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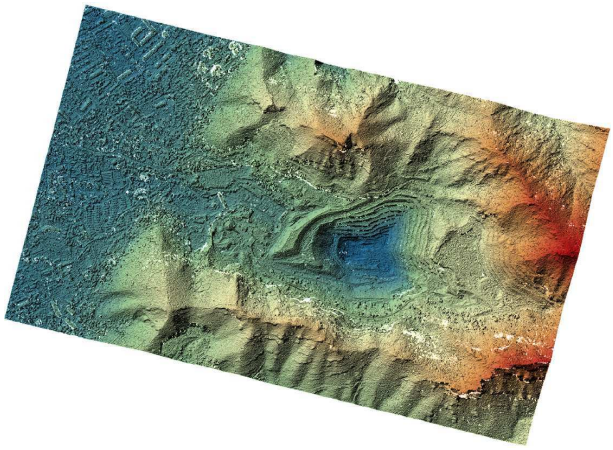
CNES CCT TSI Workshop

3D RECONSTRUCTION

22-23 June 2017

ENSEEIHT, Toulouse, France



ONLINE REGISTRATION (free but mandatory !) **:**

- ✓ http://cct.cnes.fr/content/animations-du-cct-17
- ✓ Select “programme et inscription” in front of “Reconstruction 3D”
- ✓ Select “Registration for this event”
- ✓ Fill in the form

NB: The number of participants for each company / lab might be restricted, if a large attendance is foreseen during registration process.

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FINAL AGENDA

THURSDAY 22 JUNE 2017

9:00-9:15	**Welcome**
9:15-9:30	***Introduction*** Eric Boussarie (CNES)
	FIRST SESSION: STEREO PIPELINES
9:30-10:00	***Adaptation of the free open source photogrammetric pipeline MicMac to compute seismic deformation*** Ewelina Rupnik (DIAS, IGN, ENSG), Marc Pierrot-Deseilligny (Univ. Paris-Est, LASTIG LOEMI, IGN, ENSG), Arthur Delorme (IPGP), Yann Klinger (IPGP)
10:00-10:30	***Terrestrial and extraterrestrial surface reconstruction with the Ames Stereo Pipeline*** Scott McMichael, Oleg Alexandrov, Ross Beyer, Terrence Fong (NASA)
10:30-11:00	***High resolution and large scale stereo mapping*** Pablo d'Angelo (DLR)
11:00-11:30	**Break**
11:30-12:00	***Building the Globe in 3D*** Leif Haglund (VRICON)
12:00-12:30	***3D Geometric modeling of urban scenes from satellite imagery*** Dorothy Liuyun Duan (INRIA), Lionel Laurore (LuxCarta Technology)
12:30-13:45	**Lunch**
13:45-14:15	***S2P: Satellite Stereo Pipeline*** Carlo de Franchis, Enric Meinhardt-Llopis, Gabriele Facciolo, Jean-Michel Morel (CMLA), Julien Michel (CNES)
14:15-14:45	***S2P on steroids: Automatic 3D on HPC at CNES*** Julien Michel, Jean-Marc Delvit, Myriam Cournet (CNES), David Youssefi, Christophe Palmann, Loïc Dumas (CS-SI)
	SECOND SESSION: MATCHING ALGORITHMS
14:45-15:15	***Advances in Semi-Global Matching*** Heiko Hirschmüller (Roboception GmbH)
15:15-15:45	***Some hidden option of the free open source correlator MicMac*** Marc Pierrot-Deseilligny (Univ. Paris-Est, LASTIG LOEMI, IGN, ENSG)
15:45-16:30	**Break**
16:30-17:00	***Multi scale and multi window algorithms*** Antoni Buades (UIB), Gabriele Facciolo (CMLA), Julia Navarro (UIB)
17:00-17:30	***Adaptive patch methods for stereo computation*** Pascal Monasse (LIGM, Ecole des Ponts ParisTech)
17:30-18:00	***MGM: A Significantly More Global Matching for Stereovision*** Gabriele Facciolo, Carlo de Franchis, Enric Meinhardt-Llopis (CMLA)

