

"Mapping from Fused High Resolution Satellites  
Stereo Imageries"

By

Researcher:

Dr. Eng. Ashraf Sharawi

Aerial Photography and Photogrammetric Department  
National Authority for Remote Sensing and Space Sciences (NARSS),  
Cairo, Egypt

XXIII FIG CONGRESS AND INTERGEO 2006  
Munich, Germany, 8-13 October 2006

Motivations

- 1- Increasing demand of "Decision Makers" for detailed data that can be obtained only from large scale maps, that should be achieved in the most economical way, concerning the least time, minimum cost, and maximum achievable accuracy.
- 2- Existence of several space systems that can be used for large scale map production and updating, with reasonable accuracy and cost.

Motivations

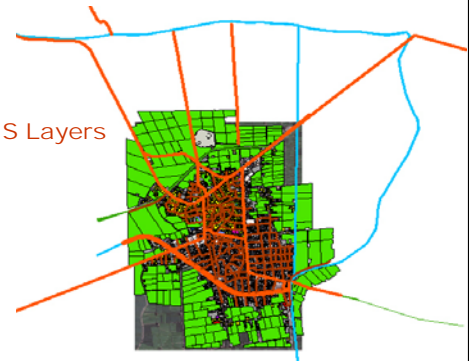
General Organization of Physical Planning in Egypt:

"Design of General Strategic Plans for the Development of all Egyptian Villages", different parameters are:

- Determine Activities;
- Determine Urban Boundaries;
- Determine Priorities of executed projects;
- **These Studies are done for more than 4000 villages;**
- Consequently, Complete Geo-referenced GIS Projects are required (Geo-Data Base);
- The required database is based on High Resolution Satellite Images (QuickBird Pan-Sharpned).

Motivations

Building GIS Layers



One of the Villages in the Project as an Example

Motivations



Detailed Features

Motivations



Detailed Features

## Motivations



Detailed Features

## Motivations



Max. Enlargement for Urban Areas

## Motivations



Errors During Mapping from Satellite Images for Urban Areas

## Objectives

Performing a feasibility study on the possibility of fusing different types of satellite Images in producing and updating topo maps in Egypt, taking into consideration the available data and current requirements in Egypt.

## Digital Image Fusion

> Image fusion is the **combination**, of two or more different images, to form a **new image**, by using a certain algorithm.

> Fused images provide **increased interpretation capabilities**, since data from **different characteristics** are combined.

> The images vary in **spectral** and **spatial** resolution, as well as in **time**, and therefore give a more **complete view** of the observed objects.

## Benefits of Image Fusion

- Provide **stereo-viewing capabilities** for **stereo photogrammetry**.
- **Improve geometric corrections**.
- Sharpen images.
- Enhance certain features not visible in either of the single data alone.
- Complement data sets for improved classification.
- Detect changes using multitemporal data.
- Substitute missing information (e.g. clouds-VIR, shadows-SAR) in one image with signals from another sensor image.
- Replace defective data.

## Applications of Image Fusion

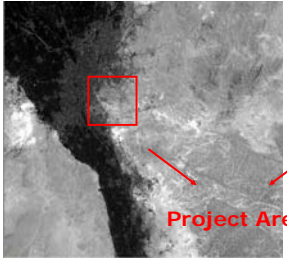

- Topographic Mapping / Map Updating.
- Land Use and Urban Area Identification.
- Forestry.
- Coastal/Ice/Snow Monitoring.
- Geology.

## Different Remotely Sensed & Ancillary Data Sets Available in NARSS

- 1- Stereo SPOT- P.
- 2- High Resolution IKONOS Data.
- 3- Old Orthophoto Map (GCPs).

## Different Remotely Sensed & Ancillary Data Sets Available in NARSS

**(1) Input Data:**  
Stereo SPOT-P (10 m Resolution), Level 1A, Covering Cairo.





Project Area

Left Image (5/7/1995)    Right Image (25/7/1995)

## Different Remotely Sensed & Ancillary Data Sets Available in NARSS

**(2) Input Data:**





**Single IKONOS**  
**(1 m Resolution)**  
**Covering Cairo**  
**(Dated:1999)**

Project Area

## Input Data

El-Moqatum Plateau (Cairo)


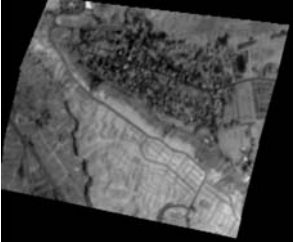
Identify Control Points:  
7 GCPs.  
Old Aerial Orthophoto  
1:10,000 Scale.

