



The *Drone* Transversal Program

<https://labsticc.fr/fr/programmes-transverses/drones>

Jean-Philippe Babau

Some challenges (Blue Event Drones, Sea pole)

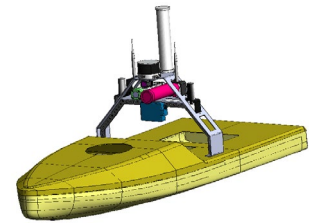
- Applications
 - Sub-marine positioning
 - Navigation in an difficult environment (hostile, dangerous, perturbed, shared)
- Design
 - AI techniques to reduce volume and increase quality of output data flow
 - Miniaturization
 - Smart and dedicated sensors
 - Communications between drones, between drone and other systems
- Non functional requirements
 - Safety
 - Cyber-security
- System level
 - « the sea F1 » : real-time monitoring, guidance, maintenance
 - Integration in a global observation system : drone for transport, operating drone, swarm of drones, heterogeneous drones, ...

Application domains

- Environment observation
 - Animal species for biologist, fishing...
 - Seabed for cartography, geology, evolutions
 - Measurement of physical parameters for ocean behavior understanding, ecology...
- Sub-marine operations
 - Mineral extraction
 - Welding
- Maintenance of sea wind turbines
- Military applications

The Lab-STICC and the drones

- Equipment with CPER funding
 - SMD-MAR, RACAM, BrestBayBase,
- Several teams involved
 - SHAKER, ROBEX, M3, OSE, MATRIX, IRIS, INUIT, COSYDE, SI3, PIM ...
- Multi-teams projects
 - NAVIDRO



CPER examples

- SMD-MAR
 - 2015-2020
 - ENSTA Bretagne, IFREMER, UBO, UBS, IMT-A
 - Aerial, sub-marine and surface drones
- BrestBaybase
 - 2021-2027
 - IFREMER, ISEN, Ecole Navale, UBO et UBS
 - Surface drones, sensors and embedded platforms





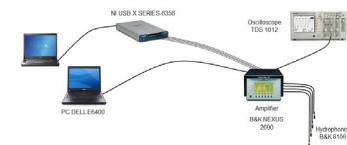
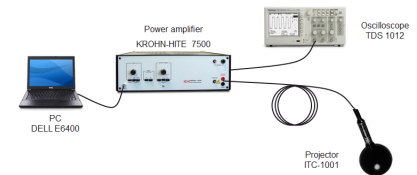
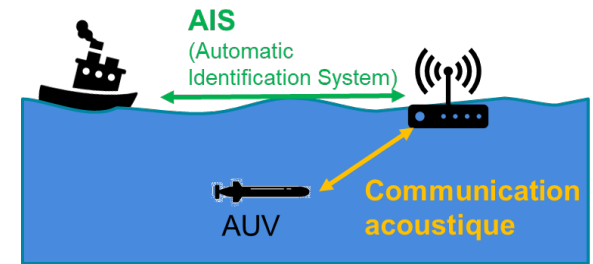
Design of mobile robots

- The ROBEX team
 - BERTHOLOM Alain, CASTILLO HERRERA Alam, DAMERS Julien, FOURNIOL Nathan, JAULIN Luc, LE BARS Fabrice, LEPERS Benjamin, MASSE Damien, MOPIN Irène, MORIN-DUPONCHELLE Guillaume, PONCHART Marie, RIGAL Rémi, ROHOU Simon, TILLET Joris, VIEL Christophe, ZERR Benoît
- Application domain and research objectives
 - Algorithms for autonomous robots to follow an exploration mission
 - Avoidance of bidden zones, respect of robot integrity, function of navigation and capacity to return to starting point
 - Sailing robots
- Oleron experiment: <https://youtu.be/vl8AkSodZ8Q>
- Guerledan experiments : <https://youtu.be/8c4yLWQ724Q>
- Sub-marine : <https://youtu.be/f78XWfO4dBE>
- Hardware chip : <https://youtu.be/WCMF0qgFlwg>



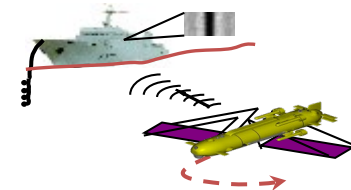
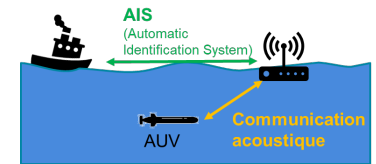
Sub-marine acoustic communications

