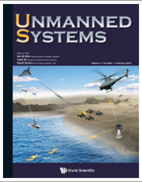
Unmanned Systems, Vol. 1, No. 1 (2013) 1–2

DOI: 10.1142/S2301385013010012

UNMANNED SYSTEMS
http://www.worldscientific.com/worldscinet/us



Editorial: The Inaugural Issue of Unmanned Systems

US

Unmanned systems are physical devices or systems equipped with necessary data processing units, sensors, automatic control, and communications systems that can perform desired tasks in unstructured environments without continuous human guidance. A fully autonomous unmanned system has the ability to gain information about and navigate through an environment, to work for an extended period without human intervention, to move either all or part of itself throughout its operating environment without human assistance, and to avoid situations that are harmful to people, property, or itself unless those are part of its design specifications. An unmanned system may also learn or gain new capabilities like adjusting strategies for accomplishing its tasks or adapting to changing surroundings.

Research on unmanned systems has gained much attention in recent years in the academic and military communities worldwide. Objects like unmanned aircraft, underwater exploiters, satellites, intelligent robots, and other unconventional structures are widely investigated as they have potential applications in the military and civilian domains. These unmanned systems are expected to have many capabilities. For example, they need to be able to sense and avoid friendly obstacles and also noncooperative obstacles. They need to have the ability to continue to operate in the event communications and/or GPS fail. Depending on the type of the vehicle they may have to operate in urban and indoor environments. There are numerous such challenges that they have to deal with in various situations. No one can anticipate all possible occurrences and build-in infinite number of contingencies into the design. The challenge is how to design unmanned system that can operate in an environment where unexpected events happen. Unmanned system design has to include traditional inner-loop control design along with algorithms for performing higher level functions such as decision making and task scheduling. This needs to be accomplished using reliable sensors, intelligent user/operator interfaces, information management and verifiable software.

Even though it is a rapid growing area, we find that there is a lack of existing journals that cover all the topics related to unmanned systems. Research findings and results related to unmanned systems are published all over the places. We find that there is an urgent need to establish a new journal devoting its entire scope to the development of unmanned systems. With the help and support from the World Scientific Publishing Company and with a long and intensive preparation, we are proud to present this inaugural issue of *Unmanned Systems*.

Unmanned Systems aims to publish high quality research and review articles in all subjects related to the development of automatic machine systems, which include advanced technologies in unmanned hardware platforms (aerial, ground, underwater and unconventional platforms), unmanned software systems, energy systems, modeling and control, communications systems, computer vision systems, sensing and information processing, navigation and path planning, computing, information fusion, multi-agent systems, mission management, machine intelligence, artificial intelligence, and innovative application case studies.

Featured in this inaugural issue are six research and one review manuscripts from the world renowned research groups in the fields. We highlight the key contribution of each article in the following.

The work by Kang and Prasad presents the development and flight-testing of an obstacle avoidance system that can provide a rotary-wing unmanned aerial vehicle (UAV) the autonomous obstacle field navigation capability in uncertain environment. The system is composed of a sensor, an obstacle map generation algorithm from sensor measurements, an online path planning algorithm, and an adaptive vehicle controller. The novel approach of path planning presented in the paper is the integration of a newly developed receding horizon trajectory optimization scheme with a global path searching algorithm. The developed system is implemented within the Georgia Tech UAV Simulation Tool (GUST) and on the onboard computer of the Georgia

Tech UAV test bed. Simulations and flight tests carried out for the benchmark scenarios and with sensor-in-the-loop flight tests demonstrated the viability of the developed system for autonomous obstacle field navigation capability of a UAV.

The manuscript by Wongpiromsarn, Topcu and Murray provides a review of control protocol synthesis techniques that incorporate methodologies from formal methods and control theory to provide correctness guarantee for different types of autonomous systems, including those with discrete- and continuous-time state space. The correctness of the system is defined with respect to a given specification expressed as a formula in linear temporal logic to precisely describe the desired properties of the system. The formalism presented in this article admits nondeterminism, allowing uncertainties in the system to be captured. A particular emphasis is on alleviating some of the difficulties, e.g., heterogeneity in the underlying dynamics and computational complexity that naturally arise in the construction of control protocols for autonomous systems.

The work by Kopeikin *et al.* describes a unique method to control network communications through distributed task allocation to engage under-utilized UAVs to serve as communication relays and to ensure that the network supports mission tasks. It builds upon a distributed algorithm previously developed by the authors, the Consensus-Based Bundle Algorithm (CBBA) with relays, which uses task assignment information, including task location and proposed execution time, to predict the network topology and plan support using relays. In this work, the algorithm is extended to explicitly consider realistic network communication dynamics, including path loss, stochastic fading, and information routing. Simulation and flight test results validate the proposed approach, demonstrating that the algorithm ensures both data-rate and interconnectivity bit-error-rate requirements during task execution.

Next, Keller *et al.* presents a computationally efficient approach to trajectory management for coordinated aerial surveillance. The design of a trajectory definition and management algorithm suited for a multi-agent persistent surveillance application is described. The proposed solution post-processes the output of a point-by-point path planner and converts it into a minimal representation. Key design requirements include minimization of mission execution time, ability to seamlessly redirect agents based on information acquired by sensor feedback, and robust adherence to mission and vehicle motion constraints. A simple coordinated aerial surveillance scenario is described and demonstrated using the algorithms presented.

The work by Doherty *et al.* addresses high-level mission specification and planning for collaborative unmanned aircraft systems. It proposes a formal framework and architecture based on the unifying concept of delegation that can be used for the automated specification, generation and execution of high-level collaborative missions involving one or more air vehicles platforms and human operators. The authors describe an agent-based software architecture, a temporal logic-based mission specification language, a distributed temporal planner and a task specification language that when integrated provide a basis for the generation, instantiation and execution of complex collaborative missions on heterogeneous air vehicle systems.

The paper by Hu *et al.* provides an overview on recent developments in cooperative control of robotic networks for search and exploration. A networked multi-robot system can be capable in handling tasks that are much beyond the capabilities of each individual robot. However, it also poses new research and technical challenges that call for novel methods for multi-agent data fusion, network topology control, cooperative path planning and tasking, etc. In this work, the authors first present a general formulation of the search and exploration problem, and then introduce the associated functioning modules for an overall search strategy. Methods and algorithms are illustrated and compared. To test and verify multi-robot cooperation algorithms in any given environment, a 3D simulator is developed. The paper gives a detailed account of the simulator and demonstrates its applications in several search and coverage control scenarios. Finally, challenges and some future research directions are highlighted.

A review article by Lang *et al.* reports a new trend in the development of visual servoing for mobile robotics, which is to integrate visual information in feedback control for facilitating autonomous grasping and manipulation. The result is a visual servo system. It has wider application than the traditional visual servoing in manipulators with fixed base. The authors present in the article the state of art of vision-guided robotic applications along with the associated hardware. Two classical approaches of visual servoing: image-based visual servoing and position-based visual servoing are reviewed; and their advantages and drawbacks in applying to a mobile manipulation system are discussed. A general concept of modeling a visual servo system is demonstrated, and a practical application of mobile manipulation system, which is developed for applications of search and rescue and homecare robotics, is introduced.

Lastly, we would like to take this opportunity to thank all our editorial board members for their generous support and contributions. We would also like to acknowledge the assistance from Ms. Amanda Yun and Dr. Yan Ng of World Scientific Publishing Company, and from Dr. Xiaolian Zheng of the National University of Singapore. Xiaolian helped designing the cover of *Unmanned Systems*.

Ben M. Chen, Lihua Xie, Siva Banda
Editors-in-Chief