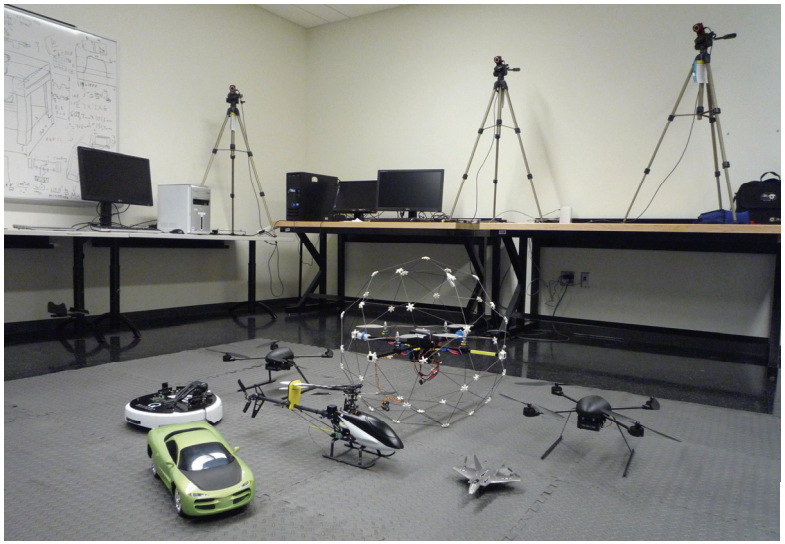
Networked Cooperative Autonomous Vehicles Project



Project Description and Objectives:

Autonomous vehicles are gaining more and more attention during the last years due to their important contribution in several tasks such as surveillance, search, rescue missions, geographic studies, military and security applications. However, many of these tasks require a cooperative decision and control of multiple Unmanned Aerial and Ground Vehicles (UAVs and UGVs) for a better management and achievement of the defined objectives.

A team of researchers at the Department of Mechanical and Industrial Engineering of Concordia University is currently working on the Networked Cooperative Autonomous Vehicles (NCAV) project. The main objective of the project is to provide theoretical and experimental results on modeling, cooperative decision and control, trajectory and path planning, formation flight, diagnosis and fault-tolerant control. An important concern of the team is to apply the achieved theoretical results to the unmanned vehicles test-bed of the Department of Mechanical and Industrial Engineering. Currently, the test-bed includes three Quad-rotor UAVs and one UGV and will be extended in the future to include more vehicles.

The team has been working on the theoretical part since 2007 and on the experimental part since February 2010 where many publications have been published and submitted to high level journals and international conferences. Some of these publications are given hereafter but the complete list of publications can be found on http://users.encs.concordia.ca/~ymzhang.

For more information, please contact Dr. Youmin Zhang on ymzhang@encs.concordia.ca or (514) 848-2424, ext. 5225

Some Related Publications (since 2009)

Journal Papers (Accepted):

H. A. Izadi, B. W. Gordon, and Y. M. Zhang, Decentralized Receding Horizon Control for Cooperative Multiple Vehicles Subject to Communication Delay, *AIAA Journal of Guidance, Control, and Dynamics*, 32(6), pp. 1959-1965, 2009.

Y. Y. Guo, B. Jiang, Y. M. Zhang, and Y. H. Cheng, Multi-model Based Actuator Fault Accommodation Scheme for Flight Control Systems, *Journal of Astronautics*, 30(2), pp. 795-800, 2009.

Journal Papers (Submitted/to be Submitted):

A. Chamseddine, Y. M. Zhang, C.-A. Rabbath, C. Join, D. Theilliol, Flatness-based Trajectory Planning/Re-planning for a Quad-rotor Unmanned Aerial Vehicle, Submitted to *IEEE Trans. on Aerospace and Electronic Systems*, 2010.

H. A. Izadi, B. W. Gordon, and Y. M. Zhang, Decentralized Receding Horizon Control in the Presence of Large Communication Delays: Stability, Feasibility and Performance, Submitted to *Automatica,* 2010.

H. A. Izadi, B. W. Gordon, and Y. M. Zhang, Hierarchical Decentralized Receding Horizon Control of Multiple Vehicles with Communication Failure, to be submitted to *IEEE Trans. on Aerospace and Electronic Systems,* 2010.

Conference Papers (Accepted):

X. B. Zhang, Y. M. Zhang, C.-Y. Su, and Y. Feng, Fault Tolerant Control for Quadrotor UAV via Backstepping Approach, *Proc. of the 48th AIAA Aerospace Sciences Meeting*, 4-7 Jan. 2010, Orlando, USA, Paper 2010-947.