- The CosyDe team
 - C. Laot, FX. Socheleau, T. Le Gall, S. Houcke, C. Bello
- Application domain and research objectives
 - Physical and protocol layers
 - Low throughput (<100 b/s) – long distance(>10km horizontal)
 - High throughput (>10 kb/s) – low distance (<2km horizontal)
 - Very high throughput (~100 kbs vertical)
 - Fiability (complex and hard environment)
 - Security
 - Applications
 - Telemetry (control and measure) and positioning
 - Transmission of images, ...
- Platforms
 - Laboratory and sea experiments
- Thesis Thalès/Région Bretagne S. Imbert (2022)
- Thesis FUI S. Lmai (2011)
- Thesis DGA G. Eynard (2008)



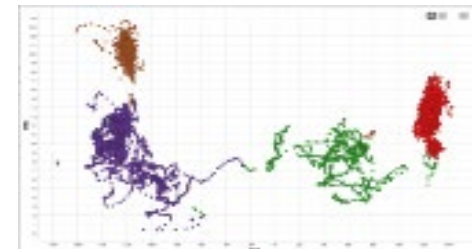
Sub-marine acoustic communications

- A bridge between AIS system and sub-marine drones
 - Collaboration with Thales and Région Bretagne funding : 96k€
- NEMOSENS - development of a swarm of low-tech sub-marine drones
 - Consortium : IMT-A, ENSTA, RTsys (leader)
 - Region Bretagne - BPI funding 166k€ for IMT Atlantique
- COMET – development of a swarm of autonomous sub-marine drones.
 - Consortium: Rtsys-Neotek , IMT-A, ENSTA Bretagne, ZTI, Williamson Electronique.
 - FUI project 1,5 M€
- Optimization of ASM communications ASM between two mobile units
 - DGA-TN project : 56 k€
- Haliostar, High throughput communication with an AUV
 - Consortium : ECA, SERCEL, DGA-TN, IFREMER, IMT-A, Ecole Navale, ENSTA Bretagne
 - Funding 30 k€.



Software architectures for surface drones

- In the SHAKER team
 - Jean-Philippe Babau, Goulven Guillou, Laurent Lemarchand, Mickael Kerboeuf
- Research objectives
 - Embedded system tuning y simulation a nd machine learning
 - Context adaptation
 - Sailing navigation
 - Multi-objective optimization
 - Efficient framework for environmental data
 - Timeseries and BigData
- Platforms
 - A surface drone (CPER SMD-MAR)
 - The *CARES* framework for drone co-simulation
- Thesis CIFRE Emilien Lavigne with Mer Concept (2016-2019)
- Thesis CDE Hamza El Baccouri (2017-2020)
- Thesis Isblue/région Manele Ait Habouche (2021-)



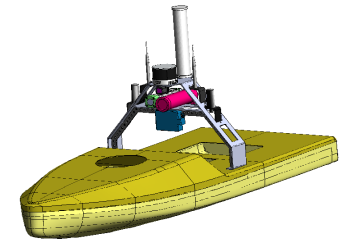
SURCOUF: Smart Unmanned surface vehicle Cooperation for Ocean surveillance on Foils

- In the SHAKER team
 - Dominique Heller, Ronan Douguet
- Research objectives
 - Collaboration between a drone and an autonomous boat
 - Boat and buoy recognition
- Platforms
 - A surface drone (CPER SMD-MAR)
 - Sensors : Camera RGB, IR, LIDAR, Radar, AIS, IMU, GPS RTK....
- A Région Bretagne project
 - 2021/2022
 - 1,1 M€ (163 K€ for Lab-STICC-UBS)
 - Consortium: IMSolutions (Geoxyz), SEAir, Lab-STICC-UBS



SURCOUF: Smart Unmanned surface vehicle Cooperation for Ocean surveillance on Foils

- Simulation : Gazebo-USVSIM
- Detection and obstacle avoidance
- Automatic docking
 - Visual servoing for Launch And Recovery System)

