

## **Dr. R V RAMANAN**

Former Adjunct Professor, IIST

Former Scientist/Engineer 'H', VSSC/ISRO



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### **Education**

- Ph.D. University of Kerala – Thesis : Lunar Transfer Trajectories
- M.Phil. Madurai Kamaraj University (1983)
- M.Sc. Madurai Kamaraj University (1982)

### **Course Offered**

- Spaceflight Mechanics (Undergraduate & Post Graduate)
- Space Mission Design and optimization (UG & PG)
- Aerospace Vehicle Design (UG & PG)
- Introduction to Space Vehicles (UG)

### **Research Guidance:**

- Ph D (Two students : ongoing)

### **Fields of Specialization:**

- Space Mission Design and Analysis including Lunar & Interplanetary Transfer Trajectory design.
- Orbit raising and maneuvering
- Optimization with main focus on transfer trajectory design of various space missions

### Professional experience:

- Joined VSSC in January 1984 and served in various capacities till joined IIST in January 2010.
- Superannuated as Adjunct Professor IIST / Scientist /Engineer 'H' (VSSC)
- Deputy Project Leader(Mission), Moon Impact Probe Project, Chandrayaan-1.
- Deputy Head, Flight Mechanics Division
- Section Head, Advanced Mission Section
- Section Head, Astrodynamics Section
- Deputy Project Director, SBL (Space Borne Lidar) Project
- Deputy Project Director (Descent Mission), Human in Space Programme (HSP)

### Awards and Recognition:

- ISRO Team excellence award for Chandrayaan-1
- Guest Scientist in DFVLR, Oberpaffenhoffen, GERMANY during Jan. 1993 - August 1993
- Visiting Scientist ESA, Darmstadt, GERMANY during July 2006
- Invited lectures in many Educational and Professional Institutes

### Membership in Professional Bodies :

- Member, Aeronautical Society of India
- Member, System society of India

### Major contributions:

- Member of Indian Mars Mission Study Team : Contribution to Mission Planning and Design
- Feasibility studies to assess ISRO Launch Vehicle capabilities for Moon Mission.
- Mission design and analysis for Chandrayaan-1 during the realization phase.
- Execution of successful Moon Impact Probe Mission : Responsible for development of mission strategies.
- Development of a new strategy, through apo selinum biasing, for lunar orbit insertion resulting in reduction in propellant mass and increase in moon orbiting mass in Chandrayaan-1 mission.
- Development of new analytical methodologies for generating lunar transfer trajectory design that achieves specified peri selinum altitude and inclination.
- Landing trajectory design and Lander payload maximization studies for the proposed Indian Lander Mission.
- Strategies for the separation of the satellites of 'PSLV missions' to ensure relative motion of multiple satellites of a single launch vehicle collision-free and plume-safe.
- Development of methodologies based on pseudo state technique that can be used as a mission design tool for planetary, asteroid and cometary missions.
- Launch opportunities and the transfer trajectory design for MARS, MERCURY, VENUS and JUPITER missions in the context of ISRO launch vehicle.
- Orbital maneuver requirements for GSLV/GLONASS mission.
- Development of Indian Atmospheric Model-2002 used in Launch Vehicle Mission design and simulations.

- Optimal trajectory design for transfer to GSO using lunar gravity assists.
- Mission Performance assessment studies using Monte Carlo Technique.
- Development of a general purpose orbit propagation software that handle 16 coordinate frames.

## PUBLICATIONS

### Internal Technical Reports :

- More than 200 internal technical covering various aspects of various ongoing and and future ISRO space mission projects

### International Peer Reviewed Journal Publications :

1. P.V.Subba Rao and R.V.Ramanan, 'Optimum Rendezvous Transfer between heliocentric elliptic orbits using solar-sail', AIAA Journal of Guidance, control and Dynamics, Vol. 15, No.5, pp. 1507-1509, 1992
2. P.V.Subba Rao and R.V.Ramanan, 'Optimal Three-Dimensional Heliocentric Solar-Sail Rendezvous Transfer Trajectories', Acta Astronautica, Vol. 29, No.5, pp. 341-345, 1993.
3. R.V.Ramanan, 'Strategy for Deployment of Multiple Satellites for Collision-Free Relative Orbital Motion', AIAA Journal of Guidance, Control and Dynamics, Vol.23, No.3, pp.556-558, 2000.
4. R.V.Ramanan, 'Integrated Algorithm For Lunar Trajectories Using a Pseudostate Technique', AIAA Journal of Guidance, Control and Dynamics, Vol. 25, No. 5, September-October 2002.
5. Ramanan R.V and Adimurthy V, "Non Impact Lunar Transfer Trajectories Using a Pseudostate Technique"; AIAA Journal of Guidance, Control and Dynamics, Vol. 28, 221-229, May-June 2005.