H. A. Izadi, B. W. Gordon, and Y. M. Zhang , Decentralized Receding Horizon Control of Multiple Vehicles subject to Communication Failure, *Proc. of American Control Conference*, St Louis, Missouri, USA, June 10-12, 2009.

Conference Papers (Submitted):

A. Chamseddine, Y. M. Zhang, C.-A. Rabbath, C. Fulford, and J. Apkarian, Modeling and Control of Quad-rotor Unmanned Aerial Vehicle: Experimental Results, Submitted to *the 49th IEEE Conf. on Decision and Control*, Atlanta, GA, USA, Dec. 15-17, 2010.

F. Sharifi, B. W. Gordon and Y. M. Zhang, Decentralized Sliding Control of Cooperative Multi-Agent Systems Subject to Communication Delays, Submitted to *AIAA Guidance, Navigation, and Control Conference*, Toronto, Ontario, Canada, 2-5 Aug. 2010.

Y.-H. Qu and Y. M. Zhang, Cooperative Localization of Low-cost UAV Using Relative Range Measurements in Multi-UAV Flight, Submitted to *AIAA Guidance, Navigation, and Control Conference*, Toronto, Ontario, Canada, 2-5 Aug. 2010.

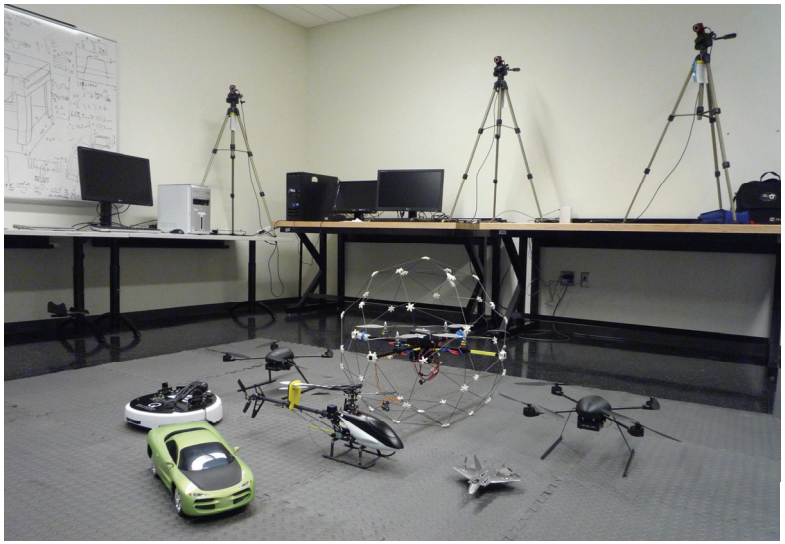
L. Ma and Y. M. Zhang, Fault Detection and Diagnosis for GTM UAV with Dual Unscented Kalman Filter, Submitted to *AIAA Guidance, Navigation, and Control Conference*, Toronto, Ontario, Canada, 2-5 Aug. 2010.

A. Bani Milhim, Y. M. Zhang, and C.-A. Rabbath, Quad-Rotor UAV: High-Fidelity Modeling and Nonlinear PID Control, Submitted to *AIAA Modeling and Simulation Technologies Conference*, Toronto, Ontario, Canada, 2-5 Aug. 2010.

Q.-L. Zhou, Y. M. Zhang, C.-A. Rabbath, and J. Apkarian (2010), Two Reconfigurable Control Allocation Schemes for Unmanned Aerial Vehicle under Stuck Actuator Failures, Submitted to *AIAA Guidance, Navigation, and Control Conference*, Toronto, Ontario, Canada, 2-5 Aug. 2010.

For more information, please contact Dr. Youmin Zhang on ymzhang@encs.concordia.ca or (514) 848-2424, ext. 5225

Projet 'Networked Cooperative Autonomous Vehicles'



Description et objectifs du projet:

Les véhicules autonomes gagnent de plus en plus d'attention grâce à leur contribution importante pendant les dernières années en plusieurs domaines comme la surveillance, la localisation, les missions de secours, les études géographiques et les applications militaires. Cependant, une grande partie de ces tâches nécessite une coopération entre plusieurs véhicules aériens et terrestres pour une meilleure gestion et accomplissement des objectifs prédéfinis.

Une équipe de chercheurs au département de génie mécanique et industriel de l'Université Concordia travaille actuellement sur un projet intitulé 'Networked Cooperative Autonomous Vehicles' (NCAV). L'objectif principal de ce projet est de développer de résultats théoriques et expérimentaux en modélisation, décision et commande coopératives, planification de trajectoires, vol en formation, diagnostic et tolérance aux défauts. Une des préoccupations de cette équipe c'est d'appliquer les résultats théoriques développés à un banc d'essai de drones au département. Actuellement, ce banc d'essai comporte trois quadri-rotors et un robot mobile à roues mais qui va être étendu pour inclure d'autres véhicules.

