# K Madhava Krishna

Raj Reddy Chair Professor Professor & Head Robotics Research Center and Head The Kohli Center on Intelligent Systems IIIT Hyderabad

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#### **Research Interests:**

Mobile robotics, Robotic Vision, Outdoor Navigation, Mechanism Design, Multi-robotic Systems

#### **Education:**

2001 November: Ph.D. from Electrical Engineering Dept, Indian Institute of Technology at Kanpur.

1998 July: Masters in Electronics Engineering from Birla Institute of Technology and Science at Pilani

1996 July: Bachelor's in electrical engineering from Birla Institute of Technology and Science at Pilani

### Fellowships:

- Fellow of the Indian National Academy of Engineering (INAE) for the year 2023
- Post Doctoral Fellowship of the French Government at the Robotics and AI Lab, LAAS-CNRS, Toulouse starting January 15<sup>th</sup>, 2002, for a period of one year.
- Qualcomm Innovation Fellowship for the year 2016-17
- Qualcomm Innovation Fellowship for the year 2017-18
- Qualcomm Innovation Fellowship for the year 2020-21
- Qualcomm Super Winner Award for the year 2021-22

#### **Major Achievement:**

Single handedly responsible for international visibility to Robotics Research. Our research center that I direct is ranked fifth in Asia in terms of research productivity <a href="http://csrankings.org/#/index?robotics&asia">http://csrankings.org/#/index?robotics&asia</a>

https://airankings.org/

## Awards:

- Best Paper Award, in ICVGIP 2010 for the paper on, "Real-time Motion Segmentation Based Multibody VSLAM", coauthored with Abhijit Kundu and C V Jawahar
- Best Runner up Paper Award in ICVGIP 2014 for the paper on, "Monocular Motion Segmentation of Rigid Bodies using In-frame Shear Constraints", coauthored with Siddharth Tourani
- Microsoft Young Researcher Award, 2008-09
- Qualcomm Innovation Fellowship Super Winner Award, 2021-2022
- Team Cerebrus comes second with its janitorial assistant at the ARTPARK-organised

## Grants:

- ZF (ZF India Private Limited), "Autonomous Driving in Adverse Conditions", 2022-2023, INR 4 million
- ▶ IHub," Towards an Interactive Autonomous Wheelchair", 2022-2024, INR 5 million
- Ati Motors (Ati Motors Incorporation Private Limited), "To explore learning or classical approaches to handle navigation without a HD map", 2024-2027, INR 4.9 million
- BRNS (Board of Research in Nuclear Sciences BARC), "Vision based Localization and SLAM for Mobile Robots", 2012-2015, INR 3.5 million
- Renault Nissan, "Parallel Algorithms for Driver Assistive Systems", 2012-13, INR 2.3 million
- > Renault Nissan, "RCS Framework Exploration and Implementation", INR 0.8 million
- Mathworks Systems, "Solutions to Driverless Car", INR 10 million, 2014 2020
- Rockwell Collins, "Fast Obstacle Avoidance for Quadrotor Systems", INR 1 million, 2017
- Rockwell Collins, "Urban MAV Exploration for Quadrotor Systems Part 1", INR 2.3 million, 2018
- Collins Aerospace, "Urban MAV Exploration for Quadrotor Systems Part 2", INR 3 million, 2019
- Collins Aerospace, "Distributed Control for Multiple MAV Collision Avoidane Systems", INR 3 million, 2020
- Rapyuta Robotics, "Indoor Topological SLAM for Warehouses", INR 2.5 million, 2019-20
- DeitY/MeitY, "Passenger Carrying Drone", Consortium Partner, INR 16 million, 2019-22
- > Qualcomm Innovation Fellowship, "Talk to The Car", INR 1 million, 2020-21
- Qualcomm Innovation Fellowship, "Monocular Reconstruction of Vehicles in Dynamic Scenes", INR 1 million, 2017-18
- Qualcomm Innovation Fellowship, "Parking Lot Assistant Drone System", INR 1 million, 2016-17
- CAIR, "Algorithms for Multi Robot Localization, Mapping and Exploration", INR 11 million
- RnD Engineers, "Localization in GPS Denied Environments", INR 2.4 million, 2015-17
- > DST, "Vision based Algorithm for Outdoor Navigation", 2011-2014, INR 3 million

- MeitY, "National Program on Perception Engineering Phase II", INR 7 million, 2015-18
- MeitY, "National Program on Perception Engineering Phase I", INR 3 million, 2009-11
- TCS Research, "Indoor Object SLAM", INR 5 million, 2017-19
- > TCS Research, "Semantic Navigation for Indoor Robots", INR 6 million, 2020-22
- CAIR-DRDO, "Autonomous Navigation for Outdoor Environments", 2010-2011, INR 1 million
- CVRDE-DRDO, "Digital Terrain Modeling using Single Laser Systems", Feb 2008– Aug 2009, INR 1 million
- BRNS BARC (Bhaha Atomic Research Center), "SLAM Algorithms: Development and Testing for Autonomous Navigation", 2008-2011, INR 3 million
- > DRDO-Extra Mural, "Snake Robots for Search and Rescue", 2009-2011, INR 1.5 million
- CAIR-DRDO, "Development of Algorithms for Mobile Robot Navigation", 2006–2007, INR 1 million
- DST, "Predictable Performance Algorithm for a Multi-robotic Surveillance System", 2005–2008, INR 0.8 million

## PUBLICATIONS

### Journals:

**1.** Open-Set 3D Semantic Instance Maps for Vision Language Navigation — O3D-SIM Laksh Nanwani, Kumaraditya Gupta, Aditya Mathur, Swayam Agrawal, A.H. Abdul Hafez, K. Madhava Krishna **Advanced Robotics - Taylor and Francis – 2024** 

2. AnyLoc: Towards Universal Visual Place Recognition -Nikhil Varma Keetha, Avneesh Mishra, Jay Karhade, Krishna Murthy Jatavallabhula, Sebastian Scherer, Madhava Krishna, Sourav Garg **IEEE Robotics Automation Letters (2024)** 

**3.** A Novel Hybrid Gripper Capable of Grasping and Throwing Manipulation Nagamanikandan Govindan, Bharadhwaj Ramachandran, Pasala Haasith Venkata Sai, K. Madhava Krishna **IEEE/ASME Transactions on Mechatronics (2023)** 

4. Shashank Srikanth, Mithun Babu, Houman Masnavi, Arun Kumar Singh, Karl Kruusamäe, Krishnan Madhava Krishna: Fast Adaptation of Manipulator Trajectories to Task Perturbation by Differentiating through the Optimal Solution. **Sensors 22(8): 2995 (2022)** 

