Towards Up-To-Date Wide-Area Information About Forest Resources

European PI(s)
Dr. Mika Karjalainen, mika.karjalainen@fgi.fi

Chinese PI(s)
Prof. HUANG Guoman, Huang.guoman@casm.ac.cn

The state of the forests is an important global environmental indicator, and the changes in the forest recourses and in the forest health status, can be considered as central factors in environmental monitoring, as they are linked to the global climate change and Earths carbon cycle. The far-reaching aim of the proposed research is to improve the methods currently used in mapping of forest resources i.e. to provide frequently, forest status related, wide-area information by using Synthetic Aperture Radar (SAR) satellite images coupled with information derived from Airborne Laser Scanning (ALS), airborne X/P-band SAR (CASMSAR), profiling scatterometer (Tomoradar) data.

Remote sensing instruments, which are typically used in mapping of forests, are: laser scanners, aerial images, optical satellite images, SAR images, and hyper/multispectral images. One can find the current status of these techniques in forest biomass estimation e.g. in Koch (2010). Clearly the most important step forward in the past years has been the use of Airborne Laser Scanning (ALS) in forest inventories (e.g. the latest Marcus Wallenberg Prize was awarded for the research related to ALS based forest inventories). However, wide-area ALS data acquisition is still rather expensive and the time interval between the consecutive nation-wide ALS surveys (taking Finland as an example) might be carried out in 5 years or so. Therefore, there appears to be niche for other techniques in forest resources mapping as well. Being able to acquire images through clouds, SAR enables constant and frequent imaging of the target area, which is an important characteristic in time-critical mapping tasks. A lot of research has been carried out in the matter of using SAR data in mapping of forests mostly based on the intensity information, which clearly has limitations, such as, the saturation effect. However, according to recent results, elevation data extracted from SAR data appears to be the key to improve the estimation accuracy.

Basically, there are two approaches to extract elevation information from the SAR images: 1) SAR interferometry (INSAR) or 2) radargrammetry. If the elevation values of the ground surface are accurately known e.g. using ALS derived a Digital Terrain Model (DTM), then the X-bands or C-bands interferometric or radargrammetric height can be related to the forest canopy height and accordingly to the stem volume. Examples of the use of INSAR data for forest canopy height estimation has been provided by Kellndorfer et al. (2004), who used the C-bands interferometric heights from the Shuttle Radar Topography Mission (SRTM) to estimate the forest canopy height. Similar results using the SRTM X-band data were presented by Solberg et al. (2010), who also estimated the above-ground biomass based on SRTM elevation values. Perko et al. (2010) and Karjalainen et al.(2011) have showed that X-band stereo SAR satellite data have potential for application in the estimation of forests biomass. Because accurate lidar based DTMs are available only in limited areas of the world, other means to derive elevation of ground surface are needed. One of the most promising techniques is the use of the longer radar wavelengths (P-band), which penetrate forest canopy and thus provide information about ground surface elevation.

The objective of the project is to develop efficient canopy measuring techniques based on satellite-derived elevation and surface models including

(1) Canopy height model extraction from laser derived elevation model subtracted from satellite given DSM (Sentinel-1 C-band interferomertry and stereo-radargrammetry)

(2) Canopy height model extraction from Chinese airborne SAR equipped with X- and P-bands (CASMSAR)
(3) Verification of canopy height models with field data and UAV-based radar profiler (Tomoradar development of FGI, improved version of the known HUTSCAT profiling scatterometer system)

Mika Karjalainen   mika.karjalainen@fgi.fi
Huang.guoman@casm.ac.cn

Synthetic Aperture
Radar SAR   Airborne Laser Scanning ALS   X/P
   SAR CASMSAR

SAR
 /   Koch 2010

ALS

   Marcus Wallenberg   ALS   ALS
                        ALS

SAR
SAR

SAR
      SAR   1   InSAR
2   ALS   DTM
    X   C
      Kellndorfer   2004
                   SRTM   C   Solberg
2010   SRTM X   SRTM
         Perko   2010   Karjalainen   2011   X   SAR

      DTM

   1   DSM Sentinel-1 C   SAR

   2   X   P   SAR   CASMSAR
     3   UAV   FGI
HUTSCAT   P   SAR