AL-BALQA' APPLIED UNIVERSITY
Faculty of Engineering
Department of Surveying & Geomatics Engineering

Photogrammetric Techniques for Cadastral Map Renewal

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Overview

- Historical Background
- Problem Definition
- Objectives
- Methodology
- Experimental Results
- Conclusions and Future Work

Historical Background

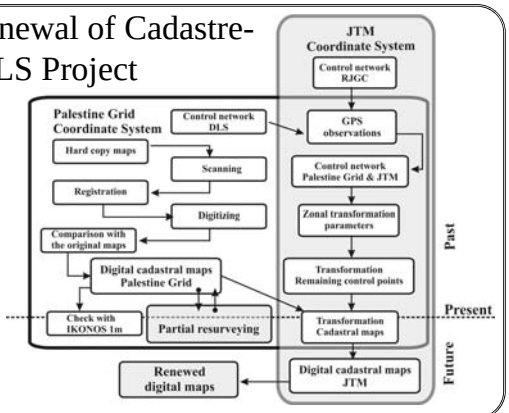
- Cadastral mapping in Jordan:
  - Started the early 30-es of the 20th century
  - About 70-80 years after the introducing of first land registers by the Ottoman Empire
  - Cadastral map scales:
    - 1:20000 and 1:10000 at the beginning
    - later on : 1:5000, 1:2500 and 1:1250
  - Methods, used for mapping :
    - chain surveying, plan table method and tacheometry.
    - since the late 80s: Terrestrial and Global Positioning Systems.

Problem Definition- Part I

- **Existing status of the cadastre**:
  - Very low precision of the initial field surveys became completely unacceptable due to:
    - Rapid increase of the land value
    - Many areas are subject to public concern
    - Or included into urban zones where better precision is required.
- **Rapidly increasing requirements of the society for:**
  - Faster access to land related information
  - Better quality- better positional and temporal precision
  - Wide range of information
  - Security of the ownership

Joint project for renewal of cadastre carried on by the Department of Lands and Survey (DLS) with the technical support of GTZ.

Renewal of Cadastre- DLS Project



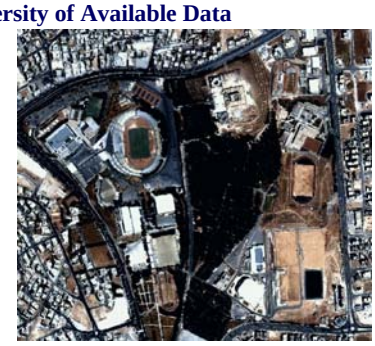
General Notes- DLS Project

- Topography of the area was not taken into consideration.
- The registered scanned images were compared only with the original hard copy maps. Comparison with ground truth (field surveying) is carried later-on sporadically.
- Quality (precision, distribution and source) of the control points is not always sufficient and time and cost consuming.
- Definition of projection and transformation types: only affine used, regardless to influencing factors.

Problem Definition- Part II

Diversity of Available Data

Satellite Imagery:

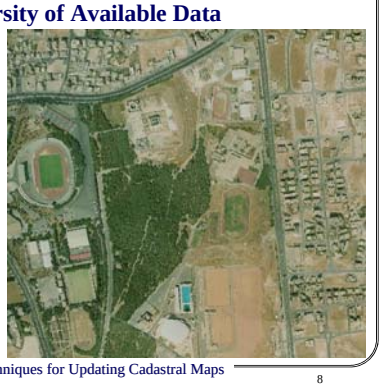


IKONOS-1m

Problem Definition- Part II

Diversity of Available Data

Aerial Stereo Photography:

