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Revision Records

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1. Glossary

Below, you will find examples; please delete them accordingly.

CMG	Control Moment Gyro
LEO	Low Earth Orbit
ACS	Attitud Control System

2. Preamble or Abstract

Space data has become critical for decision-making and operations at a daily and continuous pace. This growth has significantly impacted sectors such as:

- Urban Planning
- Maritime Route Optimization
- Agriculture
- Activity Monitoring
- Government policy support
- Business Intelligence and Communications
- Insurance and risk monitoring
- Navigation
- Military Intelligence and Communications

Most satellites operating for these applications are based on Nadir pointing (pointing straight down) or moving very slowly, which makes real-time and optimised operations very difficult. They are not agile, but with CMGs, unlocking those capabilities and ensuring a much more efficient and profitable operation is possible.
This document gives an overview of the main advantages of CMG usage in earth observation and communication satellites. The ability to rapidly change orientation while in orbit allows for better productivity, as the satellite's repositioning time is reduced. The new angle orientation possibilities offer new applications.

3. Scope:

An overview of the main advantages that Sanzar Attitude Control System (ACS) implementation offers for satellite attitude control systems, including Earth observation and communication satellites.

4. Technical Information

1. Sanzar ACS vs Reaction Wheels

Sanzar ACS provide up to 10 times more torque and momentum than a reaction wheel of the same mass and accuracy. These devices allow for greater power efficiency and higher agility capabilities.

Agile satellites are more efficient and profitable, especially in LEO, because they need very high pointing speeds and accuracy due to their proximity to Earth.

2. Sanzar ACS Advantages for Satellite Communication

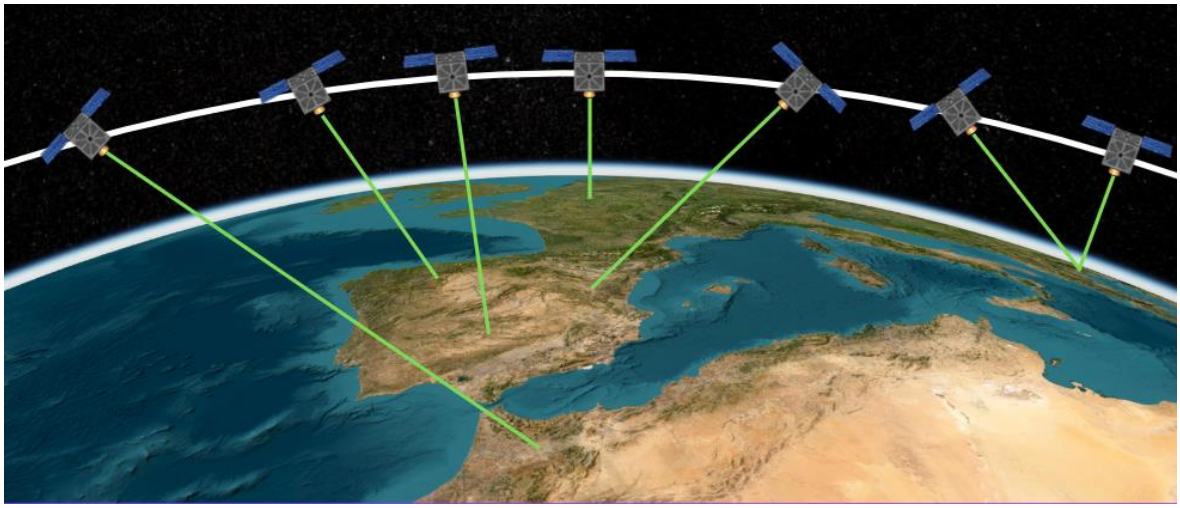
Antenna coverage

Sanzar ACS agility, together with a simple antenna, can provide the pointing accuracy and coverage area capabilities that phased antennas would have.

Laser Communications

State-of-the-art laser communication requires high accuracy and agility to ensure proper performance. Sanzar ACS can provide those performances and make their future implementation possible.

Sanzar ACS agility can provide high-speed and stable orientation to various target locations worldwide. The coverage area can be increased as larger and faster movements are possible.



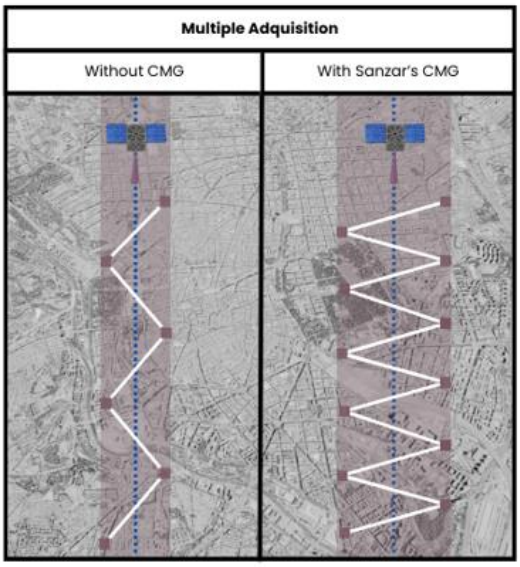
[Simulation of multi-target downlink/uplink in spread areas of the globe]

3. Sanzar ACS Advantages for Satellite Earth Observation

Multi-point Acquisition

Multi-point Acquisition consists of taking as many pictures as possible from specific locations of high importance.