6. R.V.Ramanan and Madan Lal, 'Analysis of Optimal Strategies for Soft Landing on the Moon from Lunar Parking Orbits', *Journal of Earth System Sciences*, Vol.114, No.6, pp. 807–814, December 2005.
7. R.V.Ramanan and V.Adimurthy, 'An Analysis of Near Circular Lunar Mapping Orbits', *Journal of Earth System Sciences*, Vol.114, No.6, pp. 619–626, December 2005.
8. V. Adimurthy, R.V.Ramanan, S.R. Tandon, and C.Ravikumar, 'Launch Strategy For Indian Lunar Mission and Precision Injection to the Moon using Genetic Algorithm', *Journal of Earth System Sciences*, Vol.114, No.6, pp. 711–716, December 2005.
9. V.Adimurthy et al., 'Multidisciplinary Optimization in Aerospace design : The Emerging Technology For Complex Systems', *Journal of Aerospace Sciences & Technology*, Vol. 57, No.1, February 2005. (co-author)
10. Ramanan, R.V. and Adimurthy.V, "Precise lunar gravity assist transfers to Geo- stationary Orbits", *AIAA Journal of Guidance, Control and Dynamics*, Vol.29, pp. 500–502, March–April 2006.
11. Y. Ashok kumar, R.V Ramanan et al., 'The Moon Impact Probe on Chandrayaan-1', *Current Science*, Vol.96, No.4, 25 Feb 2009
12. Jyothish R. Pillai, Alex John, Ramanan R.V., "Design and Analysis Tool for Mars atmosphere entry Missions ", Volume 5, No.1, pp.29–40, March 2013, *International Journal of Aerospace Innovations* : DOI 10.1260/1757–2258.5.1.29. (with under graduate Students)
13. Geethu Lisba Jacob , Geethu Neeler, Ramanan R.V, 'Mars Entry Mission Bank Profile Optimization', Accepted for publication in *AIAA Journal of Guidance, Control and Dynamics*. (with undergraduate students)

14. Pranav Nath and Ramanan R.V, 'Precise halo orbit design and optimal transfer to halo orbits from earth using differential evolution', *Advances in Space Research*(Elsevier), Vol.57, January 2016, pp. 202–217
15. N. Remesh, R. V. Ramanan and V. R. Lalithambika, 'Fuel Optimum Lunar Soft Landing Trajectory Design Using Different Solution Schemes', *International Review of Aerospace Engineering*, Vol.9, No.5 (2016), pp.131–143.
16. Parvathi S P and Ramanan R V, 'Iterative Pseudostate method for transfer trajectory design of Interplanetary Orbiter missions', *AIAA Journal of Guidance, Control and Dynamics*, Vol. 39, No. 12, December 2016, pp.2794–2804.
17. S. P. Parvathi and R. V. Ramanan, 'Direct Transfer Trajectory Design Options for interplanetary orbiter missions using an iterative patched conic method', *Advances in Space Research*, Vol.59, pp.1763–1774, March 2017
18. Parvathi S P and Ramanan R V, " Iterative Analytical technique for the design of interplanetary direct transfer trajectories including perturbations", *Advances in Space Research* , Vol. 61 (2018), pp. 3002–3019, May 2018.
19. Parvathi S P and Ramanan R V, 'Direct interplanetary trajectory design using a Precise Vinfinity targeting technique', *Journal of Guidance, Control and Dynamics*. Vol. 41, No. 10, October 2018,
20. Padmanabha Prasanna Simha and Ramanan R V , 'Optimal Interplanetary Transfers using Electric Propulsion', *Journal of Spacecraft Technology* Vol. 29, No. 2, pp. 21–30, July – December 2018.

### Other Peer Reviewed Articles:

1. R.V. Ramanan, 'Interplanetary Mission Opportunities, Volume 3, Issue 2, April 2013, Planex Newsletter, PRL, Ahmadabad, ISSN: 2320 - 7108.
2. V.Adimurthy and R.V. Ramanan, 'Mars Orbiter Mission: An Overview, Volume 4, Issue 1, January 2014, Planex News Letter, PRL, Ahmadabad, ISSN: 2320 - 7108.