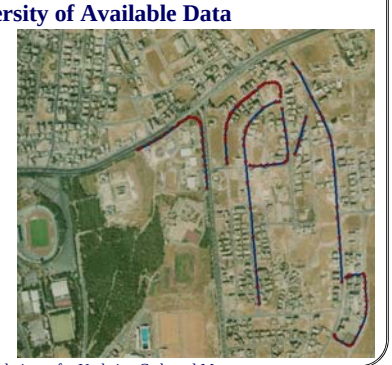


Scale 1:10000

Problem Definition- Part II

Diversity of Available Data

- **Field Surveying:**



GPS

Problem Definition- Part II

Diversity of Available Data

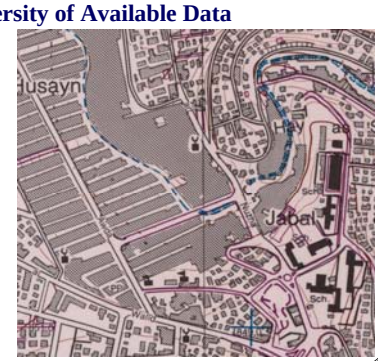
- **Hard Copy Cadastral Maps:**

DLS

Problem Definition- Part II

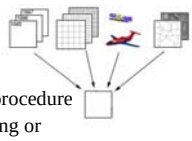
Diversity of Available Data

- **Topographic Maps:**



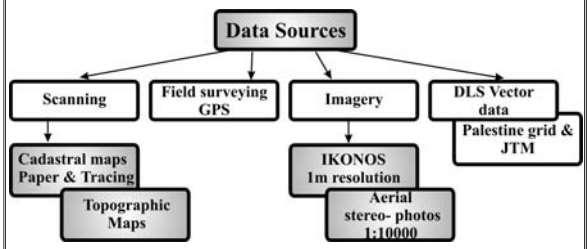
RJGC

Objectives

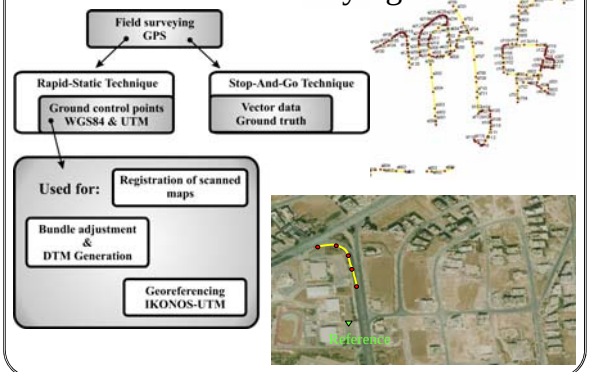


- **Data Integration**: Well established procedure that Fundamentally involves combining or merging data from multiple sources *in an effort to extract better and/or more information*
- **Evaluation of the factors, causing mismatch** between different data sources- qualitative and quantitative methods **Transformation Function**: Establishing the mathematical function that relates different data (2D-similirty, affine and polynomial)
- **Ground Truth**: fairly representation the real object space in high accuracy taking into consideration the cost associated with such requirement.