5. Dipanwita Guhathakurta, Fatemeh Rastgar, Aditya Sharma, K. Madhava Krishna, Arun Kumar Singh:Fast Joint Multi-Robot Trajectory Optimization by GPU Accelerated Batch Solution of Distributed Sub-Problems. **Frontiers Robotics AI 9** (2022)

6. Vivek K. Adajania, Aditya Sharma, Anish Gupta, Houman Masnavi, K. Madhava Krishna, Arun Kumar Singh: Multi-Modal Model Predictive Control Through Batch Non-Holonomic Trajectory Optimization: Application to Highway Driving. **IEEE Robotics Autom. Lett. 7(2):** *4220-4227 (2022)* 

7. Bharath Gopalakrishnan, Arun Kumar Singh, K. Madhava Krishna, Dinesh Manocha: Solving Chance-Constrained Optimization Under Nonparametric Uncertainty Through Hilbert Space Embedding. **IEEE Trans. Control. Syst. Technol. 30(3)**: *901-916 (2022)* 

8. "Reactive Navigation under Non-Parametric Uncertainty through Hilbert Space Embedding of Probabilistic Velocity Obstacles", SriSai Naga Jyotish Poonganam, BHARATH GOPALAKRISHNAN, Venkata Seetharama Sai Bhargav Kumar Avula, Arun Kumar Singh, Madhava Krishna and Dinesh Manocha, **To Appear in IEEE Robotics and Automation Letters, 2019**  9. "Design of a Robust Stair Climbing Compliant Modular Robot to Tackle Overhang on Stairs" Ajinkya Bhole†, Sri Harsha Turlapati†, Rajashekhar V.S Jay

Dixit<sup>†</sup>, Suril V. Shah and K. Madhava Krishna, *Robotica (2019)* 

10. "Instance Invariant Visual Servoing Framework for Part-Aware Autonomous Vehicle Inspection using MAVs", Harit Pandya, Ayush Gaud, Gourav Kumar and K Madhava Krishna *Journal of Field Robotics*, *2019* 

11. Siddharth Tourani and K Madhava Krishna, "Using In-Frame Shear Constraints for Monocular Motion Segmentation Of Rigid Bodies", *in Journal of Intelligent and Robotic Systems*, 2015, Springer.

12. AH Abdul Hafez, Mithun P, Suril V Shah and K Madhava Krishna"Reactionless visual servoing of a multi-arm space robot combined with other manipulation tasks", *in Robotics and Autonomous Systems, May 2017* 

13. **Feasible acceleration count: A novel dynamic stability metric and its use in incremental motion planning on uneven terrain.** Arun Kumar Singh and K. Madhava Krishna **RAS 2015** 

14. G Aditya, Vijay Eathakota, Arun K Singh and K Madhava Krishna, "A Simulation Framework for Evolution on Uneven Terrains for Synchronous Drive Robot", *Advanced Robotics Journal (Robotics Society of Japan)*, 2013

15. An optimal wheel-torque control on a compliant modular robot for wheel-slip minimization. Avinash Siravuru, Suril V Shah and K. Madhava Krishna *Robotica*, *2016* 

16. **Planning non-holonomic stable trajectories on uneven terrain through non-linear time scaling.** Arun Kumar Singh, K. Madhava Krishna and Srikanth Saripalli *Autonomous Robots 2015* 

17. Reactionless Maneuvering of a Space Robot in Precapture Phase F James, SV Shah, AK Singh, KM Krishna, AK Misra, *Journal of Guidance, Control, and Dynamics*, 2419-2425, **2017** 

18. Vijay P Eathakota, A K Singh and K Madhava Krishna, "Two Models of Force Actuator based Active Suspension Mechanisms for Mobility on Uneven Terrain", in Acta Astronautica, Elsevier, 2011

19. Karthikeya Viswanath and K Madhava Krishna, "Towards Load Balanced Decongested Multi Robotic Traffic Control at Intersections", *Springer Journal of Intelligent Service Robotics, March 2009* 

20. Shivudu Bhuvanagiri and K Madhava Krishna, "Motion in Ambiguity: Coordinated Active Global Localization for Multiple Robots", in *Robotics and Autonomous Systems*, 2010

21. K. Madhava Krishna, R. Alami and T. Simeon, "Safe Proactive Plans and their Execution", *Robotics and Autonomous Systems*, **54 (2006)** 244-255 (available online at <u>www.sciencedirect.com</u>)

22. A K Pandey and K Madhava Krishna, "Link Graph and Feature Chain based Robust Online SLAM for Fully Autonomous Mobile Robot Navigation System using Sonar Sensors", *to appear in Springer Verlag's LNCIS*, **2007**.

23. K Madhava Krishna and Henry Hexmoor, "A framework for guaranteeing detection performance of a sensor network", *Integrated Computer-Aided Engineering Journal*, **Volume 12**, **Number 3** / **2005**, Pages: 305 – 317, IOS Press

24. K Madhava Krishna, Srinivas Chellappa, and H. Hexmoor, 2005. "Reactive Navigation of Multiple Moving Agents by Collaborative Resolution of Conflicts", *Journal of Robotic Systems*, **22(5)**, 249-269, Wiley Periodicals, Inc

25. K Madhava Krishna and Prem K Kalra, "Detection Tracking and Avoidance for Multiple Dynamic Objects", *Journal of Intelligent and Robotic Systems*, **vol 33: 371-408** Apr 2002 Kluwer Academic

26. K Madhava Krishna and Prem K Kalra, "When does the Robot Perceive a Dynamic Object", *Journal of Robotic Systems*, **19( 2)**, Feb. 2002, John Wiley

27. K Madhava Krishna and Prem K Kalra, "Perception and Remembrance of the Environment during Real-time Navigation for a Mobile Robot", *Robotics and Autonomous Systems*, **37(1): 25-51, Oct. 2001, Elsevier** 

28. K Madhava Krishna and Prem K Kalra, "Solving the Local Minima Problem for a Mobile Robot by Classification of Spatio-temporal Sensory Sequences", *Journal of Robotic Systems*, 17(10): 549-564, Oct. 2000, John Wiley and Sons 29. K Madhava Krishna and Prem K Kalra, "Spatial Understanding and Temporal Correlation for a Mobile Robot", *Spatial Cognition and Computation*, **2(3)**, Dec. 2000, Kluwer Academic