### BOOK

Adimurthy, R.V. Ramanan, Pankaj Priyadharshi, 'Optimization in Aero Space Dynamics', ISRO Publications, ISBN No.978.81.908956-5-1, December 2012.

### CONFERENCE PAPERS (AFTER 2000)

1. Garima Agarwal and R V Ramanan,' A Unified Approach for the Optimal Constellation Design of Satellites in Low-Earth Circular/Elliptical Orbits for Continuous Coverage', AIAA SciTech Forum, 6-10 January 2020, Orlando, Florida.
2. Padmanabha Prasanna Simha and Ramanan R V, 'Low Thrust Variable Specific Impulse Fuel-Optimal Transfers Between Planetary Parking Orbits, AAS 19-611,2019 Astrodynamics Specialist conference, August 11-15, 2019, Portland, ME, USA
3. Rithwik. N and R. V. Ramanan, " Design of Halo Orbit in the Framework of Elliptic Restricted Three Body Problem using Differential Evolution", 11th IAA Symposium on the Future of Space Exploration: Moon, Mars and Beyond: Becoming and Interplanetary Civilization, June 17-19, 2019, Politecnico di Torino, Torino, Italy .

4. Yulia Akisheva et al., Ashwin ,Nikhil Verma, R V Ramanan and Shine S R, 'A Cubesat Constellation Mission For Multipoint Measurements On Mars', 13th IAA Low-Cost Planetary Missions Conference, Toulouse, June 3-5, 2019, Toulouse, France.
5. Garima Agarwal and R V Ramanan, 'Optimal Multiple Finite Burn Strategies for Trans-Lunar and Trans-Planetary Maneuvers, Proceedings of ICSS 2019, International Conference on Small Satellites, 7<sup>th</sup> - 9<sup>th</sup> February, 2019, Research Centre Imarat, Hyderabad- 500 069, India.
6. Rithwik N, Kiran Jayasurya and Ramanan R V , 'Analysis of Halo Orbits around Sun-Earth L2 for the ExoWorld mission', ExoWorld Team Meet, 4-6 January 2019, Indian Institute of Space Science and Technology, Thiruvananthapuram.
7. Padmanabha Prasanna Simha and Ramanan R V , 'Optimal transfers to Geostationary orbits using Electric propulsion', Paper Id. S2-55-IIST, pp.273-285, Conference on South Asian Satellite (GSAT-9), 13th June 2018, U.R. Rao Satellite centre, Bangalore, India.
8. Rithwik. N and R. V. Ramanan, " Halo Orbit Design Around Lagrangian Points Using Gradient and Non Gradient Based Optimization Techniques", International Conference on Frontiers in Industrial and Applied Mathematics (FIAM-2018), 26-27 April 2018, National Institute of Technology, Hamirpur, India, AIP Conference Proceedings 1975, 030019 (2018); [doi:10.1063/1.5042189](https://doi.org/10.1063/1.5042189)
9. Padmanabha Prasanna Simha and Ramanan R V , "Low thrust Interplanetary Mission Trajectory Optimization using Differential Evolution", National conference on Multidisciplinary Design, Analysis, and Optimization, 23-24 March 2018, Indian Institute of Science, Bangalore.



