US Perspectives on miniaturisation needs and impacts

Niel Dennehy
NASA

This talk will provide a US perspective on the GN&C component miniaturization. The needs and benefits of GN&C miniaturization will be identified. Planetary spacecraft mission applications, as well as Small Satellite mission applications, that drive miniaturized GN&C will be described. Some new envisioned mission applications enabled by miniaturized GN&C capabilities will be described. Some of the US technology development initiatives for GN&C miniaturization will also be highlighted. The technology and implementation challenges of miniaturization will also be touched upon. Lastly some observations on miniaturization trends and some recommendations for the international GN&C community in this important area will be put forth

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Miniaturisation needs of the Mars Network Landers

Kelly Geelen
ESA

A Mars network science mission is considered as one of the potential European missions to Mars after ExoMars. The current mission concept, called INSPIRE, considers a Soyuz launch in 2022 with a carrier spacecraft and three network science landers to be delivered to the Martian surface to investigate the interior structure and dynamics of the planet. Delivery of 3 landers within a Soyuz launch, requires the entry probes to be as compact and light as possible. Miniaturisation of equipment is hence needed, with emphases on the surface platform equipment due to the large snowball effect on the mass; i.e. for every kg on the surface, another 2 kg is needed to safely land the equipment. Compactness is also required in order to place all the electronics in a warm electronics box and eventually fit into an aeroshell shape.

The Mars Robotic Exploration Preparation (MREP) Program is currently investigating a miniaturised OBC for small landers, a compact altimeter and a low power timer board. Future developments in other avionics and sensors will also be required.

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Miniaturized Components for Space Systems: Needs, Status & Perspectives

Jian Guo
Delft Technical University

Future applications of miniaturized space systems will have special needs on miniaturized components. This paper addresses the needs, status and perspectives of the miniaturization for space systems from the perspective of a spacecraft developer, with a focus on miniaturized avionics and AOCS components being developed in the Delft University of Technology. First, the needs of future space missions on miniaturized components are discussed. Then, the up-to-date information of miniaturized avionics and AOCS components in TU Delft is presented. Here the miniaturization is in the context of the Delfi-n3Xt satellite (to be delivered to launch site within a month) and the DelFFi formation flying mission (part of the QB50 project in 2015). Finally, perspectives of space-based miniaturization will be addressed based on the analysis of both future mission needs and technological trends.

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Small INtegrated Navigator for PLanetary EXploration

Stephen Steffes, S. Theil
DLR

SINPLEX is an EC funded research and development project. Its main goal is to develop an innovative solution to significantly reduce the mass of the navigation subsystem for exploration missions which include a landing and/or a rendezvous and capture phase. The project aims to increase the scientific return of exploration missions, enable new types of missions and targets and reduce launch cost and travel time.

Future space exploration missions target asteroids, comets, planets and planetary moons. They will send robotic vehicles to these targets and provide the capability to return samples to Earth. For all space mission (and especially these kinds of missions) mass is one of the most critical factors. Thus, reducing the mass of components or complete subsystems of an exploration vehicle is a key enabling factor for the future exploration of our solar system and beyond.

Mass is reduced while still allowing good navigation performance. This is accomplished by functionally integrating the different sensors, utilizing micro- and nano-technologies for compacting electronics and using sensor hybridization approaches to improve the performance of the complete navigation subsystem.

The project objectives are: to develop an integrated novel navigation subsystem architecture, to produce a breadboard system and to demonstrate the system's performance for object relative robotic navigation for space applications.

The presentation will provide an overview of the SINPLEX project including the current design and status.

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Miniaturisation for Space

Dick Durrant
SEA

Within SEA miniaturisation for space applications is being addressed at all levels from concept studies, through prototyping to flight unit implementations. These are targeting both GNC and Avionics applications, and in particular cover:

- MEMS Gyro development
- MEMS Accelerometer development
- Future IMU capabilities
- Wireless Sensor networking
- SMART Microsystems Study (Micro-nodes)

As a systems and electronics company SEA is teamed with a number of sensor and chip development companies to meet the demands of each particular application. This provides a good insight into not only the technology and engineering aspects, but also the commercial and industrial aspects required to migrate terrestrial miniaturised technologies into the space domain.

This short talk will aim to provide an overview of the above activities emphasising:

- lessons learnt
- envisaged need to re-address architectures, interfaces and sensor performance
- 'real requirements' driven technology developments
- Industrial teaming

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Miniaturisation activities and issues for AOCS sensors

Franco Boldrini
Selex Galileo

In the users' mind miniaturization means low cost and reduced complexity, but in developing a miniaturized AOCS sensor you shall face many issues. Among them the reticence to consider new materials and technologies "not accepted for space" strongly limits the design choices... Some lessons learnt going through feasibility studies and prototyping of a miniaturized Star Tracker and Sun Sensor.

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Outcomes from the evaluation campaign for SiREUS MEMS detector and qualification

Steeve Kowaltschek
ESA

The qualification of MEMS based technologies in Space equipment is critical to market and flight acceptance. The ESA funded development resulting in the SiREUS Coarse Rate Sensor contains a MEMS gyro that has completed an evaluation programme quite bespoke to this type of component. A summary of the outcomes of the detector evaluation programme is provided showing the range of evaluation tests completed and how these were modified during the programme. Key results are presented including how the evaluation process and final parts approval were achieved as a sequence of activities. An update on in-flight heritage of the SiREUS demonstrator on Cryosat will show how in-flight performance coupled with on ground qualification and evaluation testing have been used to understand behaviours and characteristics of the system over time. Some conclusions on the approach to MEMS evaluation are made including how feedback from potential end customers can benefit future developments and iterations.