### **Premier/ Highly Rated, Cited Conferences:**

- 1. **Revisit Anything: Visual Place Recognition via Image Segment Retrieval** *Kartik Garg, Sai Shubodh Puligilla, Shishir Kolathaya, Madhava Krishna, and Sourav Garg* Published at ECCV 2024
- 2. Leveraging Cycle-Consistent Anchor Points for Self-Supervised RGB-D Registration Siddharth Tourani, Jayaram Reddy, Sarvesh Thakur, K Madhava Krishna, Muhammad Haris Khan, N Dinesh Reddy Published at ICRA 2024
- 3. **QueSTMaps: Queryable Semantic Topological Maps for 3D Scene Understanding** Yash Mehan, Kumaraditya Gupta, Rohit Jayanti, Anirudh Govil, Sourav Garg, and Madhava Krishna Published at IROS 2024
- 4. DiffPrompter: Differentiable Implicit Visual Prompts for Semantic-Segmentation in Adverse Conditions Sanket Kalwar, Mihir Ungarala, Shruti Jain, Aaron Monis, Krishna Reddy Konda, Sourav Garg, K Madhava Krishna Published at IROS 2024
- 5. **Imagine2Servo: Intelligent Visual Servoing with Diffusion-Driven Goal Generation for Robotic Tasks** *Pranjali Pathre, Gunjan Gupta, M. Nomaan Qureshi, Mandyam Brunda, Samarth Brahmbhatt, K. Madhava Krishna* Published at IROS 2024
- 6. **Bi-level Trajectory Optimization on Uneven Terrains with Differentiable Wheel-Terrain Interaction Model** *Amith Manoharan, Aditya Sharma, Himani Belsare, Kaustab Pal, K. Madhava Krishna, Arun Kumar Singh* Published at IROS 2024
- 7. **LeGo-Drive: Language-enhanced Goal-oriented Closed-Loop End-to-End Autonomous Driving** *Pranjal Paul, Anant Garg, Tushar Choudhary, Arun Kumar Singh, K. Madhava Krishna* Published at IROS 2024
- 8. Constrained 6-DoF Grasp Generation on Complex Shapes for Improved Dual-Arm Manipulation Gaurav Singh, Sanket Kalwar, Md Faizal Karim, Bipasha Sen, Nagamanikandan Govindan, Srinath Sridhar and K Madhava Krishna Published at IROS 2024
- 9. Talk2BEV: Language-enhanced Bird's-eye View Maps for Autonomous Driving Vikrant Dewangan, Tushar Choudhary, Shivam Chandhok, Shubham Priyadarshan, Anushka Jain, Arun K. Singh, Siddharth Srivastava, Krishna Murthy Jatavallabhula, K. Madhava Krishna Published at ICRA 2024
- 10. **ATPPNet: Attention based Temporal Point cloud Prediction Network** *Kaustab Pal, Aditya Sharma, Avinash Sharma, K. Madhava Krishna* Published at ICRA 2024
- 11. Anticipate & Act: Integrating LLMs and Classical Planning for Efficient Task Execution in Household Environments Raghav Arora, Shivam Singh, Karthik Swaminathan, Ahana Datta, Snehasis Banerjee, Brojeshwar Bhowmick, Krishna Murthy Jatavallabhula, Mohan Sridharan, Madhava Krishna Published at ICRA 2024
- 12. LIP-Loc: LiDAR Image Pretraining for Cross-Modal Localization Sai Shubodh, Mohammad Omama, Husain Zaidi, Udit Singh Parihar, K Madhava Krishna Published at WACV 2024

- 13. **EDMP: Ensemble-of-costs-guided Diffusion for Motion Planning** *Kallol Saha, Vishal Mandadi, Jayaram Reddy, Ajit Srikanth, Aditya Agarwal, Bipasha Sen, Arun Singh and Madhava Krishna* Published at ICRA 2024
- 14. FinderNet: A Data Augmentation Free Canonicalization aided Loop Detection and Closure technique for Point clouds in 6-DOF separation Sudarshan S, Harithas Gurkirat, Singh Aneesh Chavan, Sarthak Sharma, Suraj Patni, Chetan Arora, Madhava Krishna Published at WACV 2024
- 15. AnyLoc: Towards Universal Visual Place Recognition Nikhil Keetha, Avneesh Mishra, Jay Karhade, Krishna Murthy Jatavallabhula, Sebastian Scherer, Madhava Krishna, Sourav Garg Published at ICRA 2024
- 16. **Disentangling Planning and Control for Non-prehensile Tabletop Manipulation** Vishal Reddy Mandadi, Kallol Saha, Dipanwita Guhathakurta, M. Nomaan Qureshi, Aditya Agarwal, Bipasha Sen, Dipanjan Das, Brojeshwar Bhowmick, Arun Singh, and Madhava Krishna Published at CASE 2023
- 17. CLIPGraphs: Multimodal Graph Networks to Infer Object-Room Affinities Ayush Agrawal, Raghav Arora, Ahana Datta, Snehasis Banerjee, Brojeshwar Bhowmick, Krishna Murthy Jatavallabhula, Mohan Sridharan, Madhava Krishna Published at IEEE RO-MAN 2023
- 18. Instance-Level Semantic Maps for Vision Language Navigation Laksh Nanwani, Anmol Agarwal, Kanishk Jain, Raghav Prabhakar, Aaron Monis, Aditya Mathur, Krishna Murthy Jatavallabhula, A. H. Abdul Hafez, Vineet Gandhi, K. Madhava Krishna Published at IEEE RO-MAN 2023
- 19. **UrbanFly: Uncertainty-Aware Planning for Navigation Amongst High-Rises with Monocular Visual-Inertial SLAM Maps** Sudarshan S Harithas, Ayyappa Swamy Thatavarthy, Gurkirat Singh, Arun K Singh and K Madhava Krishna Published at ACC 2023
- 20. Learning Arc-Length Value Function for Fast Time-Optimal Pick and Place Sequence Planning and ExecutionPrajwal Thakur, M. Nomaan Qureshi, Arun Kumar Singh, Y V S Harish, Pushkal Katara, Houman Masnavi, K. Madhava Krishna and Brojeshwar Bhowmick Published at IJCNN 2023
- 21. **HyP-NeRF: Learning Improved NeRF Priors using a HyperNetwork** *Bipasha Sen, Gaurav Singh, Aditya Agarwal, Rohith Agaram, K. Madhava Krishna, Srinath Sridhar* Published at NeurIPS 2023
- 22. Conceptfusion: Open-set multimodal 3d mapping Krishna Murthy Jatavallabhula, Alihusein Kuwajerwala, Qiao Gu, Mohd Omama, Tao Chen, Shuang Li, Ganesh Iyer, Soroush Saryazdi, Nikhil Keetha, Ayush Tewari, Joshua B Tenenbaum, Celso Miguel de Melo, Madhava Krishna, Liam Paull, Florian Shkurti, AntonioTorralba Published at RSS 2023
- 23. Canonical Fields: Self-Supervised Learning of Pose-Canonicalized Neural Fields Rohith Agaram, Shaurya Dewan, Rahul Sajnani, Adrien Poulenard, Madhava Krishna, Srinath Sridhar Published at CVPR 2023
- 24. Ground then Navigate: Language-guided Navigation in Dynamic Scenes Kanishk Jain, Varun Chhangani, Amogh Tiwari, K Madhava Krishna, Vineet Gandhi Published at ICRA 2023
- 25.Sequence-Agnostic Multi-Object Navigation Nandiraju Gireesh, Ayush Agrawal, Ahana Datta, Snehasis Banerjee, Mohan Sridharan, Brojeshwar Bhowmick, Madhava Krishna Published at ICRA 2023
- 26.SCARP: 3D Shape Completion in ARbitrary Poses for Improved Grasping Bipasha Sen, Aditya Agarwal, Gaurav Singh, Brojeshwar B., Srinath Sridhar, Madhava Krishna Published at ICRA 2023
- 27.GDIP: Object-Detection in Adverse Weather Conditions Using Gated Differentiable Image Processing S Sanket Kalwar, Dhruv Patel, Aakash Aanegola, Krishna Reddy Konda, Sourav Garg, K Madhava Krishna Published at ICRA 2023