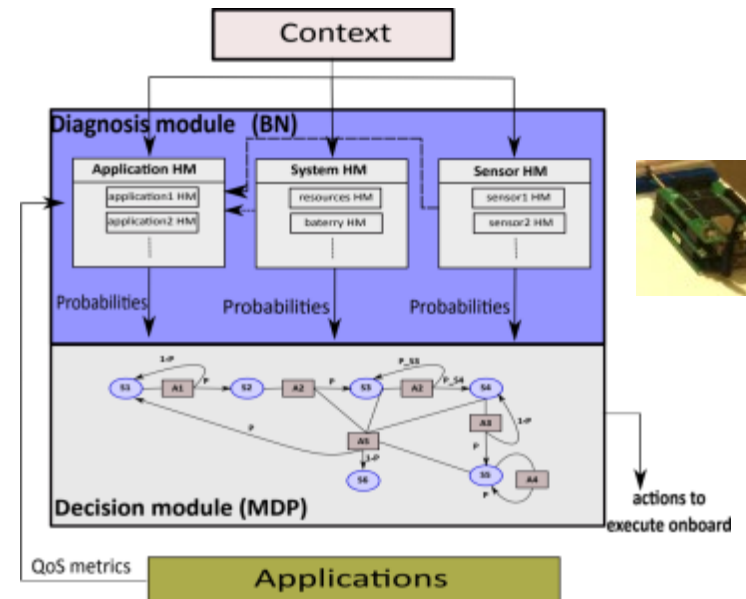


Safety and security for autonomous drones

- In the SHAKER/IRIS teams
 - Catherine Dezan, David Espes
- Application domains and research objectives
 - Cooperative heterogeneous drones (sub-marine, aerial, ...)
 - Safety/security context, embedded decision for autonomous drones
 - HW (CPU, GPU, FPGA) acceleration for AI with hard constraints (time, energy, resources)
 - Collaborative security management in a swarm of heterogeneous drones

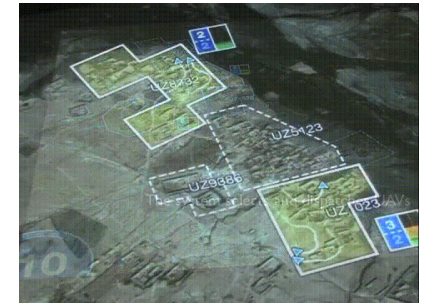


- Thesis : Sara Zermani (2013-2017), Chabha Hireche (2015-2019)
- Collaboration with QUT (Australia : 2012-2020)
- Collaboration with USP (Brazil : 2016-20XX)
- ANR HPeC (2015-2019)
- Gis-Cormorant project (5 months in 2021)
- CPER SMD-MAR, BrestBayBase (FPGA-SOC)



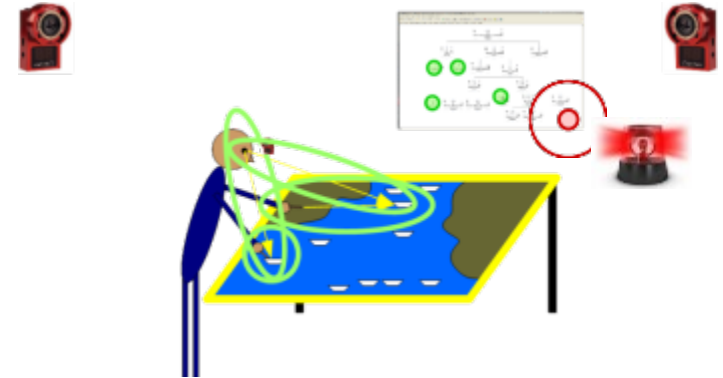
Drones and interaction

- The INUIT team
 - Jérémy Rivière, Thierry Duval, Gilles Coppin, Sébastien Kubicki et Etienne Peillard
- Scientific activities related to drones
 - HSI - Human Swarm Interaction
 - Visualization and understanding of complexity
 - Simulation of complex systems
- Research activities
 - SOS-DM, Dialodrone, Daisie, SUSIE (Supervising Swarm Intelligence), ARTUISIS projects
- Platform
 - Usage of interactive table and swarm of drones (SUSIE)
- Results
 - G. Coppin and F. Legras, "Autonomy Spectrum and Performance Perception Issues in Swarm Supervisory Control," in *Proceedings of the IEEE*, vol. 100, no. 3, pp. 590-603, 2012
 - G. Coppin, F. Legras, "Controlling swarms of unmanned vehicles through user-centered commands". *Symposium series of the Association for the Advancement of Artificial Intelligence: Human Control of Bio-Inspired Swarms*, 2012



SOS-DM: Suivi et Observation d'un Opérateur de Surveillance de flottille de Drones Marins

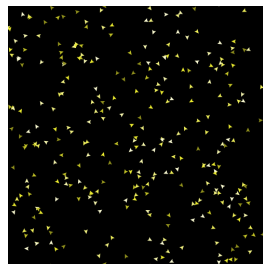
- Research activity
 - Human supervision of marines drones
 - Observation of human behavior
 - Scheduling of control tasks
 - System of alert management
- Platforms
 - Immersive simulation environment
 - Augmented virtual reality
- The PER SAMM project from région Bretagne
 - 2019/2020 : post-doc (Valéry Monthé)



