Title: Robotic Navigation – Experience Gained with Radar

Abstract: Radar has been, and still is, an integral component of very sophisticated navigation and mapping systems, and its introduction into robotic navigation applications has been inspired by its ability to penetrate dust, rain and snow and even foliage, providing robust measurements of objects occluded by such conditions, in which other sensors fail.

In robotics, sensory information is often considered in the form of simple range value decisions, with accompanying bearing and possibly elevation information. Uncertainty in the sensing process is then typically represented spatially by “smearing” the range, bearing, elevation values in space, yielding a region, rather than a point, from which the range decision is considered to have originated. This type of analysis is not surprising, given the sensors typically used by robotics engineers. Affordable laser range finders, provide outputs which are range decisions, at various bearing/elevation values. Therefore, possibly as a result of the experience gained with these sensors, the analysis of radar in robotics often follows a similar line of thinking. By the use of suitable received power thresholds, range decisions are once again extracted, and sensing uncertainty is treated in the spatial domain as just described.

Interestingly, radar and tracking engineers have interpreted sensory information differently. To a radar engineer, received power values at successive range, bearing, and possibly elevation, values are related to the possible existence of an object in space. Hence, uncertainty in the sensing process is primarily formulated in terms of the decision itself as to whether or not a landmark even exists at the range, bearing/elevation coordinates in question. Such an analysis usually gives rise to the well known concepts (in the radar domain) of probabilities of detection and false alarm, and significantly less emphasis, if any, is placed on the possible spatial uncertainty of a hypothesized landmark.

The analysis of radar in robotics has therefore led to recent advances in the representations of robotic measurements/detections, which can be non-radar (e.g. laser) based, and the map itself, and their consequences on the robustness of SLAM. Fundamentally, the concept of a set based measurement and map state representation allows all of the measurement information, spatial and detection, to be incorporated into joint Bayesian SLAM frameworks. Representing measurements and the map state as random sets, rather than the traditionally adopted random vectors, is not merely a triviality of notation. It will be demonstrated in this presentation that a set based framework circumvents the necessity for any fragile data association and map management heuristics, which are necessary, and often the cause of failure, in vector based solutions. Experimental results, demonstrating SLAM with radar as well as laser based sensors in urban and marine environments will be demonstrated.

Short Biography: Martin Adams is Professor of Electrical Engineering at the Dept. of Electrical Engineering, University of Chile. He is also a principle investigator in the industrially sponsored Advanced Mining Technology Centre (AMTC). He obtained his

first degree in Engineering Science at the University of Oxford, U.K, in 1988 and continued to study for a D.Phil. at the Robotics Research Group, University of Oxford, which he received in 1992. He continued his research in autonomous robot navigation as a project leader and part time lecturer at the Institute of Robotics, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland. He was employed as a Guest Professor and taught control theory in St. Gallen (Switzerland) from 1994 to 1995. From 1996 to 2000, he served as a senior research scientist in robotics and control, in the field of semiconductor assembly automation, at the European Semiconductor Equipment Centre (ESEC), Switzerland. From 2000 to 2010, he was Associate Professor at the School of Electrical and Electronic Engineering, Nanyang Technological University (NTU), Singapore. His research work focuses on autonomous robot navigation, sensing, sensor data interpretation and control, and he has published many technical papers in these fields. He has been the principle investigator and leader of many robotics and industrially sponsored projects, coordinating researchers from local industries and local and overseas universities and has served as associate editor on various journal and conference editorial boards.