

XXXIII Cycle

# **Design of Low Cost Navigation Systems for Robotic Vehicles** Neil Gogoi **Supervisor: Prof. Fabio Dovis**

### **Research context and motivation**





**Controlled** environment quality assessment of **raw measurements** of Android devices





Implementation of **Collaborative Ranging** in Android smartphones



#### COTS receivers, Ranging systems, Signals of Opportunity



"The use of UAVs and UGVs in precision farming in ever increasing and several benefits can be envisaged. Technologies for **low-cost** and **low** complexity reliable navigation systems able to provide centimetre level accuracy are needed."



**Navigation of Service Robotics** 

### Addressed research questions/problems





Studying the feasibility of UAV camera based aided positioning in an UGV with a **cooperative** positioning algorithm



Implementation of a cooperative navigation system based on Android devices which provides raw measurements exploiting adhoc communications.



Implementation of a full smartphone application CAPS-Loc for cooperative ranging and positioning in Android devices.

Quality assessment of different quality drones and Android smartphone in the presence of jamming and spoofing interference.





## Adopted methodologies

- > Experimental approach to available devices and existing solutions including controlled, simulated and real environment data collection
- > Modelling of measurements and errors based on past results and obtained observations in **MATLAB** environment
- > **Development** of new MATLAB algorithms to process and inculcate android GNSS receiver measurements towards cooperative positioning.

# **External Training and Other Activities**

<ul> <li>Implementation of further cooperative positioning algorithms for UAV-UGV networks with focus on tight coupling</li> <li>Integration of inertial sensors, applicable signals of opportunity and GNSS towards precise and robust UAV-UGV positioning</li> <li>Implementation of Android devices and a software GNSS receivers in the control architectures of UAVs and UGVs.</li> <li>List of attended classes</li> <li>O1TEVRV - Deep Learning (06/04/2019, 6 CFU)</li> <li>O1TEVRV - Deep Learning (06/04/2019, 6 CFU)</li> </ul>	<ul> <li>Attendance to ESA/JRC International Summer School on GNSS 2018 – July 16-27, 2018, Loipersdorf, Austria</li> <li>Winner of 2nd Prize in the GNSS applications project at the ESA/JRC International Summer School on GNSS 2018 – July 16-27, 2018, Loipersdorf, Austria</li> <li>Attendance to Network Localization and Navigation course (Prof. Moe Win, MIT), July 3-4, 2018, University of Florence, Florence</li> <li>Attendance to International Project Management in CFRP Development Programs course – June 21, 2018, Torino</li> <li>Participation in Dronitaly 2018, March 23-24, Palazzo delle Stelline, Milan</li> <li>Participation to Natural and Artificial Threats to GNSS Seminar, May 7-9, 2018, ISMB-Politecnico di Torino, Torino.</li> </ul>
<ul> <li>Provide the function of space technology. ACCS design for earth observation and gravity monitoring satellite (09/12/2018, 3 CFU)</li> <li>O1QPRPRV - Satellite Navigation Signal Exploitation for Atmospheric and Environmental Monitoring (13/09/2018, 3 CFU)</li> <li>O1SHCRV - Unsupervised Neural Networks (09/04/2018, 6 CFU)</li> <li>O1SCSIU - Machine Learning for Pattern Recognition (23/03/2018, 4 CFU)</li> <li>O2LWHRV - Communication (04/09/2018, 1 CFU)</li> <li>O8IXTRV - Project Management (04/09/2018, 1 CFU)</li> <li>O1RISRV - Public Speaking (21/08/2018, 1 CFU)</li> <li>O1SWQRV - Responsible Research and Innovation, The Impact on Social Challenges (13/09/2018, 1 CFU)</li> <li>O2RHORV - The New Internet Society: Entering the Black-Box of Digital Innovations (13/09/2018, 1 CFU)</li> <li>O1SWPRV - Time Management (13/09/2018, 1 CFU)</li> </ul>	<ul> <li>N. Gogoi, A. Minetto, N. Linty, and F. Dovis, "A controlled-environment quality assessment of android GNSS raw measurements," MDPI (Switzerland) Electronics Journal, vol. 8, no. 1, 2019.</li> <li>N. Gogoi, A. Minetto and F. Dovis, "On the Cooperative Ranging between Android Smartphones Sharing Raw GNSS Measurements", Proceedings of Vehicular Technology Conference - fall 2019, September 22-25, 2019, Honolulu, HI (USA).</li> <li>W Qin, N. Gogoi, A. Rustamov, and F. Dovis, "Assessment of Anthropogenic Disturbances on GNSS-based Navigation," submitted to UPINLBS Conference 2019, Beijing.</li> <li>N. Gogoi, A.M. Manzino, A. Cina, P. Dabove, "Fast Deformation Detection with mass market GNSS time differential observations and use of baseline constraints", Geoengineering Environment and Mining Journal (GEAM), April 2018.</li> <li>A. M. Manzino, P. Dabove, N. Gogoi, "Assessment of Positioning performances in Italy from GPS, BDS and GLONASS constellations", Geodesy and Geodynamics Journal, September 2018.</li> </ul>





**Electrical, Electronics and** 

**Communications Engineering**