- 28.CCO-VOXEL: Chance Constrained Optimization over Uncertain Voxel-Grid Representation for Safe Trajectory Planning Sudarshan S Harithas, Rishabh Dev Yadav, Deepak Singh, Arun Kumar Singh, K Madhava Krishna Published at IEEE International Conference on Robotics and Automation (ICRA), 2022
- 29.**ReF Rotation Equivariant Features for Local Feature Matching** *Abhishek Peri\*, Kinal Mehta\*, Avneesh Mishra, Michael Milford, Sourav Garg, and K. Madhava Krishna* Published at arXiv (Submitted to IEEE-IROS 2022)
- 30.DRACO: Weakly Supervised Dense Reconstruction And Canonicalization of Objects Rahul Sajnani\*, AadilMehdi Sanchawala\*, Krishna Murthy Jatavallabhula, Srinath Sridhar and K. Madhava Krishna Published at IEEE International Conference on Robotics and Automation (ICRA), 2021
- 31.**RTVS: A Lightweight Differentiable MPC Framework for Real-Time Visual Servoing** *Mohammad Nomaan Qureshi, Pushkal Katara, Abhinav Gupta\*, Harit Pandya, Harish Y V S, AadilMehdi Sanchawala, Gourav Kumar, Brojeshwar Bhowmick, K. Madhava Krishna* Published at IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2021)
- 32.**Modular Pipe Climber III with Three-Output Open Differential** *Rama Vadapalli\*, Saharsh Agarwal, Vishnu Kumar, Kartik Suryavanshi, Nagamanikandan Govindan, K. Madhava Krishna* Published at IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2021)
- 33.**RoRD: Rotation-Robust Descriptors and Orthographic Views for Local Feature Matching** *Udit Singh Parihar, Aniket Gujarathi, Kinal Mehta, Satyajit Tourani, Sourav Garg, Michael Milford, K. Madhava Krishna* Published at IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2021)
- 34. Grounding Linguistic Commands to Navigable Regions *Nivedita Rufus\**, *Kanishk Jain, Unni Krishnan R Nair, Vineet Gandhi, K. Madhava Krishna* Published at IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2021)
- 35.**RP-VIO: Robust Plane-based Visual-Inertial Odometry for Dynamic Environments** *Karnik Ram\*, Chaitanya Kharyal, Sudarshan S. Harithas, K. Madhava Krishna* Published at IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2021)
- 36. **Bi-Convex Approximation of Non-Holonomic Trajectory Optimization** Arun Kumar Singh, Raghu Ram Theerthala, Mithun Babu, Unni Krishnan R Nair, and K. Madhava Krishna ICRA 2020
- 37. **Omnidirectional Tractable Three Module Robot** Kartik Suryavanshi, Rama Vadapalli, Ruchitha Vucha, Abhishek Sarkar and K Madhava Krishna *ICRA 2020*
- 38. **DFVS: Deep Flow Guided Scene Agnostic Image Based Visual Servoing** Y V S Harish, Harit Pandya, Ayush Gaud, Shreya Terupally, Sai Shankar, and K. Madhava Krishna *ICRA 2020*
- 39. **Topological Mapping for Manhattan-like Repetitive Environments** Sai Shubodh Puligilla\*, Satyajit Tourani\*, Tushar Vaidya\*, Udit Singh Parihar, Ravi Kiran Sarvadevabhatla and K. Madhava Krishna *ICRA 2020*
- 40. **Reactive Navigation under Uncertainty through Hilbert Space Embedding of Probabilistic Velocity Obstacles** SriSai Naga Jyotish Poonganam\*, Bharath Gopalakrishnan\*, Venkata Seetharama Sai Bhargav Kumar Avula, Arun Kumar Singh, K. Madhava Krishna and Dinesh Manocha *RAL* + *ICRA 2020*
- 41. Introducing Switched Adaptive Control for Quadrotors for Vertical Operations V. Shankaranarayanan and S. Roy Optimal Control Applications and Methods, 2020

- 42. **MonoLayout: Amodal scene layout from a single image** Kaustubh Mani, Swapnil Daga, Shubhika Garg, N. Sai Shankar, J. Krishna Murthy, and K. Madhava Krishna *WACV 2020*
- 43. **"Detecting, Localizing, and Recognizing Trees with a Monocular MAV: Towards Preventing Deforestation",** Utsav Shah, Rishabh Khawad and K Madhava Krishna, ICRA 2017,
- 44. **"INFER: INtermediate representations for FuturE pRediciton"** Shashank Srinkanth, Junaid Ahmed Ansari\*, R. Karnik Ram, Sarthak Sharma, J. Krishna