Sanzar ACS provide the agility capabilities needed to quickly orient the cameras to the target locations and obtain much more information in a single pass than reaction wheels.

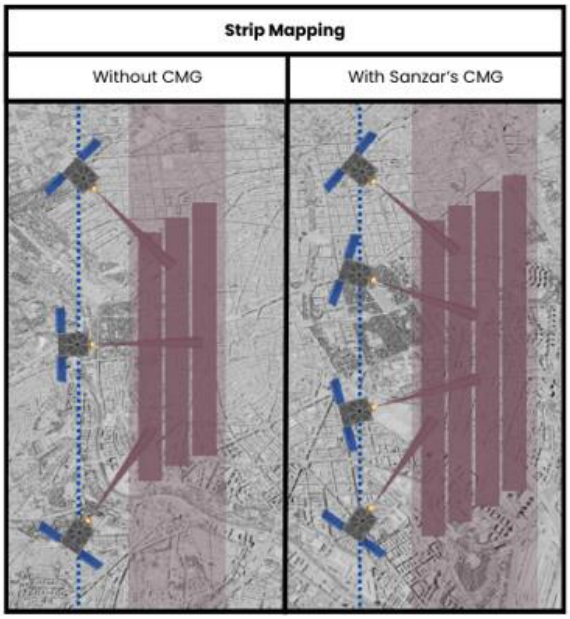


[simulation of swath angle oscillations (roll) for typical values between 25 and 45 deg] should prove that Sanzar ACS provide x3 performance concerning reaction wheels

Multi-strip Mapping

This operation mode consists of mapping long strips next to each other to cover large areas.

Moving quickly from one strip’s end to the other's beginning is essential, and CMGs provide excellent performances in this field. High slew speeds and stabilisation are possible thanks to Sanzar ACS. Agility unlocks the possibility of mapping more strips on the same pass or increasing the length of each strip.

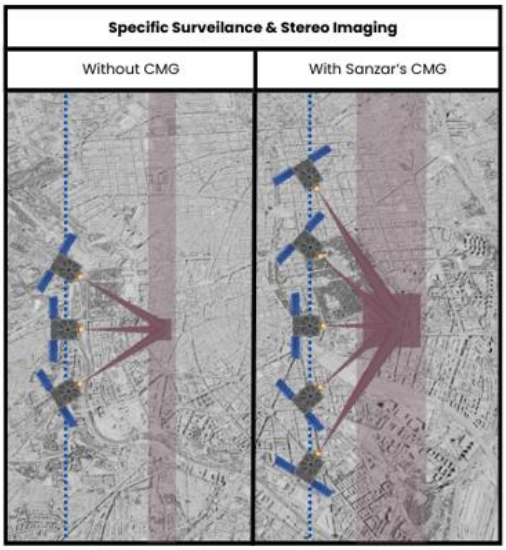


[Simulation of pitch oscillation for typical values between 25 and 45 deg] should prove that Sanzar ACS provide longer strips or more strips concerning reaction wheels

Stereo & Tri-stereo

Taking images of the exact location from different angles makes 3D mapping possible.

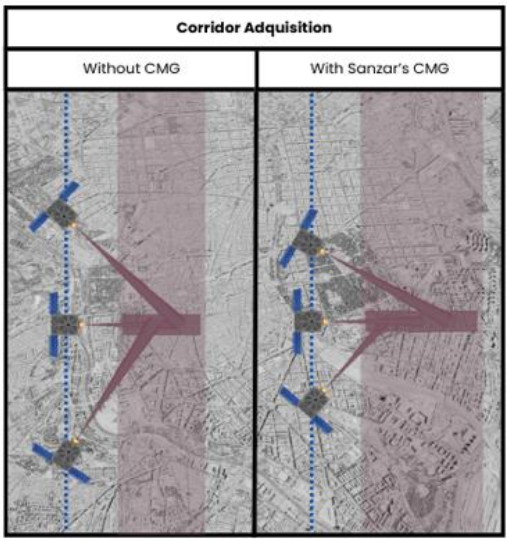
Combined with the strip mapping capabilities, CMGs offer unbeatable performance concerning reaction wheels. Agile satellites can quickly orient and take multi-angle imagery of a target strip.



[The same simulation as multi-strip but on the same strip to obtain different angles] should prove incredibly better than reaction wheels

Corridor Acquisition

Strip mapping in a direction perpendicular to the satellite's ground track is only possible with agile manoeuvres. CMGs can provide the capabilities needed for this task.



[Simulation of strip pointing perpendicular to ground track] should prove the possibility, while it should be difficult or impossible with reaction wheels.

5. References

https://blog.satsearch.co/2022-07-07-the-benefits-of-in-orbit-agility-for-satellites

https://www.nasa.gov/directorates/somd/space-communications-navigation-program/whats-next-the-future-of-nasas-laser-communications/