

Humanitarian Robotics and Automation Technologies: Research Frontiers and Methods,

By Dr. Raj Madhavan, University of Maryland, USA

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Resource person: Dr. Raj Madhavan

Dr. Raj Madhavan the Founder & CEO of Humanitarian Robotics Technologies (HumRobTech), LLC based in Maryland, USA has delivered a seminar to staff, students of Robotics and Ammachi labs. The seminar he presented and gave an insight into areas of topics he has done research. Over the last 20 years, he has contributed to topics in field robotics, and systems and control theory. His research interests lie in humanitarian robotics and automation — the application and tailoring of existing and emerging robotics and automation technologies for the benefit of humanity in a variety of domains, including unmanned (aerial, ground) vehicles in disaster scenarios. He shared his interest in the development of technologies and systems that are cost-effective, reliable, efficient and geared towards improving the quality of lives of people in under-served and underdeveloped communities around the globe.

He also gave an insight of IEEE Robotics and Automation Society, where he served as the Founding Chair of the Technical Committee on Performance Evaluation and Benchmarking of Robotics and Automation Systems. And discussed in detail about his areas of expertise

- *Humanitarian Robotics and Automation:* Application of applied systems engineering methodologies for improving the quality of life for humanity; Development and deployment of robotics technologies in underserved and underdeveloped communities across the globe in collaboration with non-profit and non-governmental organizations; Sustainability of envisaged solutions by leveraging existing and emerging technologies and working closely with stakeholders including industry, academia, government, and end-users.
- *Performance Evaluation, Benchmarking, and Standardization of Intelligent Systems:* Testing and Evaluation of intelligent robotic systems via standard test methods and performance metrics; Development of objective and quantitative schemes for assessment of robot navigation; Standardization of robots and robot systems operating in complex environments; Design of environments and data capture techniques for ground truth referenced datasets using different sensor modalities with emphasis on data requirements and map representations; Field exercises, in-situ testing, and data collection in relevant environments by collaborating with vendors, developers, and end-users.
- *Mobile Robotics:* Extensive theoretical background and practical experience with guidance, navigation, image processing, and control schemes for unmanned ground and aerial vehicles in large complex, outdoor, highly unstructured environments; Mobile robot kinematics and dynamics; Localization and navigation algorithms; GPS/INS integration; Signal processing and machine vision; Information-theoretic performance metrics for intelligent systems; Moving object prediction, tracking and estimation in dynamic environments; Statistical

pattern recognition and computer vision algorithms; Statistical analysis of the performance and confidence of the algorithms; Multi-scale signal analysis.

- *Sensing and Perception:* Laser/LADAR ranging, infra-red, GPS and INS in autonomous navigation of land vehicles and distributed heterogeneous sensing in cooperative land vehicle applications; Experience with signal conditioning and use of a variety of sensors and actuators including DC servo motors, encoders, strain gages, and piezoelectric gyros. Sensor Data Fusion: Numeric and geometric data fusion using estimation theoretic concepts (Kalman filtering, Bayesian); covariance analysis; sensor and data modeling methods; decentralized and distributed estimation and control; applications in robotics.
- *Systems and Control:* Control systems design, simulation, and implementation with both conventional and intelligent soft-computing tools; Experience with digital real-time control systems; Linear and nonlinear systems analysis and control; System identification and parameter estimation; Digital control and implementation issues; Sampling and finite wordlength considerations for sensor-based robotic control.



Mtech RAU students, staff and Ammachi labs with Dr. Raj Madhavan