Murthy, K. Madhava Krishna, *IROS 2019* 

- 45. **"Talk to the Vehicle: Language Conditioned Autonomous Navigation of Self Driving Cars",** Sriram N. N., Tirth Maniar, Jayaganesh Kalyanasundaram, Vineet Gandhi, Brojeshwar Bhowmick and K. Madhava Krishna *IROS 2019*
- 46. **MergeNet: A Deep Net Architecture for Small Obstacle Discovery** Krishnam Gupta, Syed Ashar Javed, Vineet Gandhi and K. Madhava Krishna *ICRA 2018*
- 47. Beyond Pixels: Leveraging Geometry and Shape Cues for Online Multi-Object Tracking Sarthak Sharma\*, Junaid Ahmed Ansari\*, J. Krishna Murthy, and K. Madhava Krishna *ICRA 2018*
- 48. Constructing Category-Specific Models for Monocular Object-SLAM Parv Parkhiya, Rishabh Khawad, J. Krishna Murthy, Brojeshwar Bhowmick, and K. Madhava Krishna *ICRA 2018*
- 49. **Towards View-Invariant Intersection Recognition from Videos using Deep Network Ensembles** Abhijeet Kumar, Gunshi Gupta, Avinash Sharma and K. Madhava Krishna *IROS 2018*
- 50. **The Earth ain't Flat: Monocular Reconstruction of Vehicles on Steep and Graded Roads from a Moving Camera** Junaid Ahmed Ansari, Sarthak Sharma, Anshuman Majumdar, J. Krishna Murthy and K. Madhava Krishna *IROS 2018*
- 51. **Image Based Visual Servoing for Tumbling Objects** Mithun P, Harit Pandya, Ayush Gaud, Suril V. Shah and K. Madhava Krishna *IROS 2018*
- 52. **"Reconstructing Vechicles from a Single Image: Shape Priors for Road Scene Understanding",** J Krishna Murthy, G Sai Krishna, Falak Chaya and K Madhava Krishna, ICRA 2017
- 53. **"Detachable Modular Robot capable of Cooperative Climbing and Multi Agent Exploration"**, Sri Harsha, Ankur Srivastava, Suril Shah and K Madhava Krishna, ICRA 2017
- 54. **"Exploring Convolutional Networks for End-to-End Visual Servoing",** Harit Pandya, Aseem Saxena and K Madhava Krishna, ICRA 2017
- 55. "Shape Priors for Real-Time Monocular Object Localization in Dynamic Environments", J. Krishna Murthy, Sarthak Sharma, and K. Madhava Krishna, IROS 2017
- 56. **"PRVO: Probabilistic Reciprocal Velocity Obstacle for Multi Robot Navigation under Uncertainty",** Bharath Gopalakrishnan, Arun Kumar Singh, Meha Kaushik, K. Madhava Krishna and Dinesh Manocha, IROS 2017
- 57. **"Pose Induction for Visual Servoing to a Novel Object Instance",** Gourav Kumar, Harit Pandya, Ayush Gaud and K. Madhava Krishna, IROS 2017
- 58. **"Multi-trajectory Pose Correspondences using Scale-dependent Topological Analysis of Pose-Graphs",** Sayantan Datta, Avinash Sharma and K Madhava Krishna, IROS 2017
- 59. **"Have I Reached the Intersection",** Danish Sodhi, Dhaivat Bhatt, Arghya Pal, Vineeth Balasubramanian and K Madhava Krishna, IROS 2017
- 60. **"COCrIP: Compliant OmniCrawler In-pipeline Robot",** Akash Singh, Enna Sachdeva, Abhishek Sarkar and K.Madhava Krishna, IROS 2017
- 61. **SLAM Pose-graph Robustification via Multi-scale Heat-Kernel Analysis**, Sayantan Datta, Avinash Sharma and K Madhava Krishna, CDC 2016

- 62. **Rolling Shutter and Motion Blur Removal for Depth Cameras**. Siddharth Tourani, Sudhanshu Mittal, Akhil Nagariya, Visesh Chari and K. Madhava Krishna *ICRA 2016*
- 63. **Plantation Monitoring and Yield Estimation using Autonomous Quadcopter for Precision Agriculture.** Vishakh Duggal, Mohak Sukhwani, Kumar Bipin, G. Syamasundar Reddy and K. Madhava Krishna *ICRA 2016*
- 64. **Monocular Reconstruction of Vehicles: Combining SLAM with Shape Priors**. Falak Chhaya, Dinesh Reddy, Sarthak Upadhyay, Visesh Chari, M. Zeeshan Zia and K. Madhava Krishna *ICRA 2016*
- 65. **Discriminative Learning based Visual Servoing across Object Instances**. Harit Pandya, K. Madhava Krishna and C. V. Jawahar *ICRA 2016*
- 66. **Dynamic Body VSLAM with Semantic Constraints**. dinesh reddy narapureddy, Prateek Singhal, Visesh Chari and K. Madhava Krishna *IROS 2015*
- 67. Closed Form Characterization of Collision Free Velocities and Confidence Bounds for Non-holonomic robots in Uncertain Dynamic Environments. Arun Kumar Singh, Bharath Gopalakrishnan and K. Madhava Krishna *IROS 2015*
- 68. A Class of Non-Linear Time Scaling Functions For Smooth Time Optimal Control Along Specified Paths. Arun Kumar Singh and K. Madhava Krishna IROS 2015
- 69. **Stair Climbing Using a Compliant Modular Robot**. Sri Harsha Turlapati, Mihir Shah, Phani Teja Singamaneni, Avinash Siravuru, Suril Vijaykumar Shah and K. Madhava Krishna *IROS 2015*
- 70. **Mobile robot navigation amidst humans with intents and uncertainties: A time scaled collision cone approach**. Akhil Nagariya, Bharath Gopalakrishnan, Arun Kumar Singh, Krishnam Gupta and K. Madhava Krishna*CDC 2015*
- 71. Harit Pandya, K. Madhava Krishna and C. V. Jawahar, "Servoing Across Object Instances: Visual Servoing for Object Category". *ICRA 2015*
- 72. Kumar Bipin, Vishakh Duggal and K. Madhava Krishna, **"Autonomous Navigation of Generic Monocular Quadcopter in Natural Environment"**, *ICRA 2015*
- 73. S. Avinash, A. Srivastava, A. Purohit, S. V. Shah and K. Madhava Krishna, "A Compliant Multi-module Robot for Climbing Big Step-like Obstacle", *ICRA* 2014
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- 76. H. Abdul Hafez, V. V. Anurag, S. V. Shah, K. Madhava Krishna and C. V. Jawahar **"Reactionless Visual Servoing of a Dual-Arm Space Robot",** *ICRA 2014*
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- 81. Arun K Singh and K Madhava Krishna, **"Reactive Collision Avoidance for Multiple Robots by Non Linear Time Scaling"**, in IEEE International Conference on Decision and Control, (CDC) Florence 2013
- 82. Arun K. Singh and K. Madhava Krishna, "Coordinating Mobile Manipulator's Motion to produce Stable Trajectories on Uneven Terrain based on Feasible Acceleration Count", *IROS 2013*