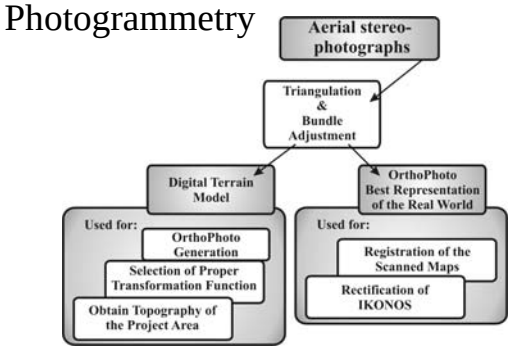
Methodology



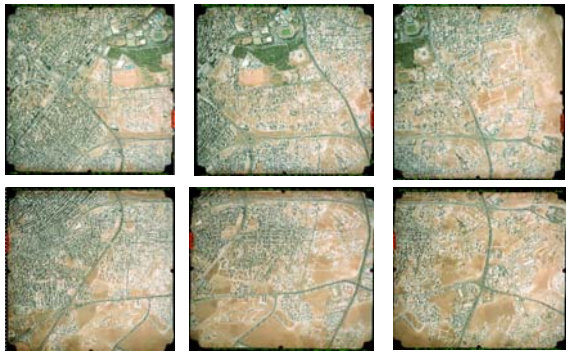
Field Surveying



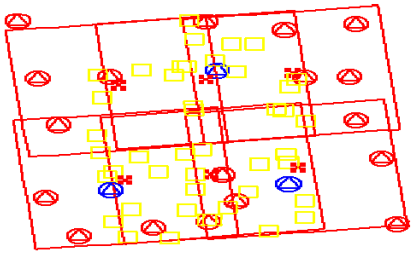
Photogrammetry



Photogrammetry



Photogrammetry

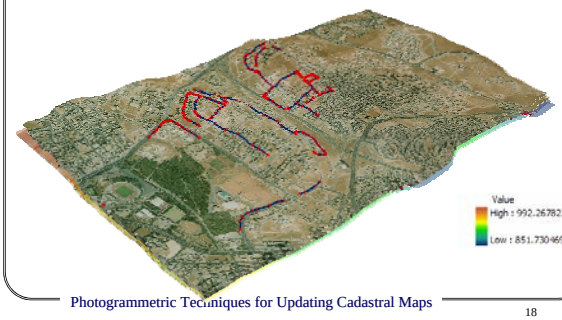


Control point Check point

Tie point

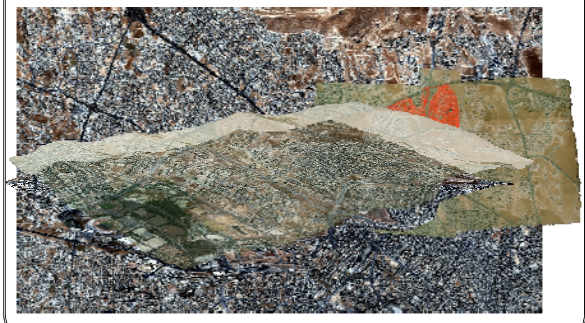
Photogrammetry

Dig Ortho-Photo el



Satellite images Geo-referencing IKONOS with Ortho-photo

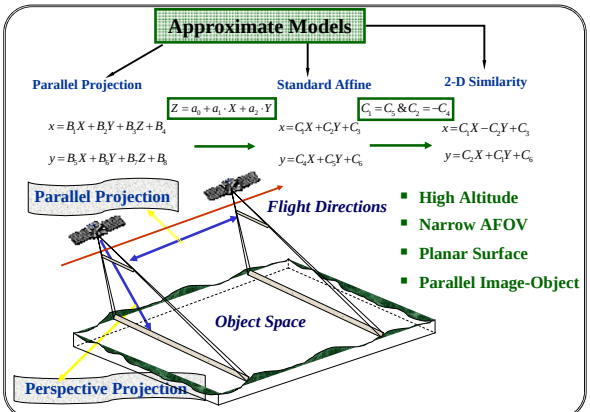
Photogrammetry: Rectified IKONOS, overlaid with Ortho-photo and DLS vector data



Scanning

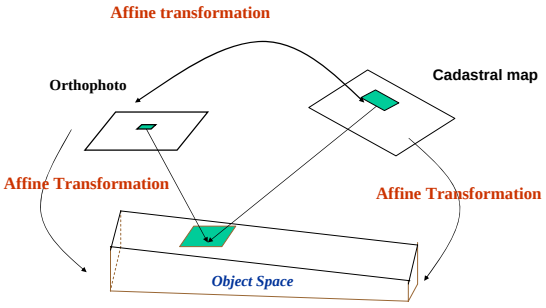
- Hard copy cadastral maps- DLS
- Topographic maps- RJGC