10. Pratik V. Dedhia and R V. Ramanan, “ Differential Evolution for Regular Orbit Determination”, ICTACEM–2017/535, Proceedings of ICTACEM 2017 : International Conference on Theoretical, Applied, Computational and Experimental Mechanics , December 28–30, 2017, IIT Kharagpur, India
11. Remesh N, Ramanan R V, Lalithambika V R, 'Optimal 3D Lunar soft landing trajectory design and evaluation of explicit guidance laws', Proceedings of the International Conference on Recent Advances in Aerospace Engineering (ICRAAE 2017), IEEE Conference ID : 40493, pp.56–61, 3–4 March 2017, Coimbatore, India.
12. S. P. Parvathi and R. V. Ramanan, 'Direct Interplanetary Trajectory Design with a Precise V–infinity Targeting Technique'., Proceedings of the International Conference on Recent Advances in Aerospace Engineering (ICRAAE 2017), IEEE Conference ID : 40493, pp.111–116, 3–4 March 2017, Coimbatore, India.
13. Shivangi Sharma and R V Ramanan,'Venus Gravity Assist Transfers to Mercury using Differential Evolution', Proceedings of the International Conference on Recent Advances in Aerospace Engineering (ICRAAE 2017), IEEE Conference ID : 40493, pp.135–139, 3–4 March 2017, Coimbatore, India
14. Parvathi S P and Ramanan R V, 'MULTIPLE DESIGN OPTIONS FOR INTERPLANETARY ORBITER MISSIONS USING PSEUDOSTATE TECHNIQUE', AAS 16–251, 26th AAS/AIAA Space Flight Mechanics Meeting, February 14–17, 2016, Napa Valley, California , USA.
15. Anandkumar and Ramanan R V, “Adaptive Guidance Scheme for Spacecraft Rendezvous in Elliptical Orbits’, AAS 16–280, , 26th AAS/AIAA Space Flight Mechanics Meeting, February 14–17, 2016, Napa Valley, California , USA.

16. Parvathi S P and Ramanan R V, "Evaluation of Iterative Analytical Techniques for Interplanetary Orbiter Missions", 6th International Conference on Astrodynamics Tools and Techniques, March 14-17, 2016, ESOC, Darmstadt.
17. Ramesh N, Ramanan R V and Lalithambika V R,"Optimal 3D Lunar Soft Landing Trajectory Design and Performance Evaluation of explicit Guidance Laws", IAC-15,C1-9-x27946, 12-16 October 2015, 66th International Astronautical Congress, Jerusalem, Israel.
18. Megh Bhatnagar and Ramanan R V, 'Modulation of Aerodynamic angles for Target Mars Site Landing using Indirect Approach', CP-84, Proceedings of Symposium on Applied Aerodynamics and Design of aerospace vehicles (SAROD2015), December 3-5, 2015, Thiruvananthapuram, India.
19. Aditya Duhan, Ramesh N and Ramanan R V, ' Optimal Trajectory Design using Direct Collocation and Pseudospectral Method', CP-134, Proceedings of Symposium on Applied Aerodynamics and Design of aerospace vehicles (SAROD2015), December 3-5, 2015, Thiruvananthapuram, India.
20. Parvathi S P, and Ramanan R.V, ' 'Analysis of Venus Mission Opportunities for Indian Launch Vehicles', 2nd Venus Workshop, October 28-29, 2014, Hyderabad, India.
21. Geethu. N , Geethu Lisba Jacob , Ramanan R.V, 'Mars Entry Mission : Bank angle modulation for landing at a target site', Volume II , pp. 554-560, Proceedings of SAROD 2013, November 21-23,2013, Hyderabad. ( B-Tech Project)
22. Jyothish R. Pillai, Alex John, Ramanan R.V., "Design and Analysis Tool for mars atmosphere entry Missions ", pp. 151-159, Proceedings of SAROD 2011, November 16-18, 2011, Bangalore, India.(B-Tech Project)

23. Vishal kumar, Ramanan R.V.,” Impulsive Maneuver Design and Analysis for Orbital Rendezvous Missions Using Lambert Problem solution”, 25th National Convention of Aerospace Engineers, November 4–5, BIT Mesra, Ranchi, India. (B Tech Internship)
24. Vijith Mukundan, Golak Prasad Sahoo, Ramanan R.V., “ Optimal Moon landing Trajectory Design with Solid and Liquid Propulsion Using SQP”, National conference on Space Transportation Systems, Indian national Academy of Engineering, Decemeber 16–18, 2011,Thiruvananthapuram, India. (Best Paper Award). (B Tech Project)
25. Maniyar Abhishek Sanjay and Ramanan R.V., “Design Analysis of configuration and Mission of Solar sail for interplanetary Missions”, National conference on Space Transportation Systems, Indian National Academy of Engineering, Decemeber 16–18, 2011,Thiruvananthapuram, India, (Best Poster Paper Award) (B Tech Internship)
26. Mishra N. K. , Patel G., Ramanan R.V., “Development of Mission Design Process for Collision avoidance of Near earth Objects” , 2nd IAA International Planetary Defense Conference, May 9–12, 2011, Bucharest, Romania. (B Tech Project)
27. R.V. Ramanan, ‘ Mission Design to Asteroids’ , Proceedings of the Awareness Programme on Threat to Earth from Asteroids, 28th November 2010, IIST, Thiruvananthapuram
28. R.V. Ramanan, ‘Planetary Mission Design and Optimization’, Special Interest Group Meet, Multidisciplinary design Optimization, May 2010, Thiruvananthapuram.

