Two years ago, in Southampton, we presented our research experiences and discussed open issues on:

- **IMAGE BLOCK ORIENTATION**
- **DENSE IMAGE MATCHING AND POINT CLOUD FILTERING**
- **SURFACE RECONSTRUCTION AND BUILDING MODELLING**

...we presented our research experiences and discussed open issues on:
Today, our research aims to...

...give an innovative and efficient answer to the questions:

**How to manage and fully exploit the potential of these data?**

**How to increase the usability of these data by the final user?**

Introduction

Currently, there are a few companies operating oblique image systems. However, **usability for the customer** was until now a **brake on the oblique market development.**

**Bruno Kessler Foundation**
3DOM = 3D Optical Metrology

**Methodologies and tools for geospatial problems**

**Oblique photogrammetry for precise mapping applications**

**AVT - Terra Messflug**

**GeoBLY Viewer**
Viewing and measurement tool for oblique imagery

**GeoBLY** - GEOmetry extraction tool from aerial OBLique imagerY
The aim of the project is to design, implement and validate an innovative software solution for:

- the management of oblique aerial surveys,
- the extraction of accurate 3D information.

The tool should meet the requirements of being:

- efficient AND accurate,
- easy to be customized for different needs,
- user-friendly for both expert and non-expert operators;

The tool should address the markets of:

- civil and construction engineering,
- building monitoring at public administrations,
- GIS departments in public administrations.

...why another software??

The project seeks to fill the gap in the actual software panorama and develop a tool that:

- is flexible and easy to be customized to different input (sensors/datasets/EO formats);
- exploits all available info, i.e. 2D (images), 2.5D (DTM) and 3D (mesh) data;
- gives quality figures of the measurements;
- is not a black-box.
Workflow and main applications

1. Project setup
2. Navigation
3. Making measurements
4. Checking and exporting measurements

- Visualize a building of interest and rotate around it at 360°;
- measure the length, height and area of any feature visible on the façade (i.e. windows, balconies, etc.) or on the roofs (i.e. chimneys, solar panels, etc.);
- verify and update the 3D cadastral database;
- monitor the status of buildings and infrastructures and identify structural damages.

The GeoBLY workflow

1. Project setup

NADIR AND OBLIQUE IMAGES
When a project is created, all images are pre-processed in order to create tiled (512 x 512 pixels) pyramids (6 levels). These data are used to speed up the rendering of images into the GUI.

ORTHOPHOTO OF THE AREA (if available)
Tiled (512 x 512 pixels) pyramids (9 levels) are generated to speed up the rendering of the ortho in the navigation panel.

3D MESH (if available)
KD-tree structure of the 3D mesh is generated to speed up the ray-tracing algorithm.
The GeoBLY workflow

1. Project setup

Once the pre-processing is done, the **available data can be imported** in the new project. In addition, the user can import:

**INTERIOR AND EXTERIOR ORIENTATION** (mandatory)

**IO** (txt file): `<camera type> <pixel size> <focal length> <PPAx> <PPAy>`

**EO** (txt file): `<image filename> <camera type> <X> <Y> <Z> <ω> <φ> <κ>`

**DTM** (if available)

NADIR SPLIT-POINT FOR SEMI-OBLIQUE IMAGES (see later)

2. Navigation

5-viewport main window, where images can be grouped:

- **by camera** (right, left, nadir, backward and forward);
- **by cardinal direction** (Nord, East, South and West).
The GeoBLY workflow

2. Navigation

A single click in the orthophoto will search all images (NA/LE/RI/BW/FW) viewing this point. The view can be also re-centered by selecting one (or more) measurement(s) and applying the “Filter by Visibility” option.

3. Measure

Different methods for making measurements are allowed, according to:

- available data
- accuracy requirements.

MONOPLOTTING WITH DTM

VERTICAL (OR HORIZONTAL) SNAPPING FOR FAST HEIGHT (OR LENGTH) MEASUREMENT.
Different methods for making measurements are allowed, according to:
- available data
- accuracy requirements.

Different methods for vector digitalization are allowed, according to the mapping needs.
- lines creation for road/rail/fence-like structures
- polygons creation for footprints/façades/parking-lots
Info on measurements (3D coordinates, length, height, perimeter, area, measurement mode and precision) can be easily accessed and checked.

Vector data (digitized in the project or imported from external file) can be organized in a multi-layer structure.