Approximate Models



- High Altitude
- Narrow AFOV
- Planar Surface
- Parallel Image-Object

Transformation

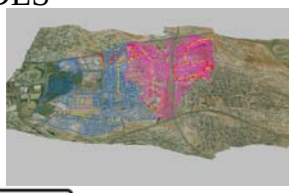


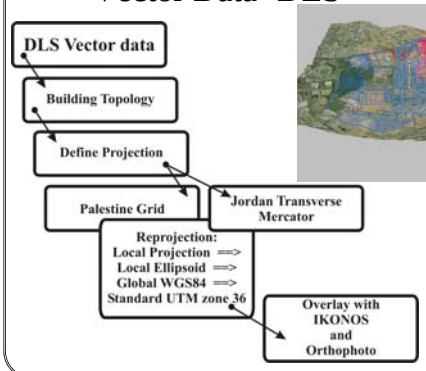
Registration Results (RMS)

RMS (m)	Projective Transformation	Affine Transformation	Similarity Transformation
Hilly area	2.13	2.701	17.426
Flat area	5.349	4.981	9.607

RMS for registration of scanned maps to orthophoto

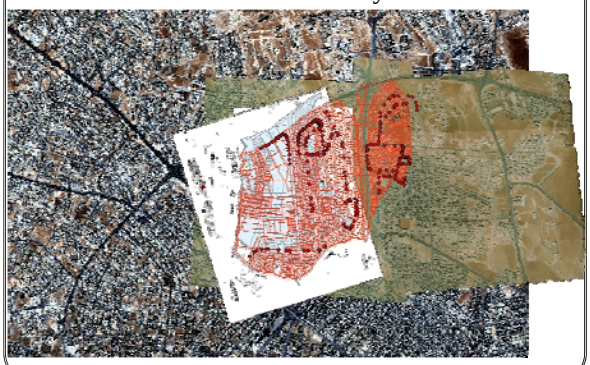
Vector Data- DLS



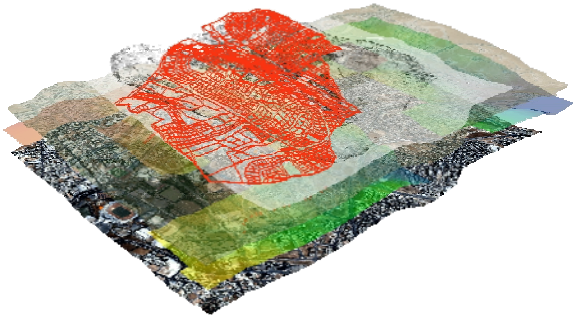


Overlay of Vector Layer (from Palestine Grid) with Ortho-photo

Results- Overlay



Results- Data Fusion



Conclusions

- Application of the method for extraction of cadastral boundaries:
  - Initial cadastral survey or resurveying:
    - Using photogrammetric marks on ground (on top of boundary marks)
    - Regardless to existence of physical boundaries
  - Check for consistence between legal boundaries-cadastral maps and physical boundaries- orthophotos
    - Cadastral maps can be very successfully updated using orthophotos in old settlement areas where agreements between neighbors exist and the physical boundaries are obviously not changed since long time.
      - physical boundaries == legal ones
      - systematic distortions of the digital map can be discovered and eliminated

Conclusions

- **Application of the method:**
  - **Extraction of new features:**
    - **Topography**
    - **Buildings**

    Play major role in Land Value!
    - **Land Marks**
    - **Land use**
    - **Environmental conditions**
    - **Other**

Multi-Purpose Cadastre

Conclusions

- Application of transformation functions
  - **Affine**: suitable for **flat** areas
  - **Projective** : for **hilly** areas
- Orthophoto is good and accurate source that represent ground truth which could be used as a base for registration
- Causes of mismatch:
  - Different accuracy in the primary sources: control points, original survey and mapping, etc.
  - Projection types
  - Scanning
  - Digitizing
  - Transformation functions (with regard to topography)

Future Work

- Applying feature extraction to produce true orthophoto for 3D modeling
- Overlaying other data sources with importance to multi-purpose cadastre:
  - Maps of infrastructure: on or under-ground
  - Land use planning
  - Other satellite imagery: Spot, Landsat
  - Other