Identify Check Points:  
10 Points on Flat Terrain.  
8 points on Top of buildings.

Geo-coding for IKONOS Image

## Input Data

El-Moqatum Plateau (Cairo)


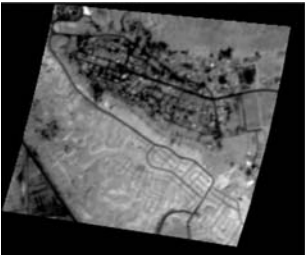
Identify Control Points:  
The same 7 GCPs.

Geometrically Corrected Image.

Geo-coding for Left SPOT Image

### Input Data

El-Moqatum Plateau (Cairo)

Identify Control Points:  
The same 7 GCPs.

Geometrically Corrected Image.

Geo-coding for Right SPOT Image

### Input Data


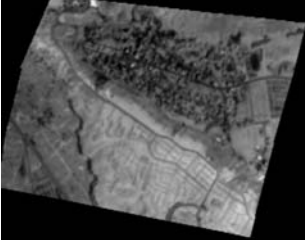
Residuals (meters) of the Ground Coordinates for the 7 Control Points After Least Squares Adjustment.

No.	Point ID	Residual E	Residual N
1	2	0.433	0.365
2	6	-0.012	0.082
3	9	0.655	-0.760
4	10	-1.206	0.024
5	12	-0.013	-0.148
6	15	0.264	0.374
7	16	-0.121	0.061
AVMR*		1.206	0.760
RMS		0.555	0.356
RMS <sub>p</sub>		0.66 m	

\* AVMR = Absolute Value of Max. Error.

### Output Data (Step-1)

El-Moqatum Plateau (Cairo)

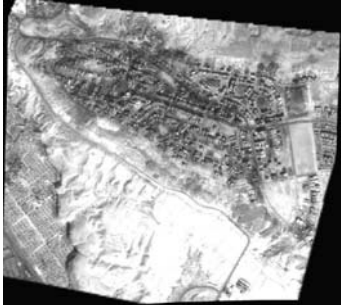
IKONOS Corrected Image

Left SPOT Corrected Image

Fusion of IKONOS with Left SPOT Images

### Output Data (Step-1)


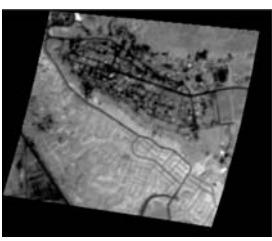
El-Moqatum Plateau (Cairo)



Fusion of IKONOS with Left SPOT Images

### Output Data (Step-2)

El-Moqatum Plateau (Cairo)

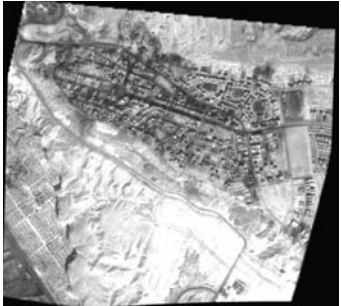
IKONOS Corrected Image

Right SPOT Corrected Image

Fusion of IKONOS with Right SPOT Images

### Output Data (Step-2)

El-Moqatum Plateau (Cairo)



Fusion of IKONOS with Right SPOT Images



### Output Data

#### Assessment of Results

- 1- **Calculation of statistics** from the **check points** derived from the **geo-corrected single IKONOS image**, as well as the **fused images**, to **assess the accuracy of maps that could be produced from this kind of images**, taking into consideration the accuracy of capturing GCPs from an old map. The procedure in this step is based on 2-D Affine transformation for the check points using the parameters calculated through the GCPs previously used for the correction of images;
- 2- A complete **map production** from the fused image; and
- 3- **Qualitative** assessment of the 3-D stereo viewing from the fused images.

