Monique Chyba, University of Hawaii, USA

A Geometrical Approach to the Motion Planning Problem for Autonomous Underwater Vehicles

Recent advances in robotics, control theory, portable energy sources, and automation increase our ability to create more intelligent robots, and allow us to conduct more explorations by use of autonomous vehicles. This facilitates access to higher risk areas, longer time underwater, and more efficient exploration as compared to human occupied vehicles. The use of autonomous underwater vehicles (AUVs) has been expanding in every area of ocean science for the past two decades. AUVs are mechanical systems that pose interesting research problems from both theoretical and practical viewpoints, and therefore provide an excellent platform to generate advances in both areas simultaneously. Clearly, the onboard energy system is the key to their ability to perform a prescribed mission. For a long duration mission, during which the AUV does not have the possibility to recharge, it is critical to minimize the energy demands of the vehicle into consideration. We will present control strategies that minimize the energy consumption of the vehicle along the path, the major difficulty being to produce control strategies that are implementable onto a real vehicle. Another practical concern for AUV implementation is under-actuation. Some vehicles are designed to operate in an under-actuated condition, while other fully-actuated vessels need to be prepared to deal with actuator failure(s) resulting from a number of mechanical issues. We will address this research interest via the implementation of control strategies developed using a differential geometric approach based on decoupling vector fields and kinematic reduction. Implementation results of our strategies onto a test-bed vehicle will be presented, matching well with theoretical predictions.

Monique Chyba received her Ph.D. in Mathematics from the University of Geneva in Switzerland. She is currently a Professor in the Department of Mathematics at the University of Hawaii, Manoa, USA. Her main research interest is the development of geometric methods to solve optimal control problems with her central objective to understand the role of singular extremals in optimal strategies for nonlinear control systems. Her most current work deals with biological applications such as efficient swimming at low Reynolds number and morphogenesis.