FINAL AGENDA

FRIDAY 23 JUNE 2017

9:00-9:30	***Simulation of high-precision image pairs for low-baseline stereovision*** Lionel Moisan (Univ. Paris Descartes)
	THIRD SESSION: APPLICATIONS
9:30-10:00	***Multi-date correlation of high and very high spatial resolution optical data for monitoring slope movements*** André Stumpf, Jean-Philippe Malet, David Michéa (Unistra)
10:00-10:30	***Integrated Sensor Orientation for UAV photogrammetry*** Mehdi Daakir (Univ. Paris-Est, LASTIG LOEMI, IGN, ENSG; Vinci-Construction-Terrassement/Sixense Mapping), Marc Pierrot-Deseilligny (Univ. Paris-Est, LASTIG LOEMI, IGN, ENSG) , P. Bosser (ENSTA Bretagne), Y. Rabot (Vinci-Construction-Terrassement/Sixense Mapping), C. Thom (Univ. Paris-Est, LASTIG LOEMI, IGN, ENSG)
10:30-11:15	**Break**
11:15-11:45	***3D applications using UAV imagery at DelairTech*** Matthias Meulien, Bastien Mancini, Jean Cesario (DelairTech)
11:45-12:15	***3D applications using satellite imagery at SERTIT*** Fahd Benatia (SERTIT)
12:15-12:45	***Reconstruction of 3D landscapes for the Rosetta mission by stereo and clinometry*** Laurent Jorda, C. Capanna, D. Nébouy (LAM, Marseille), S. Hviid (DLR, Berlin), R. Gaskell (Planetary Science Institute, Tucson, USA)
12:45-14:00	**Lunch**
14:00-14:30	***Photometric 3D-reconstruction: from modeling to resolution*** Jean-Denis Durou (IRIT)
14:30-15:00	***Model-based matching for aerial and spatial rendezvous*** Roland Brochard, K. Kanani, C. Robin, A. Masson, R. Delage (Airbus Defence and Space)
15:00-15:30	**Break**
15:30-16:00	***New perspectives on landslides and seismic risk studies from very high resolution DEMs*** Pascal Lacroix, Swann Zerathe, Emeline Maufroy (Univ. Grenoble)
16:00-16:30	***Cryospheric Sciences in 3D: new findings about snow and glaciers using Pléiades and ASTER stereo-imagery*** Etienne Berthier (LEGOS), Simon Gascoin (CESBIO), Renaud Marti (CESBIO, GEODE), Joaquin Belart (LEGOS, Inst. of Earth Sciences, Univ. Iceland), Fanny Brun (LEGOS, IGE Grenoble)
16:30-17:00	***Conclusions*** Olivier Marsal (CNES)

ABSTRACTS

FIRST SESSION: STEREO PIPELINES

Adaptation of the free open source photogrammetric pipeline MicMac to compute seismic deformation - Ewelina Rupnik (DIAS, IGN, ENSG), Marc Pierrot-Deseilligny (Univ. Paris-Est, LASTIG LOEMI, IGN, ENSG), Arthur Delorme (IPGP), Yann Klinger (IPGP):

This talk will focus on the satellite image processing pipeline available in MicMac - the free, open-source photogrammetric software. The following algorithmic aspects will be addressed: (1) the RPC-bundle block adjustment that refines the satellite's image orientation, (2) the multi-view dense image matching and 3D surface fusion that generate the digital surface model (DSM),(3) the 2D dense image matching that detects surface displacements (focus on seismic displacements).

Terrestrial and extraterrestrial surface reconstruction with the Ames Stereo Pipeline - Scott McMichael, Oleg Alexandrov, Ross Beyer, Terrence Fong (NASA):

The NASA Ames Stereo Pipeline (ASP) is an open source collection of tools for processing stereo imagery that has been in development for ten years. It takes advantage of the USGS ISIS software library to support all of NASA's imagers. In addition, it can handle RPC and frame camera models, Digital Globe's satellites (including the exact pushbroom camera models), ASTER, and SPOT5. ASP's wide array of tools can perform tasks such as gridded terrain creation, orthorectification, point cloud registration, terrain and image mosaicking, bundle adjustment, and CCD artifact correction in WorldView images. It can divide processing across multiple machines and has an optional GUI front end for running stereo on selected regions and visualizing outputs and intermediate results. We are now in the process of improving ASP's stereo performance by implementing the Semi-Global Matching and More-Global Matching algorithms, improving our image rectification, and incorporating some of the algorithms of S2P. These improved stereo capabilities are currently being used to process NASA's image data from the IceBridge program, a data set consisting of millions of stereo images taken across Alaska, Greenland, and the Antarctic.