#### Assessment of Results

##### Summary (First Category)

Image	Single IKONOS	Left Fused	Right Fused
<b>RMS<sub>p</sub> (8 Points- Top of Buildings)</b>	<b>16.46 m</b>	<b>16.97 m</b>	<b>16.85 m</b>
<b>RMS<sub>p</sub> (10 Points- Flat Terrain)</b>	<b>4.87 m</b>	<b>6.08 m</b>	<b>5.59 m</b>

↓                      ↓

(Second Category)

A complete map production from the fused image

#### Assessment of Results      Second Category

#### Assessment of Results

##### Third Category

- 3- **Qualitative** assessment of the 3-D stereo viewing from the fused images.

#### Assessment of Results

##### Third Category

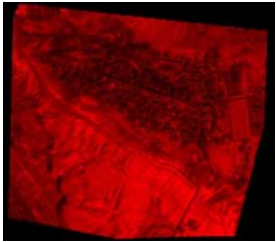
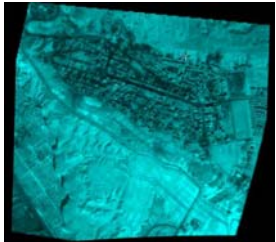
##### Qualitative

#### Assessment of Results

##### Third Category                      Qualitative

**Assessment of Results**

Third Category Qualitative

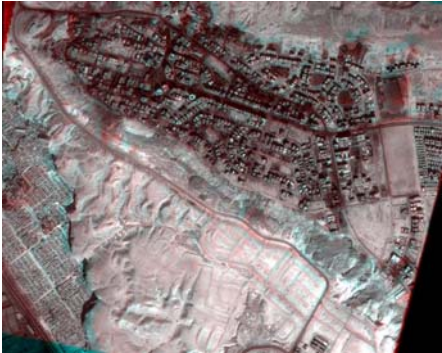



Left Fused Image Right Fused Image

**Assessment of Results**


Third Category Qualitative

Stereo Model



**Assessment of Results**

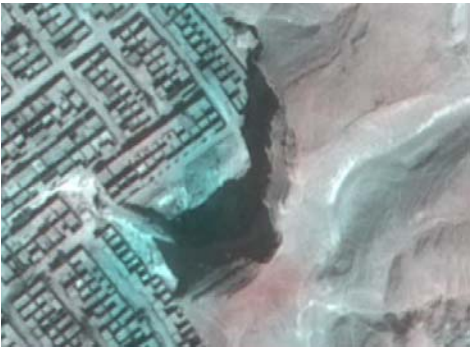
Third Category Qualitative



Single IKONOS (Max. Magnification: Hilly Area)

**Assessment of Results**

Third Category Qualitative





Fused (Max. Magnification: Hilly Area)

**Assessment of Results**

Third Category Qualitative

Comparison





Single IKONOS Fused

(Max. Magnification: Hilly Area)

**Assessment of Results**

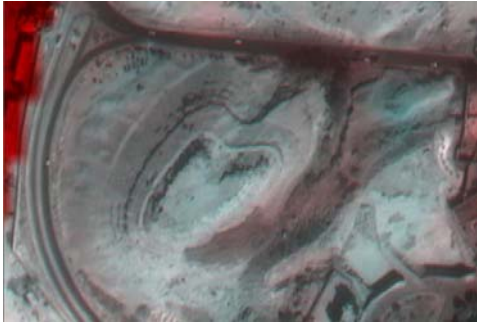
Third Category Qualitative



Single IKONOS (Max. Magnification: Hilly Area)

Assessment of Results

Third Category **Qualitative**

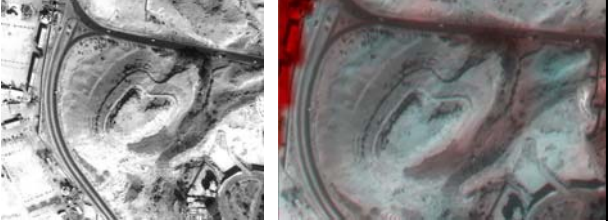


Fused (Max. Magnification: Hilly Area)

