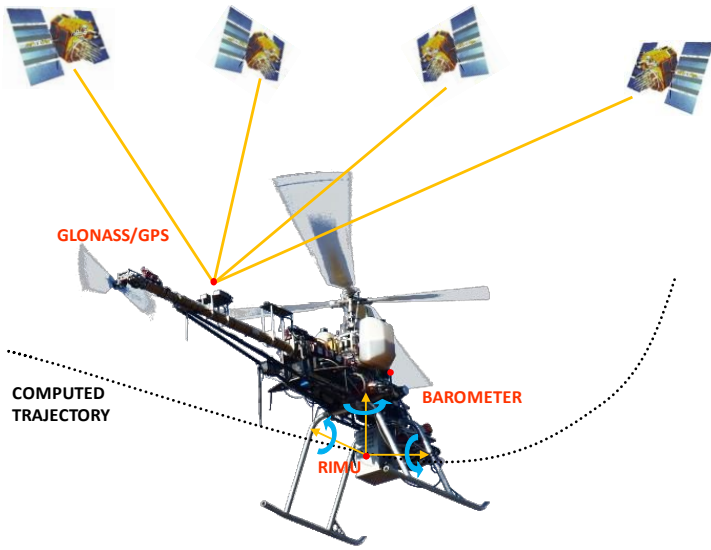


Yannick Stebler (Ph.D Student) and Dr. Jan Skaloud (Supervisor)

## Principle of Navigation



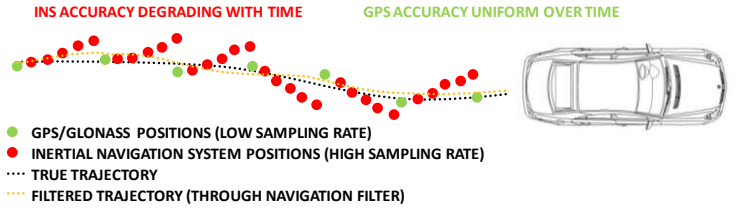
The goal of navigation is to estimate the position, velocity and orientation of a vehicle by combining (for example) :

- Global Positioning Systems (GPS) : absolute position
- Inertial Navigation Systems (INS) : relative position, velocity and orientation
- Aiding sensors : e.g. altitude (barometer), velocity (odometer)

## Research Motivation

- Optimal case** : GPS positions are available for correcting inertial navigation system positions

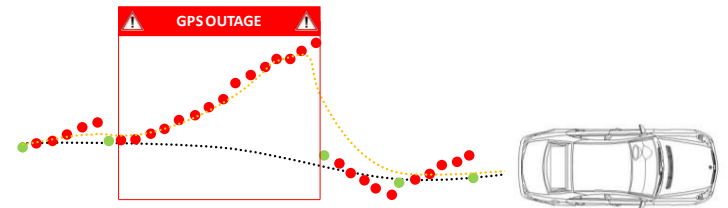
→ **Accurate filtered trajectory**



- Bad case**: What happens if GPS positions are not available?

INS accuracy degrades with time due to the errors affecting the accelerometers and gyroscopes (integrated in the IMU)

→ **Large errors in filtered trajectory**



Research Objective:

- To develop a low-cost autonomous navigation system that can operate in GPS-denied environments or even in GPS-free conditions**

## Two Research Approaches

### USE OF MULTIPLE INERTIAL MEASUREMENT UNITS (IMUs)

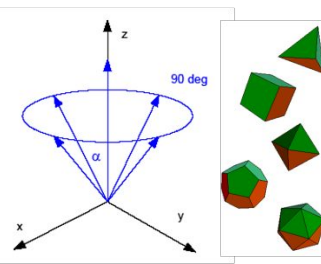
The use of redundant IMUs (RIMU) enables:

- Direct sensor noise estimation
- Better navigation performance during GPS outages
- Higher system robustness (fault-detection and isolation capabilities)

How many sensors ?



Which spatial configuration ?

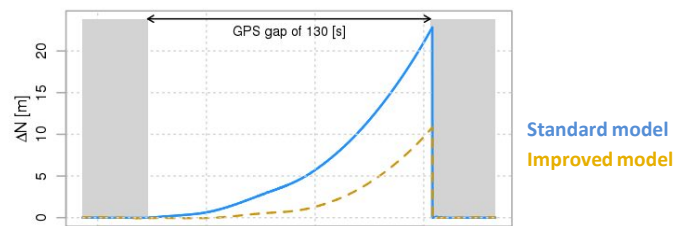


### IMPROVED MODELING OF INERTIAL SENSOR ERRORS

An improved modeling of the accelerometer and gyroscope errors enables:

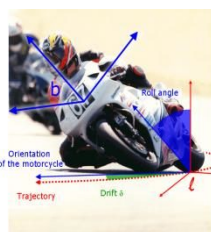
- To bound the position error growth during GPS outages
- To make correct stochastic assumptions for navigation filter design
- Development of a new procedure for modeling stochastic errors

What is the influence of improved sensor error modeling on true filtered trajectory error (e.g.  $\Delta N$  – North coordinate error) ?



## Applications

- Low-cost « black-box » technology for motorcycles enabling pre-crash accident reconstruction (without GPS)



- Development of an ultra-safe low-cost navigation system for Search-and-Rescue operations using unmanned air vehicles (with GPS)