High resolution and large scale stereo mapping - Pablo d'Angelo (DLR):

The presentation will provide an overview of the DSM generation pipeline as implemented in DLR's CATENA satellite image processing framework. Large amounts of VHR (Pleiades, WorldView) and HR (Indian Cartosat-1) data have been processed with this system in the past, from challenging dense urban areas to the highest mountains of the earth. Additionally first results on real-time image orientation and DSM generation on board of airplanes and helicopters will be presented.

Building the Globe in 3D - Leif Haglund (VRICON):

The production process is based on the principle of stereovision, and a processing method utilizing all available overlapping satellite images. Because the imagery does not need to be captured as traditional stereo pairs, today's massive and diverse archives of imagery provides abundant opportunity to quickly access data and generate products. This allows for creating highly accurate and photo realistic geospatial 3D data products with global coverage based on commercial satellite imagery archives. Vricon currently has the capacity to produce country-wide areas of 50cm resolution 3D data products with 3m Spherical Accuracy 90% (SE90) accuracy in every pixel. Moreover the processing is sensor agnostic and can make use of different satellite sources for forming the 3D surface model. Based on the 3D Surface model many different geodata products can be derived e.g. DSM, DTM, TrueOrtho, Classification layer. The talk will focus on the production process but also giving examples of the actual products on large scale areas.

3D Geometric modeling of urban scenes from satellite imagery - Dorothy Liuyun DUAN (INRIA), Lionel LAURORE (LuxCarta Technology):

Automatic city modeling from satellite imagery is one of the biggest challenges in urban reconstruction. Existing methods produce at best rough and dense Digital Surface Models. Inspired by recent works on semantic 3D reconstruction and region-based stereovision, we propose a method for producing compact, semantic-aware and geometrically accurate 3D city models from stereo pair of satellite images. Our approach relies on two key ingredients. First, geometry and semantics are retrieved simultaneously bringing robustness to occlusions and to low image quality. Second, we operate at the scale of geometric atomic region which allows the shape of urban objects to be well preserved, and a gain in scalability and efficiency. We demonstrate the potential of our algorithm by reconstructing different cities around the world in a few minutes.

S2P: Satellite Stereo Pipeline - Carlo de Franchis, Enric Meinhardt-Llopis, Gabriele Facciolo, Jean-Michel Morel (CMLA), Julien Michel (CNES):

This talk will present S2P, a fully automatic and modular stereo pipeline designed to produce digital elevation models from satellite images. The aim of S2P is to use and test off-the-shelf computer vision tools, while abstracting from the complexity associated to satellite imaging. To this aim, images are cut in small tiles for which we proved that the pushbroom geometry is very accurately approximated by the pinhole model. These tiles are then processed with standard stereo image rectification and stereo matching tools. The specifics of satellite imaging such as pointing accuracy refinement, estimation of the initial elevation from SRTM data, and geodetic coordinate systems are handled transparently by the pipeline.

S2P on steroids: Automatic 3D on HPC at CNES : Julien Michel, Jean-Marc Delvit, Myriam Cournet (CNES), David Youssefi, Christophe Palmann, Loïc Dumas (CS-SI):

S2P is the achievement of years of fruitful collaboration between CMLA and CNES. During the last 2 years, this open-source software has become the living heart of 3D reconstruction from satellite imagery at CNES. We deployed the tool within our High Performance Computing infrastructure, resulting in heavily paralleled processing. We also developed a set of pre and post-processing tools including an automatic watermask for VHR multispectral imagery, pushing automation even further. CNES is also a very active contributor to S2P, with several important pull requests that bring new ability and flexibility to the tool. During the talk, we will present two examples of use: automatic DSM generation from Pléaides HR imagery, and high latitude HR DSM using Sentinel2 L1B products.

SECOND SESSION: MATCHING ALGORITHMS

Advances in Semi-Global Matching - Heiko Hirschmüller (Roboception):

The Semi-Global Matching (SGM) method is widely used in different domains reaching from robotics and driver assistance to remote sensing. The talk will provide a brief overview and focuses then on applications in robotics and satellite image processing. In these domains, new developments around SGM are presented, like GPU implementations and error modeling. The latter consists of a pixelwise confidence probability and an Gaussian error for explicitly modeling outliers and geometric errors. This additional information is especially advantageous for fusing multiple disparity images or fitting objects into measurements. Finally, an outlook on solutions for robotics and remote sensing will be provided.