29. V.Adimurthy, S.R.Tandon, R.V.Ramanan, and C.Ravikumar, 'Exploration of the Moon and Beyond:Possibilities and Challenges in Reaching There', XIV National Space Science Symposium, Visakhapatnam, February 11, 2006
- 30.V.Adimurthy, S.R.Tandon, R.V.Ramanan, and C.Ravikumar, Optimization Research and Applications inn Space Dynamics, 37th Annual convention of Operations Research Society of India, IIM, Ahemadabad, Jan.8-11,2005.
- 31.V.Adimurthy and R.V.Ramanan, Earth Orbits and Beyond, the Quest for Optimal Trajectories , 93rd Indian Science Congress, Symposium in Space Dynamics, 2006
32. R.V.Ramanan and Madan Lal, Analysis of Optimal Strategies for Soft Landing on the Moon from Lunar Parking Orbits, 6th International Conference on Exploration and Utilization of the Moon, November 22-26, 2005,Udaipur, INDIA
- 33.R.V.Ramanan and V.Adimurthy, An Analysis of Near Circular Lunar Mapping Orbits, 6th International Conference on Exploration and Utilization of the Moon, November 22-26, 2005, Udaipur, INDIA
34. V. Adimurthy, R.V.Ramanan, S.R. Tandon, and C.Ravikumar, 'Launch Strategy for Indian Lunar Mission and Precision Injection to the Moon using Genetic Algorithm', 6th International Conference on Exploration and Utilization of the Moon, November 22-26, 2005, Udaipur, INDIA
- 35.R.V.Ramanan and V.Adimurthy, Optimal Lunar Gravity Assist Trajectories to GSO, Colloquium on Multi Disciplinary Optimization, 28th January 2004, VSSC, Trivandrum.
- 36.Challenges in Lunar / Interplanetary Missions Status Paper presented at Aero Colloquium held in January 29 2003

## INVITED LECTURES

1. Mission to Mars', 25th January 2016, Manakula Vinayagar college of Technology, Puducherry
2. 'Mars Orbiter Mission : Mission Design Challenges', 17th September 2014, Aero Club IIST, Thiruvananthapuram.
3. Interplanetary Mission Design and Optimization', Training Programme on 'Flight Dynamics and Optimization', 15th July 2014, VSSC, Thiruvananthapuram (Two Lectures for Three hours)
4. Interplanetary Mission Challenges and Opportunities', 6th December 2013, STP-2013, IISU, Thiruvananthapuram.
5. "Interplanetary Mission Design" , 22nd November 2013, SAROD-2013, Symposium on Applied Aerodynamics and Design of Aerospace Vehicles, Hyderabad.
6. 'Close Encounter of Asteroid 2012DA14', 14th February 2013, IIST, Thiruvananthapuram.
7. 'Challenges in Asteroid Missions', January 2012, PLANEX12, PRL,Ahmedabad
8. 'Interplanetary Mission Challenges and Opportunities', 25th June, 2012, STP-2012, IISU, Thiruvananthapuram.
9. 'Reaching Mars and Beyond' , 19th December 2012, STP-2012, PRL,Ahmedabad.
10. 'Chandrayaan-1 and Beyond : Indian Deep Space Initiatives', Goa Naval Air base, 16th July 2010, under the auspices of Aeronautical Society of India, Goa branch.
11. 'Planetary Mission design and Indian Launch vehicle Capabilities' , PLANEX 09, University of Rajasthan, Jaipur.

12. 'Moon Impact Probe : A success Story', PLANEX 09, University of Rajasthan, Jaipur.
13. 'Reaching the Moon : Chandrayaan-1' , IIT, Kanpur, May 2009.
14. 'Chandrayaan-1 Mission', National Institute of Aviation Technology (NIAT), Kochi, March 2009.
15. 'Flight Mechanics and Orbital Dynamics' , In-house training programs of VSSC
16. 'Trajectory Design and Optimization', In-house training programs of VSSC
17. 'Chandrayaan-1 mission', in a 2 day training program on ' Orbital Mechanics and Flight Dymanics' organized by HRD, VSSC , 2009

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