

Geomatics Laboratory

Experimental Testbeds and Platforms

GEMMA Navigation®

GEMMA is a portable, extensible, and modular software system aimed at the development of new navigation and positioning algorithms as well as at the evaluation of the performance of sensors. It has been conceived as a research toolset useful in laboratory environments. It is a complete toolset or suite, providing an integrated environment where research tasks and workflows are facilitated; a data abstraction and their corresponding interface has been devised. A batch interface exists, making possible the automation of repetitive tasks; a graphic interface has been included to ease the interaction with end-users.

GEMMA main features:

- Generation (densification) of realistic trajectories for any kind of platform: from spacecrafts, to aerial, terrestrial or marine vehicles, or even alive organisms.
- Simulation of signals (measurements) for several types of sensors, as, for instance, IMUs or GNSS receivers.
- Sequencing of sensor measurements.
- Trajectory estimation and trajectory quality assessment.

SAR hardware simulator setup for MW sensors tests

The setup consists of some RF components connected to an Agilent E8361A to simulate propagation at short range. It allows real test of microwave device at different frequencies.

Radar systems and Microwave sensors

Ibis S/L Ground Based SAR Interferometer (GB SAR)

The GBSAR is a commercially available measuring instrument consisting of a Ku-band coherent step frequency continuous wave radar, mechanically arranged to perform synthetic aperture imaging. The system can acquire coherent microwave images, of areas up to 1 km², to perform interferometric processing. The Ku-band coherent transceiver used for GBSAR measurements can be used in another configuration: a Real-Aperture-Radar (RAR) mounted on a tripod (instead of the rail used by the GBSAR). The RAR system measures 1D profiles of Single Look Complex (SLC) data. It can acquire data at a relatively high frequency: the sampling frequency is up to 200 Hz. It can be exploited to estimate the vibrations of different types of structures, e.g. high buildings, towers, bridges, viaducts, etc.

K-band radar sensor

The K-band radar sensor (developed at CTTC by the Geomatics Research Unit) uses a commercial module produced by IMST, a low-cost ultra-lightweight radar unit. The central frequency is 24 GHz with a maximum bandwidth of 3 GHz. The system is very compact and

easily deployable. The modulation used is Frequency Modulated Continuous Wave (FMCW) with two receiving channels, which - in the configuration developed - are associated to two received polarizations, vertical and horizontal. The range resolution varies depending on the bandwidth: 1 GHz corresponds to 0.15 m. The K-band sensor uses horn antennas with a typical gain of 20 dBi and a half-power beamwidth (HPBW) of 16° in azimuth and 15° in elevation. The radar is equipped with a tripod mount whose height, zenith and elevation angles can be adjusted manually, whereas the interface of the software that runs the radar is written in the Python language. The analysis of the recorded data is carried out with off-line Matlab code and has been developed by CTTC. The main limiting factor is the maximum duration of a single acquisition being related to the RAM of the computer that controls the instrument.

C band Active Reflector

In the last few years, we implemented some Active Reflectors designed with the goal of producing a device with a better cost/benefits ratio with respect to the Passive Reflector often used in satellite radar Interferometry at C-band. The main goal of this system is to provide the required high radar Cross Section (RCS) for spaceborne interferometric use of SAR imaging with adequate phase stability over temporal periods which can cover up to some years. The Active Reflector has been totally developed at CTTC, initially as a research prototype. It has been carefully tested in the laboratory and on field. The results have been published in peer review journals. The design and implementation of this device aim at achieving a trade-off among low-cost, low maintenance, easy and rugged hardware, to allow an easy installation of several devices to be feasible from a cost point of view. The performance of the proposed Active Reflector is focused on landslide and glaciers monitoring, without aiming at top geodetic performance, at least in this first version of the device. The device has been tested with Sentinel-1 imagery, but it is designed to work for any C-band Radar operating also with a slightly larger bandwidth, such as Radarsat.

Additional equipment

- Global Positioning System (GPS)/GNSS receivers
 - Geodetic grade: JAVAD TR-G3T. L1/L2/L5.
 - Geodetic grade: Novatel OEMV-3. L1/L2 (2 units).
 - Geodetic grade: Trimble 5700. L1/L2 (2 units).
- GPS/ GNSS antennas
 - Aviation grade: Antcom corp. Arinc 743. L1/L2/L5.
 - Aviation grade: Novatel 512C. L1/L2 (2 units).
 - Geodetic grade: Trimble Zephyr. L1/L2 (3 units).
- Inertial Measurement Units
 - Navigation grade: IMAR-NAVIGATION iNAV-FJI, IGI GmbH Ile.
 - Tactical grade: Northrop-Grumman LN200.
 - MEMS/Tactical grade: Analog Devices ADIS16488.
- Cameras
 - Industrial grade: Prosilica GE 4900C. Color. f 8 mm, 4872 x 3248 pix.
 - Industrial grade: Prosilica GC 2450M. Monochromatic. f 8 mm, 2448 x 2050 pix.
 - Industrial grade: Duncantech MS4100-CIR. Infrared.
 - Consumer grade: SONY-NEX5. Color. Mirrorless. Three lenses (f 18.55 mm, 16 mm, 7.3 mm). 4912 x 3264 pix.
- Other sensors
 - Barometer: Honeywell HPA200W2DB.
 - Odometer: Hengstler RI 76TD.

- Magnetometer: Leica DMC-SX
- Geodetic and surveying instruments
 - Total station: Trimble 3601 DR. Prism. CST Corporation 34mm (2 units). Level. DNV FSI.
 - Optical plummet: Tribrach W/O. (2 units).
- Computer-on-Module (COMs) / micro controller systems
 - Gumstix OVERO FIRE COM (2 unit) + 3 expansion cards (Chestnut43, Pinto-TH, Tobi). Netburner mod. 54415 + expansion card (mod. DEV-70CR). Beagleboard mod. Beagleboard-XM.
- Relevant software
 - Inpho GmbH MATCH-AT (plus DSM Lite, DTMaster Stereo, SCOP++ Kernel).
 - Novatel GrafNav / GrafNet. Novatel Inertial Explorer (2 licenses).
 - Erwin J. Kruck's BINGO.
 - National Instruments LabView Full Dev.
 - Deimos Space Granada FCM.
 - Exelis IDL / ENVI 4.7 (25 floating licenses).
 - Geonumerics GENA block adjustment (5 licenses).
 - Stereoscopic digital photogrammetric workstation.

Measurement and testing equipment

- Agilent E8361A, Keysight E8361A, HP E8361A PNA Network Analyzer, 10 MHz to 67 GHz.
- C, K, and Ku band horn antennas with different gain.
- A Ku-band transponder
- ARRA mechanical phase shifter
- A set of high radar cross section targets (metal corner reflectors) for field applications.

Others

Soldering station and tools for small mechanical arrangements.