Search and classification using multiple autonomous vehicles : decision-making and sensor management

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Abstrak

Search and classification using multiple autonomous vehicles provides a comprehensive study of decision-making strategies for domain search and object classification using multiple autonomous vehicles (MAV) under both deterministic and probabilistic frameworks. It serves as a first discussion of the problem of effective resource allocation using MAV with sensing limitations, i.e., for search and classification missions over large-scale domains, or when there are far more objects to be found and classified than there are autonomous vehicles available. Under such scenarios, search and classification compete for limited sensing resources. This is because search requires vehicle mobility while classification restricts the vehicles to the vicinity of any objects found. The authors develop decision-making strategies to choose between these competing tasks and vehicle-motion-control laws to achieve the proposed management scheme. Deterministic Lyapunov-based, probabilistic Bayesian-based, and risk-based decision-making strategies and sensor-management schemes are created in sequence. Modeling and analysis include rigorous mathematical proofs of the proposed theorems and the practical consideration of limited sensing resources and observation costs. A survey of the well-developed coverage control problem is also provided as a foundation of search algorithms within the overall decision-making strategies. Applications in both underwater sampling and space-situational awareness are investigated in detail. The control strategies proposed in each chapter are followed by illustrative simulation results and analysis.