Earth observation space missions for agricultural monitoring

1-2-2206 (3 credits)

Lecturers
Dr. Manuel Salvoldi
Prof. Arnon Karnieli

Motivation

In the last decades, satellite imagery has played an important role in effective tools for Earth observation (EO) applications, such as precision agriculture, air, land & water monitoring, environmental awareness, natural or anthropological disaster assessment, etc. In parallel, with the continuous evolution of geographic information system (GIS) solutions, it is expected that an increasing number of researchers will be involved with projects based on EO satellite images. Yet, the majority of users have little understanding of what really constitutes a satellite mission.

The objective of this course is to give the students, as actual or potential satellite image users, the ability to extract from their satellite data useful information that could boost both their research and their expertise on EO missions. Hence, this course will provide students with general knowledge on the most important aspects of a space mission.

Topics

	Subject	Details	Lecturer	Lecture/Training
1	Introduction to spacecraft missions	A brief history of the space exploration. Space mission categories. Why satellites are so useful for EO? Types of satellite missions for EO: monolithic, constellations and formation flying.	Arnon Karnieli	L=3
2	Spacecraft orbits for Earth observation	The Keplerian model, orbital elements, the geometry of spacecraft orbits. Orbits for EO missions: polar, Sun-synchronous, and Molniya. Ground track and revisit time.	Manuel Salvoldi	L=3
3	Orbit perturbations	Solar radiation pressure, third-body perturbation, atmospheric	Arnon Karnieli	L=3

		drag and the Earth gravity potential model.		
4	The impact of space environment	Sun, radiations, atmospheres, magnetic field, debris and their effects on space hardware, countermeasures and open points.	Arnon Karnieli	L=3
5	The spacecraft	Sub-systems of a spacecraft: power, structure, navigation & control, thermal control and telecommunication.	Manuel Salvoldi	L=3
6	EO instruments	Multispectral and hyperspectral instruments, specification of instruments, spectral and spatial resolutions.	Manuel Salvoldi	L=3
7	The ground segment	Ground station, scientific and ground control centers, spacecraft visibility for low orbit satellites and ground operations.	Manuel Salvoldi	L=3
8	Launch	Spacecraft integration and test. Launchers selection	Arnon Karnieli	L=3
9	EO space missions: past present and future	Overview on EO space missions: Landsat, GRACE-FO, SMAP, Terra and Aqua satellites, SPOT, Copernicus and Sentinel programs, VENμS.	Manuel Salvoldi	L=3
10	Free sources of satellite data	Google Earth, Sentinel Hub, Earth Explorer, NOAA, Copernicus Open Access Hub, Amazon Web Services, Zoom Earth, NASA Worldview, NASA EarthData (GIBS), SkyWatch EarthCache.	Manuel Salvoldi	L=3
11	Trending topics in the space sector	The democratization of the space, Cubesats, reusable launcher, artificial intelligence in spacecraft operations, laser communication.	Arnon Karnieli	L=3
12	The VENμS overview	Spatial, spectral, and temporal characteristics of the VENμS spacesystem. The scientific and technologic missions. Applications.	Arnon Karnieli	L=3

A part of the course will be dedicated to a series of video web talks where scholars and key actors from the space industry in Israel and abroad will present some of their EO space mission projects and activities for agricultural monitoring.

Prerequisite

001-2-4028 Remote sensing for agriculture, rangelands, and forestry. The course is tailored for students that don't have an engineering background, nevertheless some basic understanding of physics is recommended but not required.

Book

It is recommended to follow the material provided during the class.

Nevertheless, for who is interested in going into the topics presented in the course in greater detail, we suggest the following book:

O. Montenbruck and, E. Gill, *Satellite Orbits*. Springer,2000

W. J. Larson and J.R. Wertz, *Space Mission Analysis and Design*. El Segundo, CA, Microcosm Press, 2005.

Pasquale M. Sforza, *Manned Spacecraft Design Priciples*, Elsevier Inc, 2016

Thomas Uhlig, Florian Sellmaier, Michael Schmidhuber, Spacecraft Operations, Springer,2015

Workload & Grading

Grading is 30% for homework assignments and 70% for final exam.