

## *MAE Seminar Series*

# **The Simultaneous Localization and Mapping Problem of Robotics**

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### **Abstract**

The problem of Simultaneous Localization and Mapping (SLAM) is addressed in this talk. The SLAM problem consists of a mobile robot mapping its environment while simultaneously trying to localize itself with respect to the map. The philosophical chicken and egg problem results in a very difficult computational problem that has proved to be one of the hardest to solve in the Robotics community. Traditionally, a purely Bayesian approach is taken to the solution of the SLAM problem wherein the map is added to the robot pose as a static parameter and the pose-map pair is estimated using a Bayes filter. This approach has severe shortcomings because computational complexity and consistency are at cross purposes in the formulation. The correlations between the map components have to be maintained in order for the method to be consistent but this leads to a computationally intractable problem since the map is typically huge in any realistic application, while neglecting these correlations leads to a loss of consistency.

We propose a hybrid Bayesian/ frequentist approach for the SLAM Problem. A frequentist approach is proposed for mapping with time varying robotic poses and is generalized to the case when the robotic pose is both time varying and uncertain. The SLAM problem is then solved in two steps: 1) the robot is localized with respect to a sparse set of landmarks in the map using a Bayes filter and a belief on the robot pose is formed, and 2) this belief on the robot pose is used to map the rest of the map using the frequentist estimator. The overwhelming majority of the map is estimated using the frequentist approach which is “provably consistent” and has complexity linear in the map components, and hence, computationally tractable as well as consistent. Moreover, the frequentist estimator is immune to the data association problem. The Bayesian part of the problem inherits the complexity of the particular Bayesian method that is used to solve the problem, but the complexity can be kept under control owing to the sparseness of the feature set. Moreover, the issue of data association for the Bayesian problem is also significantly ameliorated owing to the sparseness of the feature set. The method results in the formation of dense, information rich maps that can then be used for motion planning, exploration etc.

### **Bio**

Suman Chakravorty obtained the B.Tech degree in Mechanical Engineering from the Indian Institute of Technology, Madras in 1997, and a Ph.D. in Aerospace Engineering from the University of Michigan, Ann Arbor, in 2004. Since August 2004, he has been an Assistant Professor with the Aerospace Engineering Department at TAMU. His research interests are in Robotic Mapping and Planning problems, in particular the Simultaneous Planning, Localization and Mapping (SPLAM) problem; the analysis and design of stochastic nonlinear dynamical systems using computationally efficient solutions of the Fokker-Planck-Kolmogorov equation; and in the design and control of high resolution interferometric imaging systems.

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