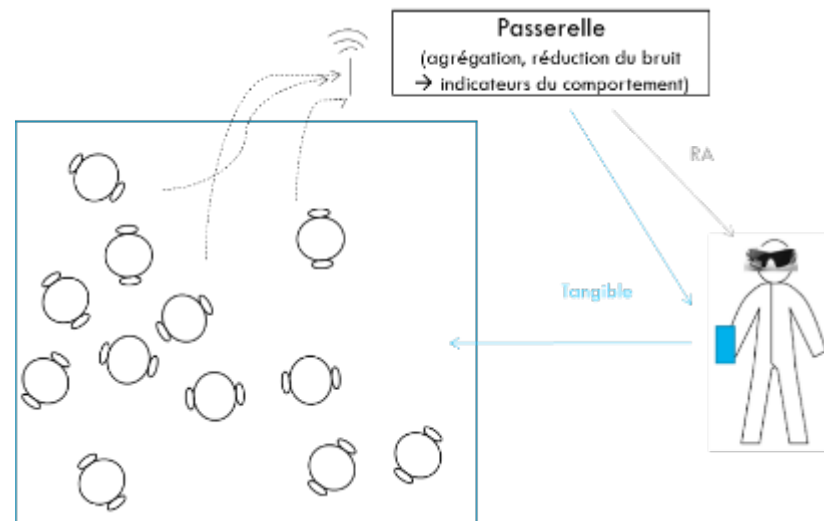
Project ANR JCJC ARTUISIS

Augmented Reality and Tangible User Interface to Supervise and Interact with robot Swarms

- Research objectives
 - How to control and interact with a complex swarm of drones
 - How to use augmented reality to provide information on the behavior of the swarm
 - Provide an interaction tool (efficient, easy-to-use, ergonomic, ...) to control space occupation of the swarm
- Thesis
 - Aymeric Henard (2021-)

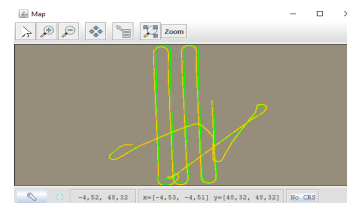
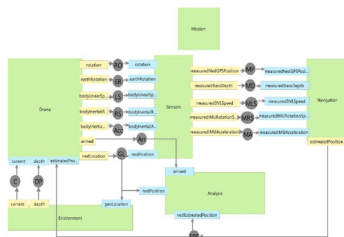
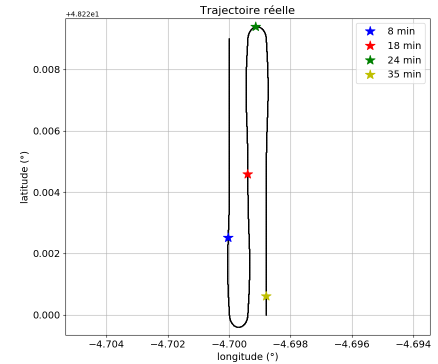


exemple de
flocking



The NAVIDRO project

- A SHOM (DGA) / Lab-STICC project
 - Teams : M3/MATRIX/ROBEX (ENSTA) et SHAKER (UBO)
- State of the art about navigation function
 - Sensors for sub-marine drones (GPS, DVL, IMU, barometer)
 - Equations de mécanisation and Kalman filter
 - 3 engineers (Marie Ponchart, Fabien Novella, Pierre Benet)
 - P Benet, F Novella, M Ponchart, P Bosser, B Clement « *State-of-the-art of standalone accurate AUV positioning - application to high resolution bathymetric surveys* » IEEE Oceans 2019
- Simulation
 - CARES/NAVIDRO : simulation of navigation function for a sub-marine drone
 - 2 post docs (Pierre-Yves Pillain et Loic Salmon)
 - L Salmon, PY Pillain, G Guillou, JP Babau “*CARES, a framework for CPS simulation : application to autonomous underwater vehicle navigation function*” FDL 2021



The Lab-STICC: a lot of skills ... for drones

- Design and experimentation of drones



- Communication protocols
 - 5G, satellite, Wifi, acoustic
 - security, performance, quality



- Signal and data processing
 - Acquisition, filtering, analysis et detection



- Radars & GPS
 - Modelling, simulation, characterization
 - The DOREDO project : Détection d'Obstacles par Radar Embarqué sur DrOne



- Embedded systems
 - ASIC, FPGA, ...
 - Performance, power consumption, communication, security, real-time, IA, ...



- System modeling
 - Systems of systems
 - Anomaly detection for maritime cyber-physiques systems





A lot of on-going projects for drones

Lab-STICC « From sensors to knowledge: communicate and act »

- All data and system cycle
 - Acquisition, filtering, communication, store et computation
 - Marine applications: an obvious application domain for Lab-STICC
 - EUR Isblue
- A lot of collaborations in the future ;)