Export in GIS-compatible format is allowed.
Mapping in GeoBLY: examples

Three examples of mapping in GeoBLY with different inputs (sensors/datasets) are showed.

If you want to play with the data, ask us for live demos at the stand.

BERGAMO (ITALY) oblique dataset

NORCIA (ITALY) semi-oblique dataset

BORDEAUX (FRANCE) oblique and hybrid dataset

Oblique dataset: Bergamo

**SENSOR**

<table>
<thead>
<tr>
<th>UltraCam Osprey Prime (Vexcel)</th>
<th>Nadir</th>
<th>Oblique 45°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor size (mm)</td>
<td>70 x 45</td>
<td>53.4 x 39.9</td>
</tr>
<tr>
<td>Focal length (mm)</td>
<td>82</td>
<td>123</td>
</tr>
</tbody>
</table>

**INPUT FOR GeoBLY**

- Images
- EO/IO (AT in Pix4D)
- DTM (1 m resolution, from DSM with in-house algorithm)
- 3D MESH (in SURE, by nFRAMES)

**DATASET**

- 20 strips, 5 x 1051 images
- Average GSD (Nadir): 8 cm
- Overlap: 80% - 60%
- Flight: AVT

### Mapping in GeoBLY: Bergamo

**Camera heads**
- Nadir
- Oblique 45°

**LiDAR unit**
- Hyperion (FOV 40°)

<table>
<thead>
<tr>
<th>Sensor size</th>
<th>Focal length</th>
<th>Point density</th>
<th>Ranging accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>53.7 x 40.3 mm</td>
<td>83 mm</td>
<td>Typically 8 pts/m² @1000m</td>
<td>&lt; 2 cm RMS</td>
</tr>
<tr>
<td></td>
<td>156 mm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sensor size**
- 53.7 x 40.3 mm

**Focal length**
- 83 mm
- 156 mm

**Ranging accuracy**
- < 2 cm RMS

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### Oblique and hybrid dataset: Bordeaux

**SENSOR:** CityMapper (Leica)

**Camera heads**
- Nadir
- Oblique 45°

**LiDAR unit**
- Hyperion (FOV 40°)

**Sensor size**
- 53.7 x 40.3 mm

**Focal length**
- 83 mm
- 156 mm

**Point density**
- Typically 8 pts/m² @1000m

**Ranging accuracy**
- < 2 cm RMS

**INPUT FOR GeoBLY**
- Images
- EO/IO (AT in HxMap)
- DTM (0.5 m resolution, from LiDAR classification)
- ...

**DATASET**
- LiDAR point cloud:
  - More than 40 mln. points
  - Average resolution (on the ground): ≈ 10 cm
- 11 strips, 5 x 241 images
- Average GSD (Nadir): 5 cm
- Overlap: ≈80% - 60%
- Flight: Leica
Mapping in GeoBLY: Bordeaux

UltraCam Eagle Mark 1 (Vexcel)

Nadir

Sensor size (mm) 104.05 x 68.02
Focal length (mm) 80

Semi-oblique dataset: Norcia

SENSOR

UltraCam Eagle Mark 1 (Vexcel)

Nadir

Sensor size (mm) 104.05 x 68.02
Focal length (mm) 80

INPUT FOR GeoBLY

• Images
• EO/IO (AT in MatchAT)
• DTM (1 m resolution)
• 3D MESH (in SURE, by nFRAMES)

DATASET

• 1341 images
• Average GSD: 5 cm
• Overlap: 80% - 60%
• Flight: AVT

Mapping in GeoBLY: Norcia

Conclusion – Current state

- Our answer to the question of “how to use the data?” is to derive accurate measurements (points and lines) from the imagery by exploiting all available info (both 2D original imagery and 2.5D/3D value-added products).

- The GeoBLY tool represents a flexible means to accomplish this task and gives several options of data management and features measurements according to different requirements (accuracy, time, etc..) and different input (sensors/datasets/formats).

- A free and light version of the tool (called GeoBLight) is developed for viewing of oblique imagery and for making simple measurements. This free version is normally given to project customers.
Import, edit, and save geometry: file format will be extended, as well as the available tools for geometry handling;

A direct link to external software (e.g. Global Mapper, ArcGIS, qGIS, etc...) and overlay of WMS/WFS may help the final user.

Web-viewer version (?)

Search via address (database background)

....Any other wishes?

Thank you for your attention! We are available for questions/demos