

## **Workshop/Tutorial T1 (Full Day)**

### **NEW DEVELOPMENTS ON SENSE-AND-AVOID SYSTEMS, FAULT-TOLERANT CONTROL AND FAULT-TOLERANT COOPERATIVE CONTROL TECHNIQUES FOR UNMANNED SYSTEMS AND THEIR APPLICATIONS**

#### **Organizers and Presenters**

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#### **Tutorial Summary**

Unmanned systems including Unmanned Aerial Vehicles or Unmanned Aircraft Systems (UAVs or UAS), Unmanned Ground Vehicles (UGVs), and Unmanned Surface/Underwater Vehicles (USVs/UUVs) have gained increased attention during the last years due to their utilization in diverse applications such as surveillance, search and rescue missions, geographic studies, military and security, etc. Sense and Avoid (S&A) is required to guarantee UAS safe flight and collision avoidance, while Fault-Tolerant Control (FTC) and cooperative control techniques contribute to advancing the state-of-the-art of available testbeds that may be used to evaluate fault-tolerant and cooperative guidance, navigation and control techniques. Based on prior and ongoing research and development and experience gained at the Diagnosis, Flight Control and Simulation Lab (DFCSL) and Networked Autonomous Vehicles Lab (NAVL) at Concordia University, this tutorial will present state-of-the-art techniques in S&A, Fault Detection and Diagnosis (FDD), FTC, as well as Fault-Tolerant Cooperative Control (FTCC) of multiple vehicles with applications to forest fire monitoring and detection, and power line inspection, with different types of unmanned systems including UAVs, UGVs, and USVs, and combining also with remote sensing techniques.

An overview of past, current and future research activities and research outcomes on S&A, FDD, FTC, and FTCC and their applications to quadrotor rotary and fixed-wing UAVs will be presented. Linear and nonlinear techniques for modeling, fault diagnosis, fault-tolerant control, path and trajectory planning/re-planning, cooperative/formation flight guidance, navigation and control, based on a quadrotor helicopter UAV and fixed-wing UAV test beds at NAVL, as well as USVs worldwide, will be discussed. A review of existing vision-based automated forest fire detection and power line inspection systems using UAVs and key issues will also be presented.

## Tutorial Outline

- 09:00 – 9:45: Introduction to Health Management, Fault-tolerant Control and Cooperative Control: Motivation, Concept, History, Existing and Future Developments
- 9:45 – 10:30: Developments on Fault Diagnosis, Fault-tolerant Control and Cooperative Control with Applications to Fixed-wing and Quadrotor UAVs Testbeds
- 10:30 – 10:45: Coffee Break
- 10:45 – 11:00: Design of Fault-tolerant Control Methods Based on Reliability
- 11:00 – 11:45: New Development on UAV Sense and Avoid (S&A) Techniques
- 11:45 – 14:00: Lunch Time
- 14:00 – 14:45: Forest Fire Detection for Real-time Monitoring Using Unmanned Aerial Vehicles
- 14:45 – 15:00: Coffee Break
- 15:00 – 15:45: An Overview and New Development on Remote Sensing and Computer Vision Technologies Used for Automatic Power Line Inspection with UAVs
- 15:45 – 16:30: Fault-Tolerant Cooperative Control (FTCC) of Multiple UAVs-UGVs in the Presence of Actuator Faults During Forest Fire Monitoring Mission
- 16:30 – 17:15: Guidance, Navigation and Control of Unmanned Surface Vehicles: From Design to Implementation
- 17:15 – 17:30: Summary, Discussion, and Feedback

## Intended Audience

- Graduate students and researchers, managers, practitioners and developers interested in UAVs/UGVs/USVs, sense and avoid, remote sensing, fault-tolerant and cooperative control, fault diagnosis, health management, fault-tolerant guidance, navigation and control, and applications to forest fire, power line, pipeline monitoring and fault/damage detection etc.

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