Some hidden option of the free open source correlator MicMac - Marc Pierrot-Deseilligny (Univ. Paris-Est, LASTIG LOEMI, IGN, ENSG):

MicMac is a free, open source photogrammetric software mainly developed at IGN. Its core functionalities are: initial orientation of perspective images, bundle adjustment of perspective and pushbroom images, computation of DSM or 3D point clouds, as well as computation of deformation maps.
This talk will focus on selected "hidden" algorithms in MicMac, among them: a "pseudo" interpolator that limits the aliasing effect, a multi-scale cross-correlation, a recursive dynamic programming (SGM)

Multi scale and multi window algorithms - Antoni Buades (UIB), Gabriele Facciolo (CMLA), Julia Navarro (UIB):

In order to correctly match a pixel, the adaptive window should favor pixels sharing the same disparity. State of the art algorithms make this configuration depend only on the spatial and color differences, identifying disparity discontinuities with color ones. Compared to these algorithms, we introduce the MSMW and the DAWA methods, which use a weight support depending on each tested disparity and not on the image configuration around the reference pixel. Besides, we use a multiscale strategy with invalidation criteria to reduce match ambiguity and computational time.

Adaptive patch methods for stereo computation - Pascal Monasse (LIGM, Ecole des Ponts ParisTech):

Based on pioneering work by Yoon and Kweon, a few adaptive patch methods have been proposed for stereo computation. They are based on heuristics trying to guess the shapes of objects in the scene without going to a full segmentation of the image, which is a problem in itself. The remarkable performance of such local methods relies on the fact that their adaptive power allows taking much larger patches than others. This comes at the price of computation time, though a recently proposed variant based on the guided filter allows having a complexity independent on the patch size.

MGM: A Significantly More Global Matching for Stereovision - Gabriele Facciolo, Carlo de Franchis, Enric Meinhardt-Llopis (CMLA):

This talk will present the more global matching (MGM) stereovision algorithm in the context of remote sensing. MGM extends the popular Semi-global matching (SGM) method. The SGM algorithm efficiently computes an approximate minimization of an MRF energy by replacing the two-dimensional smoothness term with an average of one-dimensional line optimization problems. This approximation, however, can result in low amplitude streaks in the final disparity image. MGM is based on an interpretation of SGM as a min-sum Belief Propagation algorithm, which allows to explain its streaking artifacts. Accordingly, MGM replaces the line optimization approximation with a directed graphs, which in the end allows to better enforce the initial regularity constraint. MGM has no new parameters and virtually no computational overhead with respect to the baseline SGM.

Simulation of high-precision image pairs for low-baseline stereovision - Lionel Moisan (Univ. Paris Descartes):

To obtain a 3-dimensional reconstruction of an urban scene from a stereoscopic pair of satellite images, the use of a low baseline (that is, two viewpoints close to each other) is generally preferred in order to avoid ambiguous matching situations like repeated patterns, deformations or disappearing parts due to occlusions. However, low baseline stereovision requires the analysis of image displacements at a subpixel scale, so that a careful handling of image sampling and interpolation is necessary. This requirement still applies to simulated images (synthetic stereo pairs) used to validate low-baseline stereovision algorithms. Unfortunately, producing aliasing-free synthetic images with high subpixel accuracy is not straightforward, and we will show in this talk that ray-tracing algorithms (which are widely used in image synthesis) are particularly unsuited to this task. We will then present a completely different image synthesis algorithm based on 2D numerical integration with adaptive mesh refinement, and demonstrate its interest for the quality assessment of stereovision algorithms.

THIRD SESSION: APPLICATIONS

Multi-date correlation of high and very high spatial resolution optical data for monitoring slope movements - André Stumpf, Jean-Philippe Malet, David Michéa (Unistra):

Slow-moving landslides are widespread in many landscapes with significant impacts on the topographic relief, sediment transfer and human settlements. While in situ geophysical methods and terrestrial remote sensing are indispensable for a detailed monitoring and understanding of individual landslides, their area-wide mapping and monitoring is still challenging. SAR interferometry has proven useful for the detection and monitoring of very slow movements (< 1.6 m.yr-1) but limitations are encountered for the investigation of slow-moving landslides (1.6 m.yr-1 – 30 m.month-1). Such limitations can be addressed through the analysis of archives of optical remote sensing images. To make better use of the increasingly available optical time-series, this study proposes a multiple pairwise image correlation (MPIC) technique for the analysis of optical satellite image time-series. The processing technique generates stacks of partially redundant horizontal displacement fields and computes multi-temporal indicators for a more accurate detection and quantification of surface displacement. The processing technique is optimized and can be easily embedded in high performance processing infrastructures as an on-line service. We will present the service (parallelized algorithm, processing chain, user modes) through examples of processing of time-series of very-high resolution (Pléiades) and high-resolution (Sentinel-2) satellite images at study sites in France, Italy and North America. The accuracy of the derived inventories and displacement time-series and their implications for the understanding of the seasonal landslide dynamics will be discussed.