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- 92. Aravindhan Krishnan and K Madhava Krishna, **"A Visual Exploration Algorithm using Semantic Cues that Constructs Image based Hybrid Maps",** in *IROS 2010*
- 93. A K Singh, Vijay P Eathakota, R K Namdev and K Madhava Krishna, "A Novel Compliant Rover for Rough Terrain Mobility", in *IROS 2010*
- 94. Aravindhan Krishnan and K Madhava Krishna, **"Autonomous Image Based Exploration for Indoor Environments using Local Features"**, *AAMAS 2010 (short paper)*
- 95. Piyoosh Mukhija, Rahul Sawhney and K Madhava Krishna, **"Multi Robotic Exploration with Communication Requirement to a Fixed Base Station"**, *AAMAS 2010 (short paper)*
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- 97. **"On Fast Exploration in 2D and 3D Terrains with Multiple robots",** Rahul Sawhney and K Madhava Krishna *AAMAS 2009*
- 98. Rahul Sawhney, Mahesh Mohan, K Srinathan and K M Krishna, "Reduced time fault tolerant paths for Multi-UAV coverage of 3D Terrains", AAMAS, 2008
- 99. Shivudu B and K M Krishna, **"Coordination in Ambiguity: Actively Localizing Multiple Robots"**, *AAMAS*, 2008
- Mahesh Mohan, Rahul Sawhney, K Madhava Krishna, K Srinathan and M B Srikkanth, "Covering Hostile Terrains with Partial and Complete Visibilities: On Minimum Distance Paths", *IROS*, 2008
- 101. H. Abdul Hafez, S Bhuvanagiri, K Madhava Krishna and C V Jawahar, "On-line Convex Optimization based Solution for Mapping in VSLAM", *IROS 2008*
- 102. S Bhuvanagiri and K Madhava Krishna, **"Coordinated Active Global** Localization forMultiple Robots by Disambiguating Multiple Hypotheses", *IROS 2008*
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- 105. Siddharth Sanan, Darshan Santani, K Madhava Krishna and Henry Hexmoor, **"Extension of Reeds and Shepp Paths for a Robot with Front and Rear Wheel Steer"**, *Proc of ICRA*, 2006
- 106. K Madhava Krishna and Henry Hexmoor, **"A T Step Ahead Optimal Tracking Algorithm for a Surveillance Based Sensor Network",** In Proceedings of IEEE/RSJ International Conference on Intelligent Robot and Systems, Pages 1840-1845, Edmonton, CA
- 107. K. Madhava Krishna and Henry Hexmoor **"Reactive Collision Avoidance of Multiple Moving Agents by Cooperation and Conflict Propagation",** *Proc. of ICRA, (IEEE Intl. Conf. on Robotics and Automation),* New Orleans, April 2004
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- 110. I J Nagrath, L Behera, K Madhava Krishna and K D Rajasekhar, "Realtime Navigation of a Mobile Robot using Kohonen's Topology Conserving Neural Networks", Proc. IEEE Eighth International Conference on Advanced Robotics, pp 459-464, Monterey, CA, July 1997

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- 2. Learning Actions for Drift-Free Navigation in Highly Dynamic Scenes Mohd Omama, Sundar Sripada V. S., Sandeep Chinchali, K. Madhava Krishna Published at American Control Conference (ACC 2022)
- 3. RackLay: Monocular Multi-Layered Layout Estimation for Warehouses with Sim2Real Transfer Meher Shashwat Nigam\*, Avinash Prabhu\*, Anurag Sahu\*, Tanvi Karandikar, Puru Gupta, N. Sai Shankar, Ravi Kiran Sarvadevabhatla and K. Madhava Krishna Published at ACM Indian Conference on Computer Vision, Graphics and Image Processing (ACM ICVGIP), 2021
- 4. **Probabilistic Inverse Velocity Obstacle for Free Flying Quadrotors** *Ishaan Khare, Jyotish Poonganam, Bharath Gopalakrishnan and K. Madhava Krishna* Published at IEEE European Control Conference (ECC), 2021

- 5. Non-Holonomic Collision Avoidance under Non-Parametric Uncertainty: A Hilbert Space Approach Unni Krishnan R Nair\*, Anish Gupta\*, D. A. Sasi Kiran, Ajay Shrihari, Vanshil Shah and K. Madhava Krishna Published at IEEE European Control Conference (ECC), 2021
- 6. **Incorporating Prediction in Control Barrier Function Based Distributive Multi-Robot Collision Avoidance** *Pravin Mali, K. Harikumar, Arun Kumar Singh, K. Madhava Krishna and P.B. Sujit* Published at IEEE European Control Conference (ECC), 2021
- 7. **Multi-View Planarity Constraints for Skyline Estimation from UAV Images in City Scale Urban Environments** *Ayyappa Swamy Thatavarthy, Tanu Sharma, Harshit Sankhla, Mukul Khanna and K. Madhava Krishna* Published at International Conference on Computer Vision Theory and Applications (VISAPP), 2021
- 8. Early Bird: Loop Closures from Opposing Viewpoints for Perceptually-Aliased Indoor Environments Satyajit Tourani, Dhagash Desai, Udit Singh Parihar, Sourav Garg, Ravi Kiran Sarvadevabhatla, Michael Milford and K. Madhava Krishna Published at International Conference on Computer Vision Theory and Applications (VISAPP), 2021
- 9. **BirdSLAM: Monocular Multibody SLAM in Bird's-Eye View** *Swapnil Daga, Gokul B. Nair, Anirudha Ramesh, Rahul Sajnani, Junaid Ahmed Ansari and K. Madhava Krishna*. Published at International Conference on Computer Vision Theory and Applications (VISAPP), 2021
- 10. A new geometric approach for three view line reconstruction and motion estimation in Manhattan Scenes *Ayyappa Swamy Thatavarthy*, *Tanu Sharma and K. Madhava Krishna* Published at Conference on Robots and Vision (CRV), 2021
- 11. Building Facades to Normal Maps: Adversarial Learning from Single View Images Mukul Khanna\*, Tanu Sharma\*, Ayyappa Swamy Thatavarthy and K. Madhava Krishna Published at Conference on Robots and Vision (CRV), 2021
- 12. Design and Analysis of Modular Pipe Climber-III with a Multi-Output Differential Mechanism Vishnu Kumar, Saharsh Agarwal, Rama Vadapalli, Nagamanikandan Govindan, K. Madhava Krishna Published at 2021 IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM)
- 13. DeepFly: Towards Complete Autonomous Navigation of MAVs with Monocular Camera Utsav Shah, Rishabh Khawad, K.Madhava Krishna, ICVGIP 2016
- 14. Hierarchical Structured Learning for Indoor Autonomous Navigation of Quadcopter Vishakh Duggal, Kumar Bipin, Utsav Shah, K. Madhava Krishna ICVGIP 2016
- 15. **"Fast Frontier Detection for Monocular SLAM",** Sarthak Upadhyay, K Madhava Krishna and Swagat Kumar, *ICVGIP 2016*

