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Coordinate Systems for Complex Large-scale Sensor Networks

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Abstract

Large networks of inexpensive devices such as sensors, actuators and smart RFIDs deployed over complex 2D and 3D physical spaces will be an integral part of the emerging Internet of Things. Networking operations such as self-organization, localization and routing depend on some coordinate system. While geographic coordinates fit well with our intuitions into physical spaces, their use is not feasible in harsh environments and in complex deployments. Virtual coordinate systems are able to better capture the network topology and thus provide a more natural network representation. Yet their theoretical foundations are not well developed and relating them to physical network characteristics is difficult. Derivatives of virtual coordinates, such as topology coordinates and directional virtual coordinates, mimic geographic coordinates but without the need for distance measurements. Using the theory of low-rank matrix completion, now it is possible to extract topology preserving maps even with partial virtual coordinate information or random pairwise distances. We propose a coordinate based paradigm that facilitates seamless integration of geographic and virtual coordinate information. The approach functions even with incomplete information, thus facilitating evolving systems whose performance improve over time as new information becomes available. A self-learning algorithm is presented for individual nodes to achieve network awareness, which we argue is a key step toward developing massive evolving intelligent sensor networks mimicking natural systems that get better and smarter over time.

About the Speaker

Anura Jayasumana is a Professor of Electrical and Computer Engineering at Colorado State University, where he also holds a joint appointment in Computer Science. He is the Associate Director of Information Sciences & Technology Center at Colorado State. He is a Distinguished Lecturer of the IEEE Communications Society. His research interests span high-speed networking to wireless sensor networking, and anomaly detection to DDoS defense. He has served extensively as a consultant to industry ranging from startups to Fortune 100 companies. He received the B.Sc. degree from the University of Morata, Sri Lanka and M.S. and Ph.D. degrees in Electrical Engineering from the Michigan State University. Prof. Jayasumana has supervised 20+ Ph.D. and 50+ M.S. students, holds two patents, and is the co-author of ~300 refereed papers.