

Innovative laboratory at a university for real-time acquisition of satellite high resolution optical and radar imagery

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Abstract. Remote Sensing Centers allowing real-time imagery acquisition from Earth observing satellites within the structure of Universities provides proper environment for innovative education. It delivers the efficient training for scientific and academic and teaching personnel, secure the role of the young professionals in science, education and hi-tech, and maintain the continuity of generations in science and education. Article is based on experience for creation such centers in more than 20 higher education institutions in Russia, Kazakhstan, and Spain on the base of UniScan ground station by R&D Center ScanEx. These stations serve as the basis for Earth monitoring from space providing the training and advanced training to produce the specialists having the state-of-the-art knowledge in Earth Remote Sensing and GIS, as well as the land-use monitoring and geo-data service for the economic operators in such diverse areas as the nature resource management, agriculture, land property management etc. Currently our proposal of UniScan for universities all over the world allows to receive not only MODIS data from Terra and Aqua, but also high resolution optical images from SPOT 4, IRS-1D, EROS A satellites, and radar images from Radarsat-1 satellite, including the telemetry for the first year of operation, within the footprint of up to 2,500 kilometers in radius. Creation remote sensing centers at universities will lead to a new quality level for education and scientific studies and will enable to make education system in such innovation institutions open to modern research work and economy.

Keywords: Remote Sensing, UniScan ground station, Education.

1. Introduction

The task of increasing the economic competitiveness of any country is not possible without reinforcing the role of the higher professional education, attracting youths to deliberate choice of future profession. Today, the traditional education, as an access to learning, can not keep up with the current requirements of science and industry.

Such an index as the education quality comes along with education results, currently most often referred to as “competence”. Innovation of education should be more competence-oriented than passing of knowledge that always gets out of date. Following this pattern knowledge can be acquired on an individual bases. Such kind of education should be more connected to practice than the traditional one.

Reducing competitiveness of traditional education institutions, as well as insufficient science and production integration indicate that new types of higher education institutions should be created. Nowadays, often traditional education as the system of gaining knowledge lags behind the actual current requirements of contemporary science and production.

2. Methodology

One of the solutions to resolve these problems can be the introduction of Remote Sensing Laboratories or Centers for Earth observation from Space for territories changes monitoring as research and development links in the chain of universities. This will allow the students to master practical skills having an ultra-modern laboratory base.

Traditionally remote sensing centers at universities are equipped with ground stations enabling to receive free data, such as worldwide known AVHRR from NOAA satellites series with resolution of 1,100 m and MODIS from Terra and Aqua satellites with 250, 500 and 1,000 m resolution. Important positive peculiarity of these data in that there are many open and free software tools and many of them can be found in Internet. This opens a wide field for students and researchers to change of knowledge, ideas and new developments investigating AVHRR and MODIS data for global changes on vast territories. But low resolution of these data makes considerable restrictions for their practical applications for more precision changes of local areas of the Earth.

At the same time one who wishes to receive data with middle and high resolution faces with such problems as high price for ground station and expensive telemetry fee. Usually only national large remote sensing centers have a possibility to receive data with middle and high resolution. However, it was a dream for universities...

Since 2009 ScanEx has been exercising the possibility of equipping foreign universities with technologies for receiving Earth remote sensing data of high resolution (up to 1.8 m) in real time. Participants of the world educational community can purchase the universal UniScan ground station for receiving space data already completed with telemetry licenses for the right to receive 100 scenes of EROS A, 600 minutes of IRS-1D, unlimited access to SPOT 4 images, and 50 scenes of radar RADARSAT-1 satellite for the first year of operation. Initial inclusion of the license in the functionality of UniScan ground station (pursuant to agreements with the Operators of respective Earth remote sensing missions) leads to significant cost reduction of receiving station and space imagery for universities. As a result the world universities will be able to effectively utilize the state-of-the-art space technologies in their educational process and scientific research by working with up-to-date satellite data received at their own stations with the footprint of up to 2.5 thousand kilometers in radius.

3. Results and Discussion

To date, there are over 20 Remote Sensing Centers/Laboratories operating on UniScan ground stations deployed at the leading universities in Russia, Kazakhstan and Spain. In the most cases they receive MODIS data. But among them 7 UniScan ground stations in universities of Russia are equipped not only for MODIS data, but also for other satellites (SPOT 4, IRS-P5, IRS-P6, EROS A/B, RADARSAT-1) thanks to flexible licensing policy implemented in the Russian Federation.

Based on ScanEx technology Remote Sensing Centers/Laboratories have already been operating with an excellent track record in such Russian Universities as Altay State University, Belgorod State University, Ufa State Aviation Technical University, Tyumen State University, Bauman Moscow State Technical University...