- 16. "CRF based method for Curb Detection using semantic cues and stereo depth", Danish Sodhi, Dhaivat Bhat, Sarthak Upadhyay and K Madhava Krishna, *ICVGIP* – 2016
- 17. **CRF Based Frontier Detection using Monocular Camera.** Sarthak Upadhyay, Suryansh Kumar and K.Madhava Krishna *ICVGIP 2014*
- 18. **Guess from Far, Recognize when Near: Searching the Floor for Small Objects.** M. Siva Karthik, Sudhanshu Mittal and K.Madhava Krishna *ICVGIP 2014*
- 19. Semantic Motion Segmentation Using Dense CRF Formulation. N. Dinesh Reddy, Prateek Singhal, K. Madhava Krishna *ICVGIP 2014*
- 20. **Top Down Approach to Detect Multiple Planes from Pair of Images.** Prateek Singhal, Aditya Deshpande, Harit Pandya, N. Dinesh Reddy, K. Madhava Krishna *ICVGIP 2014*
- 21. Small Object Discovery and Recognition using Actively Guided Robot. Sudhanshu Mittal, M. Siva Karthik, Suryansh Kumar and K.Madhava Krishna *ICPR* 2014
- 22. **MDP based Active Localization for multiple robots** Jyotika Bahuguna, B Ravindran and K Madhava Krishna. To appear in CASE 2009
- 23. **"Quasi-Static Simulation of a Wheeled Mobile Robot having a Passive Variable Camber",** Vijay Eathakota, G Aditya and K Madhava Krishna. *IFTOMM World Congress 2011*
- 24. A Bayes Filter based Adaptive Floor Segmentation with Homography and Appearance Cues Suryansh Kumar, Ayush Dewan, K Madhava Krishna *ICVGIP* 2012
- 25. Viewpoint based Mobile Robotic Exploration aiding Object Search in Indoor Environment Karthik Desingh, Akhil Nagariya, K Madhava Krishna *ICVGIP 2012*
- 26. **Fast Randomized Planner for SLAM Automation** Amey Parulkar, Piyush Shukla, K Madhava Krishna *CASE 2012*
- 27. Planning Trajectories on Uneven Terrain using Optimization and Non-Linear time Scaling Techniques Arun Kumar Singh, K. Madhava Krishna and Srikanth Saripalli *IROS 2012*
- 28. **Multi-Robot Exploration with Communication Requirement to a Moving Base Station** Romit Pandey, Arun Kumar Singh and K. Madhava Krishna. *CASE 2012*
- 29. **On Measurement Models for Line Segments and Point Based SLAM** Satish Pedduri, Gururaj Kosuru, K Madhava Krishna and Amit K Pandey ICAR 2009
- 30. Estimating Ground and Other Planes from a Single Tilted Laser Range Finder for On-Road Driving Yasovardhan Reddy E, Hemanth Korrapati and K Madhava Krishna ICAR 2009
- 31. **Global Localization of Mobile Robots by Reverse Projection of Sensor Readings** Hemanth Korrapati, K Madhava Krishna and Aditya Teja *ROBIO 2008*
- 32. A Mixed Autonomy Coordination Methodology For Multi-Robotic Traffic Control Aditya Teja V, D V Karthikeya Viswanath and K Madhava Krishna *ROBIO* 2008
- 33. Rakesh Goyal, K Madhava Krishna and Shivudu Bhuvanagiri, **"Sensor Based** Localization for Mobile Robots by Exploration and Selection of Best Direction", accepted at Robio, IEEE/RSJ Intl' Conference on Robotics and Biomimetics
- 34. A K Pandey and K Madhava Krishna, "Link Graph and Feature Chain based Robust Online SLAM for Fully Autonomous Mobile Robot Navigation System using Sonar Sensors", *Proceedings of ICAR 2007*
- 35. Satish Pedduri and K Madhava Krishna, "Collision Avoidance for Multiple Robots through Collision Free Paths till Next Waypoints from Collision Free Polygons", *Proceedings of ICAR 2007*
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- 38. Siddharth Sanan, Nageshwara Rao, K Madhava Krishna and Sartaj Singh, **"On Improving the Mobility of Vehicles in Uneven Terrain",** *Proceedings of ICAR* 2007
- 39. Ganesh P Kumar, K Madhava Krishna and P Menezes, **"Multi-target Detection by Multi-sensor Systems: A Comparison of Systems"**, accepted at Robio, accepted at Robio, IEEE/RSJ Intl' Conference on Robotics and Biomimetics
- 40. K Madhava Krishna and Henry Hexmoor, **"An Unconstrained Optimal Target Detection Algorithm for a Multi-Sensor Surveillance Systems"**, *IICAI*, 2005.
- 41. K Madhava Krishna, Henry Hexmoor and Subbarao, **"Parametric Control of Multiple Unmanned Air Vehicles over an Unknown Hostile Habitat",** *Proc of IEEE KIMAS*, Boston, MA 2005
- 42. K Madhava Krishna and Henry Hexmoor, **"Resource Allocation Strategies for a Multi-sensor Surveillance System"**, submitted to *Conference on Collaborative Agents*, Beijing 2004
- 43. K Madhava Krishna and Henry Hexmoor, **"A Framework for Measuring the Tracking Performance of a Sensor Network"**, Proc. of PerMis'04 (Performance Metrics in Intelligent Systems), Aug 2004, Gaitesburg, MD
- 44. K. Madhava Krishna, Henry Hexmoor and P Subbarao, **"Role of Autonomy in a Distributed Sensor Network for Surveillance"**, *Proc. of ICAI 2004*, (*Intl Conf. on Artificial Intelligence*), Las Vegas, July 2004.
- 45. K. Madhava Krishna, Henry Hexmoor, P Subba Rao and S Chellapa, **"A Surveillance System based on Multiple Mobile Sensors",** *Proc. of FLAIRS 2004, Special Track on AI Techniques in Multi-sensor Fusion,* Miami, May 2004
- 46. K. Madhava Krishna, Henry Hexmoor and P Subba Rao, "Avoding Collision Logjams through Cooperation and Conflict Propagation", *IEEE KIMAS'03* (International Conference on Knowledge Integrated Multi Agent Systems), Boston, MA, Oct 1-3, 2003
- 47. K. Madhava Krishna and Henry Hexmoor, **"Towards Quantification of the need to Cooperate between Robots",** *Proceedings of PerMIS'03 (Performance Metrics in Intelligent Systems)*, Sep. 16-18, 2003
- 48. K. Madhava Krishna and Henry Hexmoor, **"Social Control of a Group of Collaborating Multi-robot Multi-target Tracking Agents"**, *IEEE*, *AIAA 22<sup>nd</sup> Digital Avionics Systems Conference*, Indianapolis, Indiana, Oct. 12-16, 2003.
- 49. Henry Hexmoor and K Madhava Krishna, **"Collaborative and Social Reasoning about Interaction among a Large Group of Robots"**, *International Symposium on Collaborative Technologies and Systems*, San-Diego, CA, Jan. 18-23, 2004
- 50. K Madhava Krishna, K D Rajasekhar and L Behera, **"On Fast Computation of Optimal Paths from the Visibility Graph for the Minimal Workspace",** *Proc. International Symposium on Intelligent Robotic Systems*, pp 147-154, Bangalore, INDIA, Jan 1998.
- 51. **Overtaking Maneuvers in Simulated Highway Driving using Deep Reinforcement Learning** Meha Kaushik, Vignesh Prasad, K Madhava Krishna and Balaraman Ravindran *IV 2018*
- 52. **Fast Multi Model Motion Segmentation on Road Scenes** Mahtab Sandhu, Nazrul Haque, Avinash Sharma, K Madhava Krishna and Shanti Medasani *IV* 2018
- 53. **A Novel Lane Merging Framework with Probabilistic Risk based Lane Selection using Time Scaled Collision Cone** A. V. S. Sai Bhargav Kumar, Adarsh Modh, Mithun Babu, Bharath Gopalakrishnan and K. Madhava Krishna *IV 2018*
- 54. **Model Predictive Control for Autonomous Driving Based on Time Scaled Collision Cone** Mithun Babu, Yash Oza, Arun Kumar Singh and K. Madhava Krishna *ECC 2018*
- 55. **Learning Multi-Goal Inverse Kinematics in Humanoid Robot** Phaniteja S\*, Parijat Dewangan\*, Abhishek Sarkar and K. Madhava Krishna *ISR 2018*

