

Department of Electrical and Computer Engineering

Title: « FROM COVERAGE CONTROL TO OPTIMAL PERSISTENT MONITORING IN STOCHASTIC ENVIRONMENTS »

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Abstract:

Unlike the coverage control problem where a team of multiple agents (e.g., a sensor network) is deployed through fixed agent locations, the persistent monitoring problem involves the control of agent trajectories that minimize an uncertainty metric in a stochastic mission space. In a one-dimensional setting, we have shown that the optimal solution is for each agent to move at maximal speed and switch direction at specific points, possibly waiting some time at each such point before switching. In a two-dimensional mission space, such simple solutions can no longer be derived. We approach the problem by representing an agent trajectory in terms of general function families characterized by a set of parameters that we can optimize. We show that the problem of determining optimal parameters for these trajectories can be solved on line using Infinitesimal Perturbation Analysis (IPA) to determine gradients of the objective function with respect to these parameters evaluated on line so as to adjust them through a gradient-based algorithm. We apply this approach to the family of Lissajous functions as well as a Fourier series representation of an agent trajectory. Numerical examples will be shown to illustrate this method, allow for uncertainties modeled as stochastic processes, and compare this scalable approach to trajectories obtained through off-line computationally intensive two point boundary value problem solutions. Since the solutions obtained to these problems are generally locally optimal, we will also discuss methods to escape such local optima.

Biography:

Christos G. Cassandras is Head of the Division of Systems Engineering and Professor of Electrical and Computer Engineering at Boston University. He is also co-founder of Boston University's Center for Information and Systems Engineering (CISE).

He received degrees from Yale University (B.S., 1977), Stanford University (M.S.E.E., 1978), and Harvard University (S.M., 1979; Ph.D., 1982).

In 1982-84 he was with ITP Boston, Inc. where he worked on the design of automated manufacturing systems.

Between 1984-1996 he was a faculty member at the Department of Electrical and Computer Engineering, University of Massachusetts/Amherst.

He specializes in the areas of discrete event and hybrid systems, stochastic optimization, and computer simulation, with applications to computer and sensor networks, manufacturing systems, and transportation systems. He has published over 300 refereed papers in these areas, and five books. He has guest-edited several technical journal issues and serves on several journal Editorial Boards.

He has recently collaborated with The MathWorks, Inc. in the development of the discrete event and hybrid system simulator SimEvents.

Dr. Cassandras was Editor-in-Chief of the *IEEE Transactions on Automatic Control* from 1998 through 2009 and has also served as Editor for Technical Notes and Correspondence and Associate Editor. He was the 2012 President of the IEEE Control Systems Society (CSS). He has also served as Vice President for Publications and on the Board of Governors of the CSS, as well as on several IEEE committees, and has chaired numerous conferences. He has been a plenary speaker at many international conferences, including the *American Control Conference* in 2001 and the *IEEE Conference on Decision and Control* in 2002, and has also been an IEEE Distinguished Lecturer.

He is the recipient of several awards, including the 2011 IEEE Control Systems Technology Award, the Distinguished Member Award of the IEEE Control Systems Society (2006), the 1999 Harold Chestnut Prize (IFAC Best Control Engineering Textbook) for *Discrete Event Systems: Modeling and Performance Analysis*, the 2014 Engineering Distinguished Scholar Award at Boston University, a 2011 prize for the IBM/IEEE Smarter Planet Challenge competition, a 1991 Lilly Fellowship and a 2012 Kern Fellowship. He is a member of Phi Beta Kappa and Tau Beta Pi. He is also a Fellow of the IEEE and a Fellow of the IFAC.