Samara Space Geoinformation Center has been operating in Samara State Aerospace University since December 2006, and is currently one of the best equipped Earth Remote Sensing Centers in Russia and CIS countries, not only among the educational facilities, but also the state and private space monitoring centers. In December 2010 it was equipped with possibility to receive data from new generation RADARSAT-2 satellite.

Earth Remote Sensing Centers have been launched in 2007-2008 as a part of "Education" National Project in Siberian and Southern Federal Universities.

It has been currently the worldwide practice to set up Remote Sensing Centers at the higher education entities and other educational organizations. Thus, UniScan based laboratories and centers have been in operation at Kazakhstan-British Technical University of Republic of Kazakhstan (Almaty) under the auspices of Kazakhstan System Modeling Research Institute, at Satpayev Kazakhstan Research Science and Technology Institute (Almaty), at two universities in Spain (Valladolid and Valencia).

In November of year 2010 on the base of the Northern (Arctic) Federal University the Arctic Remote Sensing Center was founded in Russia (Arkhangelsk city), equipped with UniScan ground station for acquisition data from SPOT 5 and RADARSAT-2 satellites among others.

The Remote Sensing Centers deliver the real-time training for executive decision making support technology at the regional and municipal levels. The Centers can also provide the commercial service as well, e.g., training at professional development programs, contracted work in a range of various applications (management of natural resources, agriculture and forestry management, emergency response, mapping updates, cadastral work, etc.) or research and development in various fields of knowledge.

UniScan ground station is intended for receiving and processing information transmitted from Earth low-orbit satellites via X-band radio channels with the data rates up to 320 Mbps in one channel. Such rates correspond to images with a spatial resolution better than 1 meter. At present the UniScan station provides for data acquisition and processing from Terra, Aqua, IRS-P5, IRS-P6, CARTOSAT-2, SPOT 4, SPOT 5, FORMOSAT-2, EROS A, EROS B, RADARSAT-1, ENVISAT-1 and from new generation of radar satellites RADARSAT-2 and TerraSAR-X/TanDEM-X.

UniScan hardware is universal and programmable and, in most cases, ground station can be upgraded for new satellites on the software level.

UniScan is completed with software for data reception, preliminary processing, archiving, cataloguing and creation of thematic products further to be imported into various GIS formats and applications. The most popular among the specialists in Remote Sensing and GIS are ScanMagic® and ScanEx Image Processor® software applications with more than 200 installation licenses throughout Russia and abroad.

Data received from the satellites in real-time are converted into ready-for-further-analysis products within 0.5-1 hour after being received from space, which indicates a high operational degree of the process (no data, available via Internet, can be obtained in such a quick mode).

Contemporary Remote Sensing Laboratory/Center at a university allows to:

- turn the university into one of the world leading education institutions equipped with cutting-edge technology and firmware for Earth observation from space (footprint of ground station is about 12 million square kilometers);

- carry out training and advance training of specialists having skills in remote sensing and GIS, used for decision-making support;
- monitor territories and submit data in support of decision-making of regions and sub-regions.

Remotely sensed data received by Remote Sensing Laboratory/Center of a university will allow resolving following practical tasks concerning change detection using different types of remotely sensed data both optical and radar:

- topographic maps updating;
- forest fires early detection and monitoring;
- ice and snow cover condition operational assessment;
- on/off shore oil spills detection within the oil production and transportation areas;
- ecological situation of water areas and new seaports, pipelines and oil terminals construction sites;
- illegal fishing control;
- license agreements compliance monitoring within the fields of natural resources development;
- forestry monitoring (logging dynamics, logging status);
- agricultural monitoring for crop rotation rules observation and proper arable lands use;
- illegal construction control;
- monitoring of infrastructure development;
- independent and operational natural disaster damage assessment;
- hydraulic structures condition monitoring;
- creation of up-to-date thematic maps of natural objects condition (vegetation, soil cover, areas hazard rate, etc.);
- environmental impact assessment of a territory development.
- solution of hydro-meteorological and weather forecast tasks;
- environmental monitoring and others.

4. Summary

UniScan ground station technology developed by ScanEx and implemented for over 20 Remote Sensing Centers/Laboratories at universities enables new unique possibilities to receive in real-time high resolution optical and radar data on standard personal computer of users.

Since year 2009 satellite imagery service to Universities has extended worldwide outside the Russian territory, providing EROS A satellite imagery at 1.8 m resolution, IRS-1D imagery at 5.8 and 23 m, SPOT 4 satellite imagery at 10 and 20 m resolution, and SAR RADARSAT-1 imagery with resolution ranging from 100 m to 8 m. Based on the Agreement between SCANEX and the satellites Operators, and on unique flexible financial terms, the international universities can purchase the universal compact UniScan stations including telemetry for the first year of operation. This is the first precedent in the world.

5. Conclusions

Creation of state-of-the-art Remote Sensing Laboratory/Center at universities will lead to a new quality level for education and scientific studies and will enable users to make educational system in such innovation institutions open to modern research work and economy.