Integrated Sensor Orientation for UAV photogrammetry - Mehdi Daakir (Univ. Paris-Est, LASTIG LOEMI, IGN, ENSG; Vinci-Construction-Terrassement/Sixense Mapping), Marc Pierrot-Deseilligny (Univ. Paris-Est, LASTIG LOEMI, IGN, ENSG) , P. Bosser (ENSTA Bretagne), Y. Rabot (Vinci-Construction-Terrassement/Sixense Mapping), C. Thom (Univ. Paris-Est, LASTIG LOEMI, IGN, ENSG):

This presentation concerns an industrial application of 3D metrology by photogrammetry and GPS embedded on a UAV. The problem of centimeter accuracy georeferencing is addressed. In a first time, the developed instruments are presented. Then the problems of internal calibration of the camera, spatial calibration and time calibration between the sensors is detailed. Finally, experimental results are presented and discussed.

3D applications using UAV imagery at DelairTech – Matthias Meulien, Bastien Mancini, Jean Cesario (DelairTech):

Photogrammetry softwares have been adapted to support large number of individual images and it is now common to fly UAV's to build 3D maps. We'll go into the details of use cases coming from Delair-Tech's business activities: stockpile measurement, gaps detection in palm grove, plant height measurement and airport neighbourhood monitoring.

3D applications using satellite imagery at SERTIT - Fahd Benatia (SERTIT):

SERTIT, a platform of ICube Laboratory, University of Strasbourg, provides added value products that help decision makers and industrial partners in a number of domains. SERTIT's main objective is to turn satellite and airborne data into actionable information focused on specific user needs. SERTIT's 3D department focuses on the generation and processing of 3D data using satellite and airborne photogrammetry. Many studies are conducted to improve 3D model quality and deliver a product that best fits user needs. Within this domain SERTIT helps institutional and industrial partners investigating how 3D could benefit their activities in a variety of fields such as forestry resource management, infrastructure monitoring and dealing with risk during the whole management cycle.

Reconstruction of 3D landscapes for the Rosetta mission by stereo and clinometry - Laurent Jorda, C. Capanna, D. Nébouy (LAM, Marseille), S. Hviid (DLR, Berlin), R. Gaskell (Planetary Science Institute, Tucson, USA)

With more than 100 000 images acquired by its OSIRIS scientific imaging system, the Rosetta mission constituted a unique opportunity to apply 3D reconstruction techniques to generate local and global digital terrain models of the surface of comet 67P/C-G. Both the bilobate shape at global scale and the very angular and rough terrains at local scales constituted a challenging but interesting test for all the techniques available. We will present the results from a new technique called "Multi-resolution Clinometry by Deformation", combined with a high-resolution stereophotogrammetry model of the comet nucleus. The method has been applied to reconstruct a quasi-global model of the nucleus at an intermediate resolution, and very high resolution local digital terrain models of areas of geological interest. We will describe the technique and we will show a sample of reconstructed models. We will also show an inter-comparison of these models with those derived with other techniques, emphasizing the strengths and the limitations of our approach.

Photometric 3D-reconstruction: from modeling to resolution - Jean-Denis Durou (IRIT):

Photometric 3D-reconstruction techniques aim at inferring 3D clues from 2D measurements, by analyzing luminous quantities in images. This is achieved by inverting a physics-based image formation model which describes the interactions between 3D-shape, surface reflectance, lighting and camera. In this talk, I will first describe the main characteristics of the shape-from-shading problem, which uses a single view and is ill-posed. I will then describe some recent advances regarding modeling and resolution of two well-posed extensions, which use several views of a 3D-scene, taken either under varying lighting (photometric stereo) or from different points of view (multi-view stereo).

