. 80sqkm)



## 4. The UN-GGIM PSN Pilot Project New Cairo

#### **Project partner:**

- The German University in Cairo (GUC)
- The Egyptian Space Agency (EgSA)
- The Egyptian Housing Ministry
- The Egyptian Transportation Ministry
- The Egyptian Environmental Agency (EEA)
- The Egyptian Survey Authority (ESA, Cadastre)
- Hexagon
- The UN GGIM Private Sector Network
- The UN-GGIM Academic Network
- The University of Stuttgart, Germany

#### **Project duration:**

- October 2022 to Summer 2024 (about 2 years)
- MoUs under discussion







#### Left: GUC 2003

## 4. The UN-GGIM PSN Pilot Project New Cairo

#### Modernization of the Egyptian Geospatial Infrastructure by

- Layer 1: Satellite DSM generation by WV3 and WV4 multiview stereos with 0.3m GSD
- Layer 2: DTM generation by filtering and orthophotos with 0.3m GSD
- Layer 3: Airborne DSM generation using the Leica CityMapper-2 with 3cm GSD
- Layer 4: True orthophoto to be superimposed by existing cadastre information implementation of the UN IGIF and the UN FELA to modernize the Egyptian cadastre – the data reference!
- Experiments with 3D cadastre we will deliver the most modern cadastre! (real estate cad 2D, 2.5D and 3D, solar power potential cad, tree cad, ...)
- For the very first time: 3D digital twin of New Cairo Testsite

further simulations

- Simulations for Mission Zero CO2 in New Cairo (using solar energy)
- Implementing safety measures for fast access of buildings and compounds
- Simulations of the city climate using the 3D building models and DSM

The Power of Hybrid Data Combined















# 4. The UN-GGIM PSN Pilot Project New Cairo – UN IGIF

Collaboration of Min. Housing Infrastructures, Min. Water, Min Environment with GUC and Uni Stuttgart: 1PhD, 2MSc



## 4. The UN-GGIM PSN Pilot Project New Cairo – UN FELA

Collaboration of Min. Water, Egyptian Survey Authority with GUC, Hexagon & Uni Stuttgart: 1PhD, 3MSc

| FELA Goals  | FELA Requirements  | FELA Pathways            |
|---|--|--------------------------|
| Transparency and accountability<br>increased                      | Accountable and transparent governance                                     | Governance, Institutions |
| Gender-responsive and inclusive<br>of vulnerable groups           | Inclusive and recognizes all<br>forms of tenure                            | Policy and Legal         |
| Affordable investments and<br>economic return assured             | Affordable with sustainable<br>business models                             | Financial                |
| Reliable data and service quality<br>attained                     | Data maintained, secure and not<br>duplicated                              | Data                     |
| Responsible and innovation<br>oriented                            | Upgradable systems and<br>approaches                                       | Innovation               |
| Interoperability and integration<br>supported                     | Considers internationally agreed<br>standards                              | Standards                |
| Cooperation, partnerships, and<br>participation leveraged         | Strengthens partnerships and<br>supports collaboration                     | Partnerships 🕥           |
| Capacity, capability, knowledge<br>transfer and exchange attained | Facilitates capacity development<br>and knowledge transfer and<br>exchange | Capacity and Education   |
| National engagement and<br>communication enhanced                 | Advocates for effective land<br>administration                             | Advocacy and Awareness*  |

## 5. Optical High Res Remote Sensing

Collaboration of Egyptian Space Agency with GUC and Uni Stuttgart: 2MSc



31.10.2022

## 5. Optical High Res Remote Sensing - Workflow



5. Optical High Res Remote Sensing - Results

PhD Thesis Ke Gong, Univ. Stuttgart, 2020

Mesh

Refined 3D modes – Bank of American Tower, Jacksonville, FL





## 6. Summary and Expectations

- To bring the Egyptian Geospatial Infrastructure to a new level
- To modernize the Egyptian Land Administration & Management System (2D, 2.5D, 3D)
- To offer the most recent technologies of geospatial data collections and processing to Egypt (EEA, ESA, MinHUI, MinTrans, EgSA,...)
- To improve capacity building in Egyptian Agencies, Min., GUC)
- To offer Hexagon a stage in Africa demonstrating ist capabilities
- To demonstrate an active UN-GGIM Private Sector Network
- To demonstrate the option of a Zero Mission CO2 for New Cairo

### 7. Thank you and Contact Data



### PROF DR DIETER FRITSCH

University of Stuttgart, UN-GGIM Private Sector Network

#### Germany

