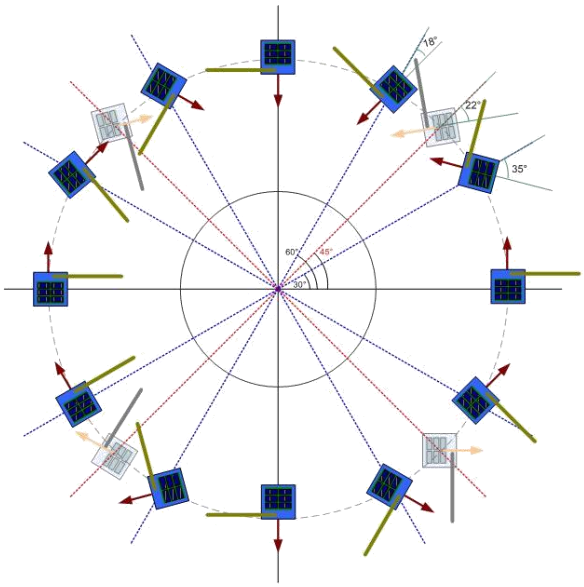
space Attitude Determination Module

Fast and robust satellite attitude determination

spaceADM **is a real time algorithm to evaluate satellite attitude** based on Kalman Filter theory. It is able to integrate data from different devices (Star Trackers, Gyros, Sun Sensors...) in order to provide highly precision estimates to satellite attitude.

On-board measurements need a refinement step to provide valuable data to the attitude control system. **Sensor fusion** through Kalman filtering significantly improves the on-line estimation reducing the effect of sensor noise and bias. Current standard approach is adopting an standard Extended Kalman Filter (EKF) processing.

spaceADM overcomes the limited performances provided by EKF by exploiting at its most the characteristics of an **Unscented Kalman Filter (UKF).**



To make it feasible spaceADM applies several mathematical and engineering innovative approaches to decrease computational cost while increasing precision.

spaceADM ensures high precision even in the case of **highly-non linear functions,** that's to say, when the satellite follows "non stable orbits" with very rapid variations in time.

Even in absence of gyro's measurements, the algorithm implemented in spaceADM is able to achieve high precision estimates combining **kinematics and dynamics models**.

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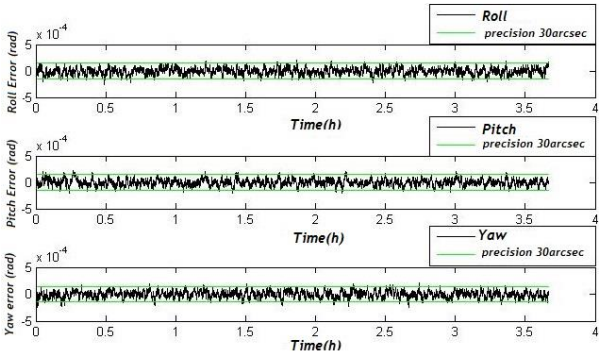
spaceADM is able to provide high precision estimates for different kind of satellites: from pico to nano platforms. Furthermore it is particularly suitable for CubeSats, which are particularly prone to noisy measurements.

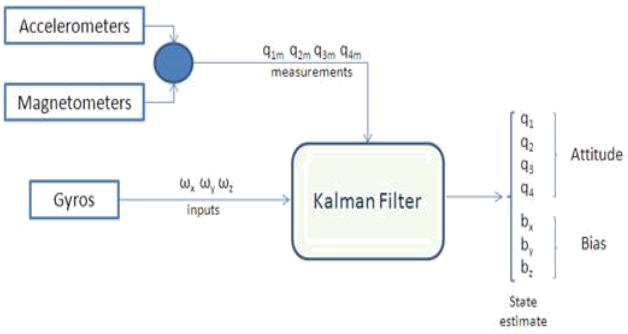


When using **Star Tracker** data, an attitude error estimate lower than **30arcsec** per axis (Roll, Pitch and Yaw) is achieved.

Axes	Precision<30arcsec	
	EKF	*spaceADM*
Roll	69,92%	99,05%
Pitch	64,61%	99,31%
Yaw	69,27%	98,85%

Different devices can be used for attitude determination:

- Star Tracker
- Gyro
- Accelerometer
- Magnetometer
- Sun senor



spaceADM can be used both on board and on ground.

On board, it is able to provide attitude measurements in real-time.

On ground it can be used to improve the attitude and the orbit estimation.

Attitude is orientation of a defined spacecraft body coordinate system with respect to a defined external frame.

Attitude determination refers to the process of measuring and determining spacecraft orientation

Controlling vehicle attitude requires *sensors* to measure vehicle orientation, *actuators* to apply the torques needed to re-orient the vehicle to a desired attitude and ***algorithms*** to command the actuators based on sensor measurements of the current attitude and specification of a desired attitude.

MAIN FUNCTIONALITIES:

- Attitude estimation using new approaches;
- Able to use different devices;
- Can be used on all kinds of satellite;
- High-accurate estimation;
- Accurate even with high nonlinearity;

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