Model-based matching for aerial and spatial rendezvous - Roland Brochard, K. Kanani, C. Robin, A. Masson, R. Delage (Airbus Defence and Space):

An ever increasing number of terrestrial and space applications require autonomy for the involved vehicles or robots. This is partly achieved through embedded vision-based navigation modules. We will focus on one of these technologies, which is the detection and tracking of a known but non- or semi-cooperative target. This technology is currently developed by Airbus Defence and Space to carry out space rendezvous and automatic air to air refuelling. Space rendezvous consists in approaching a space object (satellite, launcher stage, space module…), to eventually dock onto or capture it. Air to air refuelling consists in docking the boom of a tanker aircraft with the receptacle of a receiver aircraft to be refuelled. The tanker boom is currently controlled by a human operator on-board the tanker aircraft. Our goal is to make the refuelling autonomous using vision sensors on-board the tanker. The space object to dock with, as well as the receiver to refuel, are considered to be a priori known, at least partially, and are non- or semi-cooperative (e.g. their pose may be limited to an a priori envelop, but no pose measurements are provided in real time to the chaser). We'll present our model-based tracking, which relies upon LiDAR or camera images acquired by the "chaser", as well as the 3D model of the target. Our tracking solution has been tested on real data, acquired during the LIRIS experiment mounted on ATV-5 during its rendezvous with ISS, and on F16 aircrafts refuelled by an A310 MRTT. The performance of the detection and tracking algorithms, in terms of accuracy, robustness and computing time highly depends on the 3D model. We will detail the constraints which must be satisfied by the 3D model (resolution, complexity, quality…) as well as the reconstruction needs in various scenarios.

New perspectives on landslides and seismic risk studies from very high resolution DEMs - Pascal Lacroix, Swann Zerathe, Emeline Maufroy (Univ. Grenoble):

Very high resolution satellites with good steering capabilities are efficient to produce fine digital elevation models with less than metric uncertainties. These DEMs have proven to be useful for geomorphic studies related to natural hazards (landslides, active faults, glaciers,...). In this presentation, these DEMs will first be validated for such applications. We will then show 3 innovative case studies where high-resolution DEMs open new perspectives for studying landslide and seismic risks: (1) The use of diachronous DEMs allow us mapping and characterizing deep and shallow landslides triggered by the Gorkha earthquakes (Nepal, Mw7.9, 2015), (2) The morphological mapping of giant landslides in the desertic Western Andes of

southern Peru and northern Chile, combined with cosmogenic nuclides dating of landslide boulders, allow us establishing their failure chronology over 600 kyr, (3) The topographic curvature is known to control the amplification of seismic waves during an earthquake; through curvature computed at small scales on high-resolution DEMs, we show the first evidence of its relation to seismic damages for the Amatrice earthquake (Italy, 2016, Mw 6.0). These applications illustrate the new scales towards which geological hazards studies are now conducted.

Cryospheric Sciences in 3D: new findings about snow and glaciers using Pléiades and ASTER stereo-imagery - Etienne Berthier (LEGOS), Simon Gascoin (CESBIO), Renaud Marti (CESBIO, GEODE), Joaquin Belart (LEGOS, Inst. of Earth Sciences, Univ. Iceland), Fanny Brun (LEGOS, IGE Grenoble):

Digital elevation models (DEMs) derived from optical stereo-images are a key tool in cryospheric sciences. Differencing two or more multi-temporal DEMs allow estimating the changes in snow and ice thickness. Such information is relevant as an indicator of climate change and to quantify snow and ice contribution to regional hydrology and sea level rise. In our talk, two types of stereo-images will be discussed: (1) We will show that the new generation of sub-metric resolution satellites (Pléiades or Worldview) is a major step forward in snow and ice sciences for two reasons: (i) The corresponding DEMs are much more precise, typically 50 cm to 1 m over smooth natural surface and (ii) the DEM coverage over textureless snowfields is much better thanks to their improved radiometric depth (11 to 12 bits). (2) These high resolution sensors are recent and there is still a very strong added value in using archive stereo images from ASTER or SPOT5-HRS acquired since, respectively, 2000 and 2002. We will illustrate how the reprocessing of the entire ASTER archive (50,000 stereo pairs) allows an exhaustive and spatially resolved estimate of the mass balance of High Mountain Asia glaciers during 2000-2016.

WORKSHOP SITE:

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Public transport :

From the airport

From the airport, take the AERO bus to ”Compans-Caffarelli” bus station. Then take the metro, line B, toward "Ramonville", at “Compans-Caffarelli”. Get off at the stop "François Verdier" (6min walk from ENSEEIHT).

From the Toulouse Matabiau train station

From the “Marengo-SNCF” line A metro station, take the metro, line A, toward “Basso Cambo”. Get off at the stop “Jean Jaurès” (10min walk from ENSEEIHT).

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