Cette équipe travaille sur la partie théorique depuis 2007 et sur la partie expérimentale depuis Février 2010 où plusieurs articles ont été soumis et publiés dans des revues et des conférences internationales de haut niveau. Quelques publications sont données dans la suite mais une liste plus exhaustive peut être trouvée sur la page web http://users.encs.concordia.ca/~ymzhang.

For more information, please contact Dr. Youmin Zhang on ymzhang@encs.concordia.ca or (514) 848-2424, ext. 5225

Quelques Publications (à partir de 2009)

Revues (Acceptées):

H. A. Izadi, B. W. Gordon, and Y. M. Zhang, Decentralized Receding Horizon Control for Cooperative Multiple Vehicles Subject to Communication Delay, *AIAA Journal of Guidance, Control, and Dynamics*, 32(6), pp. 1959-1965, 2009.

Y. Y. Guo, B. Jiang, Y. M. Zhang, and Y. H. Cheng, Multi-model Based Actuator Fault Accommodation Scheme for Flight Control Systems, *Journal of Astronautics*, 30(2), pp. 795-800, 2009.

Revues (Soumises/en cours de Soumission):

A. Chamseddine, Y. M. Zhang, C.-A. Rabbath, C. Join, D. Theilliol, Flatness-based Trajectory Planning/Re-planning for a Quad-rotor Unmanned Aerial Vehicle, Soumis à *IEEE Trans. on Aerospace and Electronic Systems*, 2010.

H. A. Izadi, B. W. Gordon, and Y. M. Zhang, Decentralized Receding Horizon Control in the Presence of Large Communication Delays: Stability, Feasibility and Performance, Soumis à *Automatica,* 2010.

H. A. Izadi, B. W. Gordon, and Y. M. Zhang, Hierarchical Decentralized Receding Horizon Control of Multiple Vehicles with Communication Failure, en cours de soumission à *IEEE Trans. on Aerospace and Electronic Systems,* 2010.

Articles Acceptés à des Conférences Internationales:

X. B. Zhang, Y. M. Zhang, C.-Y. Su, and Y. Feng, Fault Tolerant Control for Quadrotor UAV via Backstepping Approach, *Proc. of the 48th AIAA Aerospace Sciences Meeting*, 4-7 Jan. 2010, Orlando, USA, Paper 2010-947.

H. A. Izadi, B. W. Gordon, and Y. M. Zhang , Decentralized Receding Horizon Control of Multiple Vehicles subject to Communication Failure, *Proc. of American Control Conference*, St Louis, Missouri, USA, June 10-12, 2009.

Articles Soumis à des Conférences Internationales:

A. Chamseddine, Y. M. Zhang, C.-A. Rabbath, C. Fulford, and J. Apkarian, Modeling and Control of Quad-rotor Unmanned Aerial Vehicle: Experimental Results, Soumis à *the 49th IEEE Conf. on Decision and Control*, Atlanta, GA, USA, Dec. 15-17, 2010.

F. Sharifi, B. W. Gordon and Y. M. Zhang, Decentralized Sliding Control of Cooperative Multi-Agent Systems Subject to Communication Delays, Soumis à *AIAA Guidance, Navigation, and Control Conference*, Toronto, Ontario, Canada, 2-5 Aug. 2010.

Y.-H. Qu and Y. M. Zhang, Cooperative Localization of Low-cost UAV Using Relative Range Measurements in Multi-UAV Flight, Soumis à *AIAA Guidance, Navigation, and Control Conference*, Toronto, Ontario, Canada, 2-5 Aug. 2010.

L. Ma and Y. M. Zhang, Fault Detection and Diagnosis for GTM UAV with Dual Unscented Kalman Filter, Soumis à *AIAA Guidance, Navigation, and Control Conference*, Toronto, Ontario, Canada, 2-5 Aug. 2010.

A. Bani Milhim, Y. M. Zhang, and C.-A. Rabbath, Quad-Rotor UAV: High-Fidelity Modeling and Nonlinear PID Control, Soumis à *AIAA Modeling and Simulation Technologies Conference*, Toronto, Ontario, Canada, 2-5 Aug. 2010.

Q.-L. Zhou, Y. M. Zhang, C.-A. Rabbath, and J. Apkarian (2010), Two Reconfigurable Control Allocation Schemes for Unmanned Aerial Vehicle under Stuck Actuator Failures, Soumis à *AIAA Guidance, Navigation, and Control Conference*, Toronto, Ontario, Canada, 2-5 Aug. 2010.

For more information, please contact Dr. Youmin Zhang on ymzhang@encs.concordia.ca or (514) 848-2424, ext. 5225