Assessment of Results

Third Category **Qualitative**


Comparison



Single IKONOS Fused  
(Max. Magnification: Hilly Area)

Assessment of Results


Third Category **Qualitative**



Single IKONOS (Max. Magnification: Green Area)

Assessment of Results

Third Category **Qualitative**

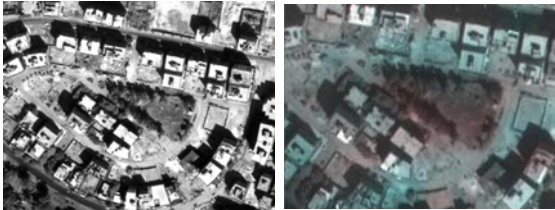


Fused (Max. Magnification: Green Area)

Assessment of Results

Third Category **Qualitative**


Comparison



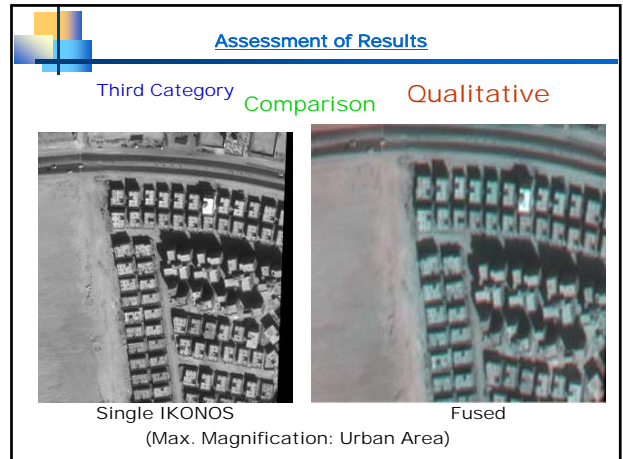
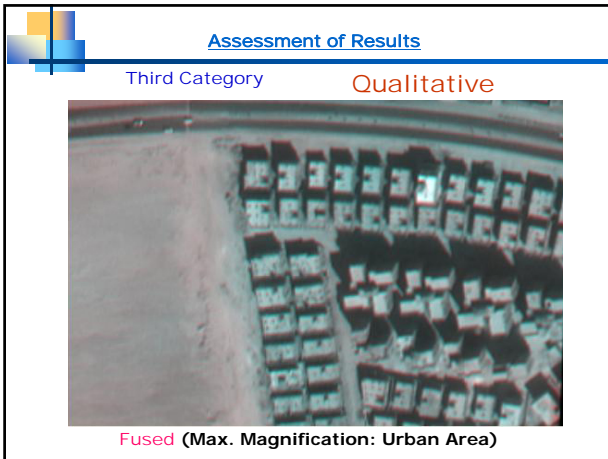
Single IKONOS Fused  
(Max. Magnification: Green Area)

Assessment of Results

Third Category **Qualitative**



Single IKONOS (Max. Magnification: Urban Area)



**Conclusions**

1- Regarding the geometry of the different images, and based on the adopted **National Map Accuracy Standards (NMAS)**, for geometric accuracy with confidence region 90% (0.3 mm from Map Scale), and from the obtained results, it can be stated that the **accuracy of mapping from geo-corrected single IKONOS images, as well as the geo-coded fused images** (single IKONOS and SPOT-P), corrected using GCPs derived from orthophoto maps of scale 1:10,000, gives an **RMS max. value of 6.08 m in planimetry**, which satisfies **theoretical large scale mapping of 1:20,000 and smaller** (practical mapping scale of 25,000), for flat terrain.

**Conclusions**

2- The geometric accuracy of the top of buildings is worst than that of the points on the flat terrain, which is true due absence of DEM.

3- Regarding the **qualitative assessment**, it is obvious that there is an **increasing description or detectability for the different land use features**, in the new fused images compared to the original single images alone, which helps strongly in photo interpretation results.

**Recommendations**

1- Completing the project using GCPs captured from ground surveying.

2- Calculating the DEM from the whole **cut area stereo model** of SPOT using ground surveying GCPs.

3- The same for the above item but for the fused images.

**Thanks**