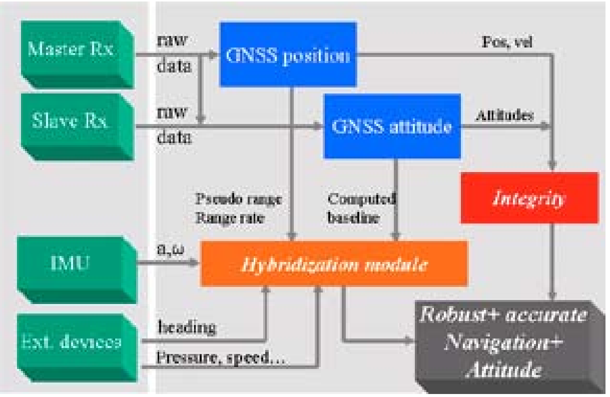
Multi-Sensor Fusion for High-Dynamic Applications

A way to improve the robustness of GNSS is to hybridize it with inertial sensors. Different strategies of hybridization are investigated depending on the level of coupling envisaged, the characteristic of sensors and the dynamic of the user. The usual Kalman filter is providing a high level of efficiency, but extended Kalman filters or particle filters are often preferred because they take into account the nonlinear nature of the inertial sensors. For high dynamic applications, deeply coupled INS-GNSS receivers using multifrequency carrier phase solutions are often used.



Automatic landing under all weather conditions using GBAS

A drawback of very precise inertial sensors is their high cost. Therefore hybridization with low cost Micro-Electro-Mechanical Systems (MEMS) sensors for civil aviation is particularly investigated. GNSS receivers can also provide attitude information by using additional antennas separated by constant baselines. This attitude solution can also be combined with the attitude given by an inertial measurement unit to improve robustness. Airborne Autonomous Integrity Monitoring (AAIM) provide a measure of integrity for the INS-GNSS solution and new concepts of AAIM (Aircraft Autonomous Integrity Monitoring) algorithms are investigated in the frame of a project.

DLR at a glance

DLR is Germany´s national research center for aeronautics and space. Its extensive research and development work in Aeronautics, Space, Transportation and Energy is integrated into national and international cooperative ventures. As Germany´s space agency, DLR has been given responsibility for the forward planning and the implementation of the German space program by the German federal government as well as for the international representation of German interests. Furthermore, Germany's largest project-management agency is also part of DLR.

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Information

Advanced Integrated Navigation Systems

Robust Navigation for High Demanding Applications

DLR

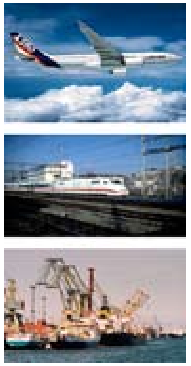
Advanced Integrated Navigation

The state of the art of satellite based navigation solutions for civil aviation is not sufficient to achieve the stringent requirements of precision landing of the level CAT IIIb/c. Even GNSS (Global Satellite Navigation Systems) with robust ground based augmentation systems (GBAS) shows its limitations.

In this context, it is necessary to define new concepts of navigation, where the satellite based navigation receivers are integrated with other systems. In addition to augmentations (SBAS –Satellite Based Augmentation System, or GBAS), it is adviseable to combine satellite based navigation with inertial navigation and/or to deeply merge it in the flight management system of the aircraft. A field of our activity is the combined architecture of an autoland system with a dual frequency GBAS. This integrated approach provides a high level of robustness and accuracy for complex applications. Novel algorithm architectures will bring also adapted performance determination based not any more on navigation performance but on "total" performance (navigation performance for integrated systems).

An induced activity is the relative navigation. In this field of activity, the problem is not any more to provide a PVT (Position, Velocity and Time) solution in an absolute way, but to provide relative positioning with a moving reference object. Several applications like formation flying of satellites, automatic docking of an Automatic Transfer Vehicle to the International Space Station, or for shipboard landing of a helicopter will profit from this technique. A challenge is to provide a robust navigation solution for high dynamic reference and rover receiver.

Integrity in GNSS



Applications for Integrity in GNSS

The key performance parameter in Safety of Life applications is the integrity i.e. the trust one can have in the function of the system. In its activities, the Institute of Communications and Navigation investigates the robustness of the navigation solution, develop techniques to monitor threats, investigate and develop techniques to detect, mitigate or exclude a faulty element of the system that drives to an unacceptable error in the navigation solution.

The GNSS integrity activity is subdivided into 4 sub-activities:
- Combined GPS + Galileo RAIM
- Satellite Based Augmentation Systems (SBAS) and Galileo/GPS Integrity Channel (GIC)
- Ground Based Augmentation Systems (GBAS)
- Aircraft Based Augmentation Systems (ABAS)

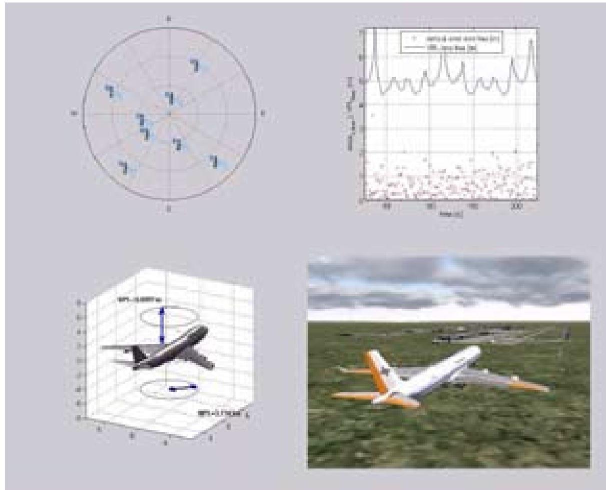
RAIM

Receiver Autonomous Integrity Monitoring is a technique that provides integrity information using a set of observed satellites. It allows to detect and to exclude a faulty satellite based on a self consistency check of observables. The actual acitivites of the Institute in the field of RAIM concern RAIM for the multi constellation (Galileo, GPS) and multifrequency scenarios.

Modern RAIM algorithms combine the onboard detection and exclusion techniques with additional integrity information from SBAS or GBAS. One important improvement is the time to alarm which is significantly reduced and can theoretically fulfill CAT III requirements.

Automatic landing with GBAS

Together with the DLR Institute of Robotics and Mechatronics, a GBAS landing demonstrator has been developed which is used to investigate and verify various GBAS algorithms, e.g. dual frequency smoothing techniques to protect against severe ionosphere gradients. In this demonstrator, an automatic landing control system is coupled with a simulated GBAS/GPS/Galileo navigation system, letting the aircraft land under CAT III conditions using satellite based navigation only.



Automatic landing in a simulated Galileo+GBAS scenario