

Fiber optic interconnects for photonic sensor technology

High Accuracy & Lightweight GNSS/ IMU Unit for Cargo Drones

Research Project IMUCOMPACT

Photogrammetry combines 2D and 3D images to convey physical information, e.g. from monitoring wind turbines to visualizing buildings and industrial plants as a basis for state monitoring.

This requires accuracy down to the centimeter range and extremely compact designs of the GPS-independent sensor systems integrated into fully autonomous and unmanned flying objects and cargo drones (or UAVs: Unmanned Aerial Vehicles).

GNSS/ IMU unit for use in unmanned aerial vehicles

The IMUCOMPACT research project aims to develop a measuring device consisting of a 6-axis inertial measurement unit.

The main goal is to achieve a significant improvement in the gyroscope properties while keeping the weight of the overall system down.

Fraunhofer IZM is developing a concept for an interferometric fiber optic miniature gyroscope (IFOG) operating on three axes.

Objectives:

- Designing and building a compact 3-axis IFOG configuration with a weight of less than 250 g/axis and a rotation speed of $\geq 90^\circ/\text{s}$
- Improving the measurement stability of the IFOG

Innovations to be realized:

- Extensive integration of components freely available on the market
- Lightweight IFOG design for integration in a cargo drone
- Optical stabilization concept based on fiber Bragg gratings (FBG) to reduce measurement errors

Project partners

- Ingenieur-Gesellschaft für Interfaces mbH
- Quantitec GmbH
(Now: IntraNav GmbH)
- MILAN Geoservice GmbH

Project volume

- € 1.82 million
- 53.4% Funding share

Duration

- 10/2018 - 03/2023

Funding code

- 13N14758

MEMS gyroscopes can be good sensors for photogrammetry when used on UAVs because they are extremely small and light and consume little power. However, they are susceptible to temperature fluctuations, humidity, mechanical stress, and their functionality is variable due to the integration performance of many devices.

Instead, optical gyroscopes are more attractive because they are electromagnetically insensitive, provide extremely precise rotation rate information, and have no moving parts. This motivated the decision of Fraunhofer IZM to design a reliable, cost-effective, and compact IFOG that works by Sagnac phase shifting.

Contribution of Fraunhofer IZM:

- Selection and assembly of optical (fiber coil, modulator, optical circulator, and SLD source) and electronic components (PCB and FPGA)
- Development of a rotating measurement setup to characterize the IFOG
- Programming of the FPGA in LabVIEW to sample the electro-optical signal at high frequency for real-time rotational analysis
- Investigation of an optical stabilization concept based on two FBGs

The FBG measure wavelength shifts to compensate for measurement errors caused by the rotation rate. The first laboratory version has a stability of approx. 0.025°.

Get to know our photonic packaging solutions for fiber interconnects and optical sensors!

Contact us!

Fraunhofer IZM: Invisible - but indispensable. Nothing works anymore without highly integrated microelectronics and microsystems technology. The basis for their integration into products is the availability of reliable and cost-effective assembly and interconnection technologies.

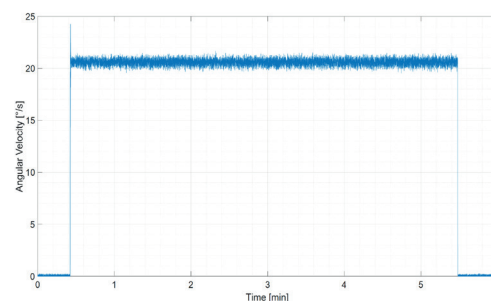
Fraunhofer IZM, a world leader in the development and reliability assessment of electronic packaging technologies, provides its customers with customized system integration technologies at the wafer, chip, and board level. The research done at Fraunhofer IZM helps make electronics more reliable and provides customers with reliable data about the durability of electronics.

IFOG applications:

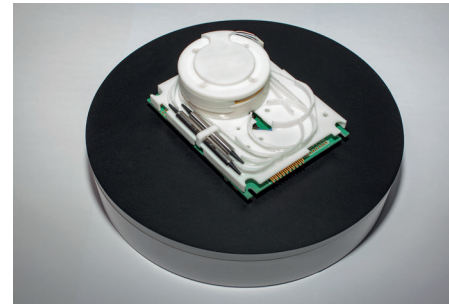
- Photogrammetry by cargo drone
- Autonomous steering of passenger cars or buses
- Position tracking of transport ships when satellite communication fails

Other areas of application:

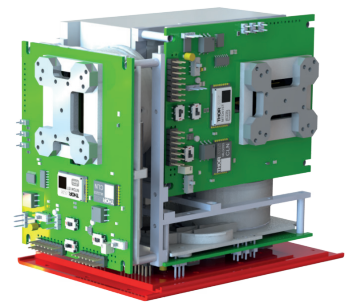
- Nanosatellites (aerospace)



Rotation measurements of the IFOG after signal processing in the FPGA



IMUCOMPACT IFOG demonstrator with 1-axis



CAD model of the 3-axis IFOG system

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Project Status (05/2023):

- 3-axis IFOG has being calibrated to temperature fluctuations.
- Reliability tests have being performed e.g. temperature stability as well as response to shocks and vibration.

More information



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