Multimodal registration of visual data across different dimensions

**Doctoral School:** Doctoral School of Computer Science  
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**Topic Description:**
The main goals of the proposed research is to organize the (visual) data coming from various sensors over a long time span. A natural way is a geographical organization of the data, i.e. transform the images into a common geotagged coordinate frame which allows analysing the data in a way required by e.g. precision agriculture. As part of this, the registration of 2D sensory information with 3D terrain models would open new possibilities like modeling flooding or analysing the effect of dry weather. Geotagging and registration with 3D models would also help analysing the effect of microclimate changes over time, or modeling the spread of various diseases in order to predict the necessary dose of pesticides or fertilizers and the precise spatial range where these chemicals need to be applied. That would significantly reduce costs and the undesirable impact of chemicals on the natural environment.

Some of the related research problems:
- Building geotagged 3D models (either from the sensory information or using 3D reconstruction techniques on UAV imagery, or aerial lidar data)
- Geometric alignment of the collected multispectral/multimodal image data within the 2D image domain
- Registration of the 2D imagery with the reference 3D surface model

**Methodology:**
Correspondence-less region-based registration algorithms for highly different modalities and/or registration across different dimensions. In particular a 3D surface obtained from sensors or other sources (aerial Lidar or DEM) has no photometric data so the only way to align with image data is a purely geometry-based approach.

When photometric data is available, then correspondence-free linear registration methods for images with covariant radiometric data can be applied. The big advantage of this case is of course the linear solution allowing real-time solutions. The challenge is to define appropriate covariant functions using heterogeneous image sensors.

**Potential application areas:**
- Combination of UAV data with satellite data with different enlightenment conditions due to weather (cloudy, partly cloudy, sunny) or time of the day (for UAV, it might not be as regular as it is with a satellite).
- Build a very accurate Digital Elevation Model of the field using 3D GPS/RTK data and visual data.

**Collaboration:**
The research work involves active collaboration with researchers from BGU, Israel and Magellium Ltd., UK.

**Keywords:**
Registration, multimodal/multispectral imagery, UAV, DEM

**Successfull candidate:**
Very good knowledge of image processing, good knowledge of geometry and computer vision, basic knowledge of remote sensing, fluent in English.

**Admissible number of students:** 1
Multimodal registration of visual data across different dimensions
Published on Informatikai Intézet (http://www.inf.u-szeged.hu)

Deadline for applications: 2016-09-30

Source URL (retrieved on 2016-11-28 22:17):