## Service:

- Reviewer for ICRA, IROS for last several years
- Associate Editor for "IEEE International Conference on Robots and Systems, IROS 2020" conference.
- Reviewer for Autonomous Robots, IEEE Transactions Journals, Automatica
- Organized several hands-on robotic workshops such as Robocamp

## **Project List:**

### Govt Projects: (Active)

- 1. Setup and Exploration of Relation between the Behavioral Planner and Motion Planner for an Autonomous Vehicle in Dynamic Environments (BBPC)
- 2. Collaborative SLAM algorithm capable of running on low powered computation device in real time (CSLAM)
- 3. Design and Fabrication of Autonomous Passenger Drone (DFAPD RRC)

## **Pvt Projects: (Active)**

- 1. To explore learning or classical approaches to handle navigation without a HD map (ELCAN HD Map)
- 2. Autonomous Driving in Adverse Conditions (ADAC)
- 3. Robotics courseware for industries and startups (RC)
- 4. Semantic and Active SLAM with Behaviour Learning (SASBL)
- 4. Semantic Navigation for Robots (SNFR)
- 5. Task and Motion Planning for Visual Object Rearrangement (TAMPVOR)

### Govt Projects: (Closed)

- 1. IRL-Center for aitificial intelligence and Robotics(CAIR) (DRDO IRL CAIR)
- 2. Predictable performance Algorithms for a Multi sensor/Multi robotics survillance system (PPA MRSS)
- 3. Development of Algorithms for Mobile Robot Navigation (CAIR-DRDO)
- 4. Digital Terrain Estimation using ladar system (DTELS-CVRDE)
- 5. Development and Implementation of Simultaneous localization and Mapping(SLAM) Algorithems for Truly Autonomous Mobile Robotics (SLAM)
- 6. Design, Fabrication and Deployment of Snake Robots for Outdoor Applications (Snake Robot)
- 7. SLAM Algorithms: Development and Testing for Autonomous Navigation(BRNS-BARC)
- 8. Snake Robots for Search and Rescue (DRDO-Extra Mural)
- 9. Autonomous Navigation Algorithms for outdoor Environment(Autonm. Nav)
- 10. Vision based algorithms for outdoor navigation(VBAON)
- 11. Vision based localization and simultaneous localisation and mapping (SLAM) for mobile robots (VBL-SLAM)
- 12. Localisation and navigation in GPS denied environments (LNGDE)
- 13. Multi Robot autonomus exploration, loxalization and mapping (MRALM)

## **Pvt Projects: (Closed)**

- 1. Parallelized segmentation for monocular cameras with temporal coherance (PSMCTC)
- 2. Integrated indoor navigation system (UURMI)
- 3. Independent motion detection/segmentation for moving monocular cameras (IMDMMC)
- 4. RCS Framework exploration and Implementation (RFEI)
- 5. Solution in the Mahindra rise driverless car challenge (SMDCC)
- 6. Autonomous driving for Indian foods (QIF)
- 7. Autonomous Urban Exploration (AUE)
- 8. Fast Obstacle Avoidance for Quadrotor Systems (FOAQS)
- 9. Solution in the Mahindra rise driverless car challenge (SMDCC PHASE 2)
- 10. Autonomous Urban Exploration Phase 2 (RRC-AUE2-RockwellCol)
- 11. Safe Navigation Requirements in Unstructured Conditions (SNRUC)
- 12. TopoMap investigates and assembles technology aimed to create topological maps based on sensory data (RRC-RAPYUTA-TIAT)
- 13. Autonomous Urban Exploration-Ph